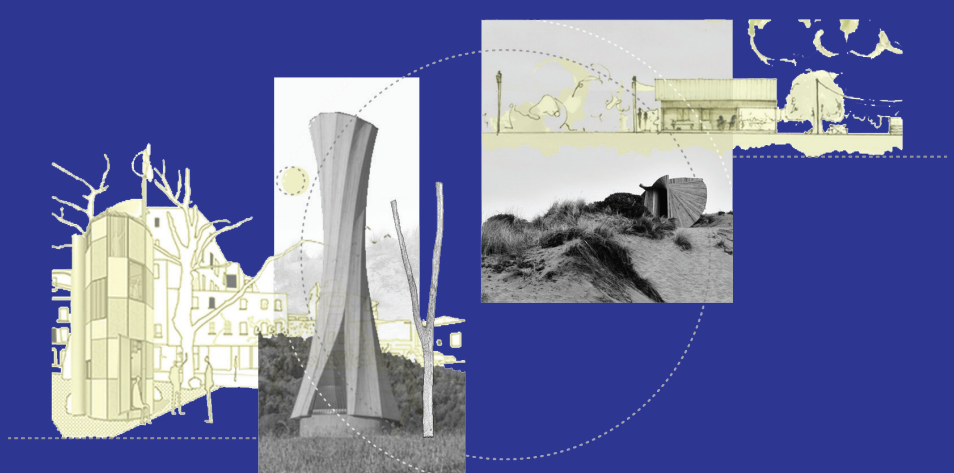
MEF University
Graduate School of Science and Engineering
Master of Science in Architectural Design
Alternative Architectural Practices

PROTOTYPING AS A TOOL AND A PROCESS IN ARCHITECTURAL EDUCATION



Ebru Şahinkaya Bucak
2022

To my Grandmother...

I would like to thank my thesis advisors Assist. Prof. Dr. Kürşad Özdemir and Assist. Prof. Dr. Ahmet Sezgin, who always shared their experiences and knowledge with me throughout my thesis process. Many thanks to Instructor Didem Sağlam for her support. I would also like to thank the MEF FADA team, who expanded my perspective on architecture that can change in today's conditions and questioned design alternatives, and the participants of the Design-Build Program who contributed to my thesis.

I am grateful to my dear family, my father Enver Şahinkaya, my mother Sevim Şahinkaya, and my sisters Eda and Ezgi Şahinkaya, who always makes me feel lucky to have them. Finally, special thanks to my husband Halil Murat Bucak for his patience with me.

Abstract

Prototyping for architecture, as a concept and practice, exceeds generating a tangible working-model as in other fields. It encompasses a holistic, instructive process in which design continues while building and by which simultaneous experience can be achieved. Also, prototyping can become an action that helps to understand the fluctuating field of architecture between theory and practice. The goal of this thesis work is to identify the benefits of incorporating the concept of prototyping to architectural studies, mainly architectural education. Over time, the architectural knowledge transferred from its master to its apprentice has turned into a formal system given in its schools at the intersection of art and engineering. In contrast to this situation, in the educational process, not only creating the architectural product praxis as a design on paper but also imagining the construction processes and after, enables the designer and the student to face different field potentials and produce solutions. Programs that include building in their education curricula are critical examples in this regard. In this thesis, the construction practice will be read through prototype production and the assessment will be done utilizing information on various Design-Build Programs. In addition, design-construction-post will be evaluated as a process in a response to the changing architect subject and architectural practice in the 21st century. Five programs from five different geographies, namely AA Hooke Park, ITKE University of Stuttgart, Rural Studio, Ciudad Abierta/Open City, and MEF FADA DBS/AAP, which care about learning by building; prototyping approaches, learning processes, participants, and tools they use will be examined.

Key Words: Prototype, Prototyping in Architectural Education, Learning by Building, Experimental Architecture

Science Code: 80107

Özet

Bir kavram ve uygulama olarak mimarlık için prototipleme, diğer alanlarda olduğu gibi somut bir çalışma modeli oluşturmanın ötesindedir. İnşa ederken tasarımın devam ettiği ve aynı anda deneyimlemenin sağlanabildiği bütünsel, öğretici bir süreci kapsar. Ayrıca prototipleme, teori ve pratik arasında gidip gelen mimarlığın alanını anlamaya yardımcı olan bir eyleme dönüşebilir. Bu tez çalışmasının amacı, prototipleme kavramının mimarlık eğitimi başta olmak üzere mimari çalışmalara dahil edilmesinin faydalarını belirlemektir. Zaman içinde, ustadan çırağa aktarılan mimarlık bilgisi bugün genellikle sanat ve mühendisliğin iç içe olduğu okullarda öğretilen formal bir sisteme dönüşmüştür. Bu duruma karşılık, eğitim sürecinde mimarlık ürünü praksisini, sadece kağıt üzerinde bir tasarım olarak var etmemek, inşa süreçlerini ve sonrasını da tahayyül etmek, tasarımcı ve öğrencisinin farklı alan potansiyelleri ile yüzleşmesini ve çözüm üretebilmesini sağlar. İnşa etmeyi mimarlık eğitim sürecine dahil etmiş programlar bu anlamda kritik örneklerdir. Bu tezde inşa pratiği prototip üretimi üzerinden okunacak ve çeşitli Tasarla-İnşa et Programları hakkında bilgiler kullanılarak değerlendirme yapılacaktır. Ek olarak, 21. yüzyılda değişen mimar ve mimarlık pratiğine bir cevap olarak, tasarım, inşa ve sonrası bir süreç olarak değerlendirilecek, inşa ederek öğrenmeyi önemseyen; AA Hooke Park, ITKE University of Stuttgart, Rural Studio, Ciudad Abierta/Open City, MEF FADA DBS/AAP olmak üzere farklı beş coğrafyadan beş programın prototiplemeye yaklaşımları, öğrenme süreçleri, katılımcıları ve kullandıkları araçlar incelenecektir.

Anahtar Kelimeler: Prototip, Mimarlık Eğitiminde Prototipleme, İnşa ederek Öğrenme, Deneysel Mimarlık

Bilim Dalı Sayısal Kodu: 80107

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Introduction

Doing an action/situation “always”, “in the same way” renders it unquestionable. Everything that is made automatically, can turn into an “acceptance”. “Acceptances” have clear boundaries and certain definitions. These “acceptances”, which standardize the producers and sterilize production, can remove the ability to make it critical. Marshall Berman’s book, Karl Marx’s thought, that everything solid melts into the air is precisely connected with this.[1] The rules of architecture and with it the architectural education, which always takes its motivation from the actual, are always open to evolvement and change.

Aristotle says that there is a strong relationship between praxis and knowledge with the concept of “phronesis” (practical knowledge). With this concept, the potential and power of the act of producing practice in the processes of reaching knowledge is emphasized.[2] In the 20th century, the concept of “reflective practice” developed by Donald Schön caused significant transformations in the perception of design and paved the way for design to be considered as an action+research.[3] Over time, Schön’s sequential (learning first and then applying) and traditional method of design education was replaced by “learning by doing” and the relationship between design and practice was strengthened with this concept. With this new approach, what Schön means by “learning by doing” is to learn and produce knowledge by redefining the problem by constantly questioning the nature of this relationship, as well as the tool and the result itself, instead of solving the problem by generating logic over the causal relationship between the tool and the result.[4] From this point of view, knowledge has become a form of learning that is reproduced in every new situation hidden in practice. As the current conditions and context change, the knowledge presented in practice also changes. In this context, these discussions are very considerable for architectural education.

In line with these two perspectives, architecture learning programs and theoretical infrastructures that break stereotypes in architectural education, offer potentials for unexpected encounters, are in contact with not only a dictating educator, but also many actors, and bring this to the agenda with the action of “prototyping” will be discussed.

1. For more information about Karl Marx’s thought that everything solid melts into the air:
Refer to: Marshall Berman, “ All That is Solid Melts Into Air: The Experience of Modernity”, 1982.

2. Aristotle, “The Nichomachean Ethics”, (MÖ. 350), 2009.

3. Donald Schön, “The Reflective Practitioner: How Professionals Think in Action”, 1991.

4. Berin Gür, “Praksis: Eylem Olarak Tasarım Ve Eğitimi, Mimari Tasarım Eğitimine Çağdaş Önermeler”, 2017, p.61.

Prototype according to the Oxford dictionary is “the first or primary type of a person or thing; an original on which something is modeled or from which it is derived; an exemplar, an archetype.” and adds; “a first full-size working version of a new vehicle, machine, etc., of which further improvements may be made; a preliminary version made in small numbers for evaluation, or from which improved or modified versions may be developed.”[5]

In this research, the concept of prototyping was used because;

- Questioning what prototyping means in different fields beyond the definition of “type generation” in the dictionary,
- Asking the question: ‘’Could the process-oriented approach of prototyping be a response to contemporary architectural criticism?’’,
- Unlocking the potentials of including not only design but also construction and beyond through prototyping in architectural education,
- Redefining the role of the architect in the multi-participant prototyping process,

In addition to these ideas, the fact that this concept is frequently emphasized in Design-Build Programs has enabled the thesis to be constructed within the framework of prototyping.

> Prototyping is not simply understood as the development of “first forms” or “first strikes” as beta-versions of products as in industrial design, but as a more general mode of doing culture: a mode that is tentative, based on bricolage, user involvement and ongoing change and improvements of products and practices, as “open innovation”, rather than on an expert in a closed lab who turns out a finished product to be used by an unknowing user. [6]

In this thesis, prototyping is accepted as a design thinking method. It will not be considered as a result-oriented object, but as a multi-input process consisting of many participants with developing technologies. It will be evaluated as a method that fills the gaps between design idea and practice and also acts as a mediator.

The structure of the thesis will be discussed in two parts for prototyping. The first chapter aims to reveal the potential of learning by doing/ building in architectural education by accepting prototyping as a tool. The second section will focus on case studies of construction practices produced

5. ‘’Prototype’’. Oxford Dictionary, Available at: https://ezproxy.mef.edu.tr:2896/view/Entry/153327?rskey=mOTV9y&result=1&isAdvanced=false#eid (Accessed: 20.06.2020).

6. Michael Guggenheim, “The Long History of Prototypes”, 2010.

in Design-Build Programs, based on the prototyping process. The theoretical foundations of prototyping, which are aimed to be revealed in the first part, will be supported through the prototyping examples and processes produced in the Design-Build Programs in the second part.

Prototyping as a Tool

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> Prototypes are actualized instances in the generative process. With this point of view, prototypes cause feed back and interaction, and are parametricly setup and operational, in order to serve as instruments in design. [7]

The purpose of this chapter is to reveal the potentials of prototyping by examining its uses and reasons in the historical process. In addition, it is to clarify the main arguments by discussing the role of prototypes in architecture and architectural education. Prototyping commonly represents the first working instance in which the efficiency and success of the industrial design and engineering field models are checked. Beaudouin-Lafon and Mackay analyze prototypes and prototyping techniques in four dimensions; representation, precision, interactivity, and evolution. The representation determines what kind of tool the prototype will be designed with. The precision defines the level of detail at which the prototype will be evaluated. The interactivity determines the extent to which the user can actually interact with the prototype. The evolution defines the expected life cycle of the prototype.[8] These concepts are also indicative of the diversity of the prototype in varying contexts and purposes.

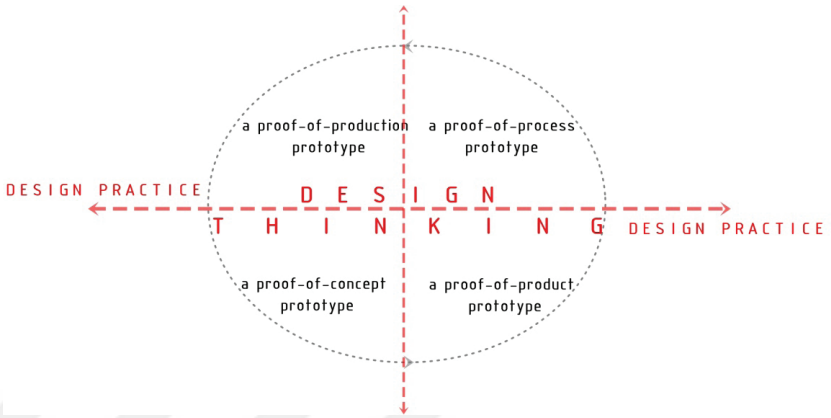
Ullman identifies four classes of prototypes based on the prototype's functions and stages in product development. These are a proof-of-concept prototype/a proof-of-product prototype/a proof-of-process prototype/a proof-of-production prototype. The first of these is a proof-of-concept prototype, in which the design method that emerges at the first stage of the design is determined. The second is a proof-of-product prototype stage, where the physical arrangement and production feasibility are done. In the third stage, a proof-of-process prototype, production method and material are tested and the most efficient one is determined. The final stage is a proof-of-production prototype that ensures the success of the entire production process.[9] Each step contains many potential experiences and information (positive or negative) gained from those experiences. The fact that there is a prototype to be produced for each stage during the design process is also an indication that prototyping is a critical tool for design.

7. Fulya Özsel Akipek, Nilüfer Kozikoğlu, "Prototypes in Architectural Education: As Instruments of Integration in the Dıgıtal Era", 2007.

8. Michel Beaudouin-Lafon, Wendy Mackay, "Prototyping Tools and Techniques, In Human Computer Interaction Handbook: Fundamentals" 2007.

9. David G. Ullman, "The Mechanical Design Process" 2003.

Figure 1: Prototyping stages and design diagram



10. Rosheim, Mark Elling, "Leonardo's Lost Robots", 2006, p. 69.

11. Shelley Gretlein, "Software Modeling for Embedded Systems", 2013, p. 86.

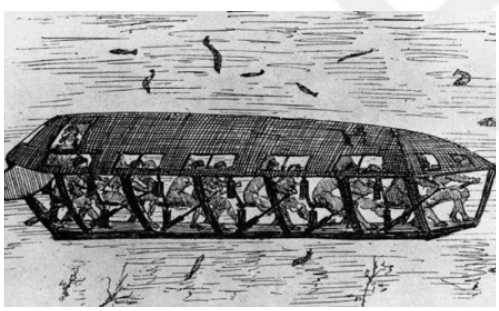


Figure 2: Drebbel sketch, first working prototype submarine, London, 1620

Figure 3: Drebbel prototype, first working prototype submarine, London, 1620

Figure 4: Drebbel product, reconstruction of the first working prototype submarine, London, 1620

Prototyping is a method to help break the boundaries between theory and practice in many design-oriented disciplines. Prototyping acts as a mediator between design thinking and design practice. It enables the development of techniques to help solve design problems by causing the design process to be concretized. These approaches are indications that it is used as a tool for design.

In this context, this chapter will be discussed under three main topics. The first will focus on the uses and potentials of prototyping. Second, the relationship between the idea of "learning by doing" and the concept of prototyping will be discussed through architectural education. Finally, prototyping will be considered as a construction practice and its usage areas in architectural education will be tried to be determined.

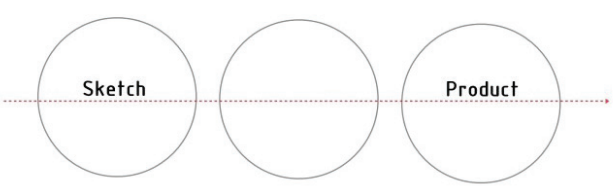
Why do we build prototypes?

Throughout history, prototyping has been used for different purposes in many different disciplines. Although its uses and forms changed over time, it represented an important stage of production for inventions. Prototypes have been scale models that work to help inventors discover and experiment. For example, Leonardo Da Vinci created prototypes of many ideas (such as airplanes, parachutes, tanks, and even robots) that are becoming a reality.[10] Before 1880, every inventor had to submit a prototype of his invention as part of his patent application.[11] In this context, prototypes became necessary for the proof of design ideas. Though this situation has changed today, the

"proof of concept (POC)" discourse that is still associated with prototyping is a product validation methodology.[12] It refers to the early version presented to verify the assumptions and test the viability of the product idea.

Prototyping represents a blueprint for predicting results in many areas of manufacturing. This provides some form of feedback on the product or condition. It is a "learning/development method" that works for the best physical and economic results up to the actual product, where mistakes are noticed with experience, to improve the product. The machines that entered our lives with the industrial revolutions after the 19th century led to the emergence of automation and mass production. These technologies enabled many complex systems to be produced in large numbers in a short time. The first example of a product to be produced in large numbers on mass production lines was very critical in this sense. In this process, prototypes are design development tools that minimize the margin of error, increase efficiency, and allow choosing the right material. Developers try to bring the product to the final stage by performing tests on prototypes. After the necessary evaluations are made, mass production begins. Therefore, prototyping is a very important step in mass production. In summary, prototypes in mass production are demonstrators that measure the performance of the product at the design stage, facilitate understanding by the user, and determine the process according to the public reaction.

The process, which continues in a linear order from the design to the product, does not work in sequence with prototyping. It eliminates the disconnection between the stages of the design. While the first diagram in Figure 8 and 9 (as the juxtaposition of images suggests) describes a sequential and discrete operation, the second diagram shows that the process is holistic rather than linear, complex rather than sequential, and integrated rather than discrete with prototyping.



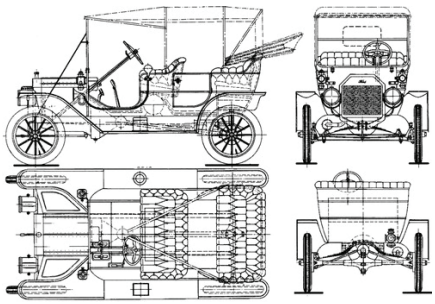


Figure 5: Ford Model T drawings, first mass production automobile, USA, 1908

Figure 6: Ford Model T prototype, first mass production automobile, USA, 1908

Figure 7: Ford Model T products, first mass production automobile, USA, 1908

12. Lila Rao-Graham, Maurice L. McNaughton, Gunjan Mansingh, "The Process and Value of Building Proof-of-Concept Prototypes", 2019.

Figure 8: Diagram without prototype

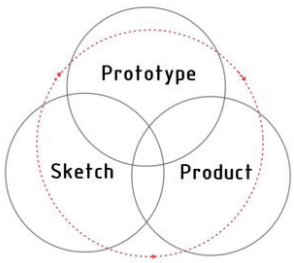


Figure 9: Diagram with prototype

Today, it is clear that prototypes still maintain their significance, even though the usage areas have changed. Michael Guggenheim underlines the concepts of "visibility" and "recent times" in the discourse of Alberto Corsín Jiménez and Adolfo Estalella at their conferences that "prototypes have acquired certain prominence and visibility in recent times".[13] These two words imply that recently prototypes have become more prominent, widespread, and major. Prototyping, which has helped design many new inventions with the changing technology throughout the historical process, is an important stage of product development methods that are widely used in many fields today. Product development includes the stages of designing, manufacturing, and marketing. It ensures the emergence of innovative products suitable for changing conditions and customers. In the competitive market, it causes the product to maintain its existence efficiently.

As a result, the effective existence of prototyping on the timeline is associated with the fact that it has many important potentials in many different disciplines. In summary, the prototype provides the items listed below;

- A better understanding of the design problem
- Developing team communication
- Adjustment of the design method, material, and form
- Quality assurance
- To understand the acceptable tolerance levels of the product to be designed
- Providing information about the real production cost, low-cost production
- Minimizing design errors by enabling functional testing
- To get feedback quickly by providing an environment for the use of different tools and equipment
- Time-saving

13. Michael Guggenheim, "The Long History of Prototypes", 2010.

Figure 10: 3D printed prosthetic leg prototype, William Root, USA, 2008

Figure 11: Consumer oriented AR drone prototype, Parrot, France, 2010

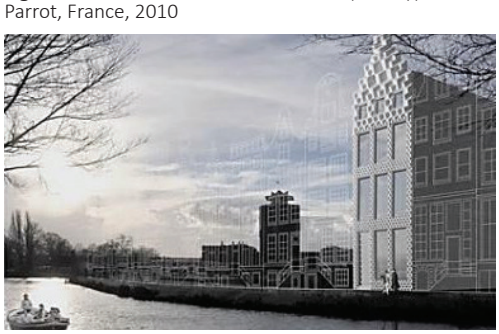


Figure 12: First full-sized 3D printed house prototype, Canal House, Dus Architects, Amsterdam, 2014

- Ability to test and plan
- To reduce the risk
- To reach a more durable and successful result product
- Presenting your idea more clearly to customers

All these potentials help to understand why prototypes are or should be built.

"Design Thinking" approach

> The poorly designed systems that we suffer from arise, in part, from our having spent the last few centuries disaggregating the world, taking it apart, both physically and conceptually, in order to understand and control it. That strategy has succeeded brilliantly on many levels. Never have we had so much command over nature, so much power at our disposal, and such dominance on the planet. This, in turn, has led us to feel as if we stand on top of the world and are nearly invincible as a civilization—which also means that we have never had farther to fall or faced so great a vulnerability as a species. (...) After centuries of disaggregation, we have arrived at a point where we need to "reaggregate" the world, to put it back together, and to see the interconnectedness of its parts. Design thinking serves such holism well. By connecting disparate phenomena and evaluating the consequences of different ways of doing things, design thinking can reintegrate what we have too often seen as separate and distinct. [14]

Design Thinking is a prototyping-oriented learning-by-doing method. It is a design methodology that provides a solution-based approach to solving problems. It's extremely useful in tackling complex problems that are ill-defined or unknown, by understanding the human needs involved, by re-framing the problem in human-centric ways, by creating many ideas in brainstorming sessions, and by adopting a hands-on approach in prototyping and testing. It is a method used in many fields such as business life, computer science, and education.

Nobel Prize laureate Herbert A. Simon first mentioned Design Thinking in his 1969 book, The Sciences of the Artificial,[15] and in the late 1980s,

14. Thomas Fisher, "Designing Our Way to a Better World", 2016.

15. Nigel Cross, "Designerly ways of knowing, Design Discipline", 2001.

16. Peter Rowe, "Design Thinking ", 1987.

17. Steven Eppinger, "Mastering Design Thinking Course Snapshot", 2019.

18. Tim Brown, " Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation Introduction", 2009.

19. Stanford d.school, "Design Thinking Steps", 2019. Available at: https://dschool.stanford.edu/resources/getting-started-with-design-thinking (Accessed: 25.06.2020)

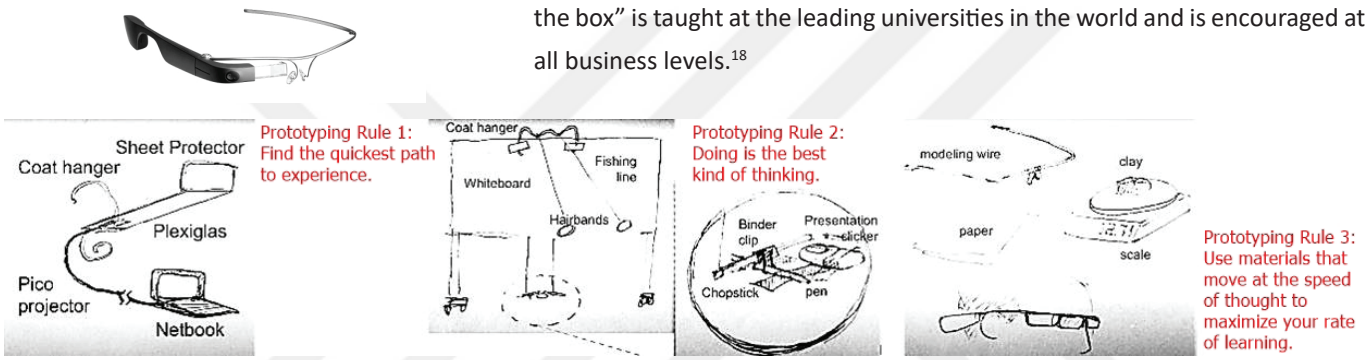


Figure 13: Google glass prototyping, Tom Chi, 2012

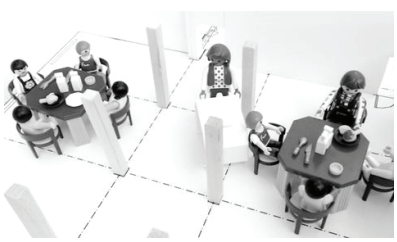


Figure 14: Prototype of a cafe for kids, The Foundations in Design Thinking Workshop-IDEO U

Figure 15: Walker prototype for adults, Mastering Design Thinking-MIT School

it was started to be talked about in the world's leading academic institutions such as Harvard, Stanford, and MIT that Design Thinking, perspective, and techniques used by designers can be integrated into areas other than design.[16] Design thinking has become increasingly popular over the past few decades because it has played a key role in the success of many high-profile, global organizations; companies such as Google, Apple, Samsung, Tesla, Airbnb, etc. have had a remarkable effect.[17] Today, the concept called "thinking outside the box" is taught at the leading universities in the world and is encouraged at all business levels.[18]

Design Thinking, which focuses on creating a strategy and understanding the problem before proposing a solution, is evaluated in five steps. The first stage, empathy, aims to provide research and understanding. In the second stage, the problem is identified. In the third stage where the idea is developed, synthesis is done. The fourth stage is the production of the prototype, the last stage is the testing stage of the prototype produced. In 2019, Hasso Plattner Design Institute has increased this five-step process to six stages and added "assess" to the final step.[19]

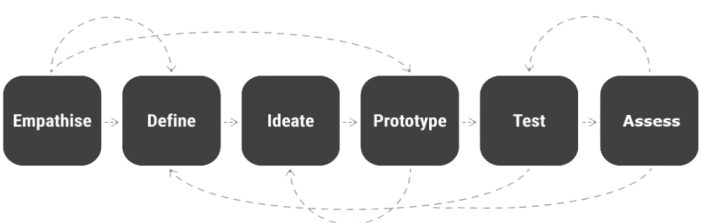


Figure 16: Design Thinking steps new diagram, Hasso Plattner Design Institute, 2019

Design Thinking is an iterative and non-linear process. This simply means that the design team continuously uses their results to review, question, and improve their initial assumptions, understandings and results. Results from the final stage of the initial work process inform our understanding of

the problem, help us determine the parameters of the problem, enable us to redefine the problem, and, perhaps most importantly, provide us with new insights so we can see any alternative solutions that might not have been available with our previous level of understanding. In this context, many companies make prototypes with the design thinking approach to develop products and embody their work.

> You use prototyping to process the ideas themselves and to help you think through the idea better. (…) I don't see prototyping as a step in the process. It's not that you research and you come up with insights and then design something and prototype it. That is a part of it, but it's much more of a mindset that you should carry throughout every step of the design process. [20]

Thanks to the interactive production process of prototyping, communication between employees/managers are ensured, ideas are shared and effective solution methods are created in a short time. In this way, time and money are saved. The prototype created with this approach does not focus on a product, but on possibilities for improvement that emerge in the process. Design Thinking, which remains effective today for many business areas, and the practice action introduced in this process, has been a way of doing generally preferred when designing in architecture and architectural education.

Prototyping in architecture

> Reality used to be in miniatures, but now everything is three-dimensional, reality has a shadow. Look, even the most ordinary ant bears its shadow patiently as if it carries its twin behind it. [21]

In the architecture and architectural education, if the design is considered as a praxis in which the theoretical transforms, it has always preserved its practical existence. Although 3d model drawings and virtual/ augmented reality applications have increased with the developing technologies, in the traditional design process, ideas are usually associated

20. Chris Nyffeler, "Why Everyone Should Prototype (Not Just Designers)", 2019.

21. Orhan Pamuk, "Beyaz Kale", 1985, p.38-39.

22. Tsou Jin-yeu, Selina Lam, Theodore W. Hall, " Integrating Scientific Visualization with Studio Education – Developing Design Options by Applying CFD", 2001.

23. Nick Dunn, "Architechtural Modelmaking", 2010, p.14.

24. Lorraine Farrelly, "Mimarlıkta Sunum Teknikleri" trans: Feyza Akder, 2012, p.14.

25. Arredamento Mimarlık, "Dosya: Mimarlığın Maket Hali", 2013, p.72.

26. Kvan, Th. And Thilakaratne Ruffina, "Models in the Design Conversation: Architecture vs Engineering, Design + Research: Project based Research in Architecture", 2003.

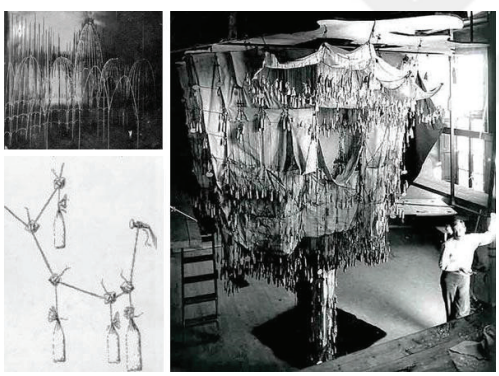


Figure 17: Antonio Gaudi, Church of La Sagrada Familia, early 1900s

Figure 18: Vladimir Tatlin, Model of the Tower, 1919

with models, mock-ups, prototypes, etc. is embodied. This act of concretization has many purposes. First of all, it gives clues about how the idea of the design will turn into a structure and provides the presentation of the technologies used. It helps to measure structural and spatial performance. It makes easier to understand the social returns of the architectural product that will emerge. In short, this is how show-try-publicize design ideas are introduced. In addition, it is a tool of persuasion for architecture. In this section, the roles of model, mock-up, and prototype in architecture will be discussed and compared, and answers will be sought to the question "What does prototyping mean in architecture?"

The model represents a three-dimensional space corresponding to important aspects of an interactive artwork design. The role and importance of model making are well documented in architectural theory.[22] Throughout history, designers have built models to explore, shape, and enhance the practice of architecture. In addition, the gaps formed during the transfer of design ideas are filled in this way. Starting from ancient times, many models of different types were used. Herodotus' book Terpsichore mentions a model used for the construction of a temple in the 5th century BC. This is considered the first recorded reference to the use of a model. It is also known that one-to-one scale models were made for the designs of various columns, which are frequently used in ancient architecture. Although there are no details in the medieval period, records of models used for church architecture have been found. [23] In the 20th century, Antonio Gaudi mainly used a large number of models of various scales to develop the complex structural forms of the Cathedral of La Sagrada Familia in Barcelona.[24] (Figure 17) The one-to-one scale model for the monument designed by Vladimir Tatlin for the 3rd International in 1920 is considered one of the most important works of model history due to its ambitious and revolutionary design.[25] (Figure 18)

The model has physical and digital variants. Today, although developing technologies increase the effectiveness of digital models, the unmediated state of physical models maintains their currentity and importance. Physical models can be categorized into three distinct groups. Conceptual models are used to articulate a design idea, Exploratory Models, are utilized in the testing and judge design concepts, and Presentation Models, which consist part of the final demonstration of the design product to others.[26]

According to the Mock-up Oxford dictionary, “an accurate, often full-size replica or model of a machine or other structure, esp. one used for instructional or experimental purposes.’’ is defined.[27] With this definition, it is possible to say that mock-ups are “advanced models”. In addition, Mock-ups can be also said to be ‘’very early prototypes’’.[28] Thanks to Mock-ups, which are not necessarily full-size, in architecture, designers are offered workspace, often with low-cost materials. Offering a thinking space between the architect and the architectural product, the mock-up also creates a discussion environment between the architect and the user. Mock-ups that make designs easy to understand are also used to persuade users/employers. (Figure 19)

One of the valuable ways of making models is prototyping, like mock-ups. The idea of spaces as a result of mass production, such as producing “machine for living”, has been the subject of architecture from time to time. For example, Citrohan home is, within three basic prototypes (Domino, Monol, Citrohan) created by Le Corbusier to create housing could be built in series like machinery, the most developed throughout his career.[29] Although the prototype usually refers to a machine that “exhibits the essential features of a latter type”, it would be difficult to say that prototyping plays always a similar role to the one described when it comes to architecture. Therefore, in the context of architecture, it can be argued that the process described is not actually prototyping in the industrial sense described, but rather a method or a form of representation in terms of the design world.[30] It is important to consider prototyping in architecture in the context of this hypothesis. The three prototype Maisons Tropicales designed and produced by Jean Prouvé to be built in Africa between 1949-1951 are a critical example in this sense.[31] Although it is the result of industrial design, the fact that each prototype is different from each other and its relationship with the local, as well as the fact that it is still being rebuilt today, summarizes the meaning and value of prototyping in architecture.

Prototypes often have the purposes and advantages of producing the model and mock-up. Although the act of prototyping is similar to modeling and mock-up, there are some differences between them. Prototypes are more inclusive. Making virtual/real modeling or mock-ups is a method for developing/testing/presenting ideas. Scale is variable. It can be full scale, or it can be reduced or enlarged in different proportions. These properties also apply to prototypes. There are physical and digital kinds of prototypes,

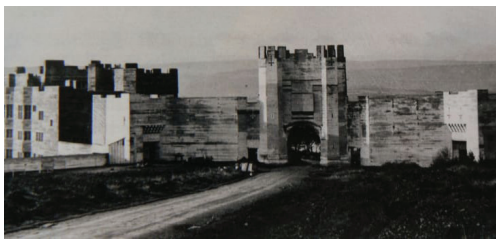


Figure 19: Edwin Lutyens, full-size mockup:The Barbican of Castle Drogoby, 1913 photo:The National Trust

Figure 20: Le Corbusier, Maison Citrohan, 1927

27. ‘’Mock-up’’. Oxford Dictionary, Available at: https://ezproxy.mef.edu.tr:2313/view/Entry/120556?rskey=i6gf7O&result=2#eid, (Accessed: 20.02.2022).

28. “Mock-ups”, Interaction-design.org. 16 February 2010, Available at: https://www.interaction-design.org/literature/book/the-glossary-of-human-computer-interaction/mock-ups (Accessed: 20.02.2022).

29. ‘’Maison Citrohan’’. Available at: https://en.wikiarquitectura.com/building/maison-citroehan/ (Accessed: 21.07.2022)

30. Antonis Papamanolis, “Prototyping and Architectural Education: An examination of the role of prototypes in the design process University of Patras”, 2018.

31. ‘’Maisons Tropicales’’. Available at: https://es.wikiarquitectura.com/edificio/maisons-tropicales/ (Accessed: 23.02.2022).

Figure 21: : Jean Prouvé, Maison Tropicale Niamey, 1949

Figure 22: : Jean Prouvé, Tropical Maison Brazzaville, 1951

as in the model. At the intersection of these two kinds, there are conceptual prototypes that work on a diagrammatic basis.[32]

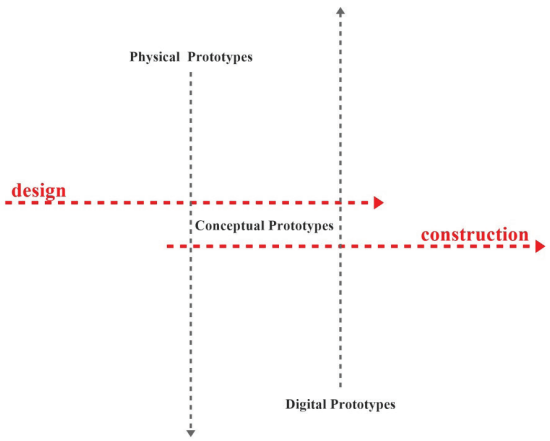


Figure 23: Kinds of Prototypes

One of the differences that distinguish prototypes from models and mock-ups is that prototyping is a multi-layered and multi-input process. Generally, they are considered holistic rather than partial and are full-scale. With prototypes, "working" spaces/systems are produced that can be experienced by the user, using real materials, not simulations. Models and mock-ups are shells used for the display or (visual) promotion of spaces, while prototypes include complete interior and exterior. Thanks to prototypes, art and technique are presented simultaneously. Due to the fact that the technologies used are close to reality, they are relatively more expensive than others. In models and mock-ups, the functionality is usually not required, but the prototype should "work" (although it has bugs and is not the final version of the function). The concept of "work" here means experienceability and testability by the user for architecture.

The close relationship of prototypes with reality and the possibility of experience can eliminate the problems that may arise between the architectural object and the user. Throughout history, architecture has been the manifestation of many fields such as culture, politics, religion, etc. Generally, buildings with a lifespan longer than human life represented society. However, it is an important problem that the user, who does not have a command of architectural knowledge, cannot have a say in the process from design to construction, and the meeting of the architectural object with the public is postponed until after production. Although studies such as

32. Fulya Özsel Akipek, Nilüfer Kozikoğlu, "Prototypes in Architectural Education: As Instruments of Integration in the Digital Era", 2007, p.172.

community-led designs[33] are being carried out today to eliminate this problem, it is a critical solution to get results by allowing the user to experience the space. In this sense, prototypes can be public's test tools in the intervenable process of architecture, rather than proofs. It can offer the user a chance to rehearse before the end of the design and construction.

Learning by building in architectural education

> In order to comprehend music, we need to learn how it is formed and what emotions it contains, and to learn a language, it is necessary to learn its words and grammar. To learn mathematics, we must know how to deal with numbers. The same is true in architecture. We have a lot of things to learn, for example, while children are learning languages, they try to learn and memorize many words to form their own sentences. This is the same in architecture; we need to collect many architectural ideas, concepts, and projects that can help develop our own thinking. However, as I said, Architecture is practice. Read, analyze and see as much as you want, but you still have to practice to truly grasp your potential. This is just like learning a language. You cannot talk without practice. [34]

Learning is the ability to react and formulate behavior in certain situations and problems. Of course, it is important to observe the performances of the others, read the instructions of others, and listen to others' explanations in order to achieve this ability. However, the person's active role in the process positively affects the learning process and learning success. According to the researches conducted in the field of education in recent years, it has been revealed that students who actively participate in the learning process learn better.[35] Learning by doing is a notable method in this context. Thanks to this method, the learner is provided to have direct contact with a certain situation or problem without intermediaries. Students learn by doing and/or experiencing themselves in such learning activities in which students take part in the center. The aim of this teaching approach is for learners to construct mental models that provide higher-order performance such as applied problem solving and

33. For more information about Community-Led Designs: Refer to: Alexiou K., Alevizou G., Zamenopoulos, T., deSousa S., and DredgeL, ''Learning from the Use of Media in Community-Led Design Projects''. *Journal of Cultural Science*, Vol.8, No 1., 2015. Available at: https://www.researchgate.net/publication/272021026_Learning_from_the_use_of_media_in_community-led_design_projects (Accessed: 16.05.2022).

34. Mohamed A. Abdellatif, "Mimari Tasarım Analizden Sunuma- Mimarlık Öğrencisi Rehberi", 2019.

35. Kimberly Harris, K., Robin Marcus, Karen McLaren, and James Fey, "Curriculum Materials Supporting Problem-Based Teaching", 2001, p.310-318.

transfer of information and skills.[36] Learning by doing is an experiential process in which people take an active role to explore the world and do something.

Learning by doing refers to an educational theory put forward by John Dewey. This approach puts practice at the center of learning, that is, it argues that students need to interact with their environment in order to adapt and learn.[37] The University of Chicago Laboratory School was founded by Dewey to bring this idea to life. Dewey's opinions have been major in establishing practices of progressive education. For example, it has been turned into a learning method, even used in the development of professional learning communities.[38]

According to the constructivist view of education, knowledge is formed through dialogue or relationships that a person establishes with the city, place, material, and other individuals. While it develops through perceptions, imitations, and tactics, it becomes subjective data with the person's comments and internal dialogues.[39] Learning by doing, which can be seen as a part of constructivist education in architecture, arises from the passion to build and make.[40]

Learning by doing always creates new encounters in the particularity of time for architecture. Each encountered situation forces the architect to come up with a solution. Therefore, this process is important for architectural education.

Throughout history, the knowledge/strategy of producing architectural products has been given to the student in different ways. Architectural education has been able to increase teaching potential with mixed models that do not distinguish between theory and practice, including both. Because the multi-layered, multi-disciplinary and open-to-face situation of learning by the building has always existed.

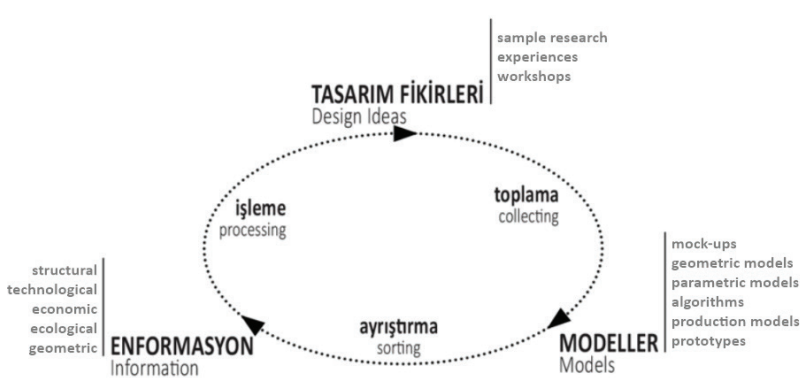


Figure 24: Conceptual model of "recycling" for the production of design information (Özsel Akipek, F., Yazar, T., 2015)

36. Daniel Churchill, "Effective Design Principles for Activity Based Learning: The Crucial Role of "Learning Objectives" in Science and Engineering Education", 2003.

37. John Dewey, "Experience and Education", 1986.

38. Dufour, R., DuFour, R., Eaker, R., Man, T., ''Learning by Doing: A Handbook for Professional Communities at Work- a practical guide for PLC teams and leadership''. Publisher : Solution Tree, 2010.

39. Semra Aydınlı, "Tasarım Eğitiminde Yapılandırıcı Paradigma", 2015, p. 241-252.

40. Oktay Yıldırım, "Mimarlık Eğitiminde Yaparak Öğrenme: Bir Bölü Bir", 2019, p.4.

Learning by building enables the architectural student to turn theoretical knowledge into a practical strategy with the active participation of the architecture student at school or in a different setting. This method contains many potentials for architectural education. These can be summarized as:

- It helps to eliminate the distance and separation between the theory and practice of architecture.
- Architecture student ceases to be a viewer and listener and becomes active part of education.
- The student of architecture confronts “real problems of the real world” from the beginning to the end of the process.
- The opportunity to meet many different disciplines is provided during the learning process.
- The ability to be a part of collective work is gained.
- Develops self-management and the ability to make critical decisions.
- More permanent information learned through experience is obtained.

It is critical that this approach, which makes the application important, offers an experimental environment. Because students who cope with every new problem that arises in the process, produce and acquire their own knowledge. Considering all these potentials, the Learning by building method is the main rationale for prototyping. In the framework of learning and building, it provides the structure for why prototypes are produced.

Experimental architecture

> Architecture has a spectator, a follower, an audience, and the experimental has accomplices. Architecture is for someone, experimentation is for the experiment itself. [41]

Learning by doing includes experience at its core. David Kolb explains learning by doing as experience-oriented. In this thinking, the learning process is shaped by four critical concepts: concrete experience, reflective observation, abstract conceptualization, and active experimentation. His approach is integrative and holistic; not only combining the processes of experience, perception, cognition, and behavior, but also seeing the

41. Levent Şentürk, “Deneysel Mimarlık Nerede Başlar, Nerede Biter?”, 2012, p.33.

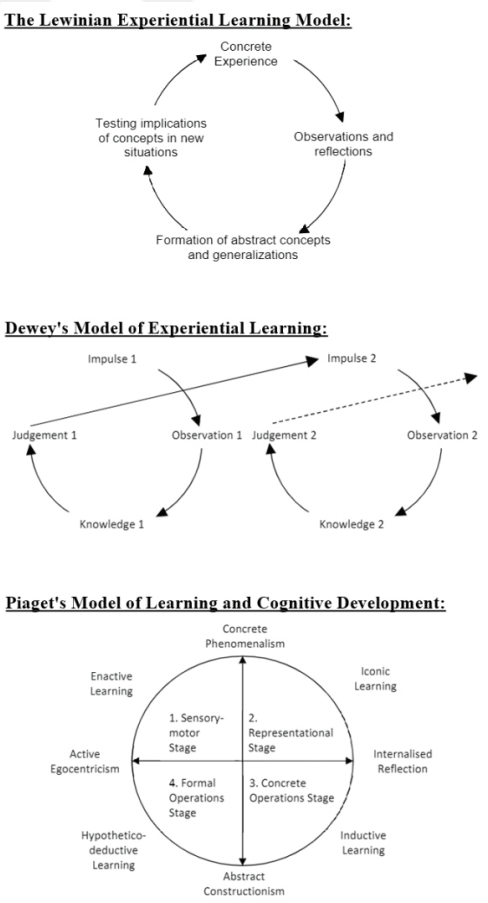


Figure 25: Experiential learning models, David Kolb,1984

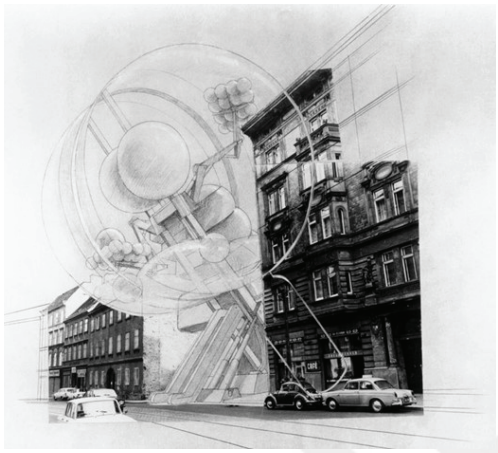


Figure 26: The Cloud, Coop Himmelb(l)au, Austria, 1968

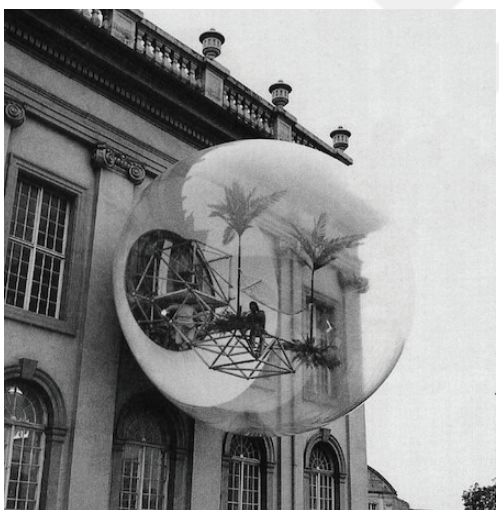


Figure 27: Oasis No. 7, Hans-Rucker Co., Documenta 5, Germany, 1972

performance, learning, and development as fundamentally similar processes operating on different time scales.[42] This method, which can be used in many areas of education, is at the heart of architecture. If design and construction are considered as a field of experimentation, participants take active actions in this field. Through these actions, they make observations, judge data, and produce knowledge. In this sense, it is very important to create experience opportunities in architectural education. Concreteness is very critical to be able to contact many senses in the experiment. So turning design into construction can provide that. Prototypes are forms of construction made for experimentation.

According to Lebbeus Woods; "An experiment is testing whether an idea or hypothesis actually works. Experiment is not the creation of hypothesis, that is the domain of theory. Experiment is not the application of results to reality, either, which is in the realm of practice. Experiment is an intermediate space between theory and practice." [43] Placing experimentation between theory and practice, Woods thinks experimentation as transformative. With this approach, experimental architecture can exist even if it does not result in a serious architectural production. In this context, not considering the prototyping only as a result product, but arguing that each model created in the process is an example of experimental architecture forms an important basis for this research.

Architectural installations based on experience and designed beyond known patterns are imagined in this context. For instance, The Cloud, designed though not produced by Coop Himmelb(l)au, is a living form, not a shell. Its structure is mobile, its materials are dynamic. "The Cloud places emphasis on technique as a means to an end but not an end in itself." [44] Oase No. 7 is an air-filled PVC foil with a diameter of 8 meters, adapted to an existing facade. It is an experiential transparent sphere that questions technology and life.

Both designs focus on process and experience, whether built or unbuilt. This focus ensures that what is produced is an example of prototyping. In this context, when viewed inductively, the boundaries of answers to the question of what is a prototype for architecture expand and require rethinking.

42. David Kolb, "Experiential Learning: Experience as the source of learning and development", 1984.

43. Lebbeus Woods, "Anarchitecture: Architecture is a Political Act. Academy Editions", 1992.

44. ''The Cloud''. Available at: http://architectuul.com/architecture/the-cloud, (Accessed: 21.01.2022).

In summary, at the end of this chapter, the role of prototypes used in different fields;

The purpose of the prototypes, which are tried to be explained with three concepts as “show-try-publicize” for architecture, may have similar aims in the business world and industry. The embodiment of the product idea and the manifestation of how it will look or be used can be explained by the concept of “show”. The technical development of the embodied idea can be achieved through prototypes. The concept of “try” explains this situation. This purpose of prototyping is often used, especially for many products to be produced in mass production. The function is tested through prototypes until the best product is obtained. User feedback on the product is very important. Because these feedbacks determine the lifetime, the amount of sales, etc of a product. The concept of “publicize” is used for user feedback that can be achieved through prototypes. The purpose for which prototypes are built can be one of these three concepts, or all three. Additionally, the potentials of learning by doing are provided when prototypes are used in education.

IN INDUSTRY			IN BUSINESS			IN ARCHITECTURE		
Show: technology	Try: function	Publicize: public reaction	Show: place	Try: ergonomics	Publicize: buyer profile	Show: archetype	Try: new form	Publicize: user and local feedback
								
Ford Model T, USA, 1908	Drebbel Submarine, London, 1620	3D Printed Canal House, Dus Architects, Amsterdam, 2014	Cafe for Kids, The Foundations in Design Thinking Workshop-IDEO U	Walker for Adults, Mastering Design Thinking-MIT School	Google Glass, Tom Chi, 2012	Maison Citrohan, Le Corbusier, 1927	Oasis No. 7, Hans-Rucker Co., Documenta 5, Germany, 1972	Maison Tropicale Niamey, Jean Prouvé, 1949

Table 1: The role of prototypes

In Table 1, a classification has been made according to the purpose of producing the prototyping samples, which were examined before, as active/ dominant. Prototypes that have not just one purpose, but others (though not dominant), can have more than one production reason in many fields.

Prototyping as a Process

02

This chapter is set up to explain whether the building practices implemented in the Design-Build Programs are prototype examples. The basis of prototyping is to acquire the know-how by experiencing the process, and in Design-Build Programs, learning by building is the aim. In line with these two similar approaches, prototyping will be considered as a process within the scope of this section, and from this perspective, all components of the process in Design-Build Programs will be examined. It is a difficult task to determine the boundaries of architecture within today's field of knowledge. With the changing technologies, transforming forms, increasing number of materials and differentiating methods of representation, the concrete ground that will help to understand architecture has become quite uncertain. In this sense, it is misleading to try to read architectural action only on the physical result product. For John Rajchman, the architectural product is defined by "interval".[45] According to Rajchman, "interval" is the pragmatism of diagnosis and diagram that destroys the boundaries separating theory and practice. Uğur Tanyeli emphasizes that the architectural object is no longer a predictable product, but a "process".[46] This situation causes us not only to question the architectural object but also to realize that the role of the architect has changed. The unpredictability of the outcome of the design affects the unique architect's position. It transforms production into an action that cannot be mentioned only by the active presence of the designer. Therefore, it may be a more accurate approach to try to understand architecture by making "accident"[47] predictions. Considering the current situation, it can be said that design is no longer an action that has a linear schedule, a hierarchical network of relations, and the completion of its tasks in a sequential manner. As a result, it is difficult to understand architecture through a "finished" architectural product. So, in order to examine today's architectural action, there is a need to re-think the ideas, approaches to be questioned on different scales, to analyze the complex network of relations, and to understand the phases.

In this framework, the architectural object means the intersection of many different processes beyond being a result product. Architecture education should also be included in these criteria for a good education model. Architecture students should be aware of all the inputs of the design, rather

45. John Rajchman, " Constructions", 1998, p. 94.

46. UğurTanyeli, " Biçimi Değil Süreci Tasarlamak", 2017, p. 312.

47. Uğur Tanyeli explains the architectural result-product by accident metaphor. Refer to: Uğur Tanyeli, ''Biçimi Değil Süreci Tasarlamak'', 2017, p. 328. Inside: ''Yıkarak Yapmak Anarşist Bir Mimarlık Kuramı İçin Altlık'', (Editor:Uğur Tanyeli), p. 311-329.

than reading a design with sterile renderings. Architecture students should not divide the process by considering design and practice as separate activities. Because there are not clear boundaries separating architectural design and practice, the process is holistic. The practice mentioned here will be read through construction, and construction through prototyping. Prototyping is a good method to think about the object of architecture with a holistic approach. Theory and practice are intertwined.

This chapter will begin around two main topics and will be shaped by study cases. The first topic is how they approach building practices in Design-Build Programs, and whether these can be examples of prototyping. In line with this inquiry, questions were asked to the Design-Build Programs selected, and the construction-prototyping relations were tried to be resolved according to the answers received. The second topic was asked about understanding the inputs of the prototypes produced in the Design-Build Programs. The prototyping process has been tried to be examined with all its subjects and objects.

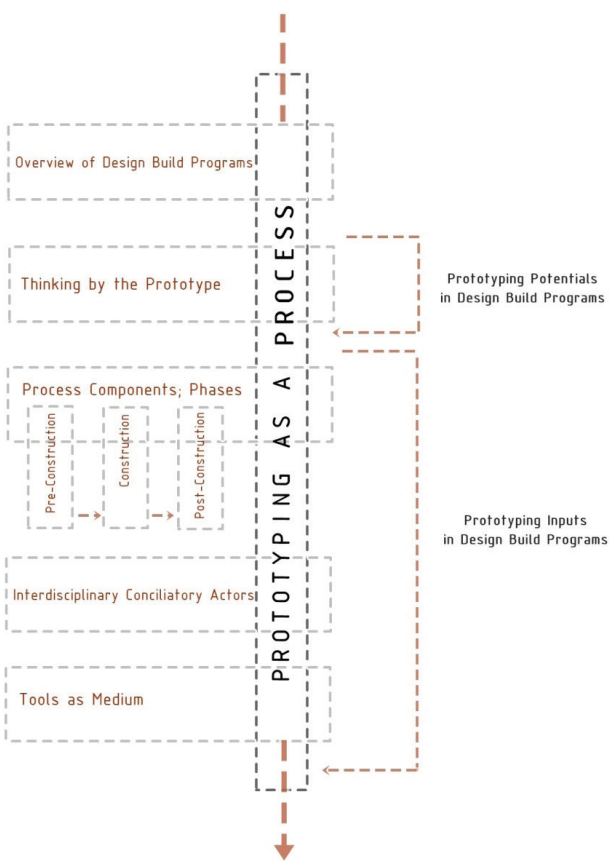


Figure 28: Chapter 2 relationship chart

The Prototyping by Process chapter will be discussed in five parts. In the first part, information will be given about the selected Design-Build Programs, and their approaches to architecture will be examined through their discourses and architectural products. While the second part questions the potential of prototyping for programs, it will also mention about the learning-by-doing approach concerning prototyping. The other three parts include the inputs to prototyping which will divide into phases, actors, and tools. The phases will be discussed from a construction-oriented perspective. The actors involved in the process from different disciplines will be determined. Finally, the tools and functions used in prototyping will be examined. Inferences will be made and discussed in line with questions specifically determined for each part and Design-Build Programs.

Overview of Design-Build Programs

In architectural education, there are programs that focus on construction as an output of the thinking process. This research will open a discussion through prototyping, based on the idea that construction as a practice means more than just building in the concrete sense. Five Design-Build Programs that include theory and construction practice in their curriculum and that accept prototyping as a process for architectural education (although they don't call it prototyping) will be examined. These programs, established within schools and private institutions, are AA Hooke Park, ITKE Stuttgart University, Rural Studio, Ciudad Abierta/Open City, MEF FADA DBS/ AAP. The fact that these programs are from five different geographies and their perspectives on construction practice helped to select the programs.

Figure 29: Locations of the Design-Build Programs

Interviews will be conducted with participants (lecturers, students, architects, etc…) within the determined programs. Before the interviews, the approaches and works of each program will be examined, and questions will be prepared according to the keywords determined within this framework. In this direction, the missions, timelines, and project descriptions of the programs will be examined, and the concepts they emphasize especially and frequently will be determined as keywords. Relationships between keywords and prototyping will be tried to be analyzed and questions will be asked to the programs in this context. In addition to the general questions that are the same for each program, specific questions have been prepared. Therefore, the questions to be asked will vary according to the programs. In interviews to be conducted with the semi-structured method, in addition to the predetermined questions, extra questions may be asked during the interview to detail the subject.

In line with the interviews, according to the answers received, Thinking by the Prototype, Process Components; Phases, Interdisciplinary Conciliatory Actors, and Tools as Medium parts will be constructed. End of parts reviews will be discussed based on the Keywords-Case Study Tables-Interviews relationships.

AA Hooke Park:

Place + Year: UK + 1982/2002
Standard Period of Study: 4-6 semesters
Participating Students: 3-7 students
Format: MSc/MArch Program
Key Words: Design + Make, 1:1 Fabrication, Prototyping, Hands-on Research, Experimental Architecture, Technology, Technique

Hooke Park hosts educational programs, as part of the Architectural Association School of Architecture. In addition to being a Design + Build graduate school program, it is a workspace where many workshops are held and the designed buildings are opened to visitors. Students go through a hands-on education process through 1:1 fabrication in an environment that includes a forest, studio, workshop, and construction site. They create experimental architectural products that they can test through prototyping.

> The programme's core agenda is to advance the materialisation of architecture through the synthesis of advanced technologies, craft techniques, and deep understanding of natural material. [48]

Within the scope of the program, the limits of the raw material are challenged with techniques such as digital 3D scanning, generative modeling and robotic fabrication. A used full-scale building project becomes a tool for design research.

Figure 30: AA Hooke Park format

48. Interview with Jordan Coppala /Backpacker, July 10, 2021.

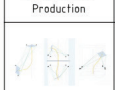
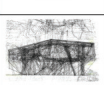
	PRE-CONSTRUCTION		CONSTRUCTION			POST-CONSTRUCTION	
	Analyses and Production	Post-Production	Structural System	Material	Method of Building	Using	Context
Project: FREE FORM STEAMBENDING Year: 2020 Participants: 3 STUDENTS							
Project: WAKEFORD HALL LIBRARY SKELETON Year: 2018 Participants: 6 STUDENTS							
Project: WOOD CHIP BARN Year: 2016 Participants: 5 STUDENTS							

Table 2: AA Hooke Park case studies

Questions:

1. How do you define the role of prototyping in your program? **(Prototyping)**

1. sp. q. Considering the methods you use in the Pre-Construction process, what does technology mean for your architecture? **(Pre-Construction Phase)**

2. Who are the participants in your construction process? **(Actors)**

2. sp. q. How would you explain the importance of the concepts of "Experimental Architecture" for architectural education? **(Post-Construction Phase)**

3. What tools do you use in the pre-construction and construction process? **(Tools)**

3. sp. q. What potentials do the high-tech tools (such as digital 3D scanning, generative modeling, and robotic fabrication) and the contradiction in the simple material-wood relationship have for your prototypes? **(Construction Phase)**

* **Zachary Mollica** *-Specialist Lecturer (Living on site, Zac is Warden of AA School's Hooke Park campus and a specialist lecturer to Design + Make 2018-2021)-* gave information about the program. **Mohammad Omar Eqbal** *-March Student, (2018-2020)-* was contacted for the interview.

ITKE (The Institute of Building Structures and Structural Design) University of Stuttgart:

Place + Year: Germany – 2000 (Jan Knippers has been director of the ITKE)
Standard Period of Study: 4 semesters
Participating Students: About 30 students
Format: MSc Program / Integrative Technologies and Architectural Design Research (ITECH)
Key Words: Full Scale/1:1 Fabrication, Prototyping, Research-Oriented, Non-Standard Architectural Applications, Experiment-Based, Technology, Computational Design, Engineering Design, Material Science, Digital Manufacturing, Fibre Composite Materials, Cross-Disciplinary

ITKE (The Institute of Building Structures and Structural Design) is one of two institutes included in the ITECH (Integrative Technologies and Architectural Design Research) MSc Program at the University of Stuttgart. Another institute is ICD (The Institute for Computational Design and Construction). ITKE's timeline goes back to the nineteenth century when the teaching of architecture began at the University of Stuttgart. But under the leadership of Jan Knippers in 2000, extensive experimental research activities have developed. The MSc Program aims to create an environment where many disciplines interact with each other, based on research and experimentation shaped around contemporary aspects of architecture.

> The goal of the ITECH program is to prepare a new generation of students from different disciplines for the continuing advancement of technological and computational processes in development of the built environment through merging the fields of design, engineering, construction, and natural sciences. [49]

The purpose of ICD is to combine the fields of design, engineering, planning, and construction to reproduce form, material, building, and environmental information through computational design and computers. Based on this purpose, it carries out its work together with ITKE. ITKE determines its field of work at the intersection of architecture and engineering fields. It rethinks new and non-standard architectural practices by pushing the boundaries of materials and structural morphologies.

49. ''ITECH''. Available at: https://www.uni-stuttgart.de/en/study/study-programs/Integrative-Technologies-and-Architectural-Design-Research-ITECH-M.Sc-00001./ (Accessed: 25.01.2022)

It enables the production of full-scale prototypes both in theory and in practice, with a particular focus on biomimetic and fiber composite materials.

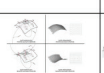
	PRE-CONSTRUCTION		CONSTRUCTION			POST-CONSTRUCTION	
	Analyses and Production	Post-Production	Structural System	Material	Method of Building	Using	Context
Project: LIVMATS PAVILION Year: 2021 Participants: ITKE-ICD TEAM							
Project: URBACH TOWER Year: 2019 Participants: ITKE-ICD TEAM							
Project: LANDESGARTENSCHAU EXHIBTION HALL Year: 2014 Participants: ITKE/ICD/IIGS TEAM							

Table 3: ITKE University of Stuttgart case studies

Questions:

1. How do you define the role of prototyping in your program? **(Prototyping)**

1. sp. q. Which main factors are shape-giving in the pre-construction process? (**Pre-Construction Phase)**

1. sp. q. How would you explain the importance of "material" in prototyping for architectural education? **(Construction Phase)**

1. sp. q. Why aren't most of your prototypes built on-site? **(Construction Phase)**

1. sp. q. What does the post-construction process mean to you? **(Post-Construction Phase)**

2. Who are the participants in your construction process? **(Actors)**

2. sp. q. What are the positive and negative aspects of the "Cross-Disciplinary" work that you have emphasized especially for architecture and engineering in your architectural education? **(Actors)**

3. What tools do you use in the pre-construction and construction process? **(Tools)**

3. sp. q. You often mention the concepts of "Technology", "Digital Manufacturing", "Computational Design" etc. in your projects. How do these concepts affect your prototypes? **(Tools)**

* **Okan Başnak -***MSc Student (2019-2021), Research Associate (2021)-* was contacted for the interview.

Rural Studio:

Place + Year: USA - 1993
Standard Period of Study: A semester / A year
Participating Students: About 4 -15 students
Format: Undergraduate/ MArch programme
Key Words: Learning by Doing, Design-Build, Energy Efficiency, Resilience, Healthful Living, Public İnterest, Design Tectonics, Local Material/Technique, Context, Vernacular Architecture, Economy, Team, Sustainability, Affordability, Equality

Rural Studio is an off-campus design-build program part of the School of Architecture, Planning, and Landscape Architecture of Auburn University. The program was established in 1993 by D.K. Ruth and Samuel Mockbee. Within the scope of the Rural Studio program, ''architecture students'' design and build "simple" things (such as residences, social centers, sports facilities, churches, etc.) for the local people in Hale County, which has a high poverty rate in the south of America. The students attending the program - one semester for third-year students and two semesters for fifth-year students - leave the campus in Alabama. They go to build projects in the poor areas and they produce architectural practices for customers who do not demand and do not even have "true-good" architectural manifestations.

> Our design-build program challenges students to consider not what can be built but rather what should be built. [50]

> There are no made up projects; everything we do serves a practical purpose in the community. When students enroll in the program, they commit to the place, to the people, and to the process. There's no easy escape. Studying here means living in a remote area where the summers are sweaty, the winters are muddy, and the cell service is spotty. It means digging in and learning everything this place has to teach us. When students study with us, they don't just learn how to design and build. They learn to listen, to work like a team, and to make a difference wherever is home. [51]

50. ''Rural Studio''. Available at:http://ruralstudio.org/about/ (Accessed: 05.02.2022)

51. ''Rural Studio''. Available at: http://ruralstudio.org/study-with-us/ (Accessed: 05.02.2022)

Within the framework of this approach, Rural Studio provides its students with the opportunity to be involved in life and to face difficulties. While aiming to train responsible and aware architects, it also shows that there is a way to cope with limited conditions.

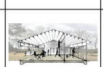
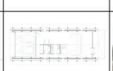
	PRE-CONSTRUCTION		CONSTRUCTION			POST-CONSTRUCTION	
	Analyses and Production	Post-Production	Structural System	Material	Method of Building	Using	Context
Project: 2020 20K HOME Year: 2020 Participants: 3 STUDENTS							
Project: THERMAL MASS & BUOYANCY VENTILATION Year: 2020 Participants: 4 STUDENTS							
Project: LIONS PARK SCOUT HUT Year: 2012 Participants: 4 STUDENTS							

Table 4: Rural Studio case studies

Questions:

1. How do you define the role of prototyping in your program? **(Prototyping)**

1. sp. q. Can we call each architectural object you produce a 1:1 prototype as it is the output of architectural education? **(Prototyping)**

1. sp. q. How would you explain the importance of "Learning by Doing" for architectural education? **(Construction Phase)**

1. sp. q. In the project you produced as part of the 2020 20K HOME Master Program, you emphasize that architecture should be reshaped with changing needs. From this perspective, what does Post-Construction mean to you? **(Post-Construction Phase)**

2. Who are the participants in your construction process? **(Actors)**

2. sp. q. 2. sp. q. How does the involvement of the user in the design process affect the architect's role in design? **(Actors)**

3. What tools do you use in the pre-construction and construction process? **(Tools)**

3. sp. q. How do the tools you use in the pre-construction phase affect your design? **(Pre-Construction Phase)**

* **Judith Seaman** *-Rural Studio Coordinator (2022/…), Rural Studio Student Worker (2021)-* was contacted for the interview.

Ciudad Abierta/Open City:

Place + Year: Chile – 1971
Standard Period of Study: Variable
Participating Students: Variable
Format: Community
Key Words: A School of Thought, Local And Experimental Architecture, Thinking-Research-Experimentation, Collective Community, Realisation, Communal Living, Merging of Public and Private Space, Local Material, Ephemeral Nature

The Open City is located on an area of 275 hectares with 3 km of Pacific coast near the port of Valparaiso. Part of the UCV School of Architecture (Catholic University of Valparaiso), the community is owned and operated by the Amereida Cooperative. Since 1970, it aims to create an experimental space for architecture.

It offers a workspace that destroys the norms of architectural practice and re-examines architecture according to the conditions of its nature and current context. This community, which has turned into a school of thought based on Experimentation and Realization, blurs the boundaries between private and public space with the designs they put forward. This situation arises from the strength of the relationship that the architectural product establishes (or does not establish) with the ground. *"The path is not the path"*[52] is the motto of the program. This is the result of the centrality given to improvisation as the basic principle of both living and building.

The Open City is a fairly large group with internal differences. The program, which hosts different disciplines beyond just doing architecture, produces theoretical contents from the expression of environment and construction. In this study, one of the many programs hosted by the Open City, the projects carried out jointly with The Scarcity and Creativity Studio (SCS) will be examined. The Scarcity and Creativity Studio (SCS) is a design and build a studio within the Oslo School of Architecture and Design (AHO). The studio focuses on "translations from drawing to building", and it aims to create interactive design processes using local conditions, scarce resources, and creativity.[53]

52. ''Ciudad Abierta/Open City''. Available at: https://www.documenta14.de/en/artists/13574/ciudad-abierta (Accessed: 07.02.2022)

53. ''The Scarcity and Creativity Studio''. Available at: http://scs.aho.no/ (Accessed: 07.02.2022)

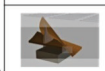
	PRE-CONSTRUCTION		CONSTRUCTION			POST-CONSTRUCTION	
	Analyses and Production	Post-Production	Structural System	Material	Method of Building	Using	Context
Project: HOSPEDERIA DE LAS ALAS Year 2012 Participants: 5+21 STUDENTS							
Project: LAS PIEDRAS DEL CIELO Year: 2012 Participants: 11+15 STUDENTS							
Project: WALK THE LINE Year: 2012 Participants: 4+16+20 STUDENTS							

Table 5: Ciudad Abierta/Open City case studies

Questions:

1. How do you define the role of prototyping in your program? **(Prototyping)**

1. sp. q. Can we call each architectural object you produce a 1:1 prototype as it is the output of architectural education? **(Prototyping)**

1. sp. q. How would you describe the Experimentation Phase of your education process, which you define as "Thinking, Research, and Experimentation"? **(Post-Construction Phase)**

2. Who are the participants in your construction process? **(Actors)**

2. sp. q. What kind of potential do you think the collective design offer to architectural education? **(Pre-Construction Phase)**

3. What tools do you use in the pre-construction and construction process? **(Tools)**

3. sp. q. How does the concept of "Local Architecture" affect the tools you use in the construction phase? **(Construction Phase)**

* **Maxwell Woods** *–Author, Literary Scholar that Crosses over ınto Architecture And Urban Studies-* gave information about the program. **Christian Hermansen Cordua** *-Professor of Architecture at AHO (2002/...)-* and **Anders Svendsen Almesveen** *-Design and Construction Team Student (2012)-* were contacted for the interview.

MEF FADA DBS (Design and Build! Studio) / AAP (Alternative Architectural Practices):

Place + Year: Turkey – 2015/2019
Standard Period of Study: A semester/4 semesters
Participating Students: About 15/10 students
Format: Undergraduate/ MArch programme
Key Words: Design-Build, Alternative, Research, Prototype, Make, Write, Real-World, Cross-Disciplinary, Cooperation, Creative, İnnovative, Ethically, Socially Responsible

DBS and AAP are two conceptually linked programs of MEF University Faculty of Arts Design and Architecture. DBS is an undergraduate summer program that students design and build to serve diverse communities in a variety of locations. Training creative, innovative, ethical, and socially responsible architects are among the aims of the program.

AAP is a graduate program. Considering the changing and transforming architectural conditions in the 21st century, architecture has ceased to be a single correct formula today. Therefore, it has become very important to understand the expanding periphery of architecture and to question its alternatives. Within the scope of the program, answers to these questions are sought. The process consists of four phases: Research - Prototype - Make - Write. Theory and practice are combined through these phases.

> We have entered a period where there are strong signs of a radical change in the modes of practicing architecture and also in the teaching of architecture. Architects of the future are expected to be working more with the public interest in mind; collaborative practices within the field and across various fields will be common; teamwork at every stage will be regular; they will be developing projects where research and design processes are intertwined; they will be practicing in a more pro-active environment. [54]

Within the scope of these two programs, which question today's conditions and the changing situation of architecture in this direction, the criteria of being a responsible, real-aware, collaborative architect are sought.

54. ''MEF FADA DBS''. Available at: https://aap.mef.edu.tr/copy-of-contact (Accessed: 07.02.2022)

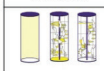
	PRE-CONSTRUCTION		CONSTRUCTION			POST-CONSTRUCTION	
	Analyses and Production	Post-Production	Structural System	Material	Method of Building	Using	Context
Project: VOLU-TE Year: 2020 Participants: 10 STUDENTS							
Project: MEDITERRANEAN TRIANGLE Year: 2017 Participants: 10 STUDENTS							
Project: THE BRIDGE TO THE DREAMS Year: 2015 Participants: 22 STUDENTS							

Table 6: MEF FADA DBS/AAP case studies

Questions:

1. How do you define the role of prototyping in your program? **(Prototyping)**

1. sp. q. How would you explain the importance of "material" in prototyping for architectural education? **(Construction Phase)**

1. sp. q. What does the post-construction process mean to you? **(Post-Construction Phase)**

2. Who are the participants in your construction process? **(Actors)**

2. sp. q. What opportunities do collaborating with different disciplines in the "real world" offer architecture students? **(Actors)**

3. What tools do you use in the pre-construction and construction process? **(Tools)**

3. sp. q. How does the concept of "alternative" affect the tools in your pre- construction process? **(Pre-Construction Phase)**

* **Arda İnceoğlu** *-Dean, Professor of Architecture Faculty of Arts, Design and Architecture, MEF University (2014)-* was contacted for the interview.

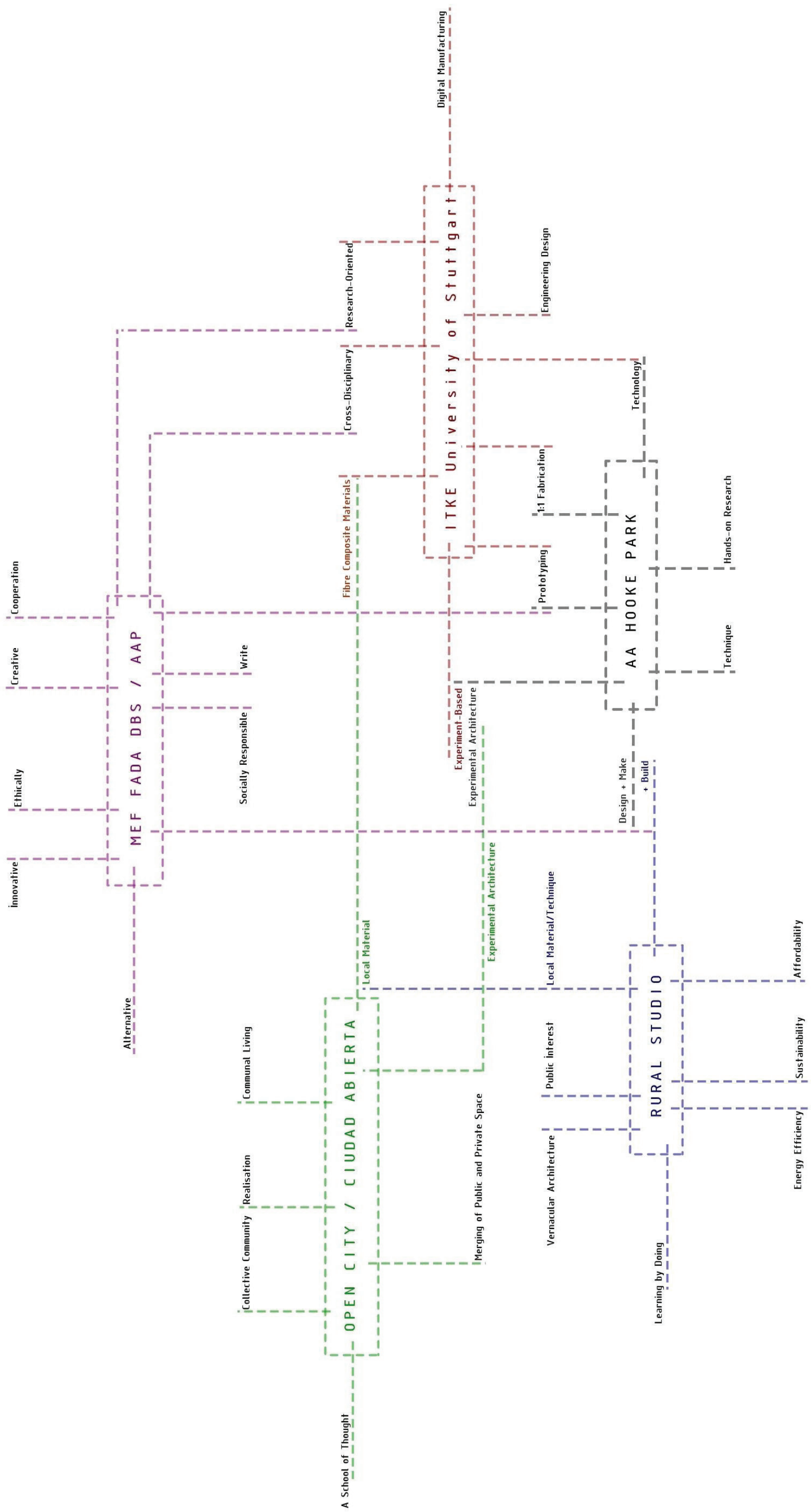


Figure 31: Keywords diagram

Thinking by the prototype

In general, testing the architectural product while it is being designed is costly and difficult. Therefore, gradual and disjointed stages emerge in architecture. Concretizing the idea on paper or on the screen is a critical action for the development of the design. That's why; models of different scales, mock-ups, prototypes, etc. are produced. With reference to the close relationship of prototyping to reality, there are many potentials it offers to the development of the design. The physicality provided by prototyping allows the space to be perceived and evaluated not only by the sense of sight but also by other senses that are just as important.[55] It ensures the realization of the experience-oriented design.

In this research, the definition of the prototype as the first example of mass production in industrial production (although the word "prototype" includes "type") will not be the same for architecture. The act of prototyping will be accepted as an experimental field and the studies of undergraduate and graduate programs that practice construction-oriented architecture will be examined. From the perspective that defines design as a process, prototyping will also be considered as a process. Architectural knowledge revealed through physical and virtual prototypes in the design process and its contribution to education will be read. In addition, it will be discussed whether the construction practices put forward as a result of the studies of the programs can be prototypes. The critical question here is: "Is every architectural object built in Design-Build Programs an example of prototyping?" or "Do Design-Build Programs describe the building practices they reveal as prototypes?" From this point of view, the construction-prototype relations of Design-Build Programs will be tried to be explained.

Case studies determined within the scope of the research reveal construction-oriented practices. However, when analyzing Keyword Diagrams (Figure 31); Aa Hooke Park, ITKE and MEF FADA DBS/AAP often use the concept of prototyping when describing construction practices, while Rural Studio and Ciudad Abierta/Open City do not often mention the concept of prototyping. With these determinations and interviews, the definition of prototyping will be tried to be put forward again.

Question 1: How do you define the role of prototyping in your program?

55. Juhani Pallasmaa, "The Eyes of the Skin: Architecture of the Senses", 1996.

AA Hooke Park Interview, Mohammad Omar Eqbal's Answer:
I would define it as one of the most important steps in our program and project because It was our criteria for marking, the prototype was 30 percent of the marks. Aside from marking, it was the measure for us to test our design and progress. For every stage, we used to make either 1:1 or 1:10 scaled prototypes. To come to the design review every week, we used to bring models or working prototypes to get a better review from our teachers. I believe when we work on making the prototype, we have to go through the understanding of the material very properly; my project and Design+Make program in general is very prototypic masters.

ITKE Stuttgart University Interview, Okan Başnak's Answer:
Different groups were given different topics during the first semester, and everyone was asked to make their prototype. In the first phase, a prototype selected from among the products released was developed. The main purpose of making designs with prototypes was to create a new construction method and a new material, not the final product. Prototyping has helped us in this regard.

Rural Studio Interview, Judith Seaman's Answer:
The prototyping process at Rural Studio is manifested in the building of "mock-ups." These are full-scale tests of construction methods, material details, and spatial schemes. They allow students to understand how imperfect materials meet in real practice versus a computer drafted construction drawing set. They also allow students to try their hand at something they've never done, or just designed, before applying that method to the larger, more permanent project.

1. sp. q. Can we call each architectural object you produce a 1:1 prototype as it is the output of architectural education?

The model of Rural Studio's student, faculty, and product line research work is based around 1:1 prototyping. The students design, review, and construct housing models by studying past work of the studio and the context of housing in the rural Southeast United States. The houses and community projects designed and built are one portion of the output of

of the education process. But others are the qualitative and quantitative research and knowledge that students leave behind for future classes.

Ciudad Abierta/Open City Interview, Prof. Christian Hermansen Cordua and Anders Svendsen Almesveen's Answers:

CH: Throughout the process, we make experiments to improve the design. But we do not call what we produce as a prototype. So we can say that we do not engage in prototyping.

AS: The role of prototyping was important alongside parametric design and testing in 1:20 scale physical modeling. As we got to the site, conditions changed- we had to make fundaments in the sand ground, and the wood available in Chile was weaker than the Norwegian pine we tested with, so 1:1 scale testing on-site became a part of the process.

1. sp. q. Can we call each architectural object you produce a 1:1 prototype as it is the output of architectural education?

CH: No, we produce buildings with a function.

AS: That is probably a way to see it. It was the first 1:1 scale project most of us had built, at least on that scale. Our project was also a sort of a shelter, so one got a sensation of the room and architectural feeling being inside it and watching out on the scenery.

MEF FADA DBS/AAP Interview, Prof. Dr. Arda İnceoğlu's Answer:

We use prototypes to develop ideas during the design phase of projects. In our DBS program, we usually build projects on-site. Although we do not call the product itself a prototype, the fact that we are learning while building is similar to the process of prototyping. However, the process of our project in Tunceli in 2021 was mostly managed remotely due to the Covid-19 pandemic. It was an experience which the design itself was the prototype and the prototype itself was the design.

As a result of the interviews, AA Hooke Park, ITKE Stuttgart University, and MEF AAP Programs used prototyping in many stages of their production. They said that the 1:1 scale final product that is usually produced can be called a prototyping sample. They emphasized that the way to try the material and the structural system not only during the design phase but also during the construction phase is through prototyping. Rural Studio calls their experimentation “mock-up” before starting the construction process. Open City, on the other hand, uses prototyping as a method to develop a design but does not refer to functional end products as prototypes. This approach is also similar for the MEF DBS program. Despite all these determinations, all five interviewed programs stated that prototyping is important for their programs.

Figure 32: Building process diagram

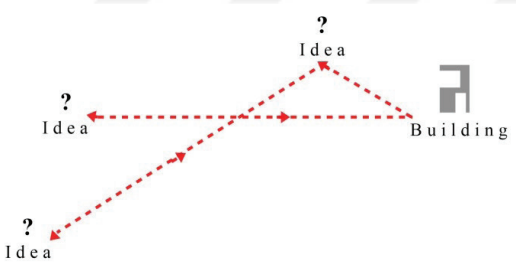


Figure 33: Prototyping process diagram

Prototypes are an alternative to concretizing the idea. It becomes easier to produce successful architectural objects with real and experiential design methods. Thus, prototyping is critical in many phases of design and construction. The main purpose of construction-oriented architectural education is not to produce a sterile object for profit, adapted to market conditions. It is to experience the instructive process of doing and to enable the participants to produce their own knowledge from the process. Therefore, studies in Design-Build programs (although some programs don’t use this concept) can be called prototypes. Because it can be said that the purpose of prototyping is similar to the aims and approaches of construction-oriented training programs in that it focuses on the process, not the result, and creates a space of experience. The prototyping definitions of the programs obtained as a result of the interviews support this hypothesis.

Process components; phases

> Architecture should no longer be understood as an object, but rather as a condition and a construction. [56]

Dividing architecture into theory and practice, or design and construction, is an inaccurate approach in today's terms. Nowadays, architecture has become a very complex activity that needs to be considered, from the tool used in designing to the participants in a building. In order to understand this complex action, it is necessary to be involved in all stages of design and construction. In traditional architectural studio education, students usually first design the project with sketches and models, and in the final stage pretend to think about materials and construction techniques on paper. Unlike traditional education, the whole process is considered simultaneously in the Design-Build approach. Therefore, the entire design and construction process is implemented as an integrated whole. At this stage, students seek answers to questions that do not come to mind in traditional design studios. Considering the importance of including construction practice, not just theory, in education, this section will be shaped. The focus will be on architectural education through"not ignoring construction" and "analyzing the process" thoughts.

Based on the assumption that the architectural product represents not only an object but a multi-layered and multi-input process, this section will be discussed through the construction stages of the prototypes of the Design-Build Programs that include not only theory but also construction practice in learning processes. In essence, prototyping means process. A process in which the designer and its participants are involved by experience. An action in which a concrete output of the learned information is produced, not read through finished product renders. An activity which building is a tool, not a goal. Therefore, it can be considered as a learning process that contributes to architectural education. This situation, which removes the materiality of the space, can be the answer to the problems of defining the architectural object that architecture is trying to deal with today. Multi-participant processes, on the other hand, can be questioned the architect's position.

56. K. Michael Hays in Deborah Hauptmann, "Critical Thought and Projective Practices: An Interview with K. Michael Hays", 2007, p. 59-60.

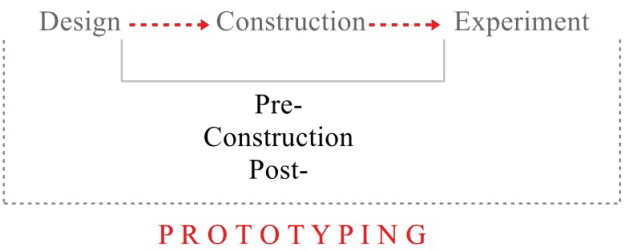


Figure 34: Prototyping phases

In this direction, it is aimed to analyze the prototyping action as before and after the process by focusing on "doing/building", and to elaborate on this section through case studies.

Pre-construction

The architectural design contains many dynamic inputs. If we think that architecture has evolved according to the conditions it is in throughout history, the knowledge of placing the stone on the stone has reached other dimensions today. With the developing information and communication technologies, the limits of the information field of architecture have changed considerably. The channels that enable us to produce the object/practice of architecture, the way we produce it, the way we represent it, and the way we use it have been affected by this change. With the increasing importance of technology in our lives after 2000, the practices of daily life and the way we use space have been transformed. Now libraries, shopping malls, museums, banks, and education and trade venues have been moved to the screens of the digital world. Technology has not only changed the way we use space but it has also affected the way we produce and represent it.

Although the abundance of possibilities for design today makes it easier to produce representations that enable understanding of the final product, some schools of architecture argue that it is important to design by building. In this context, it is the purpose of this section to examine how schools, which included the prototyping in their programs, started designing, how they managed the design process, and how they create design-build relationships. In other words, knowing that there is an architectural product to be built as a result is to understand how it affects the design process. In this direction, the following information has been obtained from the interviews with the programs.

AA Hooke Park Interview, Mohammad Omar Eqbal's Answer:

1. sp. q. Considering the methods you use in the Pre-Construction process, what does technology mean for your architecture?

Technology for me is an enabler to get more out of less. Eg: using the full potential of the material, rather than simply over-engineering it. It is also about having the machines that can push us from mass production to mass customization, and the precision and research and data to feed digital simulations that can give us material reality in the digital environment.

ITKE Stuttgart University Interview, Okan Başnak's Answer:

1. sp. q. Which main factors are shape-giving in the pre-construction process?

Our design process consisted of two stages. The first stage is the section where there is a handicraft and ideas are usually expressed through models. The second stage includes the computer development of the idea that emerged in the first stage. Therefore, it is important that the ideas can be systematized and adapted to robot arms. In other words, we can say that the tool we use determines or limits our design process.

Rural Studio Interview, Judith Seaman's Answer:

3. sp. q. How do the tools you use in the pre-construction phase affect your design?

These tools and voices lead to well-developed designs, informed, and perhaps most important – appropriate. They ensure that students know why they are making a decision or building something a particular way. It allows them to have a complete understanding of their work from the ground up and throughout scales of design.

Ciudad Abierta/Open City Interview, Prof. Christian Hermansen Cordua and Anders Svendsen Almesveen's Answers:

2. sp. q. What kind of potential do you think the collective design offer to architectural education?

CH: I am not sure what you mean by "collective studies". If it means group work, then it reflects the practice of architecture, which is collective. Architecture is only produced individually in the case of very small projects, and even in these, the claim of individuality is very problematic.

AS: The collective design has influenced how we start the design, even the tools we use in the design process. It has so many positive aspects to education. Both socially, linguistically, and both experimental, and professional. We got to know each other in Oslo, cross from different studio levels, alongside communicating with schedules Open City and school in Valparaiso. And when the time came to realize the projects on the sites chosen by the Chilean students, it all seemed natural.

MEF FADA DBS/AAP Interview, Prof. Dr. Arda İnceoğlu's Answer:

3. sp. q. How does the concept of "alternative" affect the tools in your pre-construction process?

The concept of alternative allows us to read "known truths" backwards. It incorporates different disciplines into the process, creates new encounters, and in this direction, it also offers the opportunity to diversify the tools.

The question of how to start the design has been one of the serious issues discussed in architecture. In Design-Build programs, knowing that the design is going to be built has often influenced the design process. Although the physical conditions of the construction area, the accessibility of the material to be supplied, the abilities of the participants in the construction process, economic opportunities, etc. are considered constraints, they have been important determinants for starting the prototyping. The consensus of the Design-Build programs interviewed supports this hypothesis.

In the Design-Build programs, the design is started by considering the fact that the students will build the designs and the difficulties of the project area. During the Pre-Construction process, AA Hooke Park and ITKE Stuttgart University focus on prototyping using new technologies (like robotic arms, digital resources, etc.). It emphasizes the importance of the relations between architecture and technology. Both programs said that they created prototypes at different scales to develop their designs, both manually and in the virtual

environment in the pre-construction phase. In addition, AA Hooke Park aims to reveal the unknown potentials of simple materials by using high technology. Rural Studio develops its designs mostly using traditional methods during the pre-construction process. They often develop their designs with hand drawings, mock-ups, or simpler computer drawings. At Ciudad Abierta/ Open City, this process varies according to the participants. The concept of "alternative", which is also in the name of the MEF AAP program, encourages designers to design with alternative methods. In this way, alternatives to prototyping are tried out in the pre-construction phase.

Construction

> You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete. [57]

In architectural education, constructing the designed object is realizing the architecture on paper. It is to experience the predictions of the design process in the construction process. Learning by facing the facts is a very effective method. Carpenter defines the production process as "a normative process from part to whole, from effect to cause." [58] In this respect, the process is directly related to experience and reality. In architectural education, construction is an integrated system where each action works as the catalyst of the other. The decision-makers of this cyclical process are students.

In today's traditional design studio education, students usually develop the project with the help of sketches and models and decide on materials and construction techniques at the last stage. In architectural education prototyping, contrary to traditional education, focuses on design, construction techniques, and material selection. In other words, the whole process is considered simultaneously due to the restrictive real conditions such as the user of the architectural product to be made, the place of construction, and the construction possibilities. Therefore, the entire design and construction process is applied as a nested whole. Considering all the inputs such as structure, material, and construction method that affect the

57. Buckminster Fuller, 1945. Refer to: Sieden, L. S. 2012. A Fuller View- Buckminster Fuller's Vision of Hope and Abundance for all. Divine Arts, p. 358.

58. William J. Carpenter, "Learning by Building: Design and Construction in Architectural Education", 1997, p.8.

construction process, the practices introduced in Design-Build programs and the concepts they emphasize are the subject of discussion in this section. In this context, the following information was obtained from the interviews with the determined questions.

AA Hooke Park Interview, Mohammad Omar Eqbal's Answer:

3. sp. q. What potentials do the high-tech tools (such as digital 3D scanning, generative modeling, and robotic fabrication) and the contradiction in the simple material-wood relationship have for your prototypes?

These tools help us break through the traditional norms. With 3D scanning we can bring the natural form of the wood into the digital environment, step away from Processing wood, cutting into boards, and planning the wood is very wasteful, so much material is wasted in processing. 3D scanning, when combined with robotic cutting can make unimaginable connections. Because the 6-axis robot can make innumerable customized precise cuts and drills, which is unimaginable with milling and cutting machines. (The issue with robotic fabrication I faced was a lot of pre-processing which became a problem at times when we have to adhere to deadlines.) But they are amazing tools for experimentation and mass customization. (Specially fabrication of a parametric form where every connection is unique). Furthermore, computational tools like grasshopper helped us to predict and understand the material's reaction pre-construction. Computation was a big part of our project because every part of the built pavilion was unique and getting the data out for 160 discrete elements without grasshopper and python would have been impossible. For us, the computation was more useful during the construction process not very important in the pre-construction stage, because most of the design decisions were coming because of the material's tactile and intuitive information.

ITKE Stuttgart University Interview, Okan Başnak's Answer:

1. sp. q. How would you explain the importance of "material" in prototyping for architectural education?

Wood and fiber materials are generally used in our prototypes. This is because we can incorporate technology into our works and create flexible, lightweight, and sustainable materials. In this context, the material is a serious determinant of how our prototypes will be shaped.

1. sp. q. Why aren't most of your prototypes built on-site?

Because we want to minimize the work on the construction site. We work in controlled spaces where we can use technology. In addition, it is important to reduce this problem, as the areas where we build prototypes often have noise limitations.

Rural Studio Interview, Judith Seaman's Answer:
1. sp. q. How would you explain the importance of "Learning by Doing" for architectural education?

The aim of education at Rural Studio is for students to understand that when they draw a corner, board, and nail in their career, it is put together by a real person. We want them to be mindful of their decisions as designers considering they are building something that takes resources, money, and has a fairly long lifespan. Students here do not have a right to build. The privilege of a building is earned through taking ownership of their work and proving through drawings, presentations, and prototyping that it is buildable.

Ciudad Abierta/Open City Interview, Prof. Christian Hermansen Cordua and Anders Svendsen Almesveen's Answers:
3. sp. q. How does the concept of "Local Architecture" affect the tools you use in the construction phase?

CH: We use local products, and the tools needed to process these are governed by the nature of these materials.
AS: As for the physical assembly, ordinary traditional tools were used, along with electric power tools. For the foundation, a local screwdriver method was used to dig holes with enough diameters in the sand for filling with armor and concrete. We had to be flexible and adjust

various building methods to what was available and traditionally used. This also taught us new methods and to adjust the project with the conditions, material availability, etc...

MEF FADA DBS/AAP Interview, Prof. Dr. Arda İnceoğlu's Answer:

1. sp. q. How would you explain the importance of "material" in prototyping for architectural education?

In our DBS program, we mostly use timber. We can say that we are obliged to do so. The reason we use timber is: that its tectonic relationships are easy to understand, it is easily workable, the building process accepts mistakes, timber is widely accessible, and it is a flexible and sustainable material. We produce prototypes every time in order to test the material and create details. Our limited possibilities in material selection become a defining component of our practices.

Rural Studio explains the importance of learning by building with the claim that the real equivalent of drawing can be understood. In their work, they define prototypes as transitional tools that transform a design into construction. They say that facing construction allows architects with responsibility and awareness to graduate.

AA Hooke Park, ITKE Stuttgart University, and MEF FADA DBS/AAP address the decisive power of material in the construction process. They say that the material is very important for the prototyping considering the construction method, material supply, and environmental conditions. AA Hooke Park works by combining the simple wood found in the forested project area with technology. It aims to reveal the unexplored potentials of the material. Therefore, it produces prototypes at different scales to understand the working principle of the material. ITKE Stuttgart University tries to produce different material options. Non-on-site constructions support creating an experimental environment for the material. The program argues that discovering material is an important step in prototyping. MEF FADA DBS usually uses timber and reconsiders it for each project. Timber is reinterpreted as the program's projects and conditions change. MEF AAP questions many material alternatives in the Volu-te Project.[59] The common point of view in this whole program is to reveal the strong effect of the material on the prototypes.

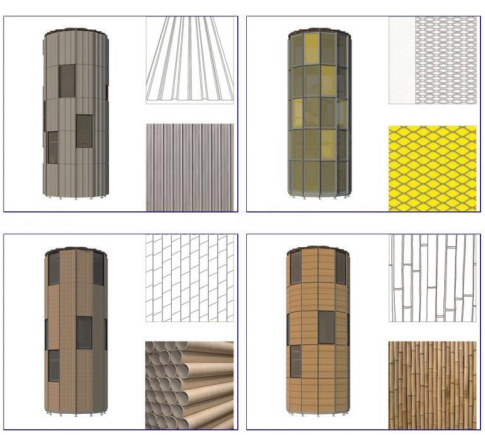


Figure 35: Volu-te material alternatives

59. VOLU-TE Living Stairs, Micro Living Unit Book, p. 44-45. Available at: https://aap.mef.edu.tr/ (Accessed: 07.05.2022)

Ciudad Abierta/Open City says that construction cannot be independent of the location. The construction process and tools should be considered according to the potentials of the place. Every prototype from this point of view always teaches its builder something new with changing places.

Post-construction

Architecture is not a process that ends when the construction is completed. It includes the post-construction story of the full-scale space. User feedback on the resulting space and architectural product is remarkable. Because, with these feedbacks, the accuracy of what is done in the design and construction process is tested. 1:1 scale prototypes offer the opportunity to experience the space with all perceptions without waiting for post-construction. But there is a critical point to be noted. The architectural object lives in its context. It changes with its users. Appadurai explains locality through the concept of "mobile space". In his opinion, the relations with the place are in constant motion and dynamic.[60] With this theoretical basis, context is a complex network related to current conditions. The architectural product is built again every time in the particularity of history. Opportunities, design while building, and processes open to change ambiguate the defined context. As a result, every architectural practice produced establishes its own "new context" with changing times and every new different condition. This approach allows us to question the purposes of producing out-of-context prototypes to develop the project.

In this section, the relationship of the prototypes produced with Design-Build Programs to the context, how they are affected by the context during construction, and how the building will continue to live will be questioned. In this direction, the following information has been obtained from the interviews with the programs.

AA Hooke Park Interview, Mohammad Omar Eqbal's Answer:

2. sp. q. How would you explain the importance of the concepts of "Experimental Architecture" for architectural education?

60. Arjun Appadurai, " Modernity at Large: Cultural Dimensions of Globalization", 1996.

Experimental architecture is very important in education because we are away from the realities of budget and client satisfaction, this is the time for crazy experiments as much as possible. Experimentation is the way to find out your calling to architecture. Design and construction is a vast field, finding your niche, where one performs their natural best can only be found through experimentation. While experimenting we come to a territory in architecture that leads to finding something new and innovative.

ITKE Stuttgart University Interview, Okan Başnak's Answer:

1. sp. q. What does the post-construction process mean to you?

In our program, we firstly focus on the development of the manufacturing process. So, the post-construction process was a concern only at the theoretical level. However, with achieving the advancements in the fabrication process, the focus gradually shifts toward the actual functionality of a building. Our pavilion is meant to be used by people for several years for the first time in ITECH. That's why in addition to the material-production system development, we address the standard architectural requirements like creating a water-tight closed envelope with a skin.

Rural Studio Interview, Judith Seaman's Answer:

1. sp. q. In the project you produced as part of the 2020 20K HOME Master Program, you emphasize that architecture should be reshaped with changing needs. From this perspective, what does Post-Construction mean to you?

In our studies within the scope of the 2020 20K HOME Master Program, the projects we have built in previous years have been reconsidered with today's conditions. With the approach that spaces change according to human needs and buildings live, we attach importance to the post-production process.

Ciudad Abierta/Open City Interview, Prof. Christian Hermansen Cordua and Anders Svendsen Almesveen's Answers:

1. sp. q. How would you describe the Experimentation Phase of your

education process, which you define as “Thinking, Research, and Experimentation”?

CH: Experimentation occurs during the design process. We begin with every student developing an individual project, we then vote for the projects with the most potential, thus reducing the projects to half. We do this 3 or 4 times until we chose the project to be built.

AS: As I recall, most of the experimentation process was trying out different parametric models in Rhino and Grasshopper, combined with Archicad and physical modeling to test both rigidity/stability, expression, and building/assembly level. It needed to be relatively easy to assemble and be flexible for changes in material/adjustments to site etc…

MEF FADA DBS/AAP Interview, Prof. Dr. Arda İnceoğlu’s Answer:

1. sp. q. What does the post-construction process mean to you?

In fact, it is not possible for us to follow up with how the project continues its life after the construction process. But it would be instructive to learn how it was used and how it was transformed.

AA Hooke Park and Ciudad Abierta/Open City often emphasize the concept of “experimentation” in their work. In the interviews with these programs, they were asked what this concept means for their programs. Both programs said that it is possible to make more suitable and more accurate designs by “experimentation”. They stated that they used this method in the pre-construction and construction process, not in the post-construction process. This situation can be achieved by incorporating prototypes into the design and construction process.

ITKE Stuttgart University and MEF FADA DBS/AAP programs stated that the life cycles of post-construction prototypes could not be followed. MEF FADA DBS said that context is important when designing, while ITKE Stuttgart University said that they usually produce prototypes independent of location. Rural Studio states that the current environmental conditions are an important input for their design. They care about how projects live with changing users and conditions in the post-construction process. Studies in 2020 20K HOME Master Program support this approach.

Interdisciplinary conciliatory actors

> In reality, architecture has become too important to be left to architects. A real metamorphosis is necessary to develop new characteristics in the practice of architecture and new behavior patterns in its authors: therefore all barriers between builders and users must be abolished, so that building and using become two different parts of the same planning process. Therefore the intrinsic aggressiveness of architecture and the forced passivity of the user must dissolve in a condition of creative and decisional equivalence where each—with a different specific impact—is the architect, and every architectural event—regardless of who conceives it and carries it out—is considered architecture. [61]

For a long time, the profession of architecture has gone out of a state where the architect knows everything, has mastered all the issues in the design process and decides on his own. Throughout the history of architecture, the architect's technical and all-in-one knowledge that is unreachable and uniqueness has changed in the current methods of performing. Therefore, the architect's role as a "legislator" has evolved as a "mediator". Nowadays, Uğur Tanyeli analyzes these two concepts as follows; "being a legislator" is placed on two supports. The first is that the architect has knowledge of building and space, and the second is that the architect is obliged to serve the community with this knowledge. But this situation (although denied) was used to work as "the pen in the hands of society-power". Consequently, the role of the legislator has lost its credibility. Being a "mediator" represents a kind of reconciliation between information and activity domains. The architect has become a link for many of the fields involved in the design process (project, human, environment, engineering, etc.).[62]

The changing situation of the architect shows that architectural education should also be questioned. Architectural education does not only need theoretical knowledge of individual processes. The multi-layered and interactive current state of architecture must exist in the education system. The education process on campus should be moved to other areas. This is a rehearsal of the "real" and "instructive" potentials that the architect will meet in his professional life.

61. Giancarlo de Carlo, "Architecture's Public" 1971, p.13.

62. UğurTanyeli, " Biçimi Değil Süreci Tasarlamak", 2017, p. 314-316 .

Today, this situation has shown itself not only in architecture but also in many production-oriented areas. Many products offered today cannot be managed by the designer alone and cannot emerge spontaneously through a process isolated from other disciplines. The expansion of the field of information and its boundaries has turned the design into a multi-input state. In this context, every object emerging in architecture has become an interactive process with many participants. In particular, the fact that its user is also in the design process has improved the situation of the living space.

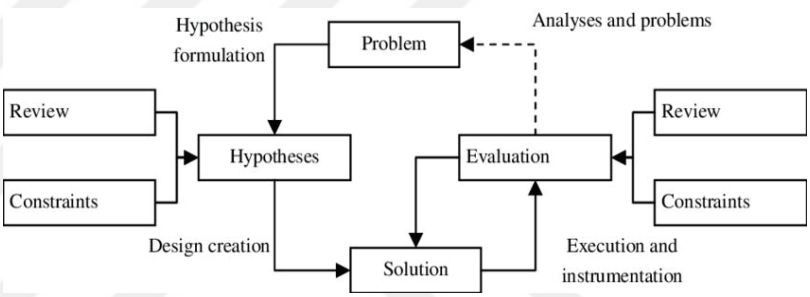


Figure 36: Collective design hypothesis formulation and correction process inspired by (Christofol, 1995; Falzon and Darses, 1992)

Prototypes produced in Design-Build programs do not belong to a single designer. Many participants are involved in the construction process and before the construction process. Designs are put forward in teams. It is not the result of a single truth, a subjective opinion. Student groups and lecturers work together to develop the design. In this way, information is shared and multiplied. It is ensured that the graduated architects are responsible and suitable for teamwork.

Project: URBACH TOWER Year: 2019 Participants: ITKE-ICD TEAM	Project: WAKEFORD HALL LIBRARY SKELETON Year: 2018 Participants: 6 STUDENTS	Project: 2020 20K HOME Year: 2020 Participants: 3 STUDENTS	Project: HOSPEDERIA DE LAS ALAS Year 2012 Participants: 5+21 STUDENTS	Project: VOLU-TE Year: 2020 Participants: 10 STUDENTS
Project: ELYTRA FILAMENT PAVILION Year: 2016 Participants: ITKE-ICD TEAM	Project: WOOD CHIP BARN Year: 2016 Participants: 5 STUDENTS	Project: THERMAL MASS & BUOYANCY VENTILATION Year: 2020 Participants: 4 STUDENTS	Project: LAS PIEDRAS DEL CIELO Year: 2012 Participants: 11+15 STUDENTS	Project: MEDITERRANEAN TRIANGLE Year: 2017 Participants: 10 STUDENTS
Project: LANDESGARTENSCHAU EXHIBTION HALL Year: 2014 Participants: ITKE/ICD/IIGS TEAM	Project: COCOON Year: 2012 Participants: 4 STUDENTS	Project: LIONS PARK SCOUT HUT Year: 2012 Participants: 4 STUDENTS	Project: WALK THE LINE Year: 2012 Participants: 4+16+20 STUDENTS	Project: THE BRIDGE TO THE DREAMS Year: 2015 Participants: 22 STUDENTS

Table 7: Participating students of the Design-Build Programs case studies

The situation is no different during the construction process. The process is open to participants from different disciplines and users' ideas and experiences. In addition, students are in the position of practitioners and

decision makers, not spectators during the construction. In this section, the position of the architect, the changing participants in the process, and their roles in these architectural programs will be questioned. In this direction, the following information was obtained from the interviews with the programs.

Question 2: Who are the participants in your construction process?

AA Hooke Park Interview, Mohammad Omar Eqbal's Answer:
Group mates, all the Master's projects at AA Hooke Park are done in groups of 3 or 4. There is the workshop manager who is a person with a wealth of knowledge and also the forster with whom we communicate to source our materials. In addition, there are the site manager who mills the freshly cut wooden logs and handles telly handler and power vehicles for movement of materials and the canteen staff for us to keep us healthy and well-fed. Also, there is a director under whose leadership the project progresses.

ITKE Stuttgart University Interview, Okan Başnak's Answer:
In our group, there were 22 architects, 6 civil engineers, 1 environmental engineer, 1 materials engineer, 2 industrial design, and 1 art undergraduate, a total of 33 students. The process was managed by 4 assistants and 2 instructors. In addition, there was a fiber company engaged in the manufacture. Unlike other years, the University of Freiburg joined our process as a client.

2. sp. q. What are the positive and negative aspects of the "Cross-Disciplinary" work that you have emphasized especially for architecture and engineering in your architectural education?

The process was very difficult for all of us, but the result was positive. Having received my undergraduate education as a civil engineer, I saw how different disciplines work. The fact that the participating students were from 22 different countries was also effective.

Rural Studio Interview, Judith Seaman's Answer:
The vast majority of building work is done by the students. They arrive with little to no experience with construction. This is preferable as it

gives the Studio the opportunity to build a foundation of respect for tools and materials and instill good building practices. Faculty and staff are present to guide, but not necessarily prevent failure. Often the greatest lessons students learn are in failing and improving, they will nearly always do it faster and better the next time around.

2. sp. q. How does the involvement of the user in the design process affect the architect's role in design?

If by the user you mean the client, it varies by project. Our community projects are geared towards the specific needs of our local residents and neighbors. However, their needs often are representative of rural Southern communities across the Black Belt region and other low-wealth rural areas. In housing projects, the homes are typically completed as research projects and treated as "spec homes." While the client's needs are accounted for, the house is not designed only for that individual. We design for the needs of a demographic, family structure, or community into which our client fits. After this student design process, the faculty research branch of Rural Studio, Front Porch Initiative, steps in to adapt the home design for distribution to further rural, suburban, and urban communities.

Ciudad Abierta/Open City Interview, Prof. Christian Hermansen Cordua and Anders Svendsen Almesveen's Answers:
CH: Our students do all the construction process; we seldom employ anyone from outside the studio.
AS: There were 6 students from our program but 1 or 2 students from the tree project joined us during the construction phase in Chile. Several of the Chilean students also were a part of the building team.

MEF FADA DBS/AAP Interview, Prof. Dr. Arda İnceoğlu's Answer:
They are usually our "hosts" we are designing the project for who have requested the project, local government, non-governmental organizations or foundations, students, and professors, as well as assistant students that we have just started to include in the DBS program in the process.

2. sp. q. What opportunities do collaborating with different disciplines in the "real world" offer architecture students?

I would call it "real situations, real people, real places" rather than "real world". In school, we produce things that are mostly a simulation, but through construction, we can address the needs and problems of real people through design.

As a result of the interviews, all of the programs carry out the pre-construction and construction process with a focus on students. While the number of participating students varies between 3-40, the course instructors follow the studies. During the design, it is worked with the consciousness of the builder. Students undertake many different tasks at every stage, from design to construction.

AA Hooke Park builds its projects with co-participants who support the work in the program's own woodland. ITKE Stuttgart University includes students from many different disciplines. They argue that this situation has nutritive potentials. Rural Studio allows its students to live in low-wealth rural areas where projects will be built during the construction phase. The aim here is to produce by understanding user needs and conditions, beyond doing architecture. User(s) are also participants in the process. Tanju emphasizes that it is a very critical action for architecture for those who do not have the experience of living in a house that meets the standards to express their demands regarding the space and to be participants.[63]

63. Bülent Tanju, "Mimarlık ve Toplumsal Sorumluluk", 2003, p.53-55.

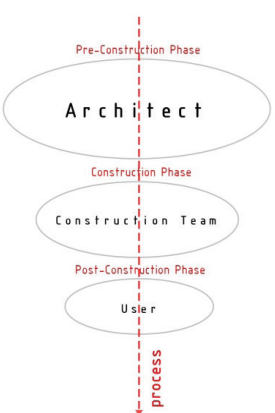


Figure 37: Traditional actors-process diagram

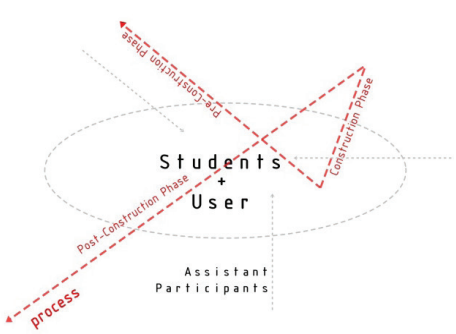


Figure 38: Rural Studio actors-process diagram

Ciudad Abierta/Open City expresses that the coexistence of students from different schools and geographies offers instructive opportunities. MEF FADA DBS/AAP programs tell students that construction creates a chance to face reality.

In summary, prototypes produced during the design and construction phases of Design-Build programs do not belong to a single architect. Moreover, project producers are not architects either. It is the result of the work of multiple student groups, with the participants nurturing the process. The aim is to draw lessons from the process, beyond making a finished building. Beyond the concept of "architecture without architecture", it repeatedly questions the current role of the architect. Additionally, prototypes provide a compromise between space, needy users, and technology (material and method). It offers the possibilities of designing by testing and learning by building, thanks to the opportunity to experience.

Tools as medium

If the only tool you have is a hammer, it's hard to eat spaghetti. [64]

In the Oxford dictionary, the word "tool" is first defined as *any instrument of manual operation* and *anything used in the manner of a tool; a thing (concrete or abstract) with which some operation is performed; a means of effecting something; an instrument* [65] is added to this definition. The word "tool" does not just mean a concrete tool, it also encompasses a method for things to be designed.

In 1980, Beck explained the criteria for "tools" with four items: First, an object must be used to do something or change the state of the environment or the user. Latter, the object must be outside and independent of the user. Third, the user must carry or hold the object while using it. Finally, the user should be responsible for the effective orientation of the object.[66] Preston defends the invalidity of this definition made by Beck. Because, according to Beck's definition, a chimpanzee that breaks a walnut with a stone is defined as a tool, while this situation is excluded since the earth cannot be a tool when it breaks the walnut by hitting the ground. He proposes to replace "tool" with "equipment" in English, in order to be able to describe an inherent tool use.[67]

64. David Allen, Refer to: Roxanne Calder, "The employable toolkit", 2022. Inside: Employable: 7 attributes to assure your working future, Part III, Major Street Publishing.

65. ''Tool''. Oxford Dictionary, Available at: https://ezproxy.mef.edu.tr:2313/search?searchType=dictionary&q=tool&_searchBtn=Search, (Accessed: 20.02.2022).

66. Benjamin Beck, "Animal Tool Behavior: The Use And Manufacture of Tools by Animals", 1980.

67. Beth Preston, "Cognition and Tool Use", 1998, p. 513-547.

Identifying the tool to be used in design practice is very important for understanding design. It is critical to frame the definition of the term "tool" used here. The concept of "tool" mentioned does not simply represent what we use when designing. It also includes the concepts of "mean" and "vehicle".[68] In other words, it is the thinking channel that mediates between the information and the product. Design tools allow the mind to think more creatively during design. In this context, when architectural design tools are mentioned, not only paper, pencil, computer, etc., but also many inputs and methods that cause/help to develop the design should be included. Considering this close relationship between design and design tools, evaluating design based on the process rather than the final product means a situation that increases the importance of design tools. Design tools are equivalent to the uniqueness of design and take a special shape to each design. It is not a previously known method that is applied in the same way every time. From this point of view, in this section, it is aimed to discuss the role of design tools in architectural education and to analyze the status of design tools, their usage patterns, and their relations with the designed product through the prototypes that emerged in the selected Design-Build programs. In this direction, the following information has been obtained from the interviews with the programs.

68. Sait Ali Köknar, "Understanding Designing Through a Tool Based World View", (2009)

Question 3: What tools do you use in the pre-construction and construction process?

AA Hooke Park Interview, Mohammad Omar Eqbal's Answer:

Pre-Construction process tools:

- Paper, pen, colors
- Rhino, Grasshopper
- Scaled physical models
- Mock-ups and prototypes when required
- 3D printers (very rarely)

Construction process tools:

- Construction drawing Printouts In 2D form separated into pieces
- Material schedule and quantity (to provide the workshop manager so that they instruct us where to source it from)
- Processing the material like planning, cutting, and marking the materials according to assembly logic

- Prepping the site for a support system
- If the cut is very unique or something that cannot be precisely done by us then we use an industrial robotic arm. This requires 3D scanning the material entirely to bring inside Rhino in point cloud form, then generating the G_codes for the robot to cut the piece (this requires careful pre-testing in the digital environment as we have to check the robot is not moving abruptly
- According to the size of the piece, we either carry it by trolley or telly handler to the site location

ITKE Stuttgart University Interview, Okan Başnak's Answer:
Although models (nails and threads were used to understand the fiber material in the models) during the pre-construction process, I can say that the computer is the most important tool for us. Programs such as Rhino and Grasshopper were used for the design; we used Google Docs for presentations and communication.
During the construction process, parts of the project were created using robotic arms. The parts coming to the construction site were lifted with the help of a crane and mounted using screws and drills.

3. sp. q. You often mention the concepts of "Technology", "Digital Manufacturing", "Computational Design" etc. in your projects. How do these concepts affect your prototypes?

We think that the construction industry should be adapted to developing technologies. Prototypes are our field of the experiment from this point of view.

Rural Studio Interview, Judith Seaman's Answer:
Mock-ups are just part of the highly iterative process that students go through in designing Rural Studio projects. Before prototyping, they have reviews with visiting critics on a near-weekly basis for several months. By bringing in outside voices, they get the benefit of a range of expertise and experiences to apply to their projects. Our visiting consultants include structural engineers, lighting designers, accessibility experts, detail fiends, interior designers, and environmental researchers. They give feedback through both the

design and construction phases, as students are still making design decisions every day while building.

Ciudad Abierta/Open City Interview, Prof. Christian Hermansen Cordua and Anders Svendsen Almesveen's Answers:

CH: We use hand tools, both manual and electric in the construction process.

AS: In addition to computer programs such as Archicad, Rhino, and Grasshopper, we also use hand drawings in the pre-construction process.

MEF FADA DBS/AAP Interview, Prof. Dr. Arda İnceoğlu's Answer:

Since our DBS program includes first-year undergraduate students, we start the design with sketches and physical models. Digital models were also started to be made with the assistant students involved in the process. For the AAP program, the stages are proceeding in similar ways. Computers are added to tools such as manual drawings and models.

In our DBS program, simple tools such as nails, screws, and hammers as well as power tools are used during the construction process. Students are allowed to use simple tools but power tools are used by instructors.

The well-known and used from time immemorial tools for design such as paper and pencil continue their effective existence today. In Design-Build programs, these have been major tools that started the work. Moreover, all programs emphasized that they produced prototypes through physical models to develop their designs during the pre-construction phase. In addition, all other programs, except Rural Studio, mentioned the importance of technology for the tools used during the pre-construction phase. They said that they produced computer-aided virtual prototypes using programs such as Archicad, Rhino, and Grasshopper. Since the students are building the construction, care is taken to ensure that there are easy-to-use tools that do not require a professional.

AA Hooke Park and ITKE Stuttgart University said that the use of robotic arms during the construction process affected the design. Rural Studio stated that the tools will change according to the conditions, that they use

more traditional tools while designing, and that their tools have diversified according to expert feedback during construction. MEF FADA DBS/AAP has revealed that the tools to be used in the design will vary according to the experience level of the student groups carrying out the studies.

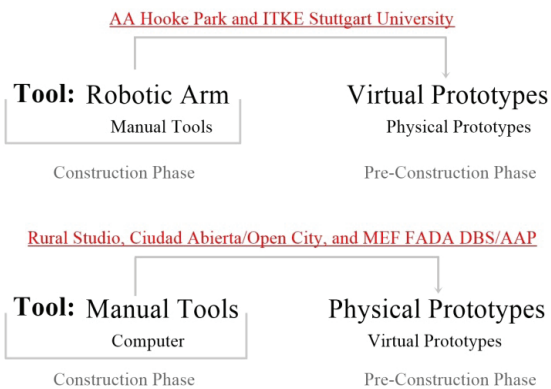


Figure 39: Tools-process diagram

Knowing with which tools the construction will be built is effective in determining what are the prototypes produced to improve the design at the pre-construction stage. For example, AA Hooke Park and ITKE Stuttgart University specifically mention the need to produce prototypes in the design virtual environment, as robotic workers will be used in construction.

Results and Discussion

In today's conditions, the role of the architect and architectural product has changed. The responsibility of the architect to have knowledge of structure and space and to present it to the society has become a role that has been assigned to him over time. However, in today's conditions, developing technologies, diversified materials, changing construction systems, etc. have directly affected the field of knowledge of architecture. Therefore, the "know-it-all" position of the architect has turned into a position that not only has the knowledge, but also knows how to learn and interpret knowledge, establishes a strategy, and provides a reconciliation between different disciplines. The architectural product, on the other hand, has become a very complex and multi-participant system. Design, construction, and experience are no longer sequential actions that begin when the previous one ends. Within the framework of these two headings, it is critical to rethink architecture and question how to respond to this situation. While these rethinking and questioning are being made, it is very important to consider architecture from its foundation, that is, from architectural education. In this research, some contemporary architectural problems are discussed through architectural education. Today, in many architectural schools, students usually finish their projects at the design stage with the theoretical training given. Many projects that remain on the paper plane may be insufficient at the point of facing reality. Conversely, incorporating construction and experience into learning offers a lot of potentials. ''Building a building'' is not the main purpose of construction-oriented education models. Uncovering the knowledge of the process by experimenting is essential. It is learned by building. In this method, which focuses on the process and experience, the end product is not important. Therefore, each construction practice is treated as a prototype.

The prototype is described in dictionaries as the first working example, often used in industrial design and engineering to check the efficiency and success of the product. Prototypes, which were obligatory in patent applications as proof of inventions and ideas in the past, have become the product development method of large companies such as Google, Apple, Samsung, Tesla, and Airbnb, which adopt the Design Thinking approach today. But in architecture, prototypes are produced for different purposes when they

are not part of mass production. It provides advantages beyond the quality control of materials, structures, etc. systems. While bringing theory and practice closer together, it also acts as a mediator between different disciplines. Prototyping, which offers the opportunity to encounter different situations, can therefore be used as a tool in architectural education.

In summary, by questioning the architectural object and the position of the architect changing with today's conditions and technologies, the starting point of this research is to build prototypes in response to the hypothesis that architecture is a process where strategies should be produced rather than a goal focused on ''making perfect buildings''. Prototypes that create multi-input and multi-layered processes in architectural education are frequently used in Design-Build Programs. Therefore, the basis of this research was established within the framework of this concept.

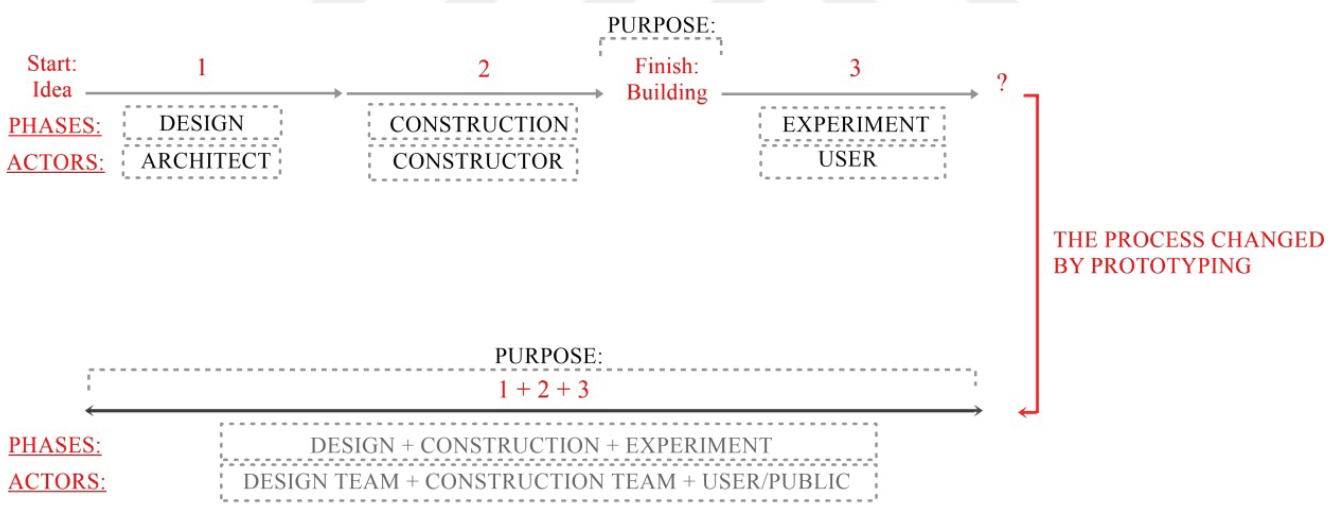


Figure 40: Diagram of the process changed by prototyping

Prototyping does not divide the process into the design, build and experiment, it is holistic. Construction continues simultaneously with the design and experiment phase. Prototypes are experienced with all the perceptions of the body, determinations are made, and accordingly the construction changes, the design changes. This is the main point that separates the prototype from 3d models and augmented/virtual reality applications that are being used with developing technologies. In addition to this virtual environment, models and mock-ups continued to exist effectively in order to embody ideas in architecture and architectural education. Prototypes are more inclusive forms of models and mock-ups. It is not partial and not a simulation.

That's why "real" experienceable spaces are created. It increases sharing in the education process by creating interactive environments. These shares are not only between the student and the teacher but the user or the public is also involved in the process. In conclusion, the role of the prototype for the architectural product can be summarized as show-try-publicize.

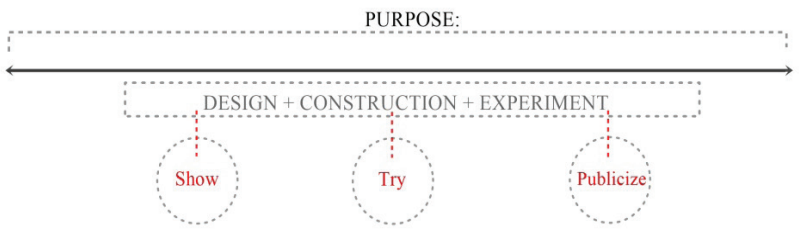


Figure 41: The role of prototyping for architecture

Show means that the product is a representation tool in which technology, aesthetics, etc. are exhibited, try means a performance measurement tool, and publicize means a persuasion tool. Prototype brings together a draft that is still in the design process, not a finished architectural product, to the public. It gives the user the right to have a say. In addition to all these, students gain applied problem-solving knowledge and skills of learning by doing. Learning by doing deals with problem-solving by establishing strategies, not results-oriented.

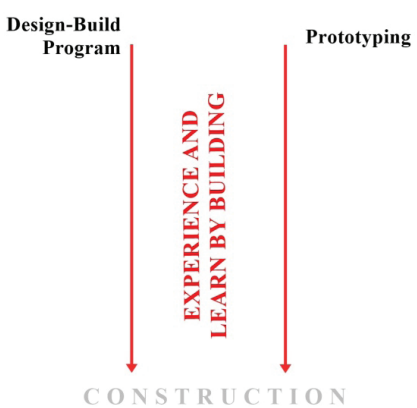


Figure 42: Design-Build Program- prototype diagram

Based on these theoretical discourses, architectural programs that include construction in their curriculum and aim to learn by building have been examined. Accordingly, five programs from different geographies, AA Hooke Park, ITKE University of Stuttgart, Rural Studio, Ciudad Abierta/Open City, and

MEF FADA DBS/AAP, were selected. It is desired to investigate how programs with similar perspectives interpret the concepts they emphasize in common in different environments. It has been discussed whether the works that emerged in these programs, which focus on the process and the potentials offered by the process, not the architectural object that will emerge at the end of the construction, can be examples of prototyping. In this direction, it was said that prototypes were used to develop the architectural product in all five programs with the questions asked. AA Hooke Park, ITKE Stuttgart University, and MEF AAP Programs stated that the final products that emerged as a result of their studies could also be an example of prototyping. In line with these interviews and the definition of prototyping focused on experience, process, and knowledge of the process, the purpose of the studies put forward in the Design-Build Programs and the role of prototyping for architecture were matched. These similar approaches have been interpreted as prototypes in Design-Build Programs, not only for the models made for product development but also for the final products built by the programs.

Attributed to the idea that prototyping examples of the works done in Design-Build Programs can be assumed, the build-oriented processes of these programs and the participants of the process; actors, and tools were explored. Understanding the process was considered important to reveal the role of prototyping in architectural education. In this context, by taking references from the case studies of the programs, questions about pre-construction, construction, and post-construction were asked.

Designing an architectural product to be built may require many different prototyping studies during the design process. For example, testing the structural system, deciding on the material selection, determining the construction method, etc. As a result of the interviews, all five programs stated that they produced physical prototypes at different scales in the pre-construction phase. AA Hooke Park and ITKE Stuttgart University emphasized the importance of technology for case studies and said that they also produced digital prototypes. Accordingly, it was concluded that the prototype had physical and virtual prototypes at different scales in the pre-construction phase. Today, although the abundance of tools for design makes it easier to produce representations that enable understanding of the final product, it may not provide access to the knowledge to be learned by experiencing it during the construction phase. With construction, its participants are offered the opportunity to face experience and reality. It is clear that the 1:1 scale

prototypes laid out in the construction phase are a serious learning-by-doing method for the actors of the process. And from this situation, each actor learns his/her own knowledge. The product of architecture continues its existence in an existing environment. It lives as a part of nature or the city. It shapes with context and changes the context. It is important for the experience to follow the relations of the prototype with its environment after construction and the state of the prototype that emerges over time. Information from the Design-Build Programs is that this can not possible except for Rural Studio. However, in order to achieve successful results from prototypes, it is critical to ensure the continuity of experimentation in the post-construction phase.

Since student groups produce prototypes in Design-Build Programs, the process is shared and interactive. It helps conscious, high-aware, and responsible architects graduate. The actors of the case studies selected for Ciudad Abierta/Open City are Chilean and Norwegian students. Even the coexistence of students from different schools and geographies provides opportunities for education. Moreover, there is potential to involve actors from different disciplines in the process. Rural Studio says that by including the user among the actors of the process, they can think differently and build prototypes more appropriately in line with the needs. Starting from the fact that it is not possible for architecture to be under the pen of only one architect in today's conditions, the actors of the prototypes produced in Design-Build Programs are able to work as a team and mediate between different disciplines.

Determining which tools will be used before and during the construction phase indicates what kind of prototypes will be needed in product development. AA Hooke Park and ITKE Stuttgart University emphasize the importance of producing virtual prototypes when designing, as they use high-tech tools in construction. MEF FADA AAP has included in its VOLU-TE Living Stairs book that alternative prototypes can be created with alternative tools. As a result, a tool is not just equipment. It is a method that provides the transition between idea and practice.

Findings:

The incorporation of prototyping as a component in the overall system of architectural design and education projects the following propositions, as findings of this study:

1. Prototyping in architecture has an apparent difference, in comparison to the field of engineering and technology. Prototypes might serve as the ultimate outcome of a design process, as observed in Design-Build Programs in architectural education. (see section Thinking by the prototype)
2. Prototyping in architecture is an integral part of the design process, rather than acting as test articles, configured to streamline mass production and use as in engineering systems.
3. Architects act as negotiators in the prototyping process between different fields of expertise. This provides precious experience to the participants in architectural education.
4. Design-Build Programs in architectural education are a viable medium to make good use of prototyping in the design process, highlighting the following features:
    - Multi-disciplinary design and production experience
    - Inclusive structure, where users observe and contribute to the architectural design and production process
    - Holistic understanding of the architectural design and production process, where design production-experience does not necessarily line up, as in conventional systems
5. Prototypes in architecture provide a tangible and easily comprehensible medium of user experience observations, differing from yet-inadequate digital simulation platforms.

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Image References

Figure 1. Prototyping stages and design diagram (Created by Ebru Şahinkaya Bucak).

Figure 2. Illustration of a Drebbel (Credit: ullstein bild/ Getty Images), Available at: https://www.history.com/news/9-groundbreaking-early-submarines [Date of Access: 10.01.2022].

Figure 3. Available at: https://www.sciencephoto. com/media/492350/view/cornelius-drebbel-s-submarine-artwork [Date of Access: 10.01.2022].

Figure 4. Reconstruction of Drebbel's submarine by Mark Edwards, 2001, Available at: https://www.researchgate.net/publication/339505556_History_of_Fire [Date of Access: 10.01.2022].

Figure 5. Available at: https://drawingdatabase.com/ford-model-t/ [Date of Access: 20.01.2022].

Figure 6. Available at: https://en.wikipedia.org/wiki/Ford_Model_T [Date of Access: 20.01.2022].

Figure 7. Available at: https://www.blendspace.com/lessons/XiB6azfOcCRjSA/model-t-mass-production [Date of Access: 20.01.2022].

Figure 8. Diagram without prototype (Created by Ebru Şahinkaya Bucak).

Figure 9. Diagram with prototype (Created by Ebru Şahinkaya Bucak).

Figure 10. Available at: https://www.behance.net/williamroot [Date of Access: 20.01.2022].

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Figure 16. Design Thinking steps new diagram, Hasso Plattner Design Institute, 2019.

Figure 17. Available at: https://99percentinvisible.org/episode/la-sagrada-familia-2/ [Date of Access: 28.01.2022].

Figure 18. Available at: https://tr.wikipedia.org/wiki/Vladimir_Tatlin [Date of Access: 28.01.2022].

Attachments

	PRE-CONSTRUCTION		CONSTRUCTION			POST-CONSTRUCTION	
	Analyses and Production	Post-Production	Structural System	Material	Method of Building	Using	Context
Project: FREE FORM STEAMBENDING Year: 2020 Participants: 3 STUDENTS							
Project: WAKEFORD HALL LIBRARY SKELETON Year: 2018 Participants: 6 STUDENTS							
Project: WOOD CHIP BARN Year: 2016 Participants: 5 STUDENTS							

AA HOOKE PARK- Case Studies

	PRE-CONSTRUCTION		CONSTRUCTION			POST-CONSTRUCTION	
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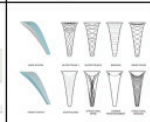
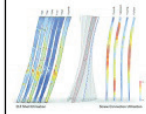
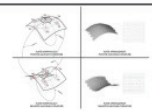
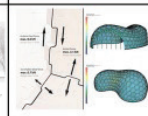
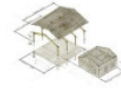
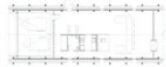
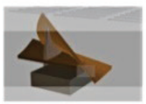
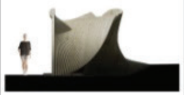
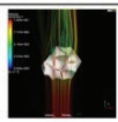
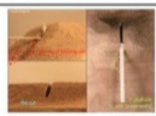
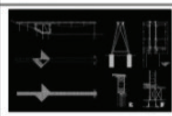
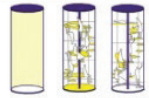
Project: LIVMATS PAVILION Year: 2021 Participants: ITKE-ICD TEAM							
Project: URBACH TOWER Year: 2019 Participants: ITKE-ICD TEAM							
Project: LANDESGARTENSCHAU EXHIBTION HALL Year: 2014 Participants: ITKE/ICD/IIGS TEAM							

	PRE-CONSTRUCTION		CONSTRUCTION			POST-CONSTRUCTION	
	Analyses and Production	Post-Production	Structural System	Material	Method of Building	Using	Context
Project: 2020 20K HOME Year: 2020 Participants: 3 STUDENTS							
Project: THERMAL MASS & BUOYANCY VENTILATION Year: 2020 Participants: 4 STUDENTS							
Project: LIONS PARK SCOUT HUT Year: 2012 Participants: 4 STUDENTS							

	PRE-CONSTRUCTION		CONSTRUCTION			POST-CONSTRUCTION	
	Analyses and Production	Post-Production	Structural System	Material	Method of Building	Using	Context
Project: HOSPEDERIA DE LAS ALAS Year 2012 Participants: 5+21 STUDENTS							
Project: LAS PIEDRAS DEL CIELO Year: 2012 Participants: 11+15 STUDENTS							
Project: WALK THE LINE Year: 2012 Participants: 4+16+20 STUDENTS							

	PRE-CONSTRUCTION		CONSTRUCTION			POST-CONSTRUCTION	
	Analyses and Production	Post-Production	Structural System	Material	Method of Building	Using	Context
Project: VOLU-TE Year: 2020 Participants: 10 STUDENTS							
Project: MEDITERRANEAN TRIANGLE Year: 2017 Participants: 10 STUDENTS							
Project: THE BRIDGE TO THE DREAMS Year: 2015 Participants: 22 STUDENTS