MATERIALITY as a PROCESS involves both art and science.

As materiality is a process that starts with the ideation and ends up with the tangible object, we may focus on the process of materiality within the frame of alternative architectural design/making process, places and designers, (teams, people, etc.).
This alternative process may be observed in the context of a school studio, an architectural office or the construction site, with the people involved considering the changing conditions of architecture (technology, industry, culture, globalization, etc.)
An academic may tell us about his/her specific materiality studio methodology while a practicing architect may reflect on his office approach to design/making process or on site construction definition. Or a person that is both practicing and academic may tell us the differences and similarities of both material processes.

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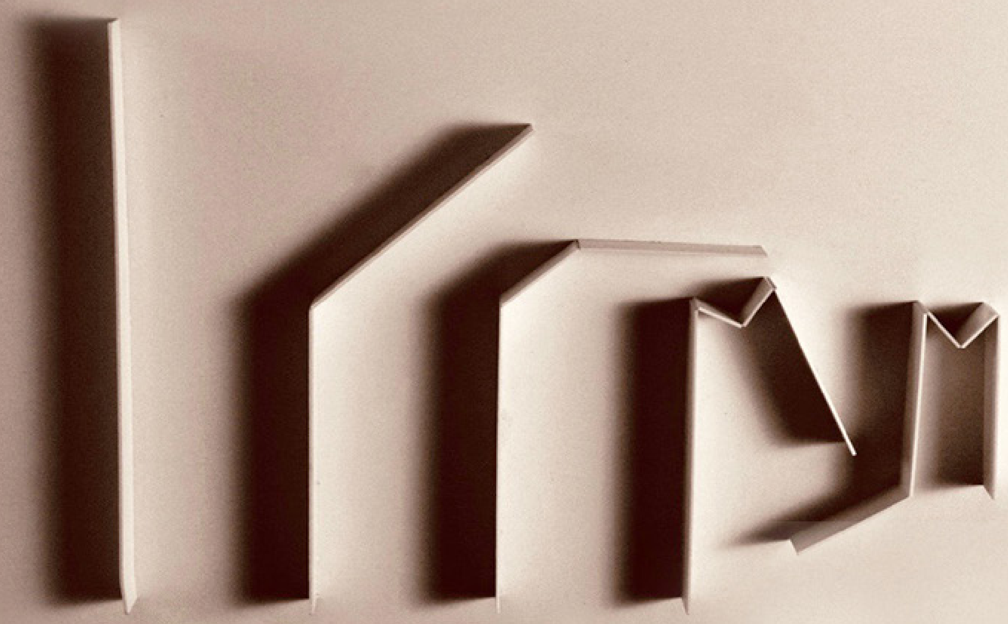
Editors
MANUEL COUCEIRO DA COSTA
BÁRBARA FORMIGA
GÜNSU MERIN ABBAS

MATERIALITY as a process

caleidoscópio

MATERIALITY
as a process



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MATERIALITY AS A PROCESS

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MATERIALITY as a process

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PEER REVIEW

CONTENTS

FOREWORD

Our concern is research about architectural design, but using only these words broad approach, larger than our goal.

Bringing more specificity to the theme, we can say that the upgrading of the understanding of the creative process or architects is continuous path, with many possible alternatives according to era, to the core of the context, to personality/experience of the author(s), and so on.

Two main feature in our case brought as focus for this book, interconnecting research being developed in the Faculty of Architecture, University of Lisbon (FAUL), namely in a research project designated as "The Architectural Design Process as Research", allocated at CIAUD (Centro de Investigação em Arquitectura, Urbanismo e Design- FAUL Research Center) and research within an Erasmus + program, which is "MATERIART: The Art and Science of Materiality in Architectural Design Education", whose partners are Department of Architecture, TOBB University of Economics and Technology Faculty of Architecture/ Turkey, FAUL/ Portugal, Department of Architecture, University of Thessaly/ Greece, Department of Built Environment, Eindhoven University of Technology/ the Netherlands and Department of Architecture, Istanbul Technical University/ Turkey. MATERIART includes a set of events, being one of them Symposium- "Materiality as a Process", held at FAUL in April 2019.

Those two features are, namely:

- within the FAUL project, the concern about the similarities and differences in architectural design research vs. scientific research in general, including the acknowledgment of the dialectic between a still dominant technocratic discourse governed by the quantitative rather than qualitative methods, against the more poetical notion of time, concept of Kairos in ancient

Greek world, that refers to the right and opportune moment, representing the advantages of a favorable occasion, process that admits trial and error.

- within the MATERIART program, the concept of materiality, including tectonics/ways of doing/thinking of architecture face technical, aesthetic and cultural implications of the emerging digital technologies, communication technologies and materialities.

The synergies between those two features turn explicit through the Symposium "Materiality as a Process", which was organized as a scientific event with call for papers and double-peer reviewing.

This book, whose chapters are the articles, considering the set of different approached was then subdivided into four parts, namely Architectural Design Epistemology, Materials and Built Architecture, Materiality in Research/Innovation and Materiality in Architectural Education, which in themselves constitute a contribute for the understanding of the architectural design process in a broader synthesis of the group of contributors in the process/event.

The editors are thankful to all those that through their work contributed for the book.

Lisbon, 12 April 2019

Manuel Jorge Couceiro da Costa/
Associate Professor-FAUL

ARCHITECTURAL DESIGN EPISTEMOLOGY

THE PHYSICAL CONSTRUCTION OF ARCHITECTURE

The end of physical space, and the beginning of the end for architecture

Bernardo Vaz Pinto
Department of Architecture and Urbanism, Lusófona University, Lisbon, Portugal

ABSTRACT

I would like to argue that physical materiality should become today the central objective of architecture as a discipline.
Not because, as it is easily understood, the physical construction of any artifact as always obliged the transformation of thought into material results, but more importantly, because the physical construction of architecture has become a specific characteristic of the discipline, in a society that prefers appearance over presence, virtual and simulated appearance over physical presence.
Because architecture is no longer alone in the spatial simulation and projection of the future. We can even argue that the most impressive and even seductive simulations of the future spaces and built environments are no longer architectural in themselves. In other words, physical construction has become architecture's unique core today. Design, to use the anglo-saxon term, or projetare to use the latin one, have become, more and more, processes that do not aim at physical construction, and are many times completely separated from it. We need then to ask the question: can architecture attain its fulfillment without being built? Can architecture be just simulated?
Architecture, instead of attempting to compete with a society defined and oriented by media principles, and therefore simulated and virtual, ie non-physical, needs to reassert itself as the discipline of the construction of meaningful physical spaces.
It needs to orient all its efforts to the physical artefact, to the physical materiality that surfaces out of the construction process, distancing itself from the multiple simulated realities that can appear to be more effective in many of the social and individual aims, but are nevertheless the negation of the discipline itself.
That means to invest in design and methodologies that aim at the built object, and test the result against the physical reality of the world around it. As architects, we no longer have the privilege to imagine and create representations of the future. We need to build them.

KEYWORDS

Architecture, construction, virtual, simulation, physical

From Simulated to Physical Reality

There seems to be no question about that the major social-cultural shift of the turn of the century was triggered by **electronical** and then **digital innovations.**

These transformations, (Image 1) which have been discussed within several disciplines, have influenced deeply the means of all cultural production, including architecture. I am arguing that these transformations can also be understood as the shift from physical reality to mediated and simulated realities.

In terms of the social cultural changes, Castells' Network Society, and subsequent "information age"[1], or Alvin Tofler's The Third Wave,[2] to mentioned only two well-known works, refer to this new and unexpected electronic capacity to transform society´s "modus operandi". There also seems to be no question that the "turbo" capitalism"[3], the free market society, and the Global village syndrome, all have been in part a result of a society that shifted from a **mechanical industrialized mass production mode**, to a **globalized electronic customized one**.

Nicholas Negroponte "Being Digital", of 1995, seems to assume these changes as fact: it is not only the dramatic transformations of processes of cultural production but **we,** human beings have become more and more dependent on the **non-physical**, on the **non-material** reality.

Negroponte defines it quite specifically as the transformation that occurs "from **atoms** to **bits**."

In the field of architecture, Peter Eisenman was one of the first to understand this, calling it the "shift from the mechanical to the electronic,"[4] a socio-cultural shift that would influence from then the production of architecture.

In his own words "the electronic paradigm directs a powerful challenge to architecture because it defines reality in terms of media and simulation, it values appearance over existence".

I would add, and relating to the theme of this talk, that the electronic era values the **non-physical** realities over **physical ones.**

So the electronic revolution of the last decades of the twentieth century has created the possibility of architecture without physical results without physical buildings: architecture becomes the construction of virtual space, and physical reality becomes substituted by the simulacrum of virtual reality.(Image 2 and 3)

While trying to compete with a society defined and oriented by media principles, dazzled with the power of the simulated image, architecture can become more a process of communication and marketing, that does not see the physical output as the ultimate goal of the discipline. (Image 4)

Not only we see an ever-growing competition scenario that do not include the construction of the building itself, but concentrates all efforts in the "realistic representation" of the building.

We seem to be losing the capacity to understand the built object as reference for the whole process.

Can architecture attain its fulfillment without being built? Simply can architecture be just simulated? (Image 5)

A Change of Paradigm?

If we accept that the electronic and digital transformations have deeply transform the discipline of architecture, what were in fact those transformations, and can we talk about a change of paradigm?

If we take the definition of paradigm defined by Thomas Kuhn in his work *The Structure of Scientific Revolutions* (1962), we will need to accept that a "scientific revolution" took place. A new way of understanding the world seems to have come into being. In architecture we will have to accept that the process, production and construction of architecture have changed to a point that earlier modes would easily become forgotten or erased.

Referring to architecture Mario Carpo has asked the question in his book *The Alphabet and the Algorithm,* in an attempt to clarify what has really been transformed in the process and the construction of architecture.[5]

Although the author does not give a clear definite answer, he later advanced with the idea of a second digital revolution as the step from machines that "make" to machines that "think".

I would argue that the transformations have been enormous, paradigmatic, in the process of what we can call today "Digital Design": New ways of representing, simulating architectural concepts, also the possibility of the characterizing new unprecedented forms of extreme complexity. (Image 6 and 7)

Paradoxically, since architecture is also centered on the **results**, the physical existence of architecture has changed much less, and in more subtle ways. Also the transformation of a society into a mediatized common ground has pushed architecture to become media itself, image, representation, anticipated reality, simulated concept. So we might argue that yes there was a change in parading in the process of Digital Design[6], but not a change in the construction of architecture.

Architecture of the non-Physical

I borrowed this image from Tcshumi,(Image 8) in an attempt to, once again, reconsider **architecture's role** in today's society, or as Tcshumi pointed out architecture's "common ground". As a social discipline architecture needs to interfere and be transformed by the "world outside", by society, it needs to address the central conditions of the social cultural context where it flourishes.

But it has also to become specific to its inner logic, so it does not become totally consumed by the "zeitgeist". How then can architecture represent the non-physical? That which needs not to be physically built? An dhow can it retain intrinsic meaning, separated from the world of media, and assume its physical materiality?

If architecture is **reduced to media**[7], if architecture is reduced to sophisticated representations and simulations of the world, it is competing with other disciplines that can do it better, like advertising, cinema, video, electronic games, and virtual reality itself.(Image 9, 10 and 11)

I would like to propose that architecture still needs to center its object within the specificities of the discipline. Today, materiality in Architecture relates directly to its construction, to its physical construction, since it is here that the discipline assumes its unique specificity.

With the real possibility of the building of "places with no space"[8], architecture's role has to include the **physical construction of meaningful spaces.** This seems to be the unique role of architecture, one that is being directly challenged by the enormous electronic transformations of society, where every commodity seems to have become nonphysical. (Image 13)

Physical construction today has become **architecture's unique core**, while *design* in Anglo Saxon word, or the *Projetare* in the latin counterpart, have become for many architectures a process that does not aim at physical construction, therefore, competing with other disciplines that do not aim to build.

So we can simulate architecture but we need to concentrate on the construction of architecture, or even the simulation of construction.

This is the new possibility given by BIM technologies, but strangely enough not yet understood by so many architects, which in turn remained **seduced by the new sensuous virtual simulations**. Simulations that have no relationship to its construction

To concentrate on the construction, on the physical construction of architecture, an effort that has more to do with architecture specific character than to the mediated aspects of society. (Image 14)

We need to test the reality of architecture, taking its experience further that just the eye/ear experience that seems to be overwhelmingly present in our mediated society.

As Juhani Pallasmaa as so well argued in his book *The Eyes of the Skin*[9], since modernity, but particularly in our present times, the sense of vision, by itself, has been strengthen by numerous technological inventions and apparatus.

Architecture: A New Autonomy

It should be clear by now that I am arguing for a new **autonomy** in architecture. An architecture that assumes its intrinsic characteristics, of which the **construction of physical meaningful spaces** shall be a central one, as it is able to **accept** and **relate** to the world outside.

I will propose, somehow provocatively, some topics where I believe this architecture is gaining terrain. Obviously, these topics relate directly, but in opposition, with some of the examples we discussed before.

The question of MEMORY and Architectural HISTORY

The transformations we have been referring to have altered profoundly the way we look at history, at the memory of what has been, and why it has been.

There is no reference, no precedent and no Typology that can used from the past: there is really no precedent for electronic and parametric algorithmic architecture besides itself. (Image 15)

The question of Geometry and Proportion

Earlier modes of projecting and characterizing architecture have fall short in the understanding and characterizing some new examples of architecture. There is no proportion or even geometry code for us to analyze some works of architecture, there is no accepted standard that can be used for a larger and wider understanding of the work.

Nevertheless, both geometry and proportion have help giving meaning to architecture, relating it to other works to specific aspects of construction and so on. (Image 16)

The question of the Physical Experience

We are surrounded by images of architecture but not by architecture necessarily. In other words, most of the architecture represented in images will never be built, or will be built in a different way that the way it was first presented. Taken the theoretical concept of Carlos Marti Aris, where he refers that certain layers of knowledge and information are like the formwork used to build an arch, after the concrete is settled, we do not need the formwork any longer. Now we can invert this view point: what about architecture that cannot be represented? But only experienced?

With the real experience of most buildings, we do not need the understanding of the process: we just experience the result, independently from the technology used in the development of the process and even the construction.

The question of the construction detail

There is an enormous difference between the simulation of architecture and the simulation of construction.

Not because, as it is easily understood, the physical construction of any artifact is in itself a result of the materials used in its processes and the materials that define its completion, but more importantly because the physical construction of architecture has become its single characteristic opposed to all the other architectures that do not seek or aim the architectural process to be its physical construction. Construction details and its knowledge and expertise is becoming a way of testing the capacity of ideas to be built (Image 17).

The question of New Functions / The question of place

Most architecture is globalized and identical; as iphones are identical, cars are identical, and tv screens are identical, whether we are in Singapore or Rome.

Even more interestingly most architecture looks identical independently form its program. The evolution of programs has also shown that more hybrid, general functions, usually including cultural thematic, have become similar and undifferentiated (Image 18).

The question of Sustainable energy

Whenever we look at the works of architecture that can be identified with an architecture of the digital, an architecture multiplicity[10], of the algorithm, we have a sense of complexity that in many cases goes against the inner logic of the sustainable process of construction. Instead of using technology for the process and for the representation and the simulation of architecture, we should be using technology for the sustainable construction of architecture (Image 19, 20 and 21).

Conclusion

Architecture today, instead of wasting effort in trying to compete with a society defined and oriented by media principles, can become more and more the "discipline of construction", separating itself from other idiosyncratic processes that do not seek the physical output as the ultimate meaning of the discipline.

We know it can do this by taking advantage of new technologies, especially BIM processes, which create intelligent and parametric models that can quantify and predefined all aspects of construction, as well as provide a full "realistic" view of the architectural outcome.

Also is seems to be clear that the importance of **process** over the **end result**, so characteristic of the first generation of "digital" architects, was very much a result of architects who could not, or did not want to build; and resulted in the first serious symptom of the shift from construction of physical reality, to the simulation of virtual materiality.

It is no longer sufficient to imagine and anticipate the architecture work, we need to concentrate on its construction so we can experience and test the results, especially when we understand that we live in an individualized, idiosyncratic society, which Koolhaas has defined has the "a society of comfort that took over the society challenge".

On the other hand, we are living in a " virtual" world, one that **substitutes** and **re-creates** physical reality by other **nonphysical** cultural constructions. They can be varied as long as they are not physical, as in Baudrillard's influenced movie Matrix: they are **real but not necessarily physical**.

So going back to my first statement I believe that architecture needs to re assert itself as the discipline for the construction of meaningful a (social) space. So it needs to orient all its efforts to the physical artefact, distance itself from the multiple simulated realities that can appear to be more effective in our individual aims, but are nevertheless the negation of the discipline itself.

That means to invest in design and methodologies that aim the built object, the built result as its main objective, that means to test the result against the conceptual ideas that defined it, and not to trust the result as a variation or a concept of the process itself.

But architecture can and shall do what it has done always: to propose solutions for society's problems. To participate with other disciplines and players, in the finding of physical solutions that can make life better to people.

IMAGES, CHARTS OR GRAPHICS LEGENDS

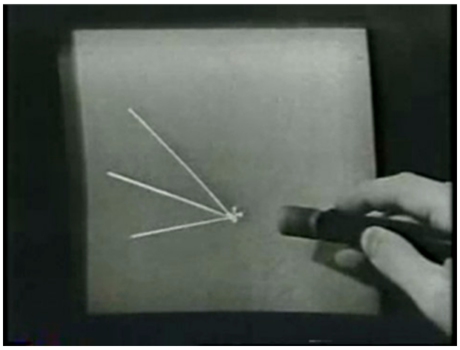

Image 1 - The Sketchpad, Ivan Sutherland.

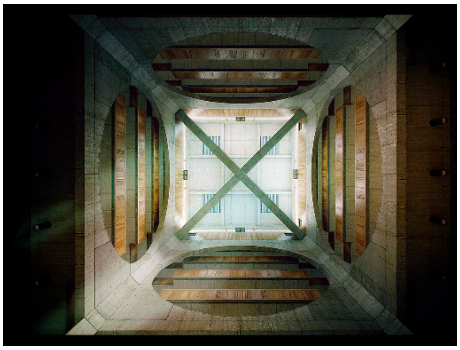

Image 2 - Exeter Library Virtual, Alex Roman

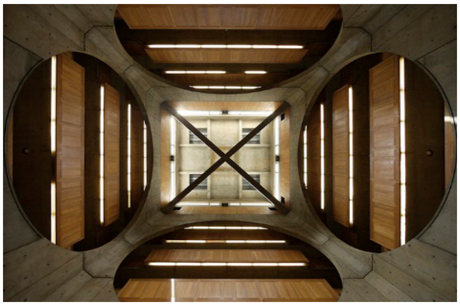

Image 3 - Exeter Library Photograph, A&T Research Group.

Image 4 - Greg Lynn, Embryological House, Thomas Mangaro.

Image 5 - Tomasso Casucci, Design Boom.

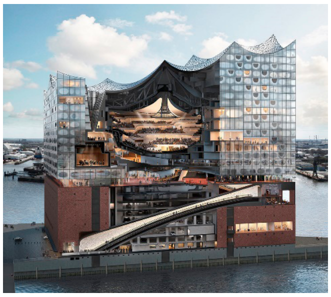

Image 6 - Hamburg Opera House, Simulation, Herzog Meuron, Archdaily

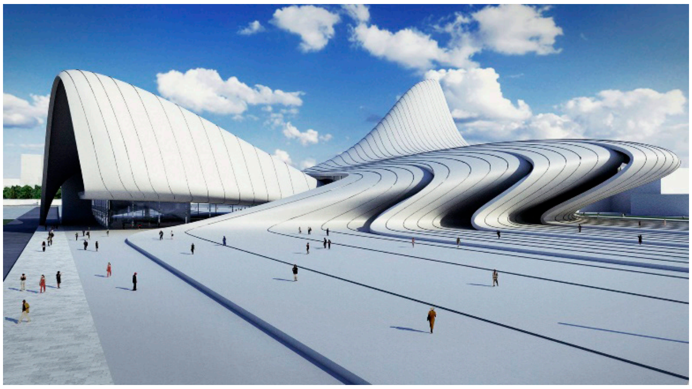

Image 7 - Hayded Aylev Centre, Zaha Hadid, Archdaily

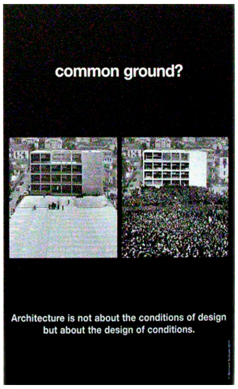

Image 8 - Bernard Tshumi, Common Ground, Diary of Knowledge.

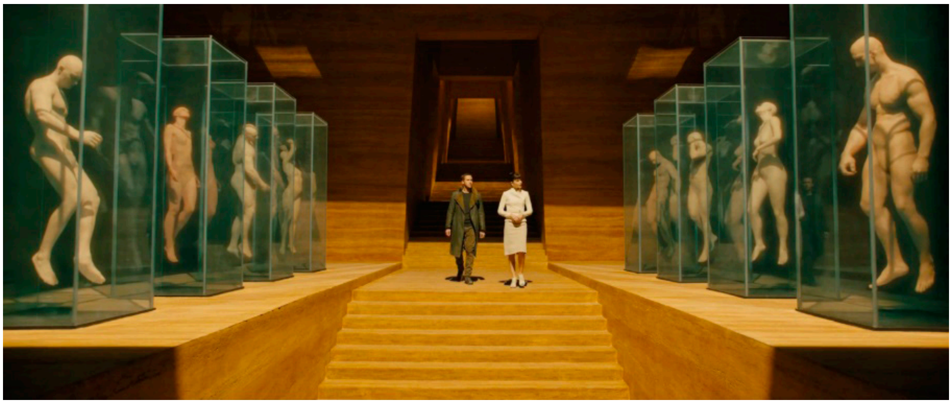

Image 9 - Blade Runner 2049, The Bleader Arquive, 2017

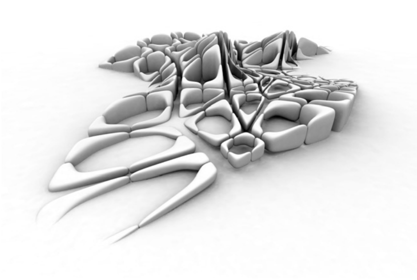

Image 10 - Kartal-Pendik Masterplan, Istanbul, Zaha Hadid Architcets.

Image 11 - US Open Golf , Live VR, NextVR, 2015.

Image 12 - Hayded Aylev Centre, Zaha Hadid, Archdaily

Image 13 - Andrey Tarkovsky , Still form the movie Nostalgia, youtube.

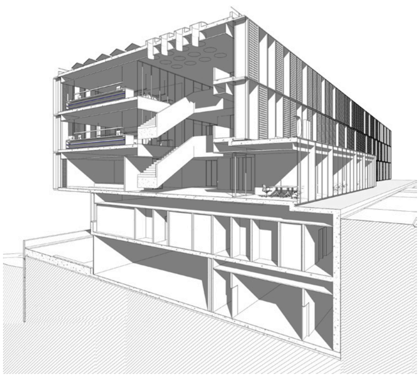

Image 14 - Biomed III, Lisbon Design Studio..

Image 15 - Paula Rego Museum, Souto de Moura, Author's photograph.

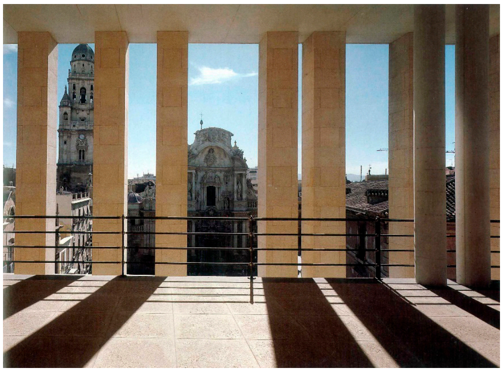

Image 16 - Murcia Town Hall, Rafael Moneo, Middleton Van Jonker.

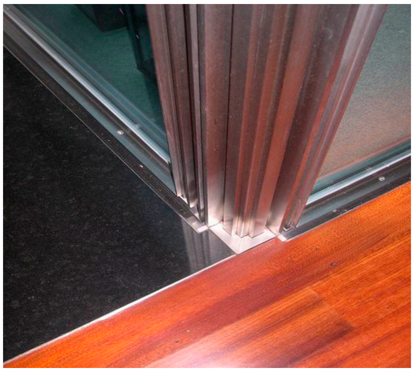

Image 17 - Private House, Souto de Moura, Author's photograph.

Image 18 - Private House, Rahul Menrothra

Image 19 - House for Elephant Caretaker, Rahul Menrothra

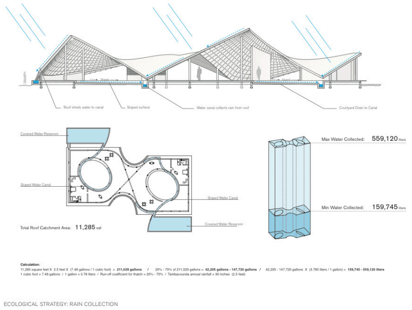

Image 20 and 21 - Cultural Centre, Senegal, Toshico Mori, Archidaily.

ENDNOTE

1 Castells, M. (2000). *The Rise of the Network Society*. Cambridge: Blackwell Publishers.
2 Toffler, A. (1980). *The Third Wave*. Bantam Books.
3 I am referring to the concept defined by Edward Luttwak in his book *Turbo Capitalism: Winners and Losers in the Global Economy*. (2000). Harper and Collins
4 Eisenman, P. (1992). *Visions of Unfolding: Architecture in the Age of Electronic Media*. Domus Magazine, Nº 734.
5 Carpo, M. (2011). *The alphabet and the Algorithm.* Cambridge: MIT press.
6 I am referring to Rivka Oxman definition of Digital Design , in Design Studies, Vol 27, No 3, May 2006.
7 I am referring to Peter Eisenman's article in Casabella, entitled : *Insignare Architectura*: *Sei Punti* . Domus Magazine, N769, p3-5.
8 I am referring to Negroponte's concept, presented in his book*, Being Digital.*
9 Pallasmaa, J. (2005). *The Eyes of The Skin.* London: Wiley.
10 I am referring to Schumacher' definition in his manifest for a new style, *Parametricism*.

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INVOLVING HUMAN SENSES IN THE PROCESS OF MATERIALITY

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Mimar Sinan Fine Arts University

ABSTRACT

With the evolution of technology, we are witnessing a progress in the building and designing methods in architecture, whereas physical involvement is decreasing more and more.
While the whole attention is directed to the final look of the building the in between process is left second hand.
If the first step towards building is the idea, and the last step involves experiencing it, then the middle and most important one should be forming the idea and materializing it. If this materiality process is remarkably substantial, then what is the proper way to teach it or learn from it?
The importance of the human senses in the architectural environment have been boldly emphasized, especially in translating human experiences and feelings that this places cause.
This study conducted by an descriptive method and literature review in the matter describes the usage of sensories during the material process. Using human senses as focus point, the study examines the development of this model, benefits and outcomes. Moreover, vision, hearing, touch, smell, taste (more or less), will help to interpret materialization and form. As a result of applying senses in the material process, we might be able to make the building transfer us some of those feelings and experiences since, every action has a reaction.
The idea behind this paper is to provoke new models of teaching and working in the process of creating the built environment and to highlight the importance and effect of senses in it.

KEYWORDS

Senses, materiality, architecture, building process, sensory input.

Introduction

The interest for the final look of the building has led on a total oblivion of the processes shaping it. For decades, one of the most popular ideas in architecture has been that beauty is the most important feature. As a consequence, architecture has been transformed into a tool for "pleasing the eye".

Yet, is it beauty all we need? Is it beauty a concrete feature or a state of mind? (Zumthor, 2011, pg.122).

An alternative approach to the problem is to give attention to the materialization process and to make it more human. In order to reach such results, we should teach to feel architecture.

To this end, I emphasize the necessity of using sensory inputs, examine each materiality process and the benefits that the senses give in each of them and show how the end product with be more than beauty pleasing. This access enables raising awareness of the need of the sensories especially in the architectural education schools. Furthermore, it developes physical connection between the creator and the building.

By using the descriptive method, the paper provides a new perspective for the sensory input, it creates a solid theory framework and it makes a user prospect for every level of the building process.

Senses, architecture, and crafts

From all the senses, in architecture the vision is the most used. The eyesight it is considered as the easiest method for capturing information whereas the eye the sensory that notices beauty.

Previous researches have confirmed that vision is the leading sense. The following fact is pointed out first by Plato (Pallasmaa, 1994) given that in Greek Architecture it is the eye that initiates any kind of communication between the other sensories (Pallasmaa, 2018, pg.32). Correspondingly, the eye observes and makes the other senses work.

The vision is accompanied by four other senses: hearing, touch, smell and taste. Steiner confirms the existence of at least 12 senses, while Pallasmaa adds equilibrium and kinesthetic as senses that are helpful in the human body (Pallasmaa, 2018, pg.50-51).

All of the five senses receive information with the help of the receptors. Each one uses different information which help people on remembering and gaining knowledge in a faster way.

In this paper as helpful tools for describing the materialization processes will be examined only the basic five senses.

The use of the senses first has been addressed as craftsmanship, the art of using hands and touch for creating art. The importance of crafts and training have been highlighted in the Bauhaus school of architecture, where such classes have been a must take for the students attending the school (Droste, 2015). Hence, the Bauhaus can be considered as one of the most important steps leading the architecture education towards the usage of senses.

Following the example of the Bauhaus, students nowadays should again learn to cope with senses and feelings, the outcome of which will result in more human and functional buildings.

One of the simplest ways of tackling this problem is to investigate each materiality process and the sensory methods used. These processes begin with a thought (idea) and are induced by observation, drawing, building and experiencing the end result.

The thought or idea is the abstract act which is based on beauty. The first thought relates mostly on aesthetics, the “sense of beauty” or the plasticity of the building. The process does not involve the usage of any of the basic senses.

Nevertheless, the real use of the sensory organs starts with observing.

Observing

Architecture can be seen, heard, and smelled. Everything that surrounds us has a voice and a story to tell and experiencing the space and materials before building it will offer better outcomes.

All along the aim is to gather information and to know the surrounding.Consequently, the observation starts with eyesight. The eye sees but, the eye wants to hear. The eye leads and starts with the hearing.

Everything around us has a sound, houses, objects, nature, streets and towns, and we listen to them just like an audience listens to a symphony (Lefebvre, 2004, pg.22).

Lefebvre (2004) in *Rhythmanalysis: Space, Time and Everyday Life*, explains the perspective of a window viewer overlooking a street junction in Paris. The viewer hidden behind a building observes the space, and the bodies using it. Even though the author makes an analyze of the rhythm of the street, he puts in light the importance of the sensories for observation. The noise caused by the traffic or the passers, the smell of the trees and nature.

The surrounding and every material has a story to tell us, a help to give through the sound, echo, shape, geometry and smell.

The smell can create a special body memory by creating time layers of the place. Even though it is invisible, can invoke emotions and can remember events. By using it, we can remember better the attributes of the place, for instance, the smell of the freshly baked bread signifies the existence of a bakery nearby.

On this basis, the senses work as an organizing whole that cannot work as separate. They create their own memory and remember everything (Pallasmaa, 2009). But, again the eye leads and the eye wants to touch.

With a touch the texture and the weight of the object can be felt and by it the history of the material can be learned. The touch can also help to understand the shape, texture and temperature. These kind of touching can provoke even emotions and make the person remember better the object by connecting it to an event or place.

The tactile senses do most of the observation work and make the hand one of the most important information collectors.

Planning - The hand draws, the hand feels

According to Pallasmaa the skin is the main referee between the body and building (Pallasmaa, 2018). The skin is the oldest of all the organs and it is the main material constituting all of the senses. Nevertheless, the skin it is only associated with the tactile senses.

In the past the ability of people to build, to hunt, or to fish was seen in the hand (Pallasmaa, 2018, pg.73) and afterwards it was connected with the crafts, and building.

The hand touches and the touch shows intimacy. With the physical interaction between the hand and an object (material), the tactile senses are awoken and in this way information are gathered.

However, all the magic work of the hand was shifted away with the developement of high technologies. Now, the hand is used as a tool to use the computer and not as an element useful in architecture, whereas the drawing process is seen as the most important step in the materialization process. What is missed nowadays is the hands ability to touch and feel.

Building – Vision, touch, smell and hearing

The work of the tactile senses should not end with the drawing stage.

Passing from the planning (drawing) to the building phase requires connecting all the knowledge the senses have gathered and transmitting them to the building.

In this phase begins the observation of the materials, shapes and textures. One way to achieve this aim is to use all the sensory organs especially touch and vision. The eye is perceiving distance while the touch intimacy and caring (Pallasmaa, 2018, pg.56).

By touching it can be felt the structure of the material, the qualities of space, scale and measure (Pallasmaa, 1994).

The hand helps to choose the right material being it warm or cold, a thing it cannot be learned without the help of the tactile senses. Alvar Aalto used the phenomenology and human cognition senses in creating some of its masterpieces. He knew what material is needed to be used where. In the opinion of whom, the wood fence creates a warm feeling and makes the building more human and satisfying for the user, whereas the metal fence gives the feeling of distance, and coldness (Williams Goldhagen, 2007).

However, the usage of new technologies is alienating people from this physical involvement. The high tech equipment creates distance between the creator and the object by reducing the sensory usage to the minimum or, what is the worst case to none (Pallasmaa, 1994). By doing so the building process loses the connection with the body. If feelings and care are not transmitted during this process than, what feelings will the building transmit later to us?

The eye sees, the hand touches, the nose smells and the ear listens. Every material, shape and texture speaks. Moreover, architecture should express the pleasure of the senses and this will come into account when we experience the ending results, the building.

Experiencing the built

"To experience architecture in a concrete way means to touch it, to see it, to hear and to smell it." (Zumthor, 2011).

The last phase is a conglomerate of all the care and affection that is given through all the phases until the completion. As a result, the product can be felt and tasted.

Taste is the sense which does not have many common points with architecture still, it can be provoked by certain colors and forms. Subsequently, it is common to provoke feelings in this phase alone.

The building should be thought as a chain of reactions where the effort of the senses can be felt at last. Now, the architecture will come into life and can be experienced.

The building will transfer all the feelings that has been given to it during the materialization phases.

By observing the surrounding, the building is in consistency with it, while the inspection of the materials and the knowledge gained from them will make it more pleasend for the users. The cooperation of the senses throughout all the processes results into a pleasent building environment.

Conclusion

The methods considered in this paper are all used to inform of the asset that the senses can be.

In summary, this paper argues the importance of the sensories during the materialization of architecture. As a result, is presented the act of each one of them in the observation, planning, building and in experiencing the built environment.

The implication of this research shows that in architecture not only the end and beauty but, all the materiality phasess should be valuable.

The main point here is not on how we perceive the physical world, but on how we should use the senses to help us create a better architecture. Overall, this method will improve the connection between the builder and the building, hence will raise the consciousness of the usage of the senses especially in the new generations who will deal with architecture. They should become part of each process and feel it.

Another important point drawn here is the ability of the senses to collect information and to remember, a fact which is confirmed by Pallasmaa, Zumthor, Holl and cited in this paper several times.

Further studies on the matter should investigate the possibility of senses to help in the developement of new technologies and to enable the collection of information from the sensory input to a digital model.

IMAGES, CHARTS OR GRAPHICS LEGENDS

Image 1 - Using vision as the only sense (Lidja Jahollari)

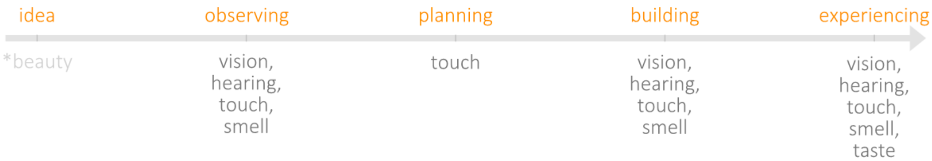

Image 2 - Senses used in each materiality phase (Gremina Elmazi)

Image 3 · Observing materials (Lidja Jahollari)

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DOMESTIC ASSEMBLAGE (DO_AS): RECIPES FOR THE MAKING OF BUILDINGS

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ABSTRACT

How can we critically approach the separation between the design and construction of a built installation on the one hand, and the separation of construction from the performance of living on the other? Design and construction follow prototypes that are produced by cultural clichés and the construction industry. On the other hand, the performance of living creates living space-time through the use of organic and inorganic materials, objects, and apparatuses for the household metabolism. Can architecture intervene between objective space and subjective living and form a practice of shaping everyday living?
We introduce the imperative "making" in order to bridge the practice of shaping an inhabitable space through the practice of cooking. "Making a building", as a metonymy for "Designing and constructing a Building" consists of the use of different building materials assembled and articulated to shape the buildings' body. Making a useful object, such as a piece of furniture, assembles and articulates matter to host the body in living modes. Making a meal, that is cooking, is also a process of material assemblage and articulation. Can all these layers of making be understood integrally as parts of one practice which is living per se?
Borrowing the term "recipe" from gastronomy, we look upon practices for shaping architectural space in a performative manner. As an alternative to patterns and typologies, "recipes" are used as a method of making a built construction and understanding this process of making per se. We are going to develop the method of building several building installations by the use of recipes by describing the building process of each different built installation separately, one by one. The description considers building as a process of making, through recipes. We formulate recipes to describe several installations as processes of building and finally we will come, by the same means, to analyze the process of designing and building the House "Monochord".
I*n most of the examples for building structures described in the paper, one can see how a single element like a brick, a straw bale, a cement brick, a piece of marble can be the principle matter by which a whole structure can be shaped under the norms of*

a recipe or a protocol. This practical method is not invented now, it is a generic method extremely archaic, coming up from the oldest times, even before design was introduced as a preliminary stage for construction. Nevertheless what is claimed is the fact that introducing recipes for the formation of structural units, such as the bricks presupposes an approach that questions materials as such, questions the potentials of every unit of matter as if it was never used before and has to be invented anew in any attempt we make in order to use it as if it has to be used for the first time ever. In other terms a brick contains all potentials we have never thought about and every time we have to invent them again.

KEYWORDS

Assemblage, recipe, protocols, building materials, making

How can we critically approach the separation between the design and construction of a built installation on the one hand, and the separation of construction from the performance of living on the other? Design and construction follow prototypes that are produced by cultural clichés and the construction industry. On the other hand, the performance of living creates living space-time through the use of organic and inorganic materials, objects, and appartuses for the household metabolism. Can architecture intervene between objective space and subjective living and form a practice of shaping everyday living?

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Borrowing the term "recipe" from gastronomy, we look upon practices for shaping architectural space in a performative manner. As an alternative to patterns and typologies, "recipes" are used as a method of making a built construction and understanding this process of making per se. We are going to develop the method of building several building installations by the use of recipes by describing the building process of each different built installation separately, one by one. The description considers building as a process of making, through recipes. We formulate recipes to describe several installations as processes of building and finally we will come, by the same means, to analyze the process of designing and building the House “Monochord”.

The Division Between Designing and the Construction Process

Wishing to look in a unified manner at the process from the conception to the construction of an object, we submit to questioning the fundamental representational tool of architecture which is none other than architectural design. We consider design not in itself, as a linguistic manifestation, but as a means of communication aiming at construction. This submitting to questioning does not aspire to replace or repeal such a powerful means of communication as the design. The design’s usefulness is confirmed by the fact of the architect sitting at his office, in front of his PC, and his conception of the building being realized out there, in the construction site, with the construction materials, hands and tools of the subjects of labor engaged in its realization. This dimension between the subject which plans and the subject which implements, the division of labor, cannot be subsumed under theoretical hypotheses. Nor is the issue at stake here a question about the redistribution of the division of labor, the separation and effects of power, although it should be. But I believe that this questioning of the distance separating design from material construction can be posited here as follows: Can a material configuration be made without the design, apart from the design or with the design as part of a process where the body of the creator plays a paramount role?

From Design to the Written Instructions

The design reproduces metric relations that concern the space of physical experience onto a space other than that of representation. Metric relations may also be described through mathematical representations or, in their simplest form, through simple arithmetic. The physicality of the represented object through the meager means of design is conveyed by the thickness of the lines and markings, not to mention three-dimensional (3D) photographic representations which, however, are no aid in the process of going from the representational field into that of realization. Three-dimensional representations remain tools of seduction, diversion and, at all events, of some kind of persuasion. As nothing is self-evident, the design's mediation in the realization of architecture is likewise not self-evident: along the vertical axis of historic depth and the geographical spread of architecture in the intercultural field. When there was still little evidence of the use of design in ancient Greek architecture, a text had been discovered in the form of a construction contract which specified in writing the form of a building under construction. The "Arsenal of Philon" (Image 1) a seaside building for the storing of ships and their equipment, was built on the basis of **written instructions** that determined construction materials, positions and the distances between them, concerning the articulation of the building's total structure. A written description, without plans, cannot describe any kind of architecture: it specifies building structures on the basis of style, repetition, the simplicity of the material unit which, by being multiplied, produces a new physical entity, the building. In place of the design, the written description codifies the ***acts*** of construction in simple and, one might say, rationalist provisions. As the structure of language dictates simple bodily actions, it does not allow for the vagueness and multiplicity of interpretations that may go with the pictorial representation of the design. This is the coded economy of the signified of a word and an ***order***, in contrast to the vagueness and complexity of the image.

Written Instructions and the Logic of Recipes

Design representations are a kind of ***instruction*** towards building. We build on the basis of a plan. The difference between building on the basis of a designed representation and building on the basis of written instructions may be clarified through an analogy, taken from the intercultural practices of the construction of daily life. In the field of cooking, the preparation of food, the use of written instructions makes clear the difference between communication at the level of pictorial representation and the level of words and language. We might consider the choice of whether we would prepare food on the basis of a photograph of the finished product or by communicating the written instructions of a recipe. (Image 2) In the one case we are offered the image of a finished concoction, while in the other the process of its preparation is described in words. In the recipe, the process is broken down into:

- selection of units of primary material in specific quantities
- management of the units (e.g. cutting, arrangement, mixing)
- temporal duration and succession of the acts of preparation.

Let us take the example of a recipe for the production of a meal, as each person has it in their own mind, and let us compare this structurally with the example of the instructions for constructing the building known as "Philon's Aresnal"[1]:

The formulation and communication of food recipes is a social practice, widely shared amongst subjects who share the experience of cooking in their daily life. With time's passing, recipes evolve not linearly but in extent, i.e. with continuous variations that make use on each occasion of the particular condition of what materials are available at the specific time or of the gastronomic preferences of the person following the instructions. This is a kind of democratic management of an information package and know-how that is constantly transformed and re-appropriated. To guard against any impression that arbitrary transference is attempted here from the world of gastronomy to that of construction, let us recall the manner in which so called vernacular architecture deals with the constructions of the shells of buildings and their typologies. In the absence of a plan, the constructor whether as a specialist (with a team of builders) or whether as the user-resident, applies a protocol of instructions with a succession of phases in the management of the construction materials, in order to give form to the final object (Image 3). It is worth pointing out here the logic of ***typology***. Typology does not concern the building's organizational principle expressed in a the kind of fixed standardization a floor plan provides. Typology concerns the succession of acts of management of the material, which is to say the process of construction. In the case in point, the verbal protocol of construction does not contain the imprint of a fixed form but concerns the organization and standardization of the construction labor. This is precisely where the analogy rests between construction and cooking. The construction protocol is nothing other but the application of a recipe. The recipe organizes the labor of the product's preparation and dictates not its final form, but the way in which it is made. Whether it's a building or a meal.

Introducing the logic of recipes as a kind of performative design for construction is neither novel nor original. But it is the understanding of a deep emerging tendency regarding the process of construction in the modern world of the digital reproduction of information; construction is very much included in this logic of production through the Internet. The pattern houses inundating the internet are nothing other than a general concession to an overall decline of the logic of the authentic plan and the uniqueness of the designed architectural object. Do you want a house designed in the style of Mies Van der Rohe? The internet offers you recipes for realizing this inauthentic ideal in a great many versions.

Domestic Assemblage

Let us return to recipes and their logic. What exactly does a cooking recipe do? It locates the materials that originate in very different worlds and will be used in the preparation of the food. Then, the quantities are defined of the materials that will be used and arranged. Immediately after that, the recipe prescribes with orders, in the imperative voice, the management of the materials through different actions both before they are cooked (chopping, slicing) and during the cooking (stirring, turning etc). This is precisely the logic of the assemblage. To assemble means to collect, to gather together some material and it simultaneously means to fit together. To fit together the gathered materials. So, as a concept, to assemble combines two related actions, to gather and to fit together. In Greek, the meaning of the word assemblage, 'synarmogi', is related to the meaning of recipe, 'syntagi'. [2] To appreciate the extent of usage of the concept of assemblage in our days, I refer to the materialist approach to history of Manuel de Landa[3], who pursues and expands the theoretical parameters of assemblage as used by Deleuze and Guattari. He proposes the understanding of historical data through a multi-faceted, network-based, multilayered approach. On the historian's desk very different materials are collected from different areas of knowledge which are assembled and fitted together in order to produce a composite, polyhedral historic discourse. It is possible to gather and fit together the materials of history, the materials of cooking and the materials of architecture with the logic of the *assemblage* which is a technique for thinking and for acting so generic, that it may be put under question by the cognitive sciences and investigated as a manner of mental processing that involves the function of memory and the mobilization of the imagination. To refer to the research of Claude Levi Strauss[4] from the 60s, he traces assemblage, using the related concept of bricolage, to the construction practices of the so-called primitives or, better, to what he termed "pensée sauvage". If, then, the logic of the assemblage refers us with nostalgia to the "pensée sauvage", as opposed to scientific-technical discourse, then we are attempting today to introduce that savage technique into the protocols of art as well as those of the so-called humanities, i.e. philosophy, anthropology and history. We do not find the work of the assemblage in the others, the savages whom we study, but we discover and appropriate it as a process and a technique within ourselves, within our own mental and physical operations.

Through fitting together, we may proceed with both theoretical and material hypotheses and constructs.

Cooking, then, as well as synthetic historiography are the performing of an assemblage. Architecture, as I wish to demonstrate below, may be the performing of an assemblage; an example ready at hand is the assemblage techniques developed by the building craftsmen of old who were managing typologies wherein were fitted architectural fragments of the historical past that were available in situ (Image 4). The collection and fitting together of the materials takes place in a unitary, indissociable process which starts with the collection of materials, assigns them into appropriate quantities and fits them together into building constructions. In the manner of the trout swimming upstream, the logic of assemblages shifts architecture from a technical-scientific process towards a kind of embodied practice. How does the architect act in an embodied way? For this embodied act to occur, the object of the architect's construction needs to be made out to the measure of his/her body, to pit itself against the body, to issue or receive orders and perform the act of architecture. How is that to happen when the act of architectural construction is subdivided into dozens, even thousands, of subject-agents of construction? Here an idea comes into play, and a challenge, of confronting architectural performance within the scale and the abilities of the performer. How? Our proposal is to explore a process of architectural performance where the architect formulates and traces the architectural issue s/he needs to solve, to their own constructional dynamics, the materials s/he gathers and has available and their inventiveness about how those are ultimately to be fitted together.

The Model (Maquette) as Construction

I hasten, therefore, to discuss the issue of the object's representation by means of the construction of a three-dimensional scale model (maquette). What is of interest here is that the **model** is the object's figure and an object itself in space, only not in its true dimensions. I would propose that we rethink the model (maquette) as the *product* of a process of construction and not as a product of the conventional application of design. Since the maquette is also the real object in a smaller size, the question is how that is constructed and not what it represents. If the maquette is the result of construction, then it could be granted autonomous status as a constructional object, become that which is really constructed: the object itself of construction. *The model is identified with the object itself and the object is but a model of itself*. In the examples we will use below, the model does not represent but, rather, is itself the object assembled-constructed. At the end of this line of reasoning, the real building is nothing other than a model of itself. And, thus, construction may be finalized with the construction of the model, not caring about the size of the real object which it describes. The construction of the maquette on the basis of construction recipes is like the preparation of a meal for fewer guests while the construction of the real object is nothing other than the application of the recipe to a larger quantity, for a greater number of guests. Let us then see some applications of this construction logic, on the basis of recipes in real scale, where in different ways, the model is itself the constructional object.

Construction Recipes – Examples

Recipe for the Construction of a Mountain with Planted Terraces

*Building Mt. Hymettus to a Metropolitan Park, Athens Architecture Biennale, Syntagma Square, Athens, 2003***.** *Model "Phyi" in Athens Conservatory, National Museum of Contemporary Art, Athens 2008* (Image 5).

The menu/program: Mountains are normally elongated folds of the earth's crust, the result of tectonic shifts of the crust's plates. The mountainous formations of the Mediterranean were often built with dry stone walls that withheld water and soil for planting.

The recipe:

- For the construction of a planted mountain in scale, we use the structural unit of the concrete plinth (40x20x15cm) and small pointed trees app. 30-40cm. in height.
- We create triangular transverse walls at a distance of 30cm. between them, creating the mountain's longitudinal shape at will.
- The serrated outline of the triangular walls receives plinths along the longitudinal axis of construction, which create the mountain's graded surface.
- The plinths are placed with the holes facing up, so they may be filled with planting soil. Trees are planted in each hole.
- The mountain is maintained by daily watering.

Recipe of the Construction of a Temporal Open-Air Amphitheater

"Dionysos' Tub. An Installation of Public Wine Pressing and Poetic Performance, Plato's Academy, Athens, 2011, National Museum of Contemporary Art (Image 6).

The menu/program: This is a public performance of grape crushing and poetic recitation at an archaeological site located in a downgraded area of central Athens.

The recipe:

- For the needs of the public performance, we distribute bales of hay, 1.20x40x50cm., in a square area of 600m^2.
- At the top of the horizontal arrangement of the bales, we place a base, also made of bales. On it a large plastic tub of 500liters issecured, for the grapes and their crushing. The must is collected to be made into wine.
- After the construction of the 'amphitheater' is performed, the grape crushing takes place with the simultaneous recitation of songs. The process is recorded.
- After the completion of the public event, the bales of the amphitheater tiers are collected and placed around the tub in a perforated arrangement, creating the monument of the performance. The recording of the action is transmitted from within the tower for visitors and passersby.

Recipe for the Construction of an Open-air Table

A marble table in the Paou Monastery Area, Pelion, 2006, Created for a public Meal, curator and artist: Maria Papadimitriou (Image 7).

The menu/program: In an agricultural area, near a marble quarry, next to a spring and under the plane trees, a public feast is organized.

The recipe:

Bales are used for the creation of a table's base, while for its surface, large marble cast-offs are selected from the surrounding area. The marble slabs, approximately one meter long and of a thickness of 5-10cm., are placed on top of perpendicular clusters of two bales, of a height of 80cm. The marble slabs are placed with a smal forklift on top of the bales. They compress the bales and a table is created with a final height of app. 75 cm. The weight of the marble slabs makes for the table's stability. In the same manner followed in reverse, after the dinner, the table is deconstructed into its constituent elements.

Recipe for the Construction of a Seat

Do_As, Domestic Assemblage, a furniture design set, Aaart Galery, Athens, 2018, Z. Kotionis (Image 8).

The menu/program: For the construction of a seat with arms, of 60x60x100cm.

The Recipe:

Materials:

- Eight bricks of 19x19x19cm.
- Two metal cables of a diameter of 14mm., one meter in length and two metallic cables, 60cm. long.
- Six slabs of a length of 60cm. and a cross-section of 9x2cm.
- A sheet of plywood, 40x40cm.
- A sheet of pvc or leather, 120cm. long and 40cm. wide
- Screws and washers for the metal cables.

The above materials are collated with the help of a manual of the IKEA type:

- After the six slabs have been drilled at the appropriate points, they are placed on the metallic cables along with the upright bricks. The metallic cables pass through the holes of the bricks.
- The materials that are run through the metallic cables, as if on a spit roast, are then secured with the screws to make the construction sturdy.
- On the strip of pvc or leather which is wrapped around the two slabs, the seat is deposited. The tightening of the screws provides the construction with solidity and the suspended seat with plasticity.

Recipe for the Construction of a Metropolitan Habitat "Multidome"

"Multidomes" Metropolitan Habitat Project for the Multitude, Benaki Museum, Athens 2012 (Image 9).

The menu/program: A plan of construction is proposed as alternative to the Greek apartment block building, which was designed for the subject of "the people" and the unit of the family. The "Multidome" menu prescribes the creation of simple structures as the abode of a new subject, the metropolitan crowd in complexes of vertical communities.

The recipe:

- Residential units 50 to 75 m^2. are represented by wooden structural bricks of 4,5x4,5x13cm.

- The bricks are placed according to the arrangement of alternating a full one with half an empty one, in an alternation of open-air and enclosed residency.
- Ways of arranging the units are sought, i.e. typologies for their vertical layout where the total construction creates a vacant space, which is the reference point of the vertical community.
- On the basis of already existing typologies from the world of architecture, e.g. amphitheatric or tower-like arrangements, or the typologies of objects, such as basket or hull, vertical constructions are created of units whose arrangement produces an overall communal vacant space.

Recipe for the Construction of a Housing Block (Hot_Camp. A Trans Urban Block)

"Hot_Camp. A Trans Urban Block", "Tomorrows", international exhibition of Onasis Foundation, Athens 2016, Nante 2019, Z. Kotionis (Image 10).

The menu/program: The creation is proposed of an urban square block of middle scale, capable of being assimilated at the outskirts of a city, to host a kind of urban-farming life for transient or semi-settled populations.

The recipe:

- On a plot of land, 50x50m., arranged comparatively spaciously, are placed residences with communal yards, spaces for house animals and small cultivations.
- The block as a whole is sheltered by a bioclimatic light canopy of a surface of 2500m^2. after the manner of a green house.
- The plot is separated into four squares of 25x25m. which make up the grid of the overall shelter with plant supports.
- For the creation of the block, at a scale of 1:25 concrete plinths are used as the basic material, of 40x20x20, which represent single-space residential units of a surface of 5x10m., and a height of 5m. for the placement of a loft.
- The units are arranged in a grid formation creating rooftop terraces, and four courtyards at ground level that communicate with one another under a single, open-air, sheltered area.

Recipe for the Creation of a Residence - The Monochord

House "Monochord", Volos-Pelion, Greece, 2015, Z. Kotionis (Image 11).

It permanently accommodates a couple with multiple hostings of friends and an extended family.

The last reference to this house which was designed and constructed with the architect's involvement in all stages of the design and construction, is an example of the practice of assemblage in architecture as described at the beginning of this argument. Essentially, the design of the residence manages multiple carry-overs, one of which prescribes the floor plan and intersection of the building based on the ancient typology of the three-naved basilica church. As in popular Byzantine construction practice, the builder engages in variations of the type on the basis of the materials available on site, so here the typology of the basilica is reconceived to include a program of residency. On the paths of this typology of the basilica, the recipe is articulated for the layout of the plan. We may call this a "Syntactical Recipe". Then, on the tissue of this syntanctical recipe and on the shell of the building, as its construction commences, part recipes are woven, in situ, without a general plan /implementation study. The problems of organization of the internal space are solved each time using the part recipes. The final style in the space of the building is restored through the fitting together of the part recipes for construction according to the scale of the body and the hand that builds.

The Syntactical Recipe:

- On a plot of land 9x15m., is placed, in accordance with the legal provisions, a free standing residence building of 11x6.90m.with a basement and three levels.
- The floor plan is tripartite with a central segment 4.30m. wide and two wings along the side, of a mixed width 1.30m. (clear 1.00m.) In the wings (the side naves of the basilica) are placed all the service spaces. In the central nave are hosted the so-called serviced spaces.
- Transversely, the building is also subdivided in three equal segments of 2.65m. On the longitudinal axis of the building, the middle segment is a perpendicular hole-atrium, along the building's entire height (or in the longitudinal section, according to the logic of a basilica with cupola)
- The two side naves or built out of enforced concrete while the middle nave is made exclusively out of wooden beams and slabs.
- First, the side naves are erected from concrete and the, the wooden box is inserted of the middle nave.
- There is no subdivision of spaces inside the residence with walls and doors but only with movable partitions.
- The materials of the semi-partitions are either soft (curtains) or permeable (reeds) or semi-transparent (polycarbonate sheets)

Part Recipes of Adjustments:

As there has been no implementation study, solutions are given through part recipes for the organization of the interior spaces which follow and modify the prescriptions of the "syntactical recipe".

- The partitions are produced on the longitudinal axis my means of a recipe, based on the sliding polycarbonate sheets.
- The partitions are produced on the transverse axis with fabric (curtains) or reeds woven onto a metallic frame.
- The staircases have three different recipes with a mixing of materials such as: slabs that have been left over from the construction of the shell, perforated grilles, ropes and metallic frame.
- Part recipes produce localizations within the residence such as the fireplace, the kitchen, the yard etc.

In the construction of the "Monochord" there is one very critical moment precisely in the transition from the implementation of the syntactical recipe to the structure's completion. In a way, once realized, the constructed shell of the basilica constitutes the model (maquette) of the building. We then enter the model and make the necessary modifications, insets, additions etc., in order for the model to become an object of residence in the particular way that this happens. The part recipes-solutions play the role of a posteriori constructional appropriation within the time of the model's maturation as from a building, it becomes a home.

Recipe for the Construction of a Tower-Gutter, "ESCAPE"

"Escape", Performance and Installation in Giorgio De Chirico Museum, Volos 2004, Z. Kotionis (Image 12).

The menu/program:

The recipe:

- We select a structural unit, the concrete plinth, of 40x20x15cm. with pumice stone as in inert material for easier use.
- We select a cooperative process for transferring the concrete plinths from the orthogonal pallets to the site of construction.
- We place on the ground the concrete plinths in circular formation. The number of the concrete plinths – at a small distance from one another – is determined by their proximity to the builder's body who remains still, at

an immovable centre and builds as far as the span of his/her arms extends from hi/hers body. The circle's diameter reaches between one and one and a half meters, depending on the builder's body.

- We repeat the rings along the height with the logic of joining two units with a gap over the middle of the unit directly below. The constructions gains in height and reaches the greatest height allowed by the setting of plinths with extended arms, which is about 2.00 to 2.20 meters.
- After the completion of the construction we observe that the builder is encased inside his/her creation. So that s/he does not damage it in order to exit, a rope ladder from a nearby tall construction is used.
- The builder escapes his/her creation by climbing on the rope ladder, with the help of a friend.

In most of the examples for building structures described in the paper, one can see how a single element like a brick, a straw bale, a cement brick, a piece of marble can be the principle matter by which a whole structure can be shaped under the norms of a recipe or a protocol. This practical method is not invented now, it is a generic method extremely archaic, coming up from the oldest times, even before design was introduced as a preliminary stage for construction. Nevertheless what is claimed is the fact that introducing recipes for the formation of structural units, such as the bricks presupposes an approach that questions materials as such, questions the potentials of every unit of matter as if it was never used before and has to be invented anew in any attempt we make in order to use it as if it has to be used for the first time ever. In other terms a brick contains all potentials we have never thought about and every time we have to invent them again.

IMAGES, CHARTS OR GRAPHICS LEGENDS

TRANSLATION

I. (l. 1–4).
Gods.

Specifications for the Arsenal of stone for naval tackling, by Euthydomus, son of Demetrius of Melite, and Philo, son of Execestides of Eleusis.

II. (l. 4–7).

[They have resolved to propose(?) that:]

An arsenal for tackling shall be built at Zeia, beginning near the propylaion which leads from the agora as one approaches from behind the shipsheds which are roofed-in together, 4 plethra in length, 55 feet in width, inclusive of (the thickness of) the walls.

III. (l. 7–15).

Excavate to a depth of 3 feet from the highest point of the area, remove the rubbish, and lay foundations upon the firm ground, raising them level and straight everywhere, in accordance with the rule. Lay foundations for the piers as well, at a distance from either wall of 15 ft., including the thickness of the piers, the number of piers in either row being 35, thus leaving a passage for the public through the middle of the arsenal 20 ft. in width between the piers; the width of the foundations shall be 4 ft. and the stones shall be placed alternately as stretchers and headers.

IV. (l. 15–19).

Build the walls and the piers of the arsenal of stone from Akte, laying a directing-course (ΕΥΘΥΝΤΗΡΙΑ) for the walls, of blocks 3 ft. wide, $^{3}/_{2}$ ft. high, and 4 ft. long, but $4^{3}/_{4}$ ft. at the angles.

V. (l. 19–26).

And upon the directing-course lay upright stones (ΟΡΘΟΣΤΑΤΑΣ) over the middle of it, 4 ft. long, $^{5}/_{2}$ ft. plus one dactyl in width, 3 ft. high – but at the angles the length depends on the dimensions of the triglyphs – leaving apertures for two doorways at either end of the arsenal, 9 ft. wide; and construct a pillar (ΜΕΤΩΠΟΝ) between the doorways at either end, 2 ft. wide and 10 ft. deep (in inward direction), and let the wall against which each door opens turn off so as to abut on the outermost pier.

VI. (l. 26–30).

Then upon the upright course build the walls of ashlars 4 ft. long, $^{5}/_{2}$ ft. wide – but the length at the angles depends on the dimensions of the triglyphs – and $^{3}/_{2}$ ft. high. Let the height of the walls above the directing-course be 27 ft., inclusive of the triglyph frieze beneath the cornice.

VII. (l. 30–34).

But let the height of the doorways (that is: above the directing-course) be 15½ ft. (scribal error; see commentary below), and place above them lintels of Pentelic marble 12 ft. long, as thick as the walls and 2 courses high; and erect doorposts of Pentelic or Hymettian marble, laying under them sills of Hymettian marble. And over the lintels place a cornice projecting 1½ ft.

72

[Θ]εο[ί].

[Σ]υγγραφαὶ τῆς σκευοθήκης τῆς λιθίνης τοῖς κρεμαστοῖς σκεύεσιν Εὐθυδόμου Δημητρίου Μελιτέως, Φίλωνος Ἐξηκεστίδου Ἐλευσινίου. σκευοθήκην οἰκοδομῆσαι τοῖς κρεμαστοῖς σκεύεσιν ἐν Ζείαι ἀρξάμενον ἀπὸ τοῦ προπυλαίου τοῦ ἐξ ἀγορᾶς προσιόντι ἐκ τοῦ ὄπισθεν τῶν νεωσοίκων τῶν ὁμοτεγῶν, μῆκος τεττάρων πλέθρων, πλάτος πεντήκοντα ποδῶν καὶ πέντε σὺν τοῖς τοίχοις. κατατεμὼν τοῦ χωρίου βάθος ἀπὸ τοῦ μετεωροτάτου τρεῖς πόδας, τὸ ἄλλο ἀνακαθαράμενος ἐπὶ τὸ στέριφον στρωματιεῖ καὶ ἀναλήψεται ἴσον κατὰ κεφαλὴν ἅπαν ὀρθὸν πρὸς τὸν διαβήτην. στρωματιεῖ δὲ καὶ τοῖς κίοσιν ἀπολείπων ἀπὸ τοῦ τοίχου ἑκατέρου πέντε κ[αὶ δέκ]α πόδας σὺν τῶι πάχει τοῦ κίονος, ἀριθμὸς τῶν κιόνων ἑκατέρου τοῦ στοίχου πέντε καὶ τριάκοντα, διαλείπων δ[ί]οδον τῶι δήμωι διὰ μέσης τῆς σκευοθήκης πλάτος τὸ μεταξὺ τῶν κιόνων εἴκοσι ποδῶν. πάχος [δ]ὲ ποιήσει τὸ στρῶμα τετράπουν, τιθεὶς τοὺς λίθους ἐναλλὰξ φορ[μη]δὸν καὶ παρὰ μῆκος. οἰκοδομήσει δὲ τοὺς τοίχους τῆς σκευοθήκη[ς κα]ὶ τοὺς κίονας Ἀκτίτου λίθου, θεὶς εὐθυντηρίαν τοῖς τοίχοις [π]λάτος τριῶν ποδῶν, πάχος τριῶν ἡμιποδίων, μῆκος τετραπόδων τῶν λ[ίθ]ων, ἐπὶ δὲ ταῖς γωνίαις τετραπόδων καὶ τριῶν παλαστῶν. καὶ ἐπὶ τῆς εὐθυντηρίας ἐπιθήσει ὀρθοστάτας περὶ μέσηι τῆι εὐθυντηρία[ι] μῆκος τετράποδας, πάχος πενθημιποδίων καὶ δακτύλου, ὕψος τρίποδας, τοὺς δ' ἐπὶ ταῖς γωνίαις μῆκος ἐκ τοῦ μέτρου τῶν τριγλύφων, διαλείπων θυραίας κατὰ τὸ πλάτος τῆς σκευοθήκης, δύο ἑκ[α]τέρωθεν, πλάτος ἐννέα ποδῶν. καὶ οἰκοδομήσει μέτωπον ἑκατέρωθε[ν] ἐν τῶι μετα[ξ]ὺ τῶν θυρῶν, πλάτος δίπουν, εἰς δὲ τὸ εἴσω δεκάπουν. καὶ περικάμψει τὸν τοῖχον μέχρι τῶν πρώτων κιόνων, πρὸς ὃν ἀνοίξεται ἡ θύρα ἑκατέρα. ἐπὶ δὲ τοῦ ὀρθοστάτου πλινθίσιν οἰκοδομήσει τοὺς τοίχους, μῆκος τετράποσιν, πλάτος πέντε ἡμιποδίων, ἐπὶ δὲ ταῖς γωνίαις μῆκος ἐκ τοῦ μέτρου τῶν τριγλύφων, πάχος τριημιποδίοις. ὕψος δὲ ποιήσει τῶν τοίχων ἀπὸ τῆς εὐθυντηρίας ἑπτὰ καὶ εἴκοσι ποδῶν σὺν τῶι τριγλύφωι ὑπὸ τὸ γεῖσον, τὰς δὲ θυραίας ὕψος πέντε καὶ δέκα ποδῶν καὶ ἡμιποδίου. καὶ ἐπιθήσει ὑπερτόναια λίθου Πεντελῆικοῦ μῆκος δώδεκα ποδῶν, πλάτος ἴσα τοῖς τοίχοις, ὕψος δίστοιχα παραστάδας στήσας λίθου Πεντελῆικοῦ ἢ Ὑμηττίου, ὀδοὺς ὑποθεὶς Ὑμηττίους. καὶ γεῖσον ἐπιθήσει ἐπὶ τῶν ὑπερτοναίων ὑπερέχον τρία ἡμιπόδια. καὶ ποιήσει θυρίδας κύκλωι ἐν ἅπασιν τοῖς τοίχοις καθ' ἕκαστον τὸ μετακιόνιον, ἐν δὲ τῶι πλατεῖ τρεῖς ἑκατέρωθεν, ὕψος τριῶν ποδῶν, πλάτος δυοῖν ποδοῖν, καὶ ἐναρμόσαι εἰς ἑκάστην τὴν θυρίδα χαλκᾶς θυρίδας ἁρμοττούσας. καὶ ἐπιθήσει ἐπὶ τοὺς τοίχους γεῖσα κύκλωι καὶ τοὺς αἰετοὺς οἰκοδομήσει καὶ γεῖσα ἐπιθήσει καταιέτια. καὶ στήσει τοὺς κίονας ὑποθεὶς στυλοβάτην κατὰ κεφαλὴν ἴσον τῆι εὐθυντηρίαι, πάχος τριῶν ἡμιποδίων, πλάτος δὲ τριῶν ποδῶν καὶ παλαστῆς, μῆκος τεττάρων ποδῶν· πάχος τῶν κιόνων κάτωθεν δυοῖν ποδοῖν καὶ τριῶν παλαστῶν, μῆκος σὺν τῶι ἐπικράνωι τριάκοντα ποδῶν, σφονδύλων ἕκαστον ἑπτὰ μῆκος τετραπόδων, τοῦ δὲ πρώτου πεντέποδος· τὰ δὲ ἐπίκρανα ἐπιθήσει ἐπὶ τοὺς κίονας λίθου Πεντελῆικοῦ· καὶ ἐπιθήσει ἐπιστύλια ξύλινα ἐπὶ τοὺς κίονας κολλήσας, πλάτος πέντε ἡμιποδίων, ὕψος ἐννέα παλαστῶν ἐκ τοῦ ὑψηλοτέρου, ἀριθμὸς δεκαοκτὼ ἐφ' ἑκάτερον τὸν τόνον. καὶ μεσόμνας ἐπιθήσει ἐπὶ τοὺς κίονας ὑπὲρ τῆς διόδου, πλάτος καὶ ὕψος ἴσα τοῖς ἐπιστυλίοις. καὶ ἐπιθήσει κορυφαῖα

VIII. (l. 34–39).

Make apertures for windows all around, in all the walls, one opposite each intercolumniation, and 3 at either end, 3 ft. high and 2 ft. wide. And fit into each aperture a grating of bronze fitting closely. Upon the walls all around lay cornices, build pediments and place the pedimental cornices.

IX. (l. 39–45).

Erect the piers and place under (each of) them a base (ΣΤΥΛΟΒΑΤΗΝ) level with the directing-course, $^{3}/_{2}$ ft. thick, 3¼ ft. wide, 4 ft. long; the lower thickness of the piers shall be $2^{3}/_{4}$ ft., and their height, including the capitals, 30 ft., consisting of 7 drums 4 ft. high except the first which shall be 5 ft. Lay capitals upon the piers of Pentelic marble.

X. (l. 45–59).

Place wooden beams upon the piers and fit them together, $^{5}/_{2}$ ft. wide, $^{9}/_{4}$ ft. high at the highest point, 18

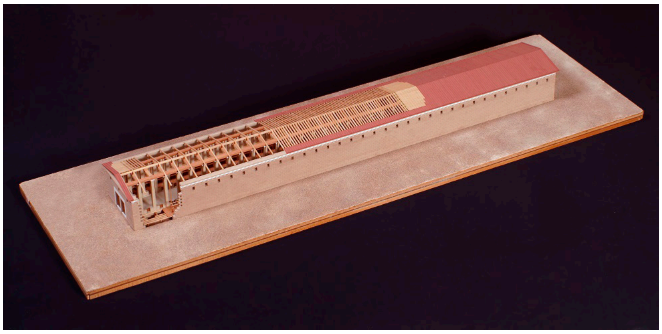
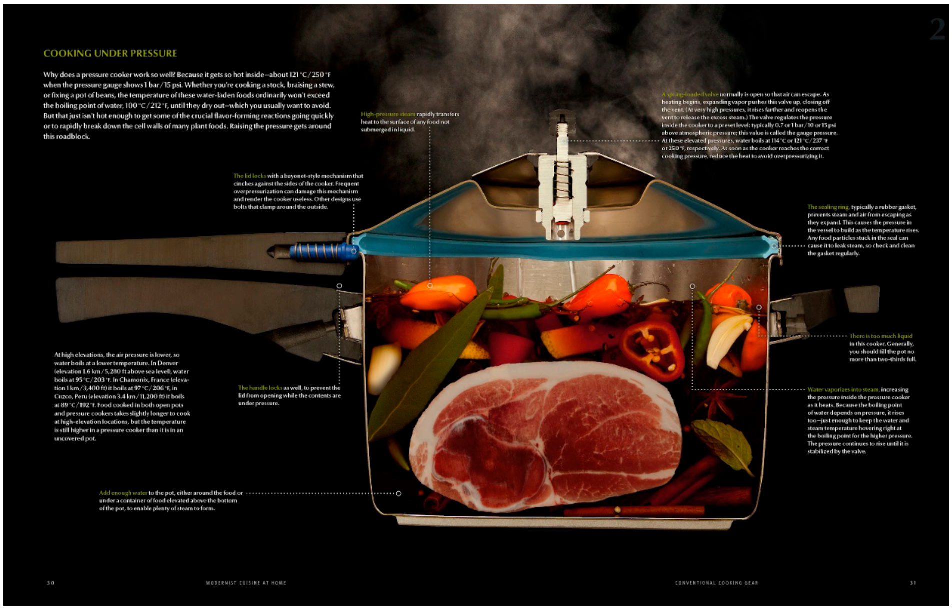


Image 1 - The “Arsenal of Philon”, description and model (A,B)



2

COOKING UNDER PRESSURE

Why does a pressure cooker work so well? Because it gets so hot inside—about 121 °C / 250 °F when the pressure gauge shows 1 bar / 15 psi. Whether you're cooking a stock, braising a stew, or fixing a pot of beans, the temperature of these water-laden foods ordinarily won't exceed the boiling point of water, 100 °C / 212 °F, until they dry out—which you usually want to avoid. But that just isn't hot enough to get some of the crucial flavor-forming reactions going quickly or to rapidly break down the cell walls of many plant foods. Raising the pressure gets around this roadblock.

High-pressure steam rapidly transfers heat to the surface of any food not submerged in liquid.

A spring-loaded valve normally is open so that air can escape. As heating begins, expanding vapor pushes this valve up, closing off the vent. (At very high pressures, it rises farther and reopens the vent to release the excess steam.) The valve regulates the pressure inside the cooker to a preset level: typically 0.7 or 1 bar / 10 or 15 psi above atmospheric pressure; this value is called the gauge pressure. At these elevated pressures, water boils at 114 °C or 121 °C / 237 °F or 250 °F, respectively. As soon as the cooker reaches the correct cooking pressure, reduce the heat to avoid overpressurizing it.

The lid locks with a bayonet-style mechanism that cinches against the sides of the cooker. Frequent overpressurization can damage this mechanism and render the cooker useless. Other designs use bolts that clamp around the outside.

The sealing ring, typically a rubber gasket, prevents steam and air from escaping as they expand. This causes the pressure in the vessel to build as the temperature rises. Any food particles stuck in the seal can cause it to leak steam, so check and clean the gasket regularly.

There is too much liquid in this cooker. Generally, you should fill the pot no more than two-thirds full.

At high elevations, the air pressure is lower, so water boils at a lower temperature. In Denver (elevation 1.6 km / 5,280 ft above sea level), water boils at 95 °C / 203 °F. In Chamonix, France (elevation 1 km / 3,400 ft) it boils at 97 °C / 206 °F, in Cuzco, Peru (elevation 3.4 km / 11,200 ft) it boils at 89 °C / 192 °F. Food cooked in both open pots and pressure cookers takes slightly longer to cook at high-elevation locations, but the temperature is still higher in a pressure cooker than it is in an uncovered pot.

The handle locks as well, to prevent the lid from opening while the contents are under pressure.

Water vaporizes into steam, increasing the pressure inside the pressure cooker as it heats. Because the boiling point of water depends on pressure, it rises too—just enough to keep the water and steam temperature hovering right at the boiling point for the higher pressure. The pressure continues to rise until it is stabilized by the valve.

Add enough water to the pot, either around the food or under a container of food elevated above the bottom of the pot, to enable plenty of steam to form.

30 MODERNIST CUISINE AT HOME

CONVENTIONAL COOKING GEAR 31

Image 2 - A recipe from "Modernist Cuisine"

Image 3 - A vernacular settlement, Agios Lavrentios, Mt. Pelion

Image 4 - The Byzantine temple of Aghios Eleftherios, Athens, detail

Image 5 - Buiding Mt. Hymettus to a Metropolitan Park, Athens Architecture Biennale, Syntagma Square, Athens, 2003. Model "Phyi" in Athens Conservatory, *National Museum of Contemporary Art*, Athens 2008. Z. Kotionis Image An Installation of Public Wine Pressing and Poetic Performance, Plato's Academy, Athens, 2011, *National Museum of Contemporary Art*, Ph.Giannini, Z. Kotionis **(A,B)**

Image 6 - "Dionysos' Tub". An Installation of Public Wine Pressing and Poetic Performance, Plato's Academy, Athens, 2011, National Museum of Contemporary Art, Ph. Giannini, Z. Kotionis **(A,B)**

Image 7 - A marble table in the Paou Monastery Area, Pelion, 2006, Created for a public Meal, curator and artist: Maria Papadimitriou, Z. Kotionis (A,B)

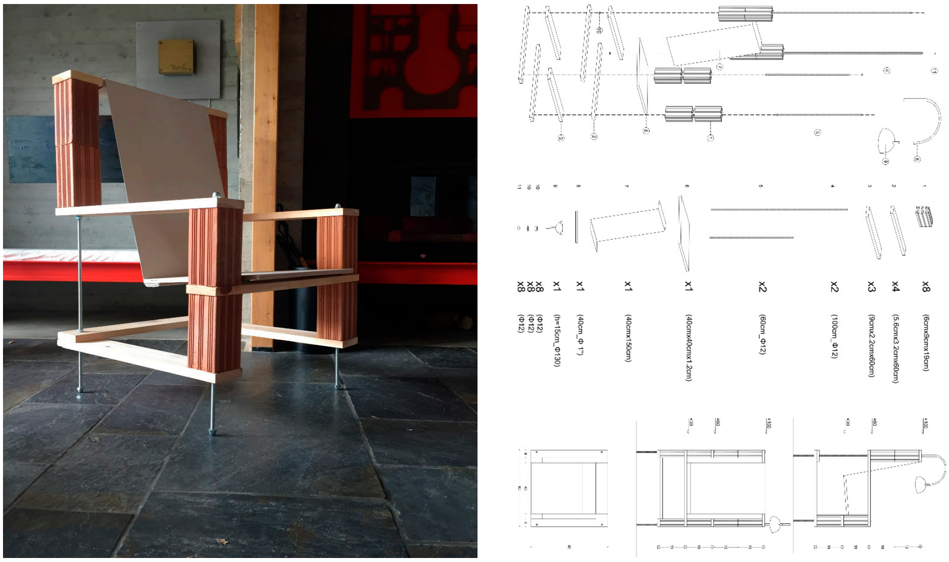


Image 8 - “Do_As, Domestic Assemblage”, a furniture design set, Aaart Gallery, Athens, 2018, Z. Kotionis (A, B)

Image 9 - “Multidomes” Metropolitan Habitat Project for the Multitude, Benaki Museum, Athens 2012 (A,B)

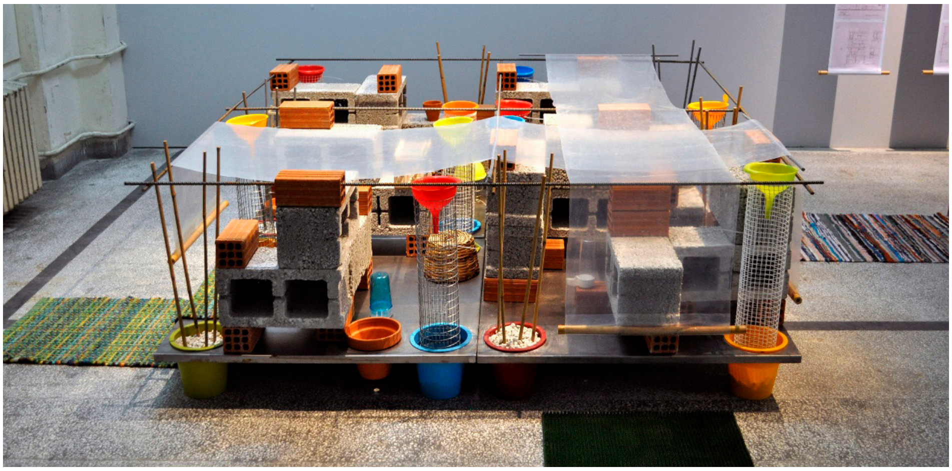


Image 10 - “Hot_Camp. A Trans Urban Block”, “Tomorrows”, international exhibition of Onasis Foundation, Athens 2016, Nante 2019, Z. Kotionis

Image 11 - “Monochord House”, Volos-Pelion, 2014, Z. Kotionis

Image 12 - "Escape", Performance and Installation in Giorgio De Chirico Museum, Volos 2004, Z. Kotionis

ENDNOTES

1 "Philon's Arsenal" (347/346 BC) was designed by the architect Philo and was completed at the time of Lycurgus. The discovery and partial excavation of the Arsenal of Philo took place during 1988-1989. In 1888, a marble inscription (IG II^{2}1668) was discovered with the detailed description of the construction and use of the building, written by Philo. The Arsenal was built between the Hippodameian Agora and the ship sheds, NE of the deepest recess of the gulf of Zea with its axis running from SW to NE. The building was 18m wide and 130m long with entrances on both its narrow sides and two colonnades of piers that divided its inner space into three aisles. The central aisle extended in the whole length and height of the building, while the side aisles were separated in 34 compartments each, with lofts with wooden shelves that served as storage space.

2 It is instructive to compare the verb συν-*αρμόζω* with συν-*τάσσω*, as the fitting ('αρμογή') is a kind of matching for the creating of a condition of orderliness for the part being fitted. This conceptual affinity is lost in the Latin-derived term 'recipe' which connotes something you receive (in order to be cured or quench your hunger); late Middle English: from Latin, literally 'receive!' (first used as an instruction in medical prescriptions), imperative of recipere .

3 Manuel DeLanda, *Assemblage Theory*, Edinburgh University Press, 2016

4 Claude Levi-Strauss, *The Savage Mind*, Weidenfeld and Nicolson, 1962, chapter I: *The Science of the Concrete*, p.1-35

REPRESENTATIONS OF PERFORMATIVE ARCHITECTURE IN DESIGN SYNTHESIS

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ABSTRACT

The design process covers the entire sequence of design activities and includes individual loops of briefing, analysis and synthesis within evaluation and decision making. The development of computer tools that support design synthesis are especially significant for connecting different study fields, which is essential in performative building design. Computational design synthesis includes four major activities as Cagan (2005) states, which are representation, generation, evaluation and guidance in performative architecture practices as well. The solutions to conventional design problems may be pursued through fully realized designs or more abstract visualizations. Visual representations are used for capturing the forms or attributes of design artifacts within a design space, where a number of representational structures are embedded into a single representation. The design space is unlimited in size, and includes past, present and future design states for creating, designing, or inventing in design problems. To this end, performative design can also be visually represented throughout the design synthesis process computationally, which structures the design space for different purposes. The aim of this study, therefore, is to investigate and review visual representations that enable a dialog between designers and other individuals within performative design processes, and integrate various data coming from different disciplines. Computational representations are examined in computational design synthesis process on the purpose of communication, analysis, design development and interoperability for performative architecture.

KEYWORDS

Performative architecture, design synthesis, computational design, visual representations, integrated design process

Introduction

The developments of computational design approaches and techniques are significant in architectural design processes since they have the capacity to improve design decision-making and increase the efficiency and effectiveness of design actions. In the models which aim to find a solution or an answer to design problems, the complex relationship between users, tools and design media changes the design process along with the design concepts, including performative design, tectonics, geometry and material expression (Oxman, 2006). The recent models combine performance with design representation, generation and evaluation. To this end, interaction between different design factors plays a significant role in the new digital models.

Digital design models in performative design lead architects to expect tools that connect design factors and building performance. In this manner, new computational design tools are introduced with a focus on improving design process efficiency with convenient information exchange between design tools and performance analysis tools. These tools allow users to control building geometry, space types, materials, daylight, thermal zones and so forth in 3D models which architects are already familiar with. The ability of the tool is the most significant factor in this selection, since the focus of each project differs and each tool offers a different functionality in a digital model. The most significant digital models, as discussed by Oxman (2006), are integrated compound models, which are based on integrated design process that combine formation, generation, evaluation and performance. Compound models are considered as the ultimate future objective of integrated design media, which aim to enable the interaction with any design module, data and information flow in multiple directions (Oxman, 2006). To this end, compound models provide a wider perspective to interdisciplinary design teams in an integrated manner.

Computational design processes, in analytical and generative modes, have great potential to foster design synthesis. It is possible to categorize models of computational design synthesis into four major activities, that are representation, generation, evaluation and guidance (Cagan, Campbell, Finger, & Tomiyama, 2005). This paper aims at investigating and elaborating performative design synthesis in computational mediums via visual representations within the design synthesis activities. In design synthesis, design space is in an ordered structure in which each instance is a solution to a common design problem (Cagan, Campbell, & Kotovsky, 2003). The solutions may be pursued through fully realized designs or more abstract visualizations. The main shift in computational design synthesis occurred in the representations formulated by the developer of the computational design method. Within visualized spaces, solutions that have similar configurations are organized proximately (Cagan et al., 2005). Therefore, in order to examine the space of solutions, little transformations are made to designs to arrive circumjacent solutions. By conducting numerous modifications in design space, a wide range of solutions can be explored. In this sense, the computational representations are instrumental for capturing the forms or attributes of the design space (Cagan et al., 2005). In general, a number of representational structures are embedded into a single representation. The representations that form the design space vary from underlying ordering media such as grids or zones to functional orders and relations that are often present implicitly in design representations (Oxman, 1997). The space does not have a limit and includes past, present, and future design states for creating, designing, or inventing in design problems (Cagan et al., 2005). In computational systems, the challenge is to effectively find the set of solution that best meets the demands of the design problem.

Performative design artifacts, therefore, can be represented throughout the design synthesis process computationally, which defines the design space for different purposes. The representations provide a medium that enables a dialog between designers and other individuals, and integrate different datasets originating from diverse disciplines. The evaluation process is pursued within the same medium, and all the changes is conducted through computational representation tools. In this manner, the next sections will elaborate the computational representations used in performative design process on the purpose of communication, analysis, design development and interoperability.

Representation for Communication

The systematic assessment of building performance requires flexible and seamless communication between different disciplinary domains and phases (Gursel, Stouffs, & Sariyildiz, 2007). In architectural design, communication is provided through visual media from the beginning to the end of the design process, including all visual representation techniques. The basis of visual and mental connection between designers can be considered as the design sketch, since it brings a solid graphical response to the designer's actions (Oxman, 1997) Schon suggests that the designer's concern is the graphical conversation with the design (Schon, 1992), and all the visual representations starting from sketching allow designers to have conversation with design ideas in this manner. Factors affecting the design development can be represented as simple sketches in the early phases as it can be exemplified in figure 1. These sketches are not only effective in the early phases; indeed, they direct design process in the later phases as well.

With the recent developments in computer technologies, design representations that architects and designers use for visualizing and communicating change as well. In new computer-supported design activities, the concern is also to ensure that the design process and collaborative design activity that the architects are used to are not disrupted by new computer tools. In this respect, computer tools that aim at creating a continuous communication in order to strengthen the collaborative nature of design activity have to be guided by a better understanding on the ways in which the collaborators work and what obstacles they encounter in their work (Gabriel & Maher, 2002). It is important to emphasize that in contrast with the general opinion, representation for communication in computer medium has a wide range of techniques and alternatives. These representations should not be limited to communication through only realistic renderings, since rendering tools runs the risk of misrepresenting design by prioritizing visuality over content in general. The design form or the physicality of design artifacts are not the only aspects that should be visualized in the design process (Blaise, Domenico, Luca, & Dudek, 2004). Thus, representations for communication in performative architecture must also include various sketches, diagrams, charts and orthographical drawings that have the capacity to construct relationships, such as architect-architect, architect-client, architect-other disciplines and so forth.

Representation for Analysis

One of the most outstanding aspects of performative architecture is its analysis-based approach. Performative architecture is typically associated with the precise analysis of performance issues during the design process in order to go beyond a design based on just concept and estimation, which might not provide performative design solutions (Shi, 2010). After the architectural model creation in the design process, a simulation tool is chosen in order to analyze one or several performance factors that the designer would like to consider. The analysis and assessment processes come later when the simulation data becomes readable and understandable by architects.

Analysis and evaluation process, as a part of the design synthesis, reveals the worth and potential success of the design. Although the designer might benefit from the generation of design concepts, a level of design analysis must be included in the automated synthesis system that responses the concept generation (Cagan et al., 2005). The analysis and evaluation may be in the form of analytical expression for some design problems, however, simulation and evaluation are often included in most design problems. Yet, combining simulation tools within computational synthesis has its own difficulties since simulation data is complicated due to its content, which contains a number of design measures that require balancing of multiple objectives (Cagan et al., 2005).

Computational performative designs provide a complex process to architects, who consider multiple performance dimensions interrelated to each other, and cannot be considered in isolation within the process. For the analysis process within performative design synthesis processes, information within architectural models is considered as inputs while the results and deliverables become outputs (Tang, Han, & Chen, 2004). At this point, computational tools aim at creating representations for visualizing information that is embedded into the architecture model and make them available and seamlessly perceivable for architects. Visual representations provide a number of perspectives that guide the collected data and analysis of information in order to make architectural choices according to the design goals (Tang et al., 2004) (See: Figure 2). Analyzed data resulting from design goals provide consistent representations of architectural model within the same medium.

Representation for Design Development

Computational representation of an architectural idea aims at identifying and formalizing a level of knowledge that is essential for transforming a model according to interactions of other representations and graphical medium (Oxman, 1997). In order to transform a specific knowledge into a representation, making specific modifications and changes in representations is necessary. However, the representations that modifies and changes the design model are not accustomed techniques such as drawings, since they are procedural and do not allow to make flexible manipulations unless they transformed into explicit forms of other representation. It is emphasized by Oxman in 1997 as following:

> *In the development of explicit representations of form, humans are able to transform implicit knowledge to explicit representational structure. This appears to enable novelty through modification and change which transcend, contradict, or depart from the generic representation.* (Oxman, 1997).

The transformation of implicit knowledge to a well-formed representational structure provides modification and change of designs within, or through, the representations. In each design activity, there must be various representations in order to encourage the manipulation of designs. For performative architecture, a solid knowledge about the design requirements and their architectural correspondence is required in order to manipulate multiple representation and models produced through design activity (See: Figure 3). In computational performative design, the modification process through representations follows a re-use activity of the previously existing representational content of a design solution (Oxman, 1997). The modification process occurs in the same medium in which all the knowledge, architectural model and its representations exist. In this sense, the design process turns into an activity which aims at formalizing the necessary knowledge and reasoning in representational model.

Representation for Interoperability

The architects, computational modelers, and engineers are working in close collaboration in performative design process in order to create the most accurate and complex buildings. Therefore, it requires a network of interdisciplinary interrelations and focuses on the integral design due to the simultaneous integration of various and interdisciplinary aspects (Sariyildiz, 2012). In order to solve a design problem, performance factors are simplified to simpler models in order to analyze and determine design purposes. In simple models, it would be the most ideal case to construct representations that can be examined through different disciplines within the same problem space since diverse approaches are needed in performative architecture (Cagan et al., 2005).

The traditional building performance analysis process is conducted by an analysis expert who collects building information from drawings and photos, and then creates an analysis model within a selected analysis tool. However, due to arbitrary decisions and assumptions during the definition of the building's simulation, the results might not be reliable and reproducible (Moon, Choi, Kim, & Ryu, 2011). Moreover, this process tends to exclude architects from the design process since they do not have the ability to control performance simulations and the data commentated by the analysis expert.

In this respect, the main problem in performative architectural design is the lack of the ability to share data between different mediums and applications, which is called interoperability. Interoperability aims at integrating data in order to eliminate the manual reproduction of data that already exists in another medium (Eastman, Teicholz, Sacks, & Liston, 2011). Since the manual reproduction of partial design data does not support iteration that is required for finding solutions to complex problems during a design process, and leads to some level of inconsistency coming from errors occurred in manual copying, researchers focus on the ways in which different data and disciplines can be integrated within the same medium (Eastman et al., 2012).

The solution that is used as a common method is tool-to-tool exchange. Nevertheless, tool-to-tool exchange is usually challenging, since each tool has its own internal schema (Eastman et al., 2012). The exported data is available to the extent permitted by the exporting tool. Therefore, designers run the risk of not completing design changes and modifying the model as the information flows in one direction and does not allow to reciprocate between design alternatives (Eastman et al., 2012). Therefore, the need for interoperability in performative design process is usually managed through multiple representations of a project within the model or tool levels as it is seen in the figure 4. A seamless exchange of data should be pursued and data reducdancy needs to be eliminated in order to allow bidirectional update of information coming from the architectural model (Moon et al., 2011). The interoperability problems cannnot not solved only by translating an architectural model to another format, indeed, it can be settled by modifying and extending the model information in order to represent the different uses of the design.

Conclusion

The concepts of building performance are explored in architectural design by means of computational design tools and methods. In performance integration, the computational design approaches provide a comprehensive perspective among various knowledge disciplines and involved parties. These approaches focus on a wide range of design goals, whether architectural and performative. The contribution of computational approaches allows modelling and collaboration for visualization, analysis and evaluation of building performance, realization, construction and operational services within performative architecture. Performative design by means of computational tools offers unique opportunities in architectural design, which provide a more integrated and precise design decisions.

Through the use of computational tools in performative design, explicit computational models can be used for the representation, sharing, evaluation and visualization of design knowledge. The integrated compound models include formation, generation, evaluation and performance and provide interaction, and data and information flow in multiple directions. Design synthesis process in performative architecture is redefined since architectural representations in performative design acquire new purposes, such as communication, analysis, design development and interoperability. The ability to represent and evaluate performative design considerations is critical to their long-term success, adoption and incorporation of the performance considerations into the design process. To this end, complex performative design processes can be synthesized through computational methods and visual representations provide significant improvements within design processes.

IMAGES, CHARTS OR GRAPHICS LEGENDS

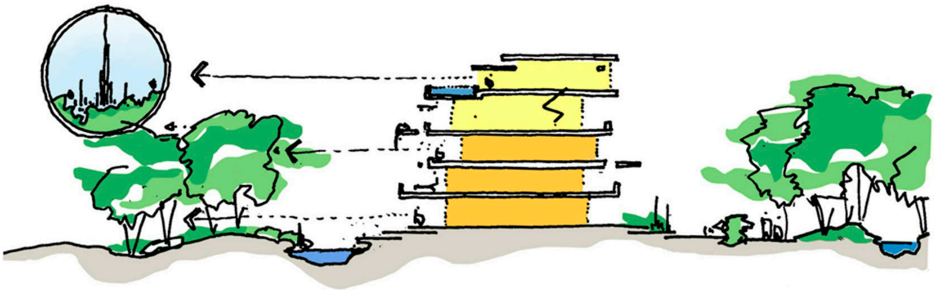

Image 1 - A design sketch that shows the performance aspects of the project Ashjar at Al Barari by 10 DESIGN, Dubai, United Arab Emirates (Behance, 2014).

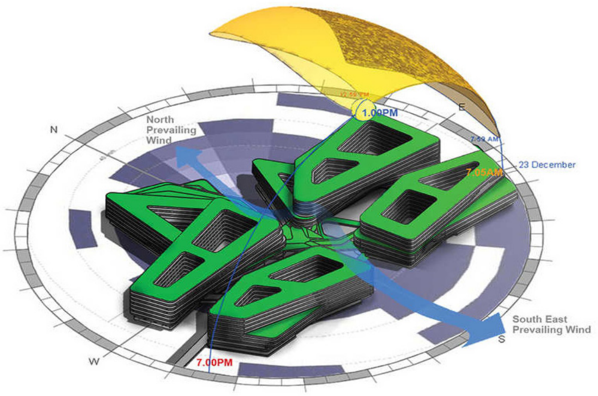

Image 2 - A representation of building form analysis that shows the effects of the performative factors for the project of Singapore University of Technology and Design designed by UNStudio, Singapore. (Frearson, 2015).

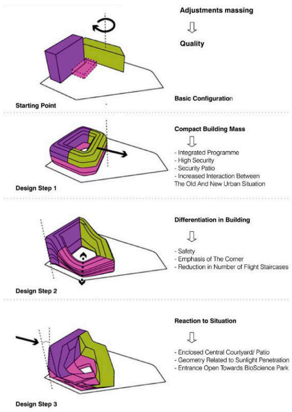

Image 3 - A visual representational model that shows the design modification process of the project Mirai House by UNStudio in Leiden, The Netherlands (UNS, 2012).

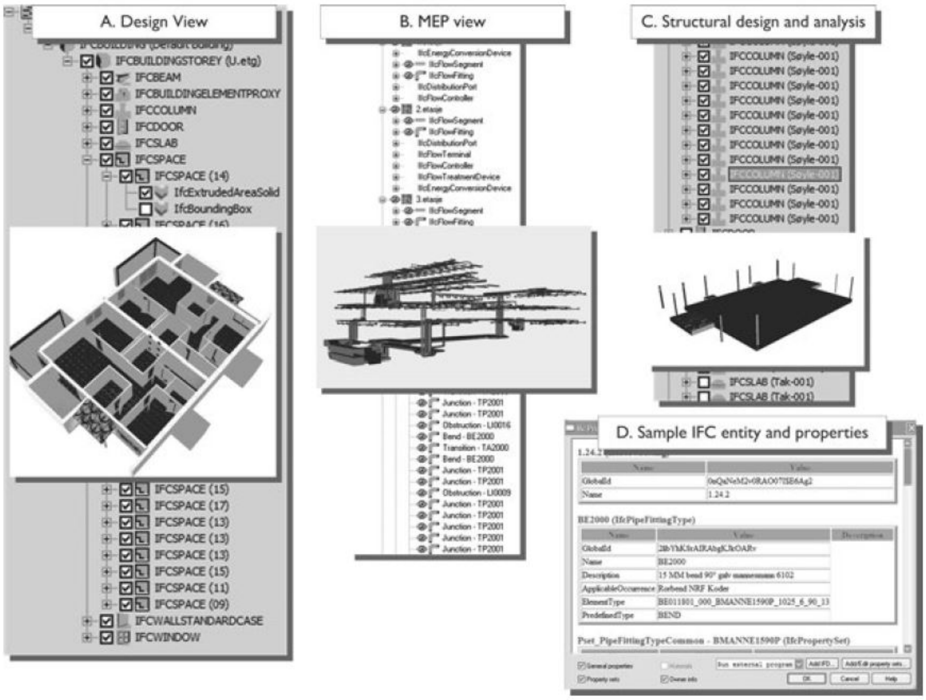

Image 4 - The figure shows three examples of specific domain uses from a project, which are; an architectural view, a mechanical system view, and a structural view. It also shows a sample object or entity and sample properties and attributes within BIM library (Eastman et al., 2012).

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THE TRIGGERING FAILURES AND ATTRACTIVE DEFICIENCIES IN DESIGN THROUGH MAKING PROCESSES

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ABSTRACT

In practical and theoretical design education, material performance appears to be an indispensable element of design process. Besides creating a support environment for three-dimensional thinking, material itself is acknowledged as a design input and explored through the design process. Although design through making is the ancient way of doing architecture it was forgotten and replaced by 2d and 3d representations, yet the evolution of CAD/CAM tools brought back the interest in material and making in the design process. In this paper we will introduce an elective course focused on the process of making and the material performativity in a hands-on design process. Architectural Experimentation is an elective course we conducted in Fall 2017-2018, with the explanatory title: Exploring the Making Process Through Materials, Manufacturing & Performativity. In design process students focus on the quality and visuality of the output and we observed that through experimenting with material failures triggered achievement and deficiency attracted solutions. In this paper we associate failure with triggering and deficiency with attractiveness in the process of exploring material potentiality. Besides the given assignments and the student design, observed problem solving patterns developed by the students in the design process will be discussed in the light of the "triggering failure" and "attractive deficiency" concepts that we suggest and elaborate in this paper.

KEYWORDS

Design process, design through making, hands-on learning, material exploration.

Introduction

Design through making has been an evolving topic within design discourse lately in relation to the rise of digital tools and manufacturing methods (Bunnell, 2017). Architecture used to be a set of full-scale experiments, created by a knowledge of theory and practice and combined manual skills with vast knowledge. As Turnball (2003) discusses this kind of architectural practice in the case of the medieval French Cathedral Charter, which was built by a tradition of shared solutions and skills transformed through collective work into coherent tradition. The division between practice and design initiates in the renaissance by Alberti which identifies "the architect as a man of 'learned intellect and imagination', who is able to 'project the whole forms in mind without any recourse to the materials." (Ingold, 2013). The separation between the making and the design continued until modern times. Controversially, the realization of architectural design got more and more complex and making become an immense resource for ideas, experimentations and research (Sheil, 2004) with the help of evolving CAD, CAM technologies. Making and material explorations are developing areas which requires expertise in the physical and the tactile. Therefore, in this course we aimed to introduce the hands-on aspect of making in order to familiarize the students to the physical field of forces and material relations. We aimed for a completely manual process with minimum use of sketches and digital modeling, moreover focusing on the material in hand and how to process it towards a defined design problem.

Architectural Experimentation Course

The main intention while preparing this course was to focus on the act of making and its reflection on the design process, by exploring different production techniques that could be applied by the students in architectural design studios and support the architectural design process held in the studios. Therefore, the course was composed through different actions of making and a new attitude based on learning by doing was adopted other than standard educational pedagogies. The architect by definition in mostly associated with design, and architectural design studios focus on the design process in the education of young architects. Yet, architects are responsible of the construction of their design as well which is mostly neglected in the architectural education. Gray states that this divergence originates from the fact that representation and abstraction phenomena inherent in the architectural design studios (Gray, 2010). Complex intellectual processes, representations and abstractions including limited studio times throw the material and the action of making into second plan in the limited period of time of a semester.

In order to reinforce making related production and enhance this thinking channel, we opted to focus on the discovery of materials, their potentials and the process of making. This is an elective course of three hours a week, with focus on the making process, material, manufacturing and material performance. During this course, we targeted the investigation of the process of making and its representations, basic materials of different natures were explored and their performativity was tested. The students were expected to be hands on, experimenting material and creating accurate solutions to defined design problems, with detailed documentation of each step. Learning from action was an important aspect of this course which led to a tight schedule, requiring large number of productions each week. During the 14 weeks semester, we assigned them three material exploration projects, paper, wire and plaster that they were expected to design with and produce an exhibition space for the output of their design processes during each assignment.

The first three weeks after the introductory first class were appointed to focus on the discovery of paper and augmenting its strength. We expected the student to develop three different units out of paper with no use of adhesive and develop a composition out of these units. Each student was expected to select a design problem to work with, some focused-on lighting elements, others on wall partition, sitting elements etc. The transition of the 2-dimensional material into a functional 3-dimensional object was a challenge to achieve, some created very rigid structures while others failed into piles of paper.

In the following three weeks wire was the material on table and the students were expected to investigate this linear material in to achieve volumetric expressions. The use of a secondary or adhesive material was restricted on this stage, binding, combining, joining, duplicating was expected to be attempted within the forces and limits of the material itself. The final output of this material exploration was anticipated to be a free-standing composition of 3-dimensional volumes. This assignment had no functional expectations it was introduced as an intermediate phase to facilitate the transition to the 3-dimensional fluid material, plaster.

The third and last material, plaster as a mixture of gypsum and water, was this fluid material that required working with mold. The requirement of preparation and planning in this phase led us to have a group work class in addition to the three weeks assigned to each material, which made this assignment a 4 weeks length. The students were awaited to go back to the design problems they were working on in the first assignment and study it with fluid material. The aim was to focus on the performance of different materials under the same functional expectations with a focus on the volumetric potential and performance of these materials. We left the last three weeks of the course for the design and preparation of the student work exhibition which they called "Beyond Boundaries", and was held in Öney Architecture's building in Kuruçeşme.

We formulated this course in a linear flow, with three different assignment following each other with no expectation of hybridization and multi channeling between them. The students intertwined and reinterpreted each material within itself and its preceding one. They revised their own making process according the material they were working with and their identified design problem within the course. They did not only explore and extend their productions but reinterpret each other's error and experiments into positive input to their own design process. Each deficiency and problem that have emerged in the course triggered a new discovery, therefore they named their exhibition "Beyond Boundaries" in relation to the blurring individual design process boundaries and fertile sparks of interaction between each other. The working processes of the students which affected each other beyond their individual processes in relation to the sharing and collective production environment are considered as complex network of relations that are difficult to untangle. In the following section we aim to identify and explain the potencies of this multi-layered design process where failures and deficiencies shaped the learning process of the students.

From Paper to Plaster Design Through Making

Each student explored a design idea they selected through the assigned materials (paper and plaster) of different nature and were expected to shape their design through making and learn from the material by doing. As discussed previously, we studied three different materials of different properties in this course paper, wire and plaster, however we will focus on paper and plaster in this paper. Wire work was a transitional assignment to investigate the cross dimensional transitions. On the other hand, the design problem selected by the student in the first assignment on paper was continued on the third phase of plaster work which provides an array of examples that settle the ground for pedagogical discussion and comparison. In all experimentation processes within the scope of the course, students were asked not to make preliminary research and case studies, even during the active moments of production, it was ensured that they did not use the techniques tested and practiced by someone else. Hence, students approached material with intuitive and implicit anticipation that led them manifest the making process with technical approaches of different possibilities.

We observed that there were some students who proceed in a linear way, with determined goals (Students 1 &5 in Figure 02), while others made use of the material and experiment as much as possible with its potential without having the design problem in mind (Students 3 & 6 in Figure 02). This nonlinear attitude led them to produce as much output as possible in order to explore the utmost of the material, each failure led to a new exploration these students (Students 2, 3 & 6). So, beyond the linear design process which focused on the best solution of the initial idea in mind, the students with constant exploration created many outputs during the process which we refer to as attractive deficiencies in this paper. The individual and group assignment created an important interaction in the course which led to ideas splashing around from one student to another with each one adding value to the exploration made by the previous comrade. The failure in one student's design process became a source of a new trial for another student in many cases.

Individual Work

Students were expected to select a design problem in the beginning of the course and then resolve it using paper (modules) as material. After a break of wire work and group work introduction of plaster they were expected to study the same design problem with a different material plaster. After the group work, each student gets back to solve their initial design problem with the new material. During this assignment a high number of interaction and inspiration was observed in the class (see figure 02). Students were sharing experiences and knowledge they gathered from previous group experimentation. The individual work before the group work and the one after it demonstrated differences. While in the first individual assignment each student tried to be as eccentric as possible, and be different than the others, on the later individual work they learned to share knowledge and adapt each other's' failure into their own design processes.

Group work

In the beginning of the plaster assignment we grouped students of two to work together and understand the nature of this fluid material. They were expected to develop 15 cm to 15 cm cubes with different density and textures. All of the groups focused on different aspects of the material, some studies texture, others density, color and shape. This exploration module helped the students to experiment the material differently and learn from each other's experiments. the interaction of students' co-working space and collective understanding of the studio which has a progressive learning process and a lot of triggering failures, was reinforced by each student giving solutions, comments and suggestions to the other. The method that one student accepts as a failure and leaves it during the process, became a powerful design input for another student. We can say that the cross-interaction between students have created the main dynamics of the studio.

The process of designing through making in the frame of this course was dominated by two concepts we observed, triggering failure and attractive deficiency. Failures are essential parts of the design process especially if this design process is described through making. Material shortage and potential is the main input in design through making that shapes the design or the initial idea. Therefore, failures related to material properties trigger new potentials and defined its limits that have been explored widely by the students in developing new solutions to their initial design problems. The concept of attractive deficiency was assigned to explore the cases in which students surrender to the material and make out of the failure a deficiency that reflected the design process. The qualities of the design artifact express and celebrate the deficiency and impreciseness that make it.

It is undoubtedly hard to have a linear design process without any error, the well planned, controlled and safe temptations of learning by doing may seem as flawless processes. Yet, there can be no progress without failure. In this section we praise failure and take it as triggering factor that guides us toward a better design. We focus on these breakpoints in the design process and define them as triggering failures of making. There failures turn to have a positive impact on the process such as the thickness of the plaster. The thin layer of plaster was defined as the insufficiency of the material, however its light permeability opened new aspects and potential of the material. The thin plaster surface-light relationship become an aspect that students aimed to achieve in relation to the need of transparency in their design problems. This kind of failures are considered as triggers in the intellectual and practical way of thinking. These momentary actions, evolved to be a dominating design pattern in this course. The actions of discovery that spread throughout the assignment in both individual and group work.

There are some cases in the design process in which the failure did not transform or led to a new trial. The importance of this failure in the process was its attractivess, aesthetically and intellectually the process of making that output attracted attention. It reflected the making process with all its deficiencies therefore we called these attempts attractive deficiencies. The deficiencies in the individual and group work of students and the final product in the aforementioned cross-readings are valuable, because they provide different advantages, although they do not serve the intended design and production process. We wish to emphasize that the deficiencies are not seen as failures although they were created out them. Although they do not answer the design problem, they are important outputs of a making process-oriented design. For instance, a multi-part modular wall to be produced just using paper material can become a very mobile and volatile wall due to the inadequate production of the paper modules. In this case, the moving, flexible and lightweight surface produced can be considered as a new separating wall design, even if the targeted one was a solid, one-piece separator wall. Even if the targeted design solution is not attained the final product evokes different uses.

The difference of these attractive deficiencies from triggering failures is that these deficiencies are a condition/phenomenon of the final product; enables the discovery of new potentials for a stationary output and the identification of new functions. But the triggering failures are actions encountered for going toward the intended process: each action defines a new trial that aims to go towards the result. These failures require new discoveries and new actions for production, while attractive deficiencies bring new definitions of functions, programs and goals. The final product in which attractive deficiencies arise is not expected to be repaired, because the end product is now redefined and provides a high degree of operability for the new function defined; but the triggering failures bring new solutions and every solution can be defined as a new method of discovery/experimentation process.

Conclusion

The course architectural experimentation has been a fruitful experimentation area from learning and teaching points of view. The student of this course had the satisfaction of experimenting and fulfilling a set of designs with a different method, by exploring the material and its potential. On the other side we had the chance to observe a very productive environment defined by few rules. The open-ended possibilities of materials, the interaction of students and the evolution of the design problems has been a significant experience which led us to understand the importance of failure and what it can triggers on one side and on the surprise output that bear no aesthetic expectation but displaying it deficiencies. It may be difficult to integrate such a methodology to design studio in which larger scale spatial problems are entangled yet this course demonstrates the significance of making and hands-on experimenting in a design process.

IMAGES, CHARTS OR GRAPHICS LEGENDS

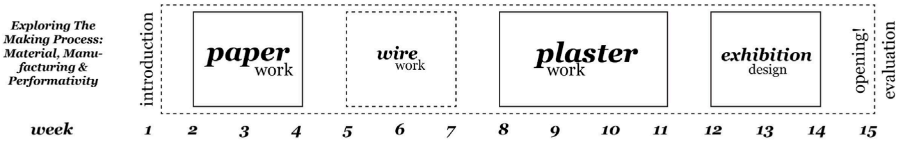

Image 1 - The distribution of assignments on the 14 weeks semester.

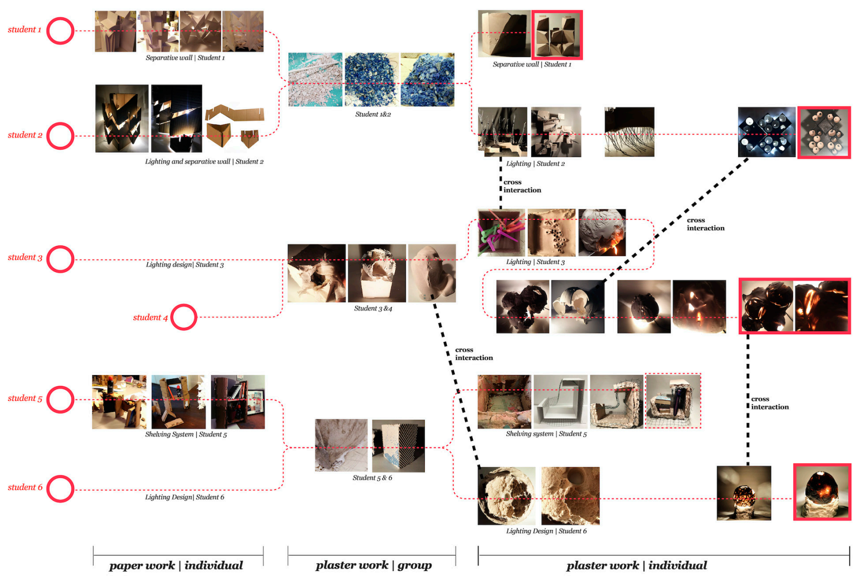

Image 2 - The Diagram demonstrating student interaction during different assignments.

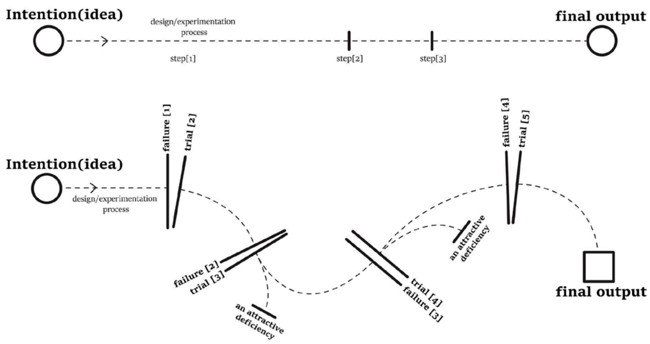

Image 3 - The linear design process on the top and the failure and trial process with intermediate deficiency output on the bottom.

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DOUBLE PROCESSING OF THE DESIGN

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ABSTRACT

This paper focuses on the design studio, which is central to architectural curriculum. The argument is developed through the knowledge of architectural design experiment and pedagogy of Architectural Design Studio 5. In Studio 5, we focus on making design process visible, as a way of emphasizing the design as a research environment. Different strategies are developed and implemented to make design process apparent. In this paper, one of these strategies, called as the 'thing' will be illustrated with the process and products of Studio 5. The 'thing' is proposed as a way to map the design fragments. Within and from the 'thing' the design fragments originate, develop and take form. The purpose of the 'thing' is to make the design ideas visible and to ensure the linkage of the discourse and architectural object.

KEYWORDS

Design studio, architectural design process; the thing; mapping; monitoring.

Introduction

Design studio is the backbone of architectural education. Until now, it has been widely discussed that design studio is a process and experience based environment. Architectural design studio is the only place where the activity of architectural design is experimented. There is a more critical reason for experimental nature of the design studio than the practical benefits that may result from it. Experiment requires many failed attempts and dead-ended explorations to find one that is fertile enough to open out onto a rich new landscape of possibilities. In very deed, this waste and trial-error process is what makes architectural design a research, hereby the design studio a research environment.

In architectural design studio, knowledge is produced by the designers' perceptions in the process of gaining experience. To make the knowledge apparent a concrete act called monitoring is necessary, and the design lasts only as long as this act can last. As Sartre (1988) denotes, *the creative act is only an incomplete and abstract moment in the production of a work*. The *design fragments* are reversed, rejected, dismantled, combined with new fragments and reconstructed over and over again. Design fragments address a moment of transformation within the design process. In this regard, it becomes essential to monitor this process in order to evolve these fragments, thus to make various qualities of architectural work visible, such as theoretical framing, historical positioning, critical reflection, as well as the attitude and background of the designer.

The work presented in this paper is motivated by the need to make whole design process visible. In our understanding, architectural design studio is a *coevolutionary* environment for thinking, creating and producing on architectural design, not an environment for transmitting architectural knowledge. In line with this, in Studio 5[1], knowledge is experienced and constructed from the synergy of the studio via materialization processes. These processes address the intricacy of intellectual and actual sources of the design experience. Addressing and incorporating these seemingly distinct and diversified aspects of the design makes the experience and knowledge produced in the studio visible.

Design is a process. It is a double process in the design studio: the architectural object and the 'thing'. These two processes cannot replace each other, yet one evolves within and from the other. Traditionally, the object is the visible output of the design studio. We propose that the 'thing' is the invisible output. Our research is built around the idea that making the 'thing' visible serves a unique capacity to increase research potential of the design studio. In Studio 5, we aim to develop ways to make the 'thing' visible and thus to make the idea and the research which generates the object apparent. This paper presents our research with some examples from the studio. The research aims to explore how initial design ideas arise and develop through periodically monitoring the evolution of the design within the architectural design studio. It also emphasizes how the designer reveals the fragments of the design.

In the following sections, knowledge of architectural design experiment and pedagogy of Architectural Design Studio 5 is introduced, discussed and presented with some examples from the studio.

Research by Materialization

Materiality is a process which starts from the moment that the design appears in mind, until the production of the object. In architectural education, this process is nowhere more apparent than in architectural design studio. The design studio is a laboratory of architecture. Research is an integral part of this laboratory. Alejandro Zaero-Polo (2016) describes laboratory as an environment that is constituted by an infinitely open field of technical and theoretical positions with a specific purpose. He differentiates the laboratory from a traditional polytechnic school and a traditional liberal arts school as it has, primarily, a specific operative purpose. The laboratory focuses on to produce a solution to a problem and considers any technique and position legitimate as long as it serves to achieve the purpose that is targeted. More importantly, as Zaero-Polo (2016) declares, the participants' creativity lies precisely in their originality in defining their approach to the problem.

Architectural design has intellectual and actual components. Intellectual components are all the ideas, praxis and methods that are used to produce the actual, that is the architectural object. The object appears as the visible outcome of the process; however, it is not alone. There is also the idea, research and knowledge produced in the process. These two components together constitute the research potential of architectural design.

Revealing the idea and knowledge that is embedded in the design process could increase creativity and research potential. Architectural design is an intensive journey in which the act of design and the discourse are turned around, intellectual and actual sources are mixed and blurred to a point where at times it might even be hard to distinguish the both. Unconventionally, personalizing and mapping this journey does not only give clearer focus in research but also functions to bridge the gap between research and design as separate areas. This approach requires a close monitoring from the designer to avoid loss in design ideas. Such a process has a rather more iterative and emergent nature where design and discourse are constantly interrogated and reframed.

Traditional representations in design studio are focused upon visual representation of the design object. Visual representations are mostly non-explicit with respect to presenting the idea behind form making and the development of the object. It the design process is considered as a materialization process, it could go far beyond merely representing the visual object. The design materializes not only the object but also the discourse. In traditional approach, the discourse is embedded to the object yet it is not explicit. In fact, the discourse comprises the object, yet it is always incomplete since it is invisible. Moreover, the things that are produced by the object throughout the process are also not explicit. If architectural design process is considered as a research area, it requires to be well addressed.

In order to consider design process as a research area there is a need to explicate the flow of fragments and the ideas and knowledge that is embedded in process. When design process begins, the research and production also begins. The idea, praxis and the object simultaneously evolve.

Double Processing of Materialization

There is no condition that can be explained with a single concept; we always need another concept. Likewise, the design process has at least two sides. One of these sides produces architectural object, while the other one includes all the ideas that produce the object. The latter is the one that produces architectural knowledge, thus it is the one that emphasizes architectural design as a research area. The object also produces knowledge however it needs a medium to make this knowledge apparent. In other words, we make the object visible yet we do not make the idea visible. As a consequence, the object becomes dominant. As Sönmez (2016) argues, prioritizing the object and developing architectural knowledge over it has a negative effect on architectural milieu, causing all stakeholders to have same perspective on all qualifications of the design.

Similarly, Peter Eisenman (1996) argues that architecture requires at least *two texts*. Between these texts, there is no dominance or originary value but rather a structure of equivalences, where there is uncertainty instead of hierarchy. Eisenman (1996) defines this condition as *twoness*. He asserts that the second text will always be within the first text and thus between traditional presence and absence, between being and non-being. In Eiseman's understanding, between is not a between dialectically, but a between within. Following Eisenman, it can be speculated that in architecture, usually, design is the first text, whereas the idea is the second. While the first text is visible, the second one is not.

All these suggest that one product is not enough to explicate architectural design process. At least two things are needed to explicate it. Further, it appears that there is a need for a tool or medium to monitor the design process and expose the research that has been done. In other words, there is a need for *another text*. For this reason, in Studio 5, we aim to develop strategies to expose whole design process, and thus make the idea, research and knowledge produced in the process visible.

Before elaborating this point further, it is important to note that we consider the design process as the first text. It is neither the object nor the idea that is dominant. There are at least two more texts: one of them is the object, and the other one is the *research object*. Research object is material. It is a product of the process. It produces and represents the knowledge. In this regard, the search for the research object is one the main motivations of Studio 5.

For Example: Studio 5

Architectural Design Studio 5 provides a multi-layered experimental studio environment, which is open to the use of any type of thinking, designing, expression and tools. Our design studio approach aims to welcome, enable and enhance multiplicity and plurality by constantly readjusting itself. The exact structure of the studio is only roughly set out on beforehand, with enough flexibility to anticipate and accommodate new ideas. In this way, the students and coordinators could experience the moment while constructing it.

In Studio 5, students are mostly given an ill-defined problem aimed to provoke discussion on the design agenda. 2-dimensional and 3-dimensional architectural design techniques are enhanced with 4-dimensional architectural techniques as well as artistic exercises, which are referred as 'poetic acts'. These artistic exercises are aimed at constructing and strengthening the development of the design as well as encouraging students to find various ways for expressing their ideas. In a similar way, the founders of the school of Valparaiso base their architectural thought on poetry: poetry expresses and architecture creates. With this perspective, thinking and building are not two autonomous acts that follow one another, rather poetic reflection and material experimentation meld (Castro and Gil, 2016).

To make the intrinsically non-linear approach of Studio 5 more constructive, different strategies are developed and implemented. The *'thing'* arise from one of these strategies. Recalling Eisenman, in the design studio, if the first thing is the design, the second one is the 'thing'. Elizabeth Grosz (2001) describes the 'thing' as the real that we both find and make. From this definition, it can be speculated that the 'thing' has technical, intellectual and intuitive aspects. Further, Grosz emphasizes materiality of the 'thing' and she claims that the 'thing' has a life and characteristics of its own. According to her, the 'thing' is the resource for making things and for leaving trace on things. She writes 'the thing is our provocation to action and is itself the result of our action'. Our approach to the 'thing' shares the same idea with Grosz, being both the source and result of the design while illustrating twoness of the design. In a similar manner with the 'thing' she describes, the 'thing' we propose is active, material and evolutionary.

The participants of studio 5 are expected to map their own 'thing', by monitoring all their ideas and materializations from the beginning, while they are developing the design. The 'thing' arises within and from the object. The qualities of the 'thing' can be listed as follows:

1. The 'thing' is beyond archiving the things that are produced in studio, since it requires monitoring and mapping everything that is produced with technical, intellectual or intuitive modes of production. In this sense, the 'thing' can be conceived as a tool, which correlates and translates interactions of cognitive, perceptive processes, in relation to their external representation. It constructs and reveals the relationship between the idea and making, form and content, representation and meaning, discourse and design, idea and object.
2. The 'thing' could be conceived as a board in which all the fragments are reflected. Design fragments address a moment of transformation within the design process. Besides consolidating the whole, these design fragments themselves are developed in the process. A new fragment is developed by the experience and knowledge gained from the development of another fragment. In this way, every new fragment transforms itself, the studio environment, the professional body of the students and coordinators, as well as the architectural design.
3. The 'thing' relates all these fragments with the object. The 'thing' exposes the knowledge that is produced through the design process. It has an important potential since it enables evaluating the process. Conventionally, the design process is not monitored from the start. For this reason, evaluation is done only on the architectural object. And the object seems to be the only outcome of the research that has been done. However, the object comprises ideas and knowledge that are not visible. These ideas and knowledge need to be visible to completely understand, reflect and evaluate the process.

4. The 'thing' contains all levels of design thinking as well as all transitions from inception to materialization. It allows the possibility of addressing elusive issues that underlie the design process. We can therefore conclude that the 'thing' is a dense, self-generative and communicative notational system. With these qualities, it produces a sort of magic potion powered by the mental images of the designer, makes it a precious tool for creativity. Most of all, the 'thing' embraces two distinct but complementary things: one on the path of materiality, the design, and the other on the path of conception, concerning what one has in mind to create.

Conclusion

There had been many studies on the experimental and process based nature of architectural design studio. Different from these studies, we aimed to reveal research potential of the design process by making it visible. The aim of our studio approach is primarily to feed and contribute to the debate and research rather than to offer a design project as a solution. In this sense, we consider design studio as a platform for exploration and testing of ideas by means of design, thus the design becomes both the method and outcome. In an architectural design studio, process is repeated many times with the change of the students. In these processes, students get the chance of experiencing their own architectural designs and developing them in line with these experiences. Hence, instead of the product, the experience of producing becomes more important. The architectural design objects built on this experience become both the source and product of information that is used in design generation process.

Architectural design studio holds potential research energy and we propose that the 'thing' could turn this energy into kinetic energy. In this way, the efficiency of the research environment of the architectural design studio can be increased. We propose the 'thing' as a research tool, which supports the development of research together with the design process. It can be claimed that with the 'thing', the design remains open and experimental. Monitoring crucial since it enables real-time mapping of the design process. The evolution of the design is a result of intellectual and actual sources. These diversified, multi-layered and complex sources need to be mapped in order to release the stored energy and research potential of architectural design studio. This would also enable students to be aware of their own thinking thus providing a powerful thinking ground for their future design practices and consolidating both the designer identity and studio character.

In our approach, the 'thing' goes far beyond projecting the existing relations, towards constructing and highlighting new ones. We acknowledge architectural design as a metamorphic process, which can hardly be understood by just focusing on the design object. Rather than this, focusing on the design generation process, its relations and design fragments gain importance in Studio 5. As discussed in previous chapters, architectural design consists of constantly evolving fragments, which generate new results in every transformation, reconstruction and incorporation. The potential of this evolution is very constructive, productive and creative so that it enhances plurality and multiplicity in studio environment.

IMAGES, CHARTS OR GRAPHICS LEGENDS

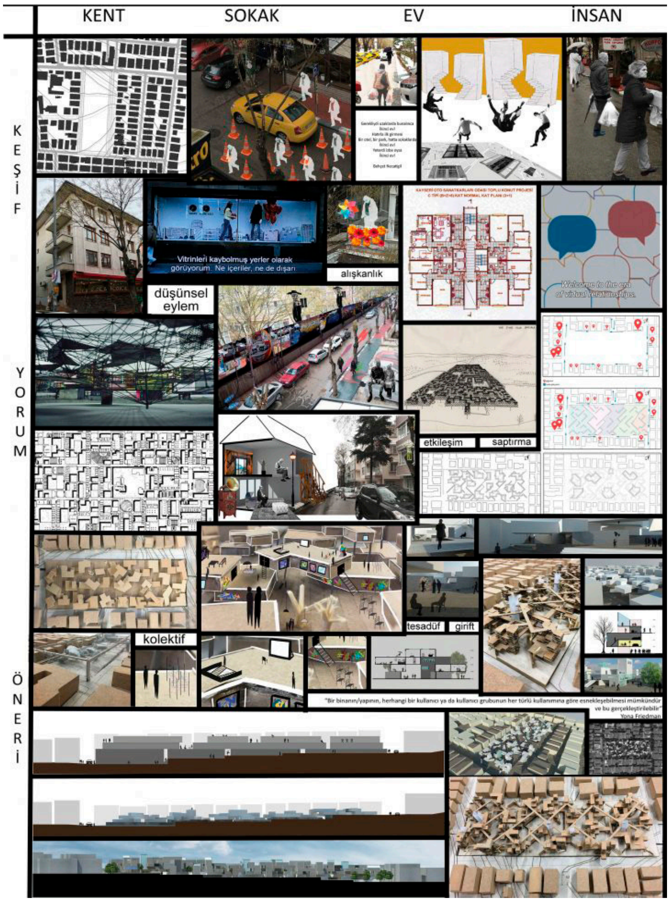

Image 1 - The thing as a matrix (Credit: Sevgi Su Sarıhan, Zeynep Demirhan, 2015-2016 Spring Semester).

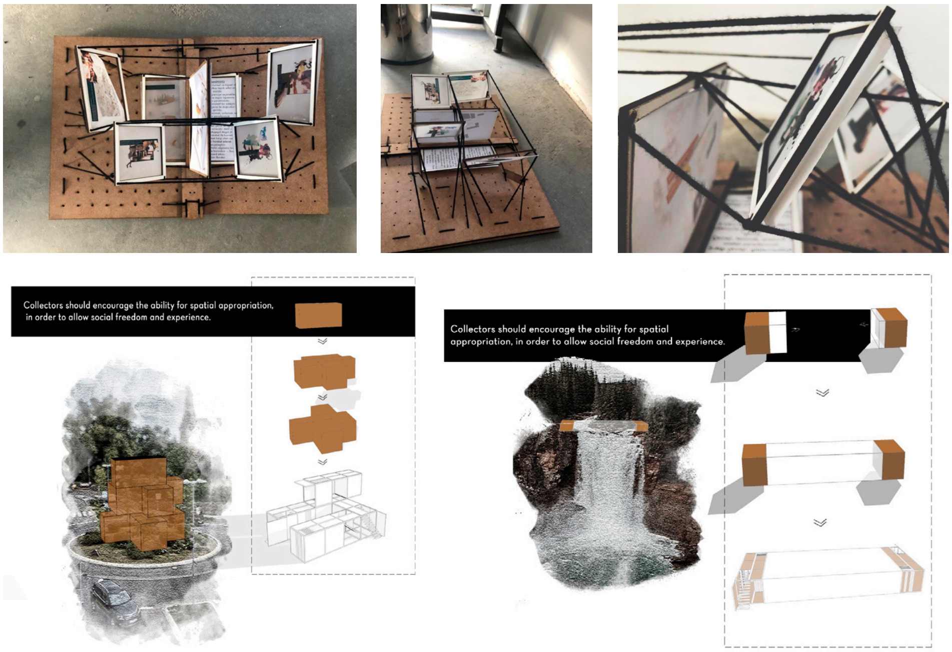

Image 2 - The thing as a 3D book (Credit: Ecenaz Tütüncü, Cansu Usta, 2017-2018 Fall Semester).

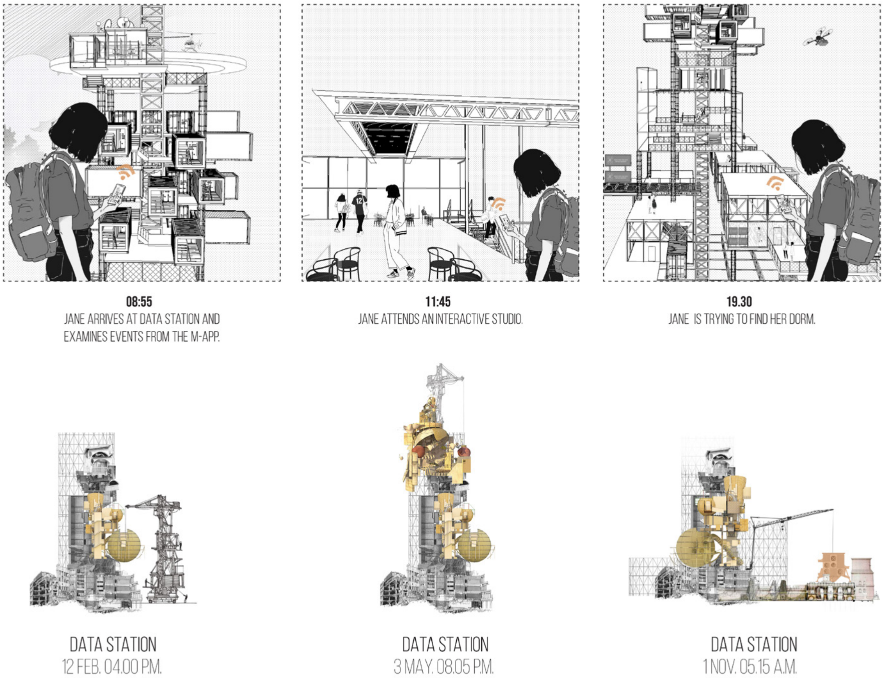

Image 3 - The thing as a Storyboard (Credit: Pelin Gür, Şevval Çöloğlu, 2018-2019 Spring Semester).

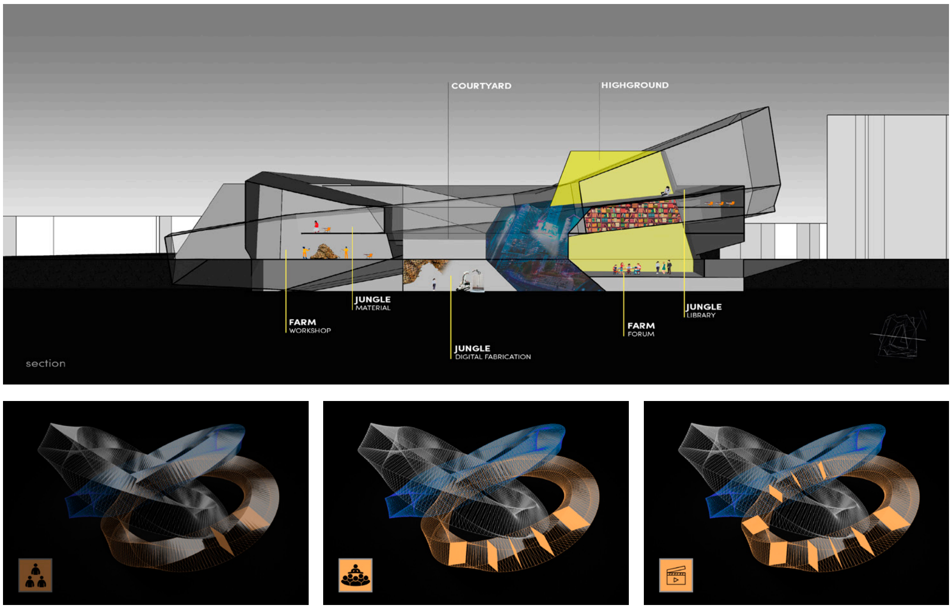

Image 4 - The thing as a 4D Mobius strip (Credit: Ayşegül Aktaş, Sedat Ercan, Onur Salur, 2018-2019 Spring Semester).

ENDNOTES

1 Studio 5 is one of the architectural design studios in Architecture Department of TOBB University of Economics and Technology, which is supervised by Nur Çağlar, Zelal Öztoprak and Işıl Ruhi Sipahioğlu. The images presented in this paper are based on experimental work developed by the participants of Studio 5. For more information and examples, please visit www.studio5.etu.edu.tr.

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MATERIALS AND BUILT ARCHITECTURE

MATERIALS – AS A CONCEPTUAL ARCHITECTURAL DESIGN PARADIGM

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ABSTRACT

In the context of MATERIART / Art and Science of Materiality in Architectural Design Education, as an approach for this submission abstract to the symposium Materiality as a process, we assume to consider materiality as a possible operative scale / paradigm for architectural design epistemology, reflecting on their specific values Among those and not being exhaustive, we emphasize the power of materials, particularly of natural materials, as components of this materiality as a process, namely optimising:

. the potential of the locus and corresponding tectonics

. the study of the technical characteristics and applications of those materials, with inherent development of their geometries, stereotomies and stereomorfologies

. the levels of sustainability

. innovative architectural design proposals, from the general to details

These and other values turn explicit in many examples which, although spread in the world, in this case we collect from a geographic boundary, the Iberian Peninsula, Portugal and Spain, providing a sample including diverse materials (stone, earthenware, cork…), organized with criteria that touch art, technique and science and brings out materiality evolution, confirming its permanent renewing capacity.

Through the presentation of a case study, considering a unique tangible building that used natural cork as a cladding or even self-supporting material, in exterior and interior walls of buildings, developing new uses of cork for building industry with powerful visual and sustainable effects, we will share a reflection and the achievements of this reinterpreted attitude – the consideration of material as a conceptual architectural design paradigm – looking for forward synergies about this thematic.

KEYWORDS

Materiality, architectural epistemology, stone, earthenware, cork

Introduction

"There is much to learn from architecture before it became an expert art. The untutored builders in space and time – the protagonists of this show – demonstrate an admirable talent for fitting their buildings into the natural surroundings. Instead of trying to conquer nature, as we do, they welcome the vagaries of climate and challenge of topography."

These paragraphs, by Bernard Rudofsky in "Architecture without architects", are a good introduction, for the text of the present submission, to the symposium **Materiality as a process**, in the context of the Erasmus + Program MATERIART / Art and Science of Materiality in Architectural Design Education.

In fact this submission paper explores the concept of materiality as a possible operative scale / paradigm for architectural design epistemology, timeless and so with or without architects and allowing a multiplicity of "research" and pragmatic criteria – in this assumption, materials, particularly natural materials and their technologies of application, are at the core of this path to buildings, with a very strong link to locus and corresponding tectonics.

For this approach, that could be analyzed worldwide, we will nevertheless consider a geographic boundary, namely the Iberian Peninsula, Spain and mostly Portugal and three different materials, stone, earthenware and cork, looking for common grounds confronting different ages strategies, but only considering cork for the presentation of a case study.

Vernacular and erudite architecture

The choice of those natural materials follows the initial and obvious choice, by the untutored builders, for using local raw materials, whose application was then influenced by geologic, topographic, climatic, economic and social factors – in Portugal, roughly speaking, we may consider two different sub-zones:

- one, to the south, with Mediterranean characteristics, although leaning on the Atlantic, namely Mediterranean-continental clime, predominance of plain topography and clay and limestone as geologic substrates, vegetation characterized by cork oak, holm oak and olive tree, agriculture mostly by wheat and vineyards with correspondent gastronomy and social organization (latifundium) – concerning construction, there is a prevalence of earthenware - (Image 1 and 2);

- another in the north, with truly Atlantic influence, namely a more humid and continental clime, predominance of rugged topography and granite and schist as geologic substrates, vegetation characterized by eucalyptus, pine and olive trees, agriculture mostly by vineyards and cereals and correspondent social organization (minifundium) – concerning constructions, prevalence goes for stone - (Image 3 and 4).

Considering those prevalence's of building materials, earthenware more in the south stone (granite and/or schist), more in the north, the potential of materiality as an architectural paradigm is confirmed, becoming in itself a factor of characterization of vernacular architecture and consequently of human societies.

Cork, the bark of the cork-oak tree, can be found all around Portugal but mostly in the south, not so common as a building material, it doesn't reach a level of regional prevalence and it's use, although ancestral, only recently is gaining dimension and visibility - (Image 5 and 6).

Nevertheless, we include cork in our approach to materiality, considering that it is a natural material, coming from the national tree of Portugal and whose application in buildings also requires morphological options on account of it's properties, as it will be later shown through a case study.

In vernacular architecture, there's a sense of cooperation with nature, accepting it's laws including some discomfort and somehow there's a tendency to impose a certain routine in daily life, usually related to agriculture and therefore stable in what concerns it's characteristics, being utilitarianism a very important one.

The techniques are very simple and basic with limited evolution – considering a structural approach, no big embrasures or empty spaces were practicable.

Keeping within the frame of the same materials, stone and earthenware, opposite to vernacular, erudite architecture incorporates a spiritual inquietude that asks for frequent renewing, that brings aesthetics concerns, that implement new symbolic values, that upgrades comfort – all this require new technologies and faster actualization, in parallel becoming more worldwide.

Obviously, vernacular and erudite architectures interacted, but always keeping their essential status – the popular may incorporate noble elements, at the risk of some loss of purity, the erudite styles, sometimes inherit local references.

In this evolution and considering the higher concerns of erudite architecture, we sense that the initial and main concerns for building upgrade were either religious, to what correspond cathedrals, fulfilling a spiritual attitude that relates sky and earth, god and men, implying more and larger inner empty spaces with light, in other words verticality and lightness, or defensive, to what correspond robust buildings with appropriate morphologies strongly linked to topography.

Materiality

Stone

For the purpose of this paper, reflecting on materiality, the main issue is nevertheless the material itself and the correspondent technical development of its applications.

Though stereotomy, for lightness or for strength according to function and ruled by metaphysical principles, namely the initial form, the divine measure units and the privileged series of numbers, which defining measurements organize those units, geometry was then the stronger instrument and paradigm of that development and stone was the elected material.

Responding to functional needs, be it religious, power dictates or war techniques, nevertheless stone properties were determinant for the morphology of the constructions, which are characterized, according to the condition of a compressible material, by arches, vaults and domes or, otherwise, by strong and large walls, whose strength was amplified through intricate stereotomy in exterior surfaces including round, tilted or sharp angles forms– specificities of materiality as an epistemological paradigm - (Image 7 and 8).

Architecture was no more trying to fit and be ruled by nature, but opposite, considering the limited options and under the constraints by the properties of the chosen materials, there was an attempt to dominate that nature through technique.

The reasons for stone surely related structural resistance, but also perenniality, which allows for symbolic values – structural preference for stone was overpast when durable traction resistant materials appeared and introduced better performance within the range of the structural solutions, changing the role of this material towards construction.

But the symbolic power of stone remains and, nevertheless, even nowadays with the help of appropriate design tools, advance computers and software, new experiences on the development and upgrading of structural morphologies are taking place, like in the Sagrada Família in Barcelona, curiously allowing the building of the dream of Gaudi, plenty of organic forms, created in an era when this kind of tools didn't exist:

- it's a building whose construction period will run for 144 years, 1882-2026 (prevision), but a very special period, along which occurred profound and very fast technical and epistemological changes;
- it's amazing to compare the calculation methods and references of Gaudi, from nature and through models or "inverse" models of elaborated

geometric forces and surfaces and those, through computation and associate building techniques, used nowadays, complementing each other for the production of one of the greatest stone construction, renewing and confirming the potential of this material - (Image. 9 and 10).

Materiality is through this example at his best, putting in evidence material as an architectural paradigm - (Image. 11 and 12).

Earthenware

Besides structural achievements other concepts arouse as references for architectural design development, such as sustainability.

Again, lessons from untutored builders are crucial, in this case more related to earthenware materials, less resistant and durable than stone, but with higher performances relating thermal insulation / comfort, easier to work and cheaper, what turns these material / construction methods, namely adobe and mud walls, more convenient for plain architecture and communities, although in more developed stages of those techniques some monumentality can also be achieved.

Like stone it's a compressible material, although it's fabrication requires some molding for the parts, brick format of formwork sometimes with the inclusion of a inner component (as straw) and not only cut, so the correspondent organizing geometries expressing themselves through stereotomy but also stereomorfology– the morphological characteristics of the building are similar to those of stone, with arches, vaults and domes, as well as large walls, imposing it's presence, although verticality is limited due to material less resistance - (Image. 13 and 14).

Earthenware construction occurs also predominantly where geographically the raw material exist, stressing that it is extremely recyclable, so fitting nowadays concerns about sustainability and circular building chain.

Although the durability problems, needing maintenance, mainly waterproof, care, being a compressible material it can last long, assumptions that direct the correspondent innovation – through the study of the properties of the material, namely chemical composition or ageing performances, through essays of new composites, through systematic analysis of it's morphologic variants and correspondent geometries, through new buildings techniques… - again materiality as an architectural paradigm, considering a building material with past, present and future.

Cork

Cork-oak (Quercus Suber L.) is the National Tree of Portugal.

And cork is the only product that allows Portugal to be the number one, at world level, as a producer, as an industrial transformer and as commercial partner. Portugal is the first producer, but also the first importer of this raw material and the first exporter of finished and intermediary cork products.

Cork's journey, from tree to building, is a transformation process that starts with the stripping or extracting of the bark from the cork-oak. The first stripping, 25 years after tree plantation, known as the "desbóia", yields cork with a very uneven structure called "virgin cork", which is hard and difficult to work; nine years later, at the second stripping, a material with an even structure is obtained, "second cork", which is not so hard, but it is at the third and subsequent stripping that the cork with the best properties for making cork stoppers is obtained, the so-called "cultivated" or "reproduction" cork - from now on, that tree will supply a good quality cork every nine years and for the next 150 years (on average each cork-oak yields 15 to 16 stripping during its life).

The essence of cork is defined by its cells, which are grouped in a very special alveolar structure; cork is light, impermeable to liquids and gases, elastic and compressible, a good thermal and acoustic insulator, incombustible, very resistant to wear and tear and with a amazing capacity of CO2 capture. Since the discovery of the agglomerates at the end of the last century the range of uses grew, in many directions, from design to sport, from aeronautics to boating equipment, from military uses to the construction sector – for this last example, some features are relevant, namely the long term behavior, the insulating characteristics, the reaction to fire, comfort aspects, decoration, anti-vibration properties.

Cork-oak and Cork Observatory – case study

The Cork-oak an Cork Observatory (CCO), our project / building, is located in Coruche, a Portuguese municipality in the province of Ribatejo and, as municipality, is the biggest national cork producer, also harboring some cork industries - so the landscape, the ambience, including fauna and flora, the work and the life of Coruche, are deeply influenced by cork.

The exact location of the CCO building is on plot 41 of the Industrial Park Monte da Barca, an industrial site development, circa 5Km east from Coruche town centre in the middle of a cork-oak forest. The plot, rectangular in plan (61,0m x 42,5m), almost horizontally leveled, faces at NW and at SE empty plots (unknown future at design stage) a street at SW and a cork-oak forest at NE - the closest neighbors are the "Grupo Piedade" - cork industry factory, the "Grupo Amorim" - cork stoppers factory, a water reservoir and a multi-industrial building (for small industries), so an industrial not so pleasant, except for the forest, environment.

Anyway we can say and feel that the core of the tectonic spirit of the place is cork.

Considering that tectonic power of the place and, as part of a broader strategic development plan, namely the Cork-oak Forest and Cork Thematic Park, the Municipality of Coruche organized an architectural design competition for the CCO building, whose goals, related to cork-oak forest and cork are to support, protect and promote industrial research projects, to promote the organization of seminars and congresses, to create and shelter a thematic data centre / library and to organize exhibitions.

The functional program called for a multipurpose atrium, reception, exhibition and circulation space, an administrative zone (office, meeting room, archives), an auditorium, a cafeteria, WCs, a data centre/library, laboratories, a classroom, a workshop and general storage.

The winning entry of Arquétipo Atelier, organized this program in two levels, the ground floor level mainly dedicated to communication and marketing, the first level more concerned with study and research and, yet, considering also a basement level for general storage.

Besides function, architects poetics looked for a spiritual, ecological and sustainable approach, fitting in landscape by soul, creating and showing innovative uses of cork in the construction sector and, so, reinforcing the programmatic goals.

So, considering the visually poor surroundings, through geometry, namely the simplicity and strength of the ancestral initial form, the square, here articulated in plan with the circle, a simple nevertheless original volume is proposed, attracting curiosity and people through a warm hug of the void connection of the exterior towards an "interior/exterior" yard, leading to the main entrance and creating a pole of attraction among the surrounding, somehow "aggressive" buildings.

On the other hand, CCO building itself is a metaphor, corresponding to the appearance of the tree after the always partial stripping, that looks like the assemblage of two different specimens. It's also a sign of the potential of the cork-oak tree and its products, presenting, besides the most common use of cork as an acoustic and thermal insulation material, innovative, mainly visual and sensorial uses of cork and, implicitly, benefiting from some admirable technical/ecological qualities of this material such as CO2 request - (Image. 15 and 16).

The CCO building, through an innovative and unique ventilated cork façade, made out of "virgin cork" (upper level) and of "second cork", so natural cork (only boiled and compressed for some flattening), approaches that image, completed by shadowing elements/leaves on the roof, echoing the background landscape – during this creative process, truly research by design, many technique questions arouse, such as dimension of the slabs (they were not industrial), fixing methods, joints dimensions, resistance, ageing performance, which were partially solved with a previous prototype - (Image 17 and 18).

Another original use of cork products are "rabanadas brocadas" screens - "rabanadas brocadas" are the remaining cork pieces from stoppers production (traditionally used for black agglomerate cork slabs production) - these pieces, placed in between two glasses, form an attractive screen used in CCO building in positions where visual contact, not totally open, was welcome.

A third kind, of uncommon approach of the use of cork products, is the application of black agglomerate cork slabs (natural product made from remaining pieces, smashed, boiled compressed and cut into slabs), which where used as outside parking cover, as outside finish for the electric generator hut (on account of acoustic properties) and inside in the auditorium, again on account of acoustic but also as a visual features, introducing relief and where a "fresco" painting was experienced (direct translucent painting, allowing the visibility of the texture) - (Image 19 and 20).

CCO building is a contribute to the widening of the possibilities of the use of cork in construction, another example of material as a paradigm of architecture, fitting the landscape by form/texture, by soul and, considering that the consumption of cork products ensures the sustainability of cork-oak plantations, by preserving the environment, the existing flora and fauna and the lives of many villagers and by its eco-efficiency (co-generation, recyclability, ...).

As a corollary of all this potential, a Research & Development Project emerged, "i-Cork/cork, architecture, design and innovation", under the coordination of the Principal Investigator Manuel Couceiro da Costa, profiting the synergies and experience of the group involved in the CCO building, design team, owner consultants and partners, together with the University of Lisbon.

IMAGES, CHARTS OR GRAPHICS LEGENDS

Image 1 – Alentejo / Traditional mud wall building

Image 2 - Alegrete, Alentejo / House with (taipa) whitewashed mud walls

Image 3 - Pedrogão, Caramulo / Granite landscape

Image 4 - Cadraço, Caramulo / Vernacular stone buildings

Image 5 – Cork stripping

Image 6 - "Capuchos" Convent / Sintra – 1560 ("virgen" and "second" natural cork)

Image 7 – Guarda Cathedral – XIV century

Image 8 – "Nossa Senhora da Graça" Fortress / Elvas XVIII century

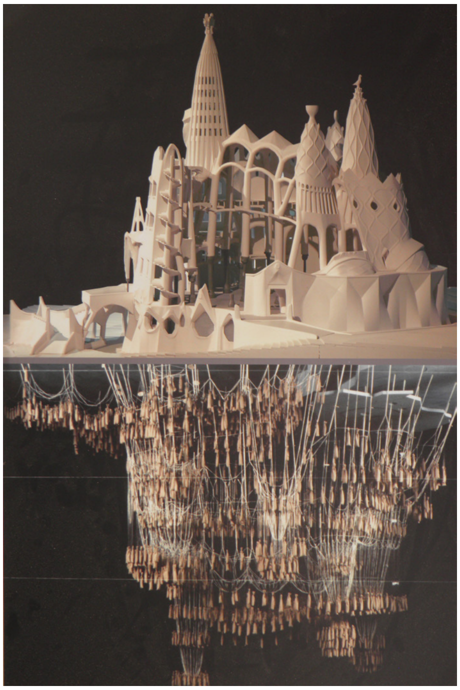

Image 9 – "Cripta Gaudi – Colonia Güell" / Santa Coloma de Cervello – study models

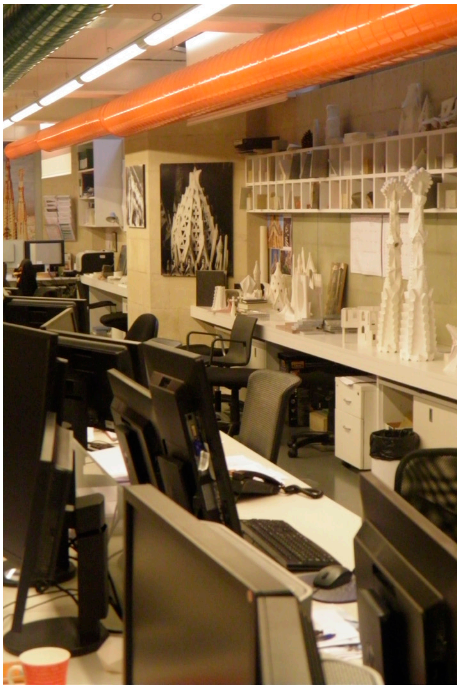

Image 10 – "Sagrada Família" / Barcelona - actual study room and equipments for current renewal

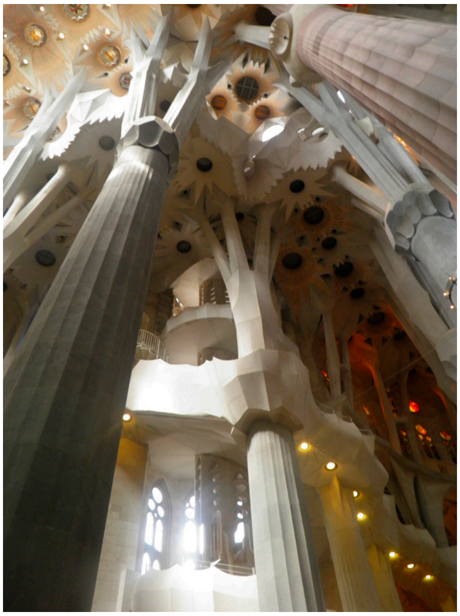

Image 11 – "Sagrada Família" / Barcelona - interior organic form

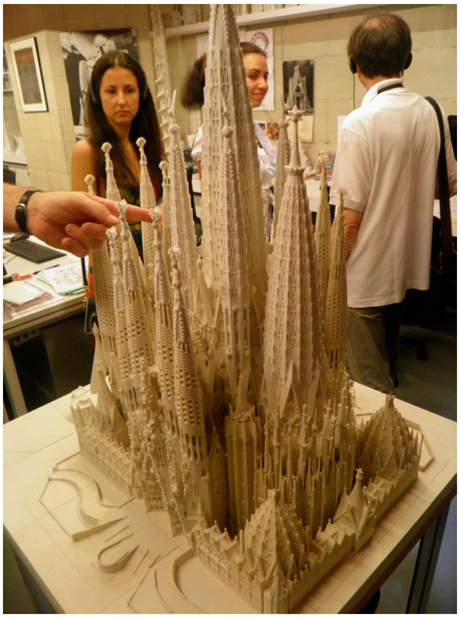

Image 12 – "Sagrada Família" / Barcelona - global model of the complete Gaudi project

Image 13 – Traditional earthenware vault closure

Image 14 – Portel Hospital – earthenware ribbed vault

Image 15 – Cork-oak and Cork Observatory / Coruche entrance

Image 16 – Cork-oak and Cork Observatory / Coruche northwest facade / light, stereotomy, textures and colour

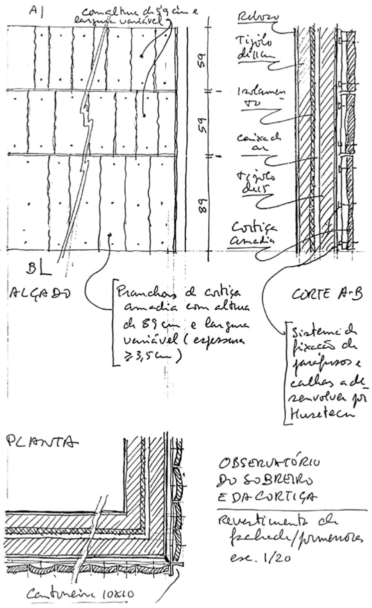

Image 17 - Cork-oak and Cork Observatory / Coruche conceptual sketchs for the ventilated facade

Image 18 - Cork-oak and Cork Observatory / Coruche ventilated cork facade setting up

Image 19 - Cork-oak and Cork Observatory / Coruche "rabanada brocada" screen and door

Image 20 - Cork-oak and Cork Observatory / Coruche auditorium painted "fresco" over black agglomerate slabs

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3, 4, 9, 10, 11 and 12 – author photos / drawings
5, 6, 15, 16, 17, 18, 19 and 20 – Cork-oak and Cork Observatory (Couceiro da Costa, Manuel / Susana)
7 – www.visitportugal.com
8 – www. Ipressjournal.pt

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THE TWENTIETH CENTURY RESIDENTIAL COATINGS, THE HOUSE OF CLEON FURTADO:

A constructive analysis based on coatings applications in São Luís of Maranhão (Brazil) interior residence

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ABSTRACT

The interior architecture in São Luís do Maranhão (Brazil) from 1940 to 1985 is an differentiated study object, mixing the international (eclectic and modernist) architecture with regional constructive techniques (tropicalist and Marajoara architecture) considering that the city is a historical and cultural patrimony of humanity by UNESCO (1998). The twentieth century architecture produced a series of changes in the building materials and the configurations of the residences. The article aims to analyze, under qualitative and phenomenological parameters, the techniques of the wood, cement and ceramic coatings applied in the residence of the architect Cleon Furtado iconic construction and to identify items in residential interiors that substantiate the architecture peculiarities aiming to organize a collection of morphologies and typologies of the period, due to the sociocultural architectural relevance production in the city's architect. The methodology seeks to identify geometric patterns, details in their elaboration, applications in the interior spaces and quantify the material type used in the coatings by means of low floors of the architect's residence, for improvements in the life's quality of the period users with applied environmental psychology principles. An unprecedented dialogue is established between the coatings applications on Brazilian modernist architectural production, with authors such as Segawa, Pernão, Barracho and Pallasmaa. It concludes seeks to reflect on the importance of the preservation of the residential architecture of the twentieth century and to support the fundamentals of the resonance of the modern and peculiarities of the production of materials in São Luís do Maranhão (Brazil).

KEYWORDS

Tropicalist architecture, interior architecture, coating techniques.

Introduction

The Modern Architecture nuances in Brazilian territory throughout the twentieth century, especially in the cities of Rio de Janeiro and São Paulo, restructured the national scene of construction and all the molds of world architecture. Brazilian architects, like Lucio Costa, organized a series of changes in the methodology of the educational system of the architecture schools in the country, leading a new way for Brazil's creative architectural process.

The late expansion of modernism to the capitals in the north, northeast, and south of Brazil developed regional peculiarities in this architectural style (Segawa, 1999), where government buildings implanted modernism in order to affirm political development as in institutions of the post office, INSS (National Social Security Institute), SULACAP Insurance Company, among other public agencies.

The foundation of a new architectural style that accepts and considers pluralism as modernism, gathered local characteristics and incorporated nationalist values, initiating the production of *Tropicalist* and *Marajoara* modernism in the period from 1940 to 1985, as a late production that explored changes and improvements for Brazilian modernism.

This article aims to explore the nuances of Brazilian modernism applied in the city of São Luís by means of qualitative and phenomenological parameters, the patterns and techniques of the ceramic, wood and cement coatings in a case study of the architect Cleon Furtado's residence. It will also be observed how these geometric standardizations and the details in the elaboration of these materials in the residential interiors stimulated improvements in the users' life quality, through floor plans and sections applied to the principles of environmental psychology.

The objective of this research is to help valorize and preserve Brazilian modernist heritage by incorporating the expressive work of innumerable nuances and modernism representations, especially in the production of materials applied to residential interiors.

Contextualization

From the 1940s, the city of São Luís, capital of Maranhão, located in the northern half of Brazil, suffered late updates in its urban layout, which modified the core of the center - derived from principles of Portuguese colonialism – in order to organize and optimize the infrastructure. The "São Luís remodeling plan" stimulated the expansion of the city, the acceptance of new constructive models and the aesthetic update of the residences parameters, of the morphology and layout and of the use of the materials and constructive finishes.

The Caminho Grande made expansions to the district of Anil towards the municipalities of Paco do Lumiar and São Jose de Ribamar (which are part of the capital metropolitan region) where, from 1952, the neighborhoods that surround the Areal region appeared, with an evasion of residents of the city center. In mid-1954, residents were forwarded to neighborhoods such as Monte Castelo, Fatima, Apeadouro and João Paulo, being considered as housing places for the new middle class that sought to escape from urban centers and now are set up as residential spaces (Moraes, 1989).

The great political and economic changes of the period resulted in the consequences of the social catastrophe for the aristocratic modernism of the Northeast, considering the improvements in the quality of life - infrastructure and better conditions in education, sanitation and other indicators of globalized quality - in which the innovation and positioning of the middle class user is consumed (Pereira, 2012):

> "[....]a special modernizing performance: individuals who are at the same time the main beneficiaries of modernity, especially in their dimensions of urbanization, schooling and democratization, but also their most convinced catalysts [...]middle-class individuals are particularly well-suited to monitor social change, for they often condense it, radicalize it to the limit, caricature it [...]they are a kind of helmsman of social change or more correctly of its modernization dimension".

The work developed in the residential interiors of the architectural project of the period, the organization of the façade and in particular the composition of colors used by the São Luís society, justifying the mixture of the tones that are typical of modernism with the work proposed by regionalist veins and culturally rooted in this architectural production under study.

It is important to emphasize the work developed by the architects Cleon Furtado, Braga Diniz and Cândido Ribeiro during the studied period, besides the valorization of the work of local professionals in disseminating the Brazilian modernism. Its nuances and peculiarities throughout its territory and the plurality of the works of this movement, promoted the development of a peculiar and unprecedented object of study: the modernist architecture of the tropicalist-Marajoara.

The residence under analysis in this article comes against the development, settling on the skyline of the historic city, tearing the Portuguese colonial architecture and maintaining as a prototype of the organization of a differentiated morphology, with a semi-detached residence, an edicule and access to garage by the street and side square. And in addition, the architect Cleon Furtado applied innumerable innovations for the region, adapted to the specific needs and for aesthetic senses of the region.

The work developed in the residential interiors of the architectural project of the period, the organization of the façade and in particular the composition of colors used by the São Luís society, justifying the mixture of the tones that are typical of modernism with the work proposed by regionalist veins and culturally rooted in this architectural production under study.

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The Residence

Cleon Nascimento Lima Furtado's modernist residence, designed by himself, belongs to the modern architectural context introduced in the historical fabric and the colonial landscape in the Historical Center of the city of São Luís, Maranhão. The building dating from 1967, is located at Beira Mar Avenue n ° 530 (image 02), and differs from its surroundings by having modern constructive characteristics using geometric shapes, free spans and new materials.

The property is characterized by being morphologically semi-detached, composed of two symmetrical residences (image 3). Originally, the residences belonged to the architect and his mother, and today he still resides in one of the houses conserving the elements and its modernist characteristics; however, he leased the other residence for commercial use and its interior modified.

Architect Cleon Furtado, is the biggest representative of the consolidation of modern residential architecture in São Luís. Born in Maranhão in 1929, he attended the Mackenzie School of Architecture in São Paulo in the 1950s, and upon returning to his native city, brought a new style of architecture with references of ideals of architects such as the German Mies Van der Rohe and the Frenchman Le Corbusier (Pflueger, 2008, p.92).

The architect's residential works distributed throughout the city's neighborhoods, such as the residence in analysis located on Beira Mar Avenue, inserted a new style that is based on the valuation of the pure form, through the use of pilotis, free plan, windows along the facades, composing a new way of building houses in the city.

Standards Identification

The internal spaces are composed of flooring with wood extracted from the typically Amazonian flora: *pau d'arco*. Patterned pagination by the living and dining room with composition spaced from the veins of natural wood. This type of parquet paging is an unprecedented pattern of exclusive use of modernist *Marajoara* architecture.

Toilets have tiles and ceramics coming in with details and pagination of the period, where the linings were exported from the French porcelain maker that the Brazilian architect Janet Costa specified for the interiors of the wet areas of the friend's residence, the also architect Cleon Furtado. (images x and y)

The main façade and the cross section that extends beyond the living and dining room are also made up of the exclusive production of the modern Marajoara architecture, with an exclusive pagination of Brazilian stones, called slate, the different nuances of stone expressing brilliance and exclusivity to the interiors, as described for the parameters of the users.

User Parameters

The qualitative and environmental psychology parameters explore the user experience in the object of study - the materials applied in the residence of the architect Cleon Furtado - based on parameters pointed out by Barracho and Pallasmaa, in contemporary studies on the use of internal elements in the layout of residential interiors .

The patterns and origin of the coatings materials are analyzed as essential elements for the qualification of these internal spaces. Colors, shapes, pagination of ceramic, cement, natural stone and wood veneers from the general north-north of Brazil, are comforting for creating a reinterpretation of already existing materials already used in the residential interiors of the region.

The use of natural elements of the region - as a point of sustainability and reuse of local material - as well as the reinterpretation of patterns of these coatings are based on the so-called "affective psychology" bound by consideration of the unprecedented nature of these constructions. Well-being is proposed in the experience with the socio-political context and parameters of the use of color palette and composition of qualitative elements (Barracho, 2001).

Qualitative

The users' experience goes beyond the concepts coming from the use of the modernist constructive elements, Barracho (2001), where the intentionality itself allows the interpretation of how we receive the real world, by the meaning of the behavior of the people of the period with the set of acts individuals and effectors by individuals "(Barracho, 2001). The lived space becomes peculiar to all the context developed in each temporal cut and in each contextualization of the users of the period.

A very important point in the user's perception of the experience in residential interiors is the use of color, pondering the physical phenomenon with the phenomenology itself within the lived space, where '' color is a physical phenomenon, and the color variety is much higher to the one the human eye can perceive. '' The organization of this process of color in the modernist period tendencies also reflects not only the adequacy to the international context, but also includes the work the addition of the regionalist aspects in the composition of the residential interiors of the period.

Environment's Psychology

It emphasizes here the importance of the coatings in the psychosocial perception of the environment, the reaction of the personal spaces, dimensioning the phenomenological sphere (Barracho, 2001) also confronting all the experience of the individual within the space dimensioned and provided by the compositional work of the construction by the architectural design.

It is important to emphasize that the composition of the coatings deposited different reactions on the psychosocial effects, determining different effects according to the organizations that will be organized. The application of contrast rules to internal spaces presents to the ITTEN system (Grimley, Love, 2007) also promotes different chromatic reactions.

Attachment to the place, in both functional and symbolic dimensions, positions the relation of objects and chromatic reactions to the feelings thus bound by users. This case on the use of applied coatings in the interior architecture establishes the relevance that the psychology of the environment provides.

Final Considerations

The architectural production of the period from 1940 to 1985 in the city of São Luís demonstrates the plight and political and social changes that fostered the construction of an exclusive production of Brazilian modernist architecture. The resonances of the modern demonstrate the vanguard of the modern constructive model but also by the installation of peculiarities in its internal flows and regionalist solutions in the formalization of layouts and constructive finishes, adding clearly already entrenched cultural traditions like the use of frames and finishes with hardwoods of the region, such as the addition of balconies and free space not ornamental but mainly of colonial origin of the rural aristocracy Northeast.

It is important to emphasize that the article merged concepts of environmental psychology and user perception together with the numerous reference books that talk about modernism, adding the analysis of the cadastral and photographic survey of the residences in question as well as the configuration of the profile of the users so that the final considerations discussed here.

This study stands out in promoting the cataloging of the numerous architectural peculiarities in the modernist period in the Brazilian territory, especially in São Luís, which still had a configuration of Portuguese colonial city and from the last decades of the twentieth century managed to modify the architectural scenario more also to develop in its territory, in an expressive growth in urban and economic infrastructure.

IMAGES, CHARTS OR GRAPHICS LEGENDS

Image 1 - Sao Luis (Maranhao, Brazil) at the 1950's. Author: Soares Photograph's Album

Image 2 - Cleon Furtado's Residence. Author: Bianca Barbosa, 2017.

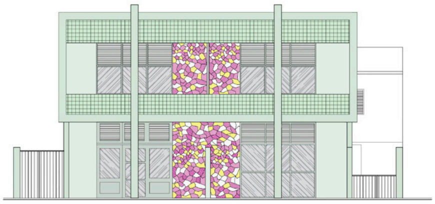
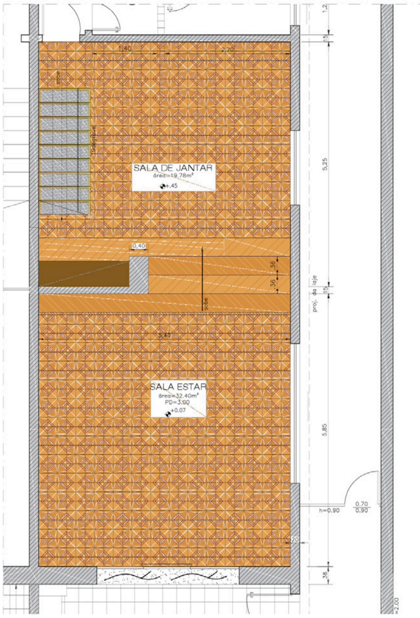


Image 3 - Cleon Furtado's Frontage.
Author: Bianca Barbosa e Larissa Nunes, 2019.



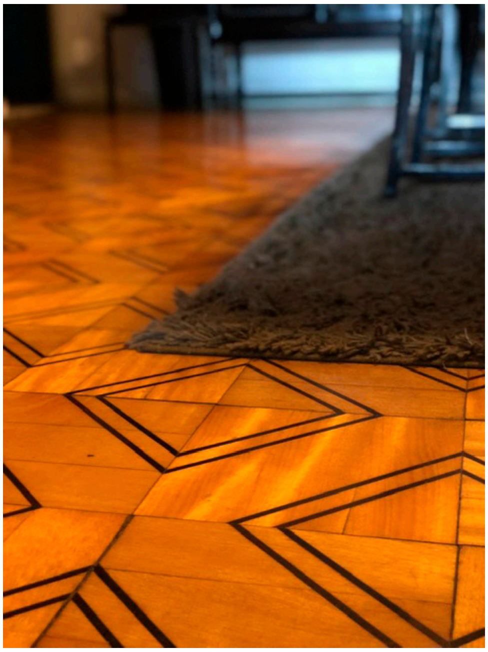


Image 4 And 5 - Cleon Furtado's Parquet Floor. Author: Bianca Barbosa e Larissa Nunes, 2019.

Image 6 And 7 - Cleon Furtado's bathroom Floor, Author: Barbosa and Nunes, 2019.

Image 8 - Cleon Furtado's Dinner Wall. Author: Bianca Barbosa and Larissa Nunes, 2019.

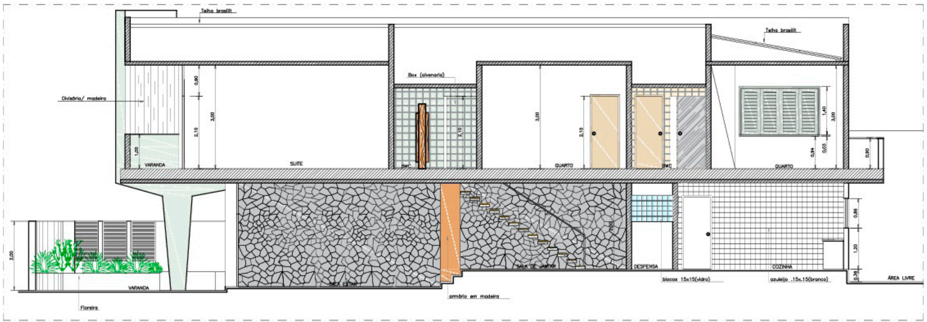


Image 9 - Cleon Furtado's Dinner and Living room Wall. Author: Barbosa and Nunes, 2019.

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FROM THE PLANNED "DOM-INO STRUCTURE" TO THE BUILDING OF THEIR OWN SPACE DOMAIN: THE BAIRRO DA JAMAICA IN SEIXAL

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ABSTRACT

Roughly 80 years separate the prototype created by Le Corbusier in 1914 - Maison Dom-Ino - aiming for the rapid creation of economic housing in a war-torn Europe, from the dystopic outcome that a set of residential buildings, built in Seixal, known as the Jamaica Neighborhood, would have after the bankruptcy of the contractor responsible for its construction. In common, the constructive system of reinforced concrete, which in the early twentieth-century draft constituted the enabling basis for architectural freedom by architects. In the example of the end of the same century, this would have the same function, only that the procedure would be made by other actors: the own residents.

Throughout this article, the process of "project appropriation" is addressed, which guided the transformation of the abandoned concrete frame into a spatiality that allowed its residential use.

Based mainly on a process of morpho-typological analysis and the interviews conducted with the pioneers living in the Jamaica Neighborhood, that is, the true builders, the hidden intentions are demonstrated behind what a superficial view suggests being a chaotic mass.

KEYWORDS

Dom-ino structure, Jamaica neighborhood, "Project appropriation", self- build construction, reinforced concrete frame

Introduction

The large-scale production of vertical buildings nowadays owes a great deal to the technique of reinforced concrete. Although the steel structure is also an option for this type of building, its inability to have the components manufactured in the site itself, coupled with a greater technical clearance on the steel industry, as well as the logistics of material transport from the factory to the construction site, makes it a more restricted option.

The great benefit of reinforced concrete that has resulted in the generalization of its use lies primarily in two factors: the ease of moulding in the most varied contexts, and the non-need of a specialized workforce.

Since the late nineteenth century, the reinforced concrete frame was widely used in constructions across Europe and the USA. The initial editions of the Béton Armé magazine (1898-1935), publication of the Hennebique Company, which was the most internationally publicized constructive patent for reinforced concrete in the transition from the 19th to the 20th century, presents examples of works ranging from multi-story factories to buildings within dense urban areas.

In fact, the Dom-ino system as a structure was nothing new in 1914; the great change lies in its architectural use as the primary solution to objectively solve an emergency housing shortage problem:

> "By November 1914, one fifth of the Belgian population was homeless. Corb's solution was almost painfully simple: a standardised, two-storey house made up of concrete slabs supported on columns and a staircase. That was it – no walls, no rooms, just a skeleton." (McGuirk. 2014)

The completion of the skeleton with elements that would make it habitable - the windows, doors and walls mostly - was never the great concern of the architect, who was interested in the versatility that the structural basis would provide (Fig. 01).

The main point of the proposal was the elimination of the wall as a determinant of the construction of the spatiality, leaving the choice of these to the constructor - whether is a professional of a company, or the resident himself (Moffett et al., 2003, 509). This was its great innovation, which in order to be feasible would require the roof as a blade where the perimeter is the only limiting element of the space, hence the Dom-Ino does not have any beams in the ceiling to join the pillars and support the slab (Aurelli, 2014), a crucial difference from the examples built in reinforced concrete at that time, where the horizontal structural grid is visible. The abstract concept of internal space construction advocated by Le Corbusier was nothing more than a prototype. However, the alliance between industrial technique and economic power was quickly incorporated by the civil construction market, and in the Portuguese case in particular, from mid-1930s beyond, the reinforced concrete frame starts to be a presence in residential real estate projects of Lisbon (Rodrigues de Castro & Mascarenhas-Mateus, 2018, 908). Almost as an averse of Positivist pragmatism from which Dom-Ino had resulted, the example of Seixal starts from the same basis as the first, with immense differences in its outcome. Instead of being the result of an economic and industrial model where the standardized construction would allow its multiplication and consequent reduction of production costs - democratizing access to housing - the unfinished frame was a residue of a disastrous real estate process. On the one hand, Dom-ino was seen as the necessary revolution to accompany architecture to the technological and social development of the time:

> "As a machine of living, architecture no longer represents values or ideologies, but is an apparatus that frames possibilities for life to occur. In it simplest for architecture becomes the act of framing spaces to be inhabited. Life as such, life as bios, cannot be represented, only enacted by specific spatial conditions that trigger uses and appropriations of space." (Aurelli, 2014b)

Diametrically opposite, in Seixal, with no other options, the floor and ceiling that the skeleton offered was the only possible solution found by the population to possess something that allowed to inhabit. This was a choice as pragmatic as that seen by Le Corbusier when designing the Dom-Ino, after all, the elements that make up the frame of Seixal more easily allows its transformation into habitation than an empty ground where everything has to be built from scratch. On the one hand, a utopian and highly universalist view, on the other, a dystopia, where its inhabitants perceive the unfinished structure of reinforced concrete as a synonym of precariousness. A place where inhabiting it represents the incapacity to have access to the basic, and of building with their own hands the necessary spatiality was the only available option.

Bairro da Jamaica: social and structural aspects

Located about 12 km from Lisbon, in the municipality of Seixal, the Bairro da Jamaica consists of 9 buildings. The tallest one, 7 storeys high, is grouped together with three other smaller vertical buildings; besides these, there is a group of low-rise rowhouses, and also an isolated vertical block (Fig. 02). During construction in the 1980s the contractor went bankrupt and in the meantime, the unfinished buildings were occupied at the beginning of the following decade by families who could not get a house by the official way, whether provided by the housing market or by the social services of the municipality.

Within the 5 hectares of land where the buildings are located live 215 families in total, which corresponds to approximately 800 people. Of the original inhabitants of the beginning of the 1990s, no one else lives in the neighbourhood; they were relocated between the end of the decade and the beginning of the 2000s. Most of the current residents come from Portuguese-speaking African Countries (PALOPs) and Portuguese born Roma.

Although the neighbourhood has been associated with organized crime and drug trafficking for decades, in the conversations with the residents all agree that this is now past, and the police themselves confirm this information.

Infrastructure is precarious in every way: the sewage runs in pipes outside the blocks and is directed to the basement of buildings, where until recently there was no connection to the sewage network.

The vertical access to the floors is by internal stairs, without lighting and with improvised handrails, so that the touch, more than sight, is the predominant sense for this dangerous route when the sun goes down. Elevators, the obvious solution to the vertical circulation of tall buildings since the late 1800s, were never installed, and their shaft remained empty in some blocks, like a scar of what could be a facilitator of a more dignified life. The high-rise construction, which is also closely linked to the development of frame structures (steel or reinforced concrete, where the walls are independent) arrives incomplete in this case, where the drawbacks far outweigh its potential virtues.

When entering the two-storey dwellings there were serious problems of infiltration and humidity, as well as bad ventilation, which create a muffled atmosphere. In the higher blocks, the residents reported having similar cases in some units.

More recently, on January 20, 2019, the discussion among residents forced the intervention of the police; this one claims to have been received with violence, having an agent wounded with a stone. Residents, however, say there has been excessive police violence. The next day, they marked a demonstration that brought together about 200 people on Avenida da Liberdade - Lisbon's main avenue - where again there were clashes between police and civilians.

These developments have reached a national dimension, going beyond the alleged case of racism or contempt of the police, and it has become a political issue. In the days that followed, several personalities, including the Prime Minister and the President of the Republic, visited the neighbourhood.

Shortly before this incident, on December 17, 2018, the community resettlement program began, initially targeting 187 people, who were distributed through several apartments in the municipality of Seixal. According to the schedule, it is only in 2022 that the entire process will be completed, allowing for the demolition of the buildings and subsequent urbanization of the land by the private company that owns the land.

The rehousing is the culmination of a promise that dates back at least of 2004, being that in the elapsed time a playground was constructed on the ground and the connection of the houses to the sewage network, however, the street lighting does not exist, so that, such as on the stairs inside of the buildings, the situation is almost total darkness at night.

The asphalt of the streets was achieved thanks to the contribution of the residents themselves to raise funds and avoid accumulating mud puddles during the rainy season.

Bairro da Jamaica: post-occupation morphological analysis

Having as a single guarantee the potentiality that the reinforced concrete frame would offer, it was up to the inhabitants of the Bairro da Jamaica to turn these possibilities into a spatiality that resembled a dwelling.

At the time the complex was visited on December 20, 2018, the tallest building was in the process of demolition, and therefore, access to its interior was forbidden. In this way, the analyzes of this wing and neighbouring buildings are based on photographic data and residents interviews. From these interviews, it was reported that the current residents actually made a loose agreement with the old ones that were relocated to purchase the space they left. In this process, they could shape the configuration of the typology they wanted, with 1 or 2 bedrooms for example - a piece of information that proves the versatility of the structure in reinforced concrete.

In the buildings composed only by 2 floors, it was possible the internal visit to some units, besides the interviews to its inhabitants.

The solution used as a border between the inside and outside in all units of the vertical blocks is the brick wall, in most cases not plastered. The choice of this material to the detriment of others such as the corrugated plate, is hypothesized to be directly related to the office of a large number of the first inhabitants to inhabit the structure: construction workers, from the former African colonies in the midst of the boom of the Portuguese real estate market of the 1990s.

To these walls is subtracted the feature that allows the natural lighting of the interior and the views to the exterior. From the interviews carried out, it is possible to notice that the majority of the residents bought the respective windows of their units, and in this case, there is a predominant pattern of being small windows, where the hypothesis of this is a consequence of the lower costs of the same ones in the construction market.

In punctual cases of the taller blocks with exposed bricks, the windows show a vertical alignment in all units, which would indicate an aesthetic concern with the exterior in the choice of window location. Although the current residents say that all the unplastered buildings of the complex were only a skeleton when the first generation residents lived in it, the latter have all been relocated today and can not be a direct source. The in situ analysis of some buildings seems to suggest that there might be some external walls when these first arrived, with the respective window gap placed. This would explain the alignment, where the preexisting gap would turn out to be an element that would facilitate appropriation.

However, in general, the dominant situation is to position the window symmetrically to the concrete frame corresponding to the internal division, or displaced nearing to one of the edges. Anyway, the window is rarely seen against the wall edges. At the 7-storey building, different from adjacent lower ones, the nonconformity of the windows in their verticality leaves no doubt that it would be a totally empty frame when inhabitants first starting occupying it. In addition to the windows, there are situations where the relationship with the outside is through a balcony. In this case, the preexistence of the hanging slab (free of pillars in one or both ends, differentiating itself from other parts of the concrete structure frame) is admitted as having influenced in the choice by not completely close this area, as is verified in many situations. The fact that one of the neighbouring vertical blocks has been occupied with the already installed walls and the hanging balcony completed may have served as a model when the residents, having found a similar structural situation in the blocks with only a concrete frame, had to build their own space (Image 3).

Still, on the subject of hanging slabs, an example of peculiar appropriation deserves to be cited due to its specificity (Image 3). It is a union between two parallel hanging slabs, which would serve as a balcony in the original project, and with the extension became a single slab in reinforced concrete. This shape is the only one verified in the buildings of all the blocks where the appropriation goes beyond what the original structure would allow.

These open areas to the outside also exist in the roof of the buildings, where they form terraces. Some are of restricted use to the dwellers of the dwellings built on roof slab, while in at least one, the inhabitants cited it to be a community space, also serving for the raising of chickens. From the descriptions of the residents, one notices that it is located just outside the stairwell, and runs along a perimeter that crosses three facades. Continuing the analysis in the vertical blocks of exposed brick, the external arrangement of the sewage pipes in the facade reveals a kind of informal agreement among residents, although this hypothesis cannot be confirmed.

Among the several pipes observed is inconclusive a standard with regard to the sewage system diagram: there are situations where from one upper floor the pipe descends lonely to the ground.

Other pipes from other floors might descend parallel to the first, without any connexion it. On the other hand, there are also examples where a given pipe receives connections from neighbours or other floors in a system that approaches the common sewer system of a vertical building.These pipes are predominantly nearby or clinging to existing pillars. The situations in which they are located more to the centre of the space between two pillars is a rare element.

It is possible to deduce that this was a prior community agreement at the time that the pioneer dwellers executed the hydraulic infrastructures, so as to impact as little as possible in the space of the neighbour below. This becomes especially relevant if we take into account that at the beginning of the concrete frame occupation the location chosen by each inhabitant for the placement of windows was not defined so that the location of pipes near the columns would avoid blocking the windows of other units in the below apartments. On the ground floor of the mentioned buildings, there is a pattern of external protrusion of their areas over open public space. This is verified in almost all the perimeter of the blocks, is an expected result, since the ground naturally offers the base to build from above, a situation that, otherwise, has to be solved by hanging consoles, as we saw previously in an existing example.

The roofing of these annexes is all made of corrugated sheets, a material that is cheaper than the tile, and which structurally behaves like a membrane that requires less structural support.

In at least two cases these annexes present commercial function, such as a bar and restaurant, being true meeting places of the community. In those examples, the relationship of the interior with the exterior is less rigid, with porches allowing the gradual transition between these two spaces.

In the two appendices of commercial use to which we had access, we note an intentional aesthetic concern more present than in the rest of the exterior of the buildings. This is above all due to painting the walls with strong colours and by using tailor-made elements such as the porch security fences.

These two elements have, above all, a symbolic image: colour contrasts widely with the association of incompleteness that the brick in sight entails, and the fences, specifically built to the site and uniform to embrace all space - hence not a patch of several elements obtained from different sources - are a counterpoint to the improvisation that predominates in the other constructive elements of the buildings.

When we analyse the blocks composed by ground floor and upper floor, occupied in its entirety by Roma dwellers, the patterns of appropriation show differences in relation to the vertical blocks. In these, the ground floor is towed in all of the examples, unlike the vertical blocks, where this occurs in some specific cases, especially in commercial spaces, and in a few residential areas.The use of transitional spaces between the interior and exterior, also with the corrugated sheet as roofing, is verified in a greater proportion than in the vertical blocks. The use of the same varies from an area for socializing to functions as space for the clothes or garage. The floor space located between the beginning of the sidewalk and the dwellings, a community space but taken care of by each respective inhabitant, is in all cases with a minimum treatment in a layer of cement. Other situations use different materials, ranging from stone to brick.

The built area of the occupation in the two storey blocks is only at ground level, leaving the upper floor like an empty concrete skeleton. This is primarily due to the fact that the access stairway to the upper floor has not been completed by the time construction company halted works, leaving only the void where the stairs should be located. The way people dealt with emptiness presents basically two solutions: some groups simply closed the perimeter of the void inside their dwelling, isolating it, while in others it is verified the incorporation of the emptiness within the dwelling, closing the ceiling slab rather than the walls. The internal visit to these units shows a huge difference between the exterior state: inside all houses have painted walls, with the exception of the ceilings, where the moisture coming from the unsealed slab prevents the application of paint. One of the units visited shows visible aesthetic designs in the treatment given to the fireplace and the arches that separate the rooms (Image 4).

It is not conclusive whether the existence of beams in the roof had influenced the location of the internal partition walls. Although some walls have been observed to follow the beams, with the bricks located in their axis or near them, in other examples the definition of the boundaries of space does not seem to obey any norm with respect to these beams (Image 4).

Conclusions

Regarding the conceptual relation of Dom-Ino as an enabler to the construction of the own spatiality by the residents, and the concrete example of Bairro da Jamaica, we notice some undesirable aspects of the first one when applied to examples directed to less-favoured economic classes. In this regard, the example of the windows illustrates how the choice of the most economic element available at the market - usually the smallest one - ended up having negative effects of ventilation and accumulation of humidity inside the dwellings. Looking at the internal spaces, the scenario of the free - plan and later occupancy with several internal configurations attest to the potential of this type of structure. This is proven by the residents, with some of them, who had just been relocated to new houses provided by the municipality of Seixal, declaring that the areas they had before were even larger than those they have now.

it is also possible to comprehend the emphasis given to the inhabitants to the private spaces, rather than on the outside and some communal areas.

For a further study, a quantitative study is needed that analyzes several units and outlines an in-depth picture of the exact role that the existence of beams in the roof interfered in the choices of the internal division of the structure.

IMAGES, CHARTS OR GRAPHICS LEGENDS

Image 1 - Dom-Ino structure as an enabler of spatial appropriation (author's creation).

Image 2 - Satellite view, the 2 storey buildings and the taller ones (Google maps and Street View).

Image 3 - Balconies in an incomplete example, its relation to a completed one, and a zoomed view of the joined slab. (Left - Google Street View. Right - author's photo).

Image 4 - Relation between the walls and beams, and esthetical intentions seen in the arch covering the one of the beams (author's photo).

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FROM DECORATED DUCK TO FILIGREE SCULPTURES

Concrete identity: Exploring the potential of the sculptural expression of concrete in the work of Bekkering Adams Architects

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ABSTRACT

Concrete identity: Exploring the potential of the sculptural expression of concrete in the work of Bekkering Adams Architects
The properties of the material concrete are unique. It can be used in a variety of applications that can give architectural design a sculptural expression, balancing between sculpture and architecture. The technique of pouring the material in moulds in a variety of shapes, colours and patterns makes it possible to look for a specific expression in architecture that fits the requirements of the assignment: function, identity and atmosphere. At Bekkering Adams Architects we look for a strong and powerful materiality, and concrete – applied in different ways – is a leading theme in our designs.
This article focuses on how concrete can be used in an innovative and sculptural manner in architecture and how the possibilities of the material are examined and tested to obtain optimal expression and develop our own architectural signature

KEYWORDS

Concrete, architecture, sculpture, precast concrete, 3D concrete printing, in-situ concrete

Introduction

This article focuses on how concrete can be used in an innovative and sculptural manner in architecture and how the possibilities of the material are examined and tested in our work to obtain optimal expression and develop our own architectural signature. The article describes a few projects by Bekkering Adams, exploring how architectural composition is completed with an unambiguous materialization where concrete plays a central role. The role of concrete (precast, in-situ poured concrete and 3D printed concrete) within the design process and the process of "making" are investigated. Three designs are analysed: the Booster pump station (The Netherlands), the school campus in Peer (Belgium) and the private residence Villa Tolhuis (the toll house) in Zaltbommel (the Netherlands); finally there is a detour to look at the novel technology of 3D concrete printing. The analysis dwells on the role of concrete surfaces, sculptural shapes and precast columns; the expression of textures, shapes and patterns in a concrete surface; and how concrete can act as a means of communication and identity within a design.

Concrete is the most used material in architecture. The possibilities of the material are almost infinite because of its freedom of shape, its strength and the simplicity of processing it. It is possible to apply textures and patterns to it and add various aggregates and colouring with pigments, so it can be used in a multitude of applications. The low cost of concrete make it a popular material and the most used building material worldwide.

Already in ancient times the material was used frequently, although in a different form than we now know: without reinforcement and with lime or trass as a binding agent. The Pantheon in Rome, with its monumental dome with a diameter of 43.3 metres, is entirely made of unreinforced concrete. Although concrete technology has taken flight over the past centuries, the dome is still the largest span of unreinforced concrete in the world. The clever use of the material made it possible to make this unsurpassed span: the recesses of cassettes reduce the weight and ensure optimal use is made of the constructive possibilities of the material: the thinning shell of the cupola upwards and the 9 meter wide oculus that caused for material reduction, resilience of the construction and the course of the heavy basalt surcharge at the bottom to the lighter pumice aggregates in the top. The use of the material also ensures the characteristic appearance of the material: seamless, profiled, smooth and solid.

After centuries of silence the material was rediscovered around the middle of the nineteenth century when Portland cement began to be used as binder. Thus cement was given a new lease of life and applied in all sorts of works of civil engineering, from bridges to pylons and from quays to water towers, hard sculptural elements disciplining the landscape.

Although applications of concrete have become more and more ingenious in recent decades – extreme spans, towering constructions, strong emulsions and lascivious volumes with futuristic shapes – the material continues to radiate simplicity. Anyone can build with concrete – pour and build – with a concrete mixer in the backyard.

Frank Lloyd Wright explored the use of concrete in Los Angeles in the 1920s when he developed the characteristic Mayan-inspired "textile block houses". When designing them he devised a system consisting of square concrete tiles with which every shape could be made. His idea was that the tiles could be poured on the spot, with local sand, blending with the landscape. It should have been a kind of self-building system whereby the homeowners gradually build up their houses and pour the tiles themselves in the weekends and create the house with simple means.

The visual language was inspired by Mayan ruins, which he had visited in previous years. He searched for a composition in which the volume of the houses rose up from and merged with the landscape. The tiles have different patterns, giving each house its own characteristic effect. There is the flat tile, the profiled tile and the perforated tile. The tiles are assembled into cubes, which can be stacked again into thick walls, columns, beams or floors and ceilings. Windows are recessed from the volume and have large wooden frames so they form big gaps in the volume and lie in deep recesses. Walls that keep the ground together seamlessly blend with the landscape in the house and form a range of levels, terraces, swimming pools and partitions. Glass in the walls with the perforated tiles creates a mysterious play of light on the wall, floor and ceiling.

Only three houses were ever built with this system and although in my perception they are some of the most beautiful works of Frank Lloyd Wright, they are the exception in his oeuvre as they reviled by the professional community for a long time.

The material has few aesthetic properties of itself: as Frank Lloyd Wright characterized it: *"Concrete would be better named 'conglomerate', as concrete is a noble word which this material fails to live up to. It's a mixture that has little quality in itself. If this material is to have either form, texture or color in itself, each must artificially be given to it by human imagination."* (Frank Lloyd Wright, pp141-142)

It is precisely in its indefinite nature that this grey mass – which has all the characteristics of liquid material as well of the hardest materials, and after hardening is as difficult to demolish as the hard rock on which concrete constructions are built – has unique qualities: *"And there remain to be developed those higher uses – non-mechanical, plastic in method, treatment, and mass-to which I have referred, working naturally with color into truly plastic beauty."* (Frank Lloyd Wright, p142)

The concrete specialist David Bennett called concrete "liquid stone", a material that can be moulded and folded into any shape like a cured rock, which can be both nested and massive; it can be fragile and richly ornamented. (David Bennett, 2007)

These characteristics discussed above have always fascinated us in our work and we have experimented with them in various projects.

Concrete is a material that you can hardly ignore when using it in construction. In addition to its well-known applications in floors, walls and roofs, we tested the possibilities of using it in a spectrum of applications in our work – creating prefab concrete in extreme shapes, using its loading-bearing capacities by means of large slender spans, pouring it into complex shapes, colouring the material with pigments, profiling and ornamenting it with moulds and rubber mats, and finally applying finishing techniques by bush-hammering and grit-blasting the material. The last experiments use 3D printing, creating an endless new range of opportunities.

The "decorated duck": the Booster pump station

In the project the Booster the properties of the material were taken as a starting point. The assignment required a large sculptural intervention, a building that could encase three large pumps of a sewerage pumping station as an enormous sleeve of 30m x 20m x 15m, and address all the problems related to noise nuisance, vibrations and protection of the sewerage works. The context, programme of requirements and building envelope forced us to deal with the volume in a creative way: the plot was smaller than the surface that we had to realize at the first level and the edge of the plot was twisted compared with the perimeter-line of the road lying alongside it. The surrounding area would be significantly higher than the volume of the booster, creating a demand to shape it as an all-round object with a roof co-designed in the volume. Our aim was to have the volume aligned with the infrastructure and so to include the future plans of the urban context in its volumetric composition. In order to meet all these preconditions, the volume on the ground floor follows the plot boundaries, envelopes the inlet of the heavy sewer pipes that come out of the ground and then constricts, to finally enlarge with cantilevers that twist parallel to the perimeter-line and road, in order to create extra surface, giving place to a circulation-platform on the first level to service the pumps and accommodate air intakes.

Using concrete we were able to solve all technical requirements at once. By using in-situ poured concrete at the foot of the building, covered with precast concrete tiles, all pipes and inlets could be incorporated into the concrete work. The superstructure was made of precast concrete, so we could apply a high-quality concrete, add pigment in the concrete, provide the concrete panels with different patterns and flutes, and give the precast panels a sandblast finish.

It is challenging to design a booster pump station in an urban area. Due to the projects large scale and that virtually no openings could be included in the volume, architectonic means had to be used to make it an attractive presence in the public domain. The closed character of the built volume can give it a grim character and because of the scale there is a risk that the building might be daubed with graffiti or other expressions of vandalism. (Image 1 and 2)

By giving the building a specific shape, making it more like a sculpture in an urban landscape than a building, and providing it with a filigree treatment of concrete, we have tried to tilt the impact of the building on its surroundings, making it an object people can relate to, which stands as a landmark in its environment. To this end, the walls are placed at different angles and the surfaces are provided with relief, colour and texture, and at night the surfaces are illuminated at different angles. The roof has various edges and is equipped with large triangular tiles of the same blue-pigmented concrete. The four roof surfaces end in a collection point where water can be drained from the roof with a gargoyle.

We carried out extensive research to find the most optimal application of the precast concrete slabs of the building, looking for the largest sizes of prefab slabs possible, with the expertise of engineers of the engineering firm ABT and the input of the concrete industry itself. Transport was the guiding principle here: the size of the panels was determined by the dimensions that could be transported by road with low-loaders, and we looked for the extremes here, maximizing their sizes. Eventually the panels, which look like large ice floes, could be made with minimal tolerances, so that seams are kept to a minimum. By mounting the panels in a mitre joint, the corners have solid appearance.

The disadvantage of prefab concrete is that the single panels are visible in the total volume, breaking it up in a patchwork of planes. To overcome this, the panels are executed with a web of flutings so that individual panels merge into a whole and the building has a continuous ornamentation. Sandblasted and grit-blasted letters in the surface, forming texts that communicate the function of the building, provide a second ornamented layer over the building, so that the effect is of one coherent sculptural form. The pigmentation in a blue-green colour of the concrete further supports this effect.

A building must speak and communicate with its environment. The texts abstractly communicate the function of the building with the outside world, as well as the blue–green colour, which creates a link with water.

In their book *Learning from Las Vegas* Robert Venturi and Denise Scott Brown distinguish between "decorated sheds" and "ducks" as two exemplary building types that communicate their meaning with the outside world in different ways. In our work we try to give our buildings a narrative quality and on the one hand let them tell a story about their significance in the city, in their context. On the other hand, we see that buildings can contain a scenario for use and thus invite the user to follow different storylines. These scenarios can initiate new uses so the building invites a diverse and rich use and connection to the public domain. The booster has a utilitarian function and can rather be regarded as an infrastructural work rather than a building. Because of the shape, textures, texts and ornamentation, we want it to be a confluence of the decorated shed and the duck: a "decorated duck".

Concrete collage: 24/7 learning campus in Peer

Architecture cannot be imagined without considering its function in an urban context. Every building can boost the public space and the challenge when designing public buildings is to make it possible that all the buildings and public space of an ensemble can be used 24/7 by many different groups.

In the project for the learning campus, the design of public space was an important part of the assignment, which was concerned with not only the school buildings themselves, but also a range of sports facilities, playgrounds, covered playgrounds and a public park. We recognised this and structured the plan with different layers, designing the various public domains as a collage. The plan consists of four single buildings that will be used by a variety of users: during the day they form the learning environment for children of different ages; in the evening they are used by the community for evening education and art and music lessons, and a boarding school, with living spaces and dormitories for children; sports facilities for various sports clubs; and finally there is a park that is a green recreation area for the community. (Image 3 and 4)

A big component in the programme was the covered playground that has the shape of a long pergola. This forms a main theme in the design and connects the two schools: primary and secondary. To connect the public domain, and the various playgrounds, all buildings are supported with large, iconic concrete sculptural columns that carry the hovering volumes as caryatides. In the composition they form anchor points, which visually connect the four buildings at ground level. They support large cantilevers and form a range of objects that take part in the design of the public space. Their large scale has an alienating effect so they can also be seen as oversized columns, landmarks, furniture or play objects that define the public space.

The paths of the park, the edges of the pergola, and the benches and seating areas included in the hard stone plinth of the building are also executed in concrete. As a result, the entire ground level has the same appearance and the entire complex of buildings forms a whole and is linked to the public space. The superstructure of the buildings has been worked out in masonry. The columns are designed as large prefab elements in a very light tone concrete mix. There are various forms of columns, with the moulds being handled as efficiently as possible. Sometimes the same formwork mould is used but rotated. The parapet of the buildings is composed as a collage. (Image 5)

Villa Tolhuis (toll house) and the challenge of using concrete in-situ

Perhaps one of the biggest challenges for an architect is to build a building entirely from concrete poured in-situ. It is labour intensive, because each part must be finished with handmade moulds, but using concrete offers enormous freedom of form, and the possibility to think about every detail almost as a kind of furniture. At the same time, all kinds of facilities can be incorporated into the concrete to produce a truly integrated design. (Image 6 and 7)

The toll house was executed by the owners themselves, creating a very direct relationship between the design and the manufacturing process. The use of the house and the spatial effect, play of light and fluid connection between outside and inside were a central theme in the design. The house consists of a series of rooms, in a strict zoning, perpendicular to a 30-meter long connecting corridor.

Two water basins form the spine of the design: an indoor basin where rainwater is collected for the greywater circuit through a large gargoyle. A mirroring pond in the patio, which is located between the living area and the studio, provides a play of light reflections in the living room. Long, narrow, horizontal light openings provide light along floors and ceilings. The concrete construction makes it possible to fit these windows without intermediate supports and to place the glass tightly in the plane without visible frame details. Piping, lighting and a central vacuum-cleaning system are included in the concrete walls and ceilings. Floor heating is included in the walls – warm walls invite you to sit against them. A long bench above the horizontal window slits can be used as a seat or to expose art objects. (Image 11)

The formwork-seams and finished centre-pins are the only decoration of the hard concrete walls. The load-bearing wall that screens the living space from the corridor is designed as a zigzag and delimits the spaces, but provides views to the enclosed patio-gardens. The formworks are taut, with only a sealant joint in the seams so angular shapes form a sharp silhouette.

Exploring the future, 3-D concrete printing

New techniques are emerging and the shapeless grey mass of concrete can now not only be poured but also printed, making the use of moulds and complicated formworks redundant. It is also possible to use concrete very precisely to reduce the amount used.

In 2015 the laboratory of the Faculty of Architecture and the Built Environment of the Technical University Eindhoven obtained a new 3-D concrete printer, which made possible new modes of production and application within the realm of architecture because of its sheer size. There were high expectations that the performance of the 3-D printer might shift the paradigms within architecture and building technology. (image 8, 9, 10)[1]

By winning the design challenge organized by the Centrum voor Cement en Beton[2] with the project The Firewall we had the opportunity to elaborate an idea into a concrete object in collaboration with the chair of Architectural Design and Engineering and the chair of Structural Design at TU/e and engaged in a design-driven research trajectory to explore the architectural properties of 3DCP. (Image 9)

With the design of the firewall we focused on three topics:

1. Freeform: new shapes and forms of the object as a whole were studied. The 3D printer makes it possible to print sculptural shapes without labour-intensive moulds. The possibilities and restrictions of inclinations, angels and cantilevers were explored as there were restrictions on printable curves, inclinations and heights. During the process different techniques and mixtures of the concrete were studied in order to increase the variety in shapes possible.
2. Ornament: the printer makes it possible to experiment with textures and ornaments and we tested surfaces with holes, patterns and an expression resembling lace. The aim was to explore a new ornamentation that was specific for the print technique: by using meandering outlines and waves and the fluidity of the material, specific soft rippling texture was obtained. Using

a special print technique, where the nozzle has a certain distance from the print-bed, the concrete could form a filigree pattern.

3. Multi-materiality: the 3DCP makes it possible to combine different materials. In the design we experimented with combinations of concrete and glass. Glass marbles were ingrained in the wet concrete.

We examined only a small number of possibilities in a process in which we were continuously confronted with the limitations of the printer: the material could have cantilevers of a maximum of 5 degrees, the corners had to have a rounding of at least 50 mm and there can only be printing in one continuous uninterrupted line. But with every step that is taken, the boundaries are stretched further and a future in which we can print filigree sculptures that support our buildings is shimmering on the horizon.

Concrete enables the designer to intervene both at the level of the expression of the material and at the level of the façade composition, the production method and ultimately the division of labour in order to design powerful beacons in the urban context that shape the urban domain.

IMAGES, CHARTS OR GRAPHICS LEGENDS

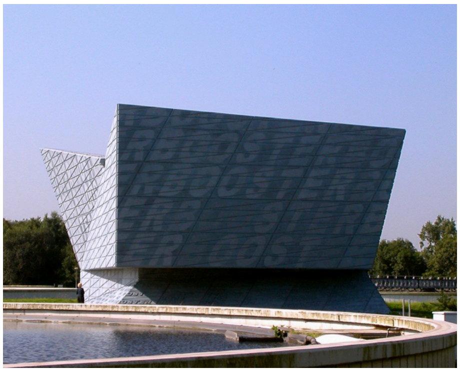

Image 1 - Booster Pump station, by Bekkering Adams Architects, *Photographer: Jeroen Musch*

Image 2 - Booster Pump station, by Bekkering Adams Architects, *Photographer Jeroen Musch*

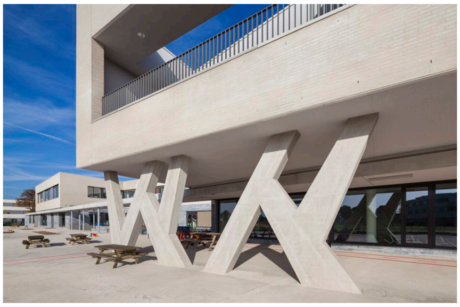

Image 3 - Primary school, schoolcampus Peer, by Bekkering Adams Architects, *Photographer: Daria Scagliola*

Image 4 - Sport complex, schoolcampus Peer, by Bekkering Adams Architects, *Photographer: Daria Scagliola*

Image 5 - Secundary school, schoolcampus Peer, by Bekkering Adams Architects, *Photographer: Daria Scagliola*

Image 6 - Six meter long window slit and bench, Private residence Toll-house, *by Bekkering Adams Architects, Photographer: Daria Scagliola*

Image 7 - Private residence Toll-house, *by Bekkering Adams Architects, Photographer: Daria Scagliola*

Image 8 - Firewall: 3D Concrete printing, *by Bekkering Adams Architects and TU/Eindhoven, Photographer: Bekkering Adams Architects*

Image 9 - Firewall: 3D Concrete printing, *by Bekkering Adams Architects and TU/Eindhoven, Photographer: Bekkering Adams Architects*

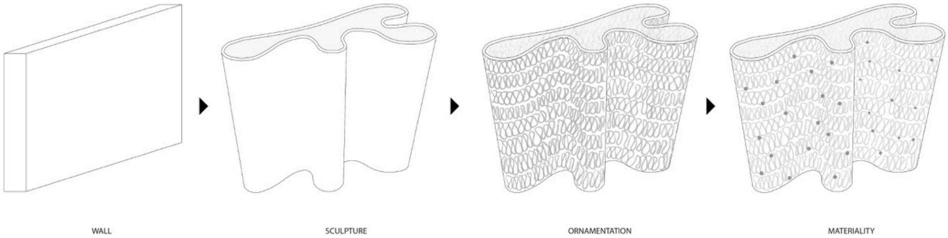

Image 10 - Diagrams Firewall: 3D Concrete printing, *by Bekkering Adams Architects and TU/Eindhoven.*

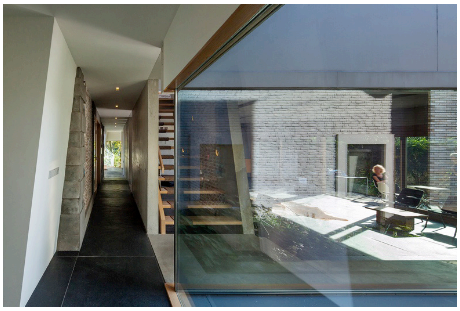

Image 11 - Insitu concrete makes it possible to create large window openings without window frames or visible constructions. *Private residence Toll-house, by Bekkering Adams Architects, Photographer: Daria Scagliola*

ENDNOTES

1 Initially, since the purchase of the 3-D printer was initiated by Professor Theo Salet, chair of Structural Design within the faculty, there was a strong emphasis on the structural properties of 3-D concrete printing (3DCP). With the elaboration of the Firewall,the architectonical properties of 3DCP were explored.

2 Dutch expertise centre for concrete applications

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THE URBAN LANDSCAPE TRANSFORMATION: ART AS A PUBLIC POLICY OF URBAN REGENERATION IN ITALY. STREET ART IN NAPLES AND ROME

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ABSTRACT
The contemporary city focuses on urban regeneration to maintain its role of centrality. One of the objectives is to create places of strong identity and social cohesion. In this creativity is a solution. In fact, art is able to develop a sense of community and identity even in those areas characterized by strong urban decay. Since the end of the 1980s, even in Italy, municipalities have used art as a public policy for urban development and marketing. Works of recognized artists have been placed in urban spaces habitually frequented by people as in the squares and in the subway stations of the city of Naples. Currently, following a global urban trend, we are witnessing an interesting phenomenon that represents a further transformation of the concept of public art: the growing spread of Street art. The murals and graffiti are in fact the new form of public art already characterized by its very nature from a more disruptive and immediate impact in everyday life. In this the experiences of Naples and Rome in their diversity offer interesting food for thought. The city of Naples appears as a singular laboratory of action for many internationally renowned artists such as Banksy who do not resist the charm of the place full of contradictions and intervene in the interstitial spaces, creating effects of surprise. Instead, Rome is the protagonist, thanks to 999 Contemporary, of the Murals experience in the Tor Marancia neighbourhood, called Shanghai, and of the interventions in the Ostiense district that has been defined as the Italian "art district".

KEYWORDS
Urban regeneration, cultural policy; public art; street art in Naples; street art in Rome.

In the contemporary city the process of weakening the traditional link between individuals and places and among individuals has undergone a strong acceleration due to globalization. The city is today even more heterogeneous and contradictory than in the past, much more fragmented and able to accommodate in itself the ethnic, cultural and religious differences. Because of its great complexity and openness, the image of the contemporary city risks losing the character of visual reference for those who live in it. Therefore, the actions of urban regeneration on which the contemporary city focuses, to maintain its role of centrality, are aimed at "returning" to the inhabitants the urban fabric as a visual, cultural, identity reference. To this end, creativity is a possible answer. In fact, art is able to develop a sense of community and identity even in those areas characterized by strong urban decay. Urban marketing actions based on art and cultural policies are often used by municipalities as opportunities to renew and develop urban realities. It is undoubted that art alone is not enough to redevelop the city but it can be a good tool for urban development and enhancement. Thanks to art, new meanings can be attributed to old and new parts of the city; thanks to artistic processes, even temporary, new ways of living and of using the city and its symbolic places can emerge.

Since the end of the 80s, the city has strongly focused on the creative and cultural industry for economic development and for generating processes of social inclusion. The concept of art itself changes profoundly and shatters into multiple dimensions.

In these years also in Italy art has been used in its various forms as a public policy of urban development.

An emblematic case is given by the experience of the city of Naples, an important city in southern Italy. Since the end of the 90s the city of Naples has undergone a so profound and general redevelopment to allow us to speak of a "rebirth" of the city of Naples. In fact, starting from 1995, the mayor of that time Antonio Bassolino promoted, with the support of the artistic coordination of Achille Bonito Oliva, Italian critic of international fame, several artistic projects. Among these there are some important initiatives aimed at an audience generally not much attracted by contemporary art. The works were placed in public spaces habitually frequented by citizens in everyday life.

A strong sign of change in the city was represented by the provisional installations of Piazza del Plebiscito, one of the most emblematic squares of the city of Naples, which had recently been pedestrianized. From 1995 to 2002 each year the square was occupied during the Christmas festivities by works of important international artists such as Mimmo Palladino, Jannis Kounellis, Mario Merz, Gilberto Zorio, Giulio Paolini, Rebecca Horn, Anish Kapoor and Joseph Kosuth. The works in Piazza del Plebiscito have strengthened the identity of the place that has become the symbol of the city's rebirth in the collective imagination of the Neapolitans. The installation of Mimmo Paladino "Mountain of salt" was the first to take place in the square (Image 1). It was a large pile of salt with forty wooden horses arranged in an apparently disordered manner. The visually impact was very strong. All the Neapolitans enjoyed photographing it and taking away a handful of salt for good. While the children of the popular "Quartieri Spagnoli" near the square climbed up there, causing a lot of controversy in the city newspapers.

Another example of this urban policy are the Art Stations of the new subway lines of Naples. These give the opportunity to travellers to enjoy during their subway journeys a multiplicity of works and performances of contemporary art. There are 15 stations involved and about 200 works by around 90 international and local artists. For this reason, in the stations there are simultaneously different artistic styles.

The examples are many and of different kinds. There are stations that contain works of art such as the Vanvitelli station, one of the first, where you can admire the works of Mario Mertz, Vettor Pisani, Gilberto Zorio and others. The Monte Sant'Angelo station is a large sculpture by Anish Kapoor. The installation of the artist's sculpture, made of corten steel, was completed in 2017 and is expected to be passed by travellers by the end of 2019. This urbanistic complex, which is still expanding through the construction of new stations, has received numerous international awards. The Toledo Station has hit the collective imagination more than any other (Image 2). It is completely covered with glass mosaics and incorporates the themes of light and sea. According to the Daily Telegraph it is the most impressive in Europe. This station was designed by the Catalan architect Oscar Tusquetz and contains artistic installations by William Kentrige, works by Bob Wilson, Oliviero Toscani (Image3) and Achille Cevoli (Image 4).

The Stations of the Art project, on the one hand, was a very expensive operation, on the other it was a worldwide unique and innovative intervention. It has approached the subway users to the fruition of contemporary art without distinction of class or culture, it has enhanced the cultural offer of the city; it has also triggered a process of redevelopment of numerous areas of the urban fabric with the construction of new buildings that represent new centralities of the city of Naples. All this has allowed us to pursue the goal of transforming Naples into a European city.

Currently, following a global urban trend, we are witnessing an interesting phenomenon that represents a further transformation of the concept of public art: the growing spread of Street Art. The murals and graffiti are in fact the new form of public art characterized by an explosive and immediate impact in the daily life of the communities. They multiply the opportunities for interaction by giving strong identity and recognisability to the most degraded places of life. At the same time they are cheap and precarious works because they are destined to a progressive deterioration.

In recent years the presence of works of art en plein air has spread also in Italy, in particular the experiences of Naples and Rome in their diversity offer interesting food for thought. The city of Naples appears as a singular laboratory of action for many internationally renowned artists such as Banksy who do not resist the charm of the place full of contradictions and intervene in the interstitial spaces, creating effects of surprise.

In Naples, the artist created a first work in the historic centre opposite the cloister of Santa Chiara, a stencil that was his interpretation of the Ecstasy of Blessed Ludovica Albertoni by Bernini, a current representation with chips and a sandwich as a sharp criticism of consumerism. Unfortunately, as sometimes happens to the best works of Street Art, Banksy's Ecstasy was cancelled by another writer, who covered it with his large mural. At the moment still exists today on an anonymous wall of the historical centre a stencil of the "Madonna with the gun" (Image 5). A Madonna who has drawn a gun in place of the halo. Near the work of the English artist there is also an old votive shrine with an image of a Virgin with Child. Very interesting was the reaction of the local community of citizens who, for fear that the work was lost, following a web petition, has obtained the authorization to protect it with a frame with glass.

Street artists from all over the world are flanked by a series of Neapolitan artists who over the last few years have modified the visual landscape of different mosaic of the built city. These include Jorit Agoch, born of an Italian father and a Dutch mother. His work is characterized by the care of the stroke and the detail in the reproduction. These factors make surprising the impact of his paintings such as the San Gennaro in Forcella (Image 6) or the small Roma Ael on the front of a building in Ponticelli. It is a district of public housing characterized by decay and delinquency, built on the outskirts of the city in the 80s and called Merola Park, now renamed Murales Park. In fact, since 2015 huge murals that decorate the blind the front of the buildings have arisen. These works of great visual impact are the result of a project of urban and social regeneration of the suburbs of Naples through the Street Art. The Murals Park in Ponticelli is in fact the first Street Art District of Naples promoted by the INWARD Observatory (International Network on Writing Art Research and Development). This is an Observatory on Urban Creativity that carries out research and development in the field of urban creativity, in collaboration with public, private and non-profit organizations, both local and national, for the redevelopment of the suburbs. The project promoted by INWARD not only includes the creation of striking works but also the creation of artistic workshops aimed at all the inhabitants of the Merola Park.

All the murals tackle important social issues such as integration, the importance of reading, the right to play, the value of motherhood and solidarity.

The first intervention in the Murales Park is the cited work of the famous artist Jorit with the title in Neapolitan dialect "Ael. Tutt' egual song' 'e criature "(Ael. The children are all the same) (Image 7). The work depicts the face of a girl from a Rom gypsy camp that the artist has really met and that today, with her timidly smiling expression, is the icon of the district's identity. Jorit painted the mural to celebrate the "International Day of Rom, Sinti and Caminanti" and the work refers to the importance of reception and integration.

Other murals followed the work of Jorit, all by artists known from Zed1 to Mattia Campo dall'Orto, from Rosk & Loste to Hope and La Fille Bertha. The hope of the project is that all artistic interventions can impress, in anyone who observes them, the importance of the values represented and encourage an entire community to pursue their dreams and satisfy their needs. The project has made Ponticelli an open-air art gallery for a new cultural and social momentum in this suburb of Naples. The municipal administration has understood the strong social and urban regeneration value of this type of public art and has consolidated its relationship with Street Art by promoting institutional actions that involve the various artists.

Street art and murals experience is also interesting in Rome, thanks to 999 Contemporary. This is a private non-profit institution dedicated to the study, practice and development of contemporary urban art through public art projects, exhibitions, educational and charitable projects working often with public institutions. 999 Contemporary has promoted since 2015 Big City Life, a large project of public participated art for urban, cultural and social redevelopment of the degraded areas of the city starting from the rough neighbourhood Tor Marancia. Such project was funded by either the City of Rome, the Rome foundation and 999 Contemporary.

Tor Marancia is a suburb of the southern part of Rome, built in 1933 in a swampy area in the countryside. This neighbourhood was nicknamed Shanghai, due to the continuous winter flooding that reminded the great Chinese city. In 1948, the Shanghai district was so unhealthy that it was decided to lift it to the ground and build the current popular blocks in its place.

In Tor Marancia today there are currently around twenty thousand people. The district is characterized by a high rate of school dropout, unemployment and the presence of organized crime.

The artists who in 2015 participated in the project Big City Life were inspired by the Roman Shanghai and its stories (Image 8). The project was promoted with the aim of transforming Tor Marancia into a district of contemporary public art involving the local community, schools and neighbourhood associations in this process. The more than five hundred inhabitants of the public housing of the historic

Lot 1 of Tor Marancia met twenty artists, who came to Rome from ten different countries to paint the entire neighbourhood. The work created by each artist was the result of this meeting for a total of twenty monumental wall paintings, made on the facades of the eleven buildings of the district. The students of primary school, secondary school and high school of the neighbourhood were protagonists of the creative workshops held by the artists. A cultural association has been established by the Tor Marancia students for the promotion, maintenance and enhancement of the neighbourhood's artistic heritage. and professional workshops have been organized for their training. Only a few works, however, are visible from the street, to admire them all you have to enter the district and to deepen the visit. Among the many beautiful murals inspired by the history of the place, the mural that portrays a child who climbs the coloured stairs and looks over the concrete buildings of the tenement, made by the French artist Seth, is dedicated to Luca, who lived in the palace and died after an accident that occurred while playing football (Image9). The mural "Veni, vidi, vinci", by the Lek & Sowat writers is a tribute to the Latin motto and to the young Andrea Vinci, a 27-year-old disabled on the second floor of a building without a lift. After the success of thescuola media murals, the Rome foundation promised to finance the construction of a lift for the boy.

The Ostiense district is also interesting. This was the first in the Capital that, thanks always to 999 Contemporary, has hosted the works of important artists, some of them internationally renowned. From Blu to Guy Denning, from Behr to Roa, many have tried their hand at embellishing railway underpasses and walls of entire buildings.

Here a former barrack illegally occupied for more than ten years by many Italian and foreign families, was completely designed on all sides by Blu, the Italian street artist best known and considered for the extraordinary quality of his works and the militant lawlessness that has continually exposed to real complaints. The former barrack shrouded in great apotropaic polychrome masks is the most amazing illegal street art (Image10). It must be said that in the case of Blu, and this also applies to other Street Artists, their interventions are not aimed at retraining contexts considered degraded, but to support exemplary human and political experiences such as housing occupations, social centres, places of urban conflict.

The heritage of murals of Rome has translated into a tourist route that touches 30 neighbourhoods, from historical and central ones such as Testaccio to the peripheral ones like San Basilio and Tor Marancia: 150 streets, for over 330 works, of which about 40 are made only in January and February 2015. The Municipality of Rome has put online an interactive map of this path.

In conclusion, Street art is the new form of public art that, starting from political and social denunciations, stimulates urban regeneration processes and awareness and education actions for the inhabitants. It contributes in a disruptive way to reinforcing the identity of degraded places both in the centre and in the suburbs of the contemporary city. It enters strongly into the collective imagination of the people and reinforces the feeling of belonging to the place and the community . The relationship between street art and people sometimes becomes so intense to stimulate the community to protect the works as their own heritage and to be recognised and utilised by public institutions that understand street art's value for urban regeneration.

IMAGES, CHARTS OR GRAPHICS LEGENDS

Image 1 - *"Mountain of salt" of Mimmo Paladino piazza del Plebiscito, Naples, 2015 (*V. Lerro)

Image 2 – *Toledo Station, Naples, 2018 (*P. de Stefano)

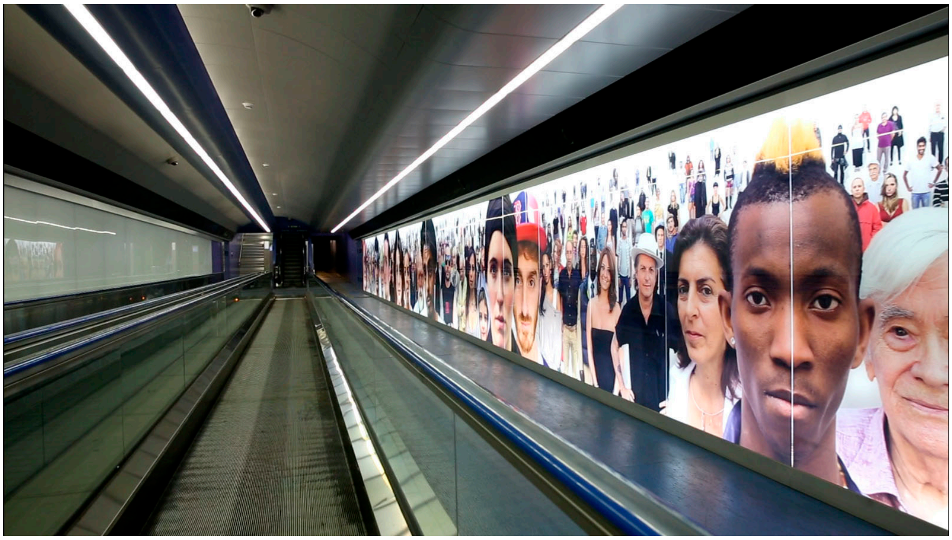

Image 3 – *'Human Race ', Oliviero Toscani, Toledo Station, Naples, 2018 (*P. de Stefano)

Image 4 – *'Man at work, Achille Cevoli, Toledo Station, Naples, 2018 (*V. Mastrangelo)

Image 5 - *'Madonna with the gun', Bansky, Naples, 2016 (*R. Mastropaolo)

Image 6 - *'San Gennaro, Jorit Agoch, Naples, 2016 (S. Siano*)

Image 7 - *'Ael. Tutt'egual song' 'e creature' 'Jorit Agoch, Naples, 2015 (P. De Stefano*)

Image 8 - *'Welcome to Shangai' 'Caratoes, Rome, 2016 (Falupe)*

Image 9 - *'The redeeming child 'Seth, Tor Marancia, Rome, 2016 (Felupe)*

Image 10 - *'Untitled ' Blu, Ostiense district, Rome, 2016 (P. de Stefano*)

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MATERIALITY IN RESEARCH / INNOVATION

FRAGMENTS FROM THE CITY, NEW SPATIALITIES

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ABSTRACT

In the contemporary context, the lines between the actual and the virtual have started to dissolve, therefore it is important to be able to develop a deeper understanding of the relationship between technology and society. Is it possible to work with new narrative forms where technology and society are understood as a unity? Within the conceptual framework of Bruno Latour's theory, the narrative resources are to be defined to describe the social mechanisms and/or technological ones. (Latour, 1990) But also, is it possible to translate the narrative resources as a way of creating these overlapping situations? In other words, could the narrative help one to grasp the knowledge of the "society plus technology" as a united entity?

This study discusses the process of a 10-day workshop which took place at Istanbul Bilgi University in 2018. Digitalized Urban Tales (D.U.T) has created an inspiring atmosphere while discovering the narrative potential of the new photogrammetry technologies. During the study, the photogrammetric method was used to collect spatial fragments from different neighborhoods in Istanbul.

First, the technique of photogrammetry will be studied as a poetic and creative tool. Secondly, the workshop's tactics of working with the narrative in the urban environment will be discussed in relation to the digital techniques. This study offers an experiment which deals with the unity of the verbal and digital methods in design education. It shows that the unity of digital tools and narration which form 'the technological narrative' creates a productive zone for creativity and criticism.

KEYWORDS

Narration, photogrammetry, education, urban culture, spatial fragments

Introduction

Is it possible to work with new narrative forms where technology and society become united? Within the conceptual framework of Bruno Latour's theory, the narrative resources are to be defined to describe the social mechanisms and/or technological ones. He suggests developing an understanding of "society and technology as an integrated whole" (Latour, 1990). But also, is it possible to translate the narrative resources as a way of creating these overlapping situations? In other words, the narrative could help one to grasp the knowledge of the "society plus technology" as a united entity. Since the borders in between the society and the technology dissolve more and more this discussion is very crucial to get a dynamic understanding.

Latour's theory initiates a pathway to discover how the new media and technology are affected by narratives and vice versa. And also the cultural and artistic production created by the new technologies transforms into a medium where one can study the society and the technology as a whole. These areas of production can be considered as the narration of the actual society. In these productions, one can see the blossoms of a "technological narrative" too. In other words, new media art can be studied within the framework of narratology theory in order to grasp the knowledge of society and technology at once.

The 10-day workshop which took place in Istanbul Bilgi University has created a very inspiring atmosphere while discovering the narrative potential of the new photogrammetry technologies. During the study, the photogrammetric method was used both to collect and recompose spatial fragments from different neighborhoods in Istanbul. This workshop, Digitalized Urban Tales (D.U.T.), embraces a large variety of trials that allows the discussion about the different approaches to the technique of photogrammetry.

This study is going to discuss the workshop D.U.T. which uses the technique of photogrammetry while collecting and retelling urban stories spatially. This workshop has been a place where the narrative met with the new technologies; both the content and the context were exploratory. First of all, the dynamics and potentials of the technique of photogrammetry are to be explored through the theories of new technologies. Secondly, the approach to urban stories will be discussed. This study shows that a workshop which uses techniques of narration and the digital tools together allows a broader understanding of the dynamics of the contemporary urban context.

Photogrammetry as a poetic tool

The technique of photogrammetry is not a new technology itself. It is basically the science of mapping using mostly aerial photographs. This technique is translated into the method of constructing three-dimensional digital models by using regular photographs through the new softwares. With some help from photogrammetry software, one can directly model up any indoor and/or outdoor space. This process doesn't require any measurement, pre-drawing or any specialized tool. The method is very simple that it works well enough with photos taken with smartphones.

The practicality of photogrammetry encourages one "to collect" places without necessarily planning in advance. This technique gives a very detailed three-dimensional version of the space where one can navigate around digitally. One can experience the space from the normally impossible viewpoints and also, one can create formal and/or fictional spatial transformations. This issue of navigation is discussed by Lev Manovich at an early date. He claims that the computer technologies offer most importantly a new kind of navigation which was not possible before. According to him, both the social sciences and art have studied space through static representations. He suggests that computer navigation reveals "the poiesis of spatial navigation" (Manovich, 2001). To navigate in a photogrammetric model is even more poetic than a generic computer-aided-design model because it takes all the data from real life and it is generated automatically, in other words independently. Normally constructing a CAD model involves many steps of preparation before getting to the fully textured and lighted version. Whereas the photogrammetric model directly gets to the final step after loading the photographs to the software which augments the poiesis in the process.

Photogrammetric modeling offers poietic experiences in the post-production phase as well. Unlike many of the digital techniques, photogrammetric modeling has the potential of being ambiguous and random. When an insufficient number and quality of photos are loaded, the software starts filling up the missing data which creates distortions in the final product. The final models might represent an original atmosphere. Virilio describes the contemporary urban environment which is loaded with lights of machinery as "an electronic topology" (Virilio, 2002). Virilio's description suggests that technology transforms the relationships in the city at a point where its materiality also changes. The photogrammetric technique has the power to change the materiality of the given place. In this case, technology manipulates the real world we live in.

The potential of being hybridized is another aspect of this technique. Once the digital three-dimensional model is created, the photogrammetric model can be exported to be placed in another 3D model, to be rendered, to become part of any 2D or 3D configuration. Referring to Leibniz's philosophy, Ryan discusses the concept of "possible worlds". She writes that the notion of the plot is expanded by the theory of "possible worlds". In the framework of "possible worlds," the plot gains the definition of "a complex network of relations between the factual and non-factual, and the actual and virtual" (Ryan, 2012). The photogrammetric models encourage the plot to be defined as a notion which creates tension between the real and the fiction by reorganizing the links between the places and the characters. The space-time relationships are also challenged by the direct digitalization of an actual place. Any digitized place becomes fully editable, transferable and re-organizable.

Photogrammetry itself is a poetic, unpredictable yet controllable technique and it was the backbone of the D.U.T. workshop. The narrative character also was mainly inspired and affected by the tools offered by photogrammetry.

Tactics of narration

The workshop consisted of three main works based on the three different neighborhoods in Istanbul. The complexity of the works naturally increased at each step with the expertise in photogrammetric software. Even the scale of the data that the participants collected has increased with the experience they gain.

Beşiktaş was the first site. It was the first experience with photogrammetry and storytelling practice. They observed the dynamics of the streets of Beşiktaş and each participant collected some 'lonely objects' that they have encountered while walking. (Image 1.) Hunting for the objects gave chance to try a large number of different examples to be modeled. This was important because one needs to learn how different textures and materials work with photogrammetry. For example, shiny and transparent materials are the most complicated. The last step was creating a creative configuration with the collected objects which is fed by the urban stories. 'The lonely objects' got together in completely different contexts. (Image 2.) This was the first experiment of space generation through narratives.

'The mission: Kadıköy' was a more defined process of a hunt. (Image 3.) Each group was tasked with taking photographs of different scale objects and spaces. The narration was to be created following a daily routine from the site. This trial was much more complex spatially and they had more time edit models digitally. (Image 4.) This process required a much longer post-production phase.

The last project was 'strange colocations' which demanded participants to configure a new spatiality in the form of a loop video by using their collection of the neighborhood of Cihangir. The process was fed by some other narrative such as a song, movie scene or photograph. These elements helped to discuss the rhythm, speed, composition, and movement of the final loop video. (Image 5.-8.) Their videos served as a medium where the audience can have a sense of the new spatiality they created out of the places they visited in real life.

To sum up, all three projects were based on real places and narratives that have been collected from those places. The photogrammetry allowed both the process of observation and production. Traditionally these are two different steps of the design process but D.U.T was a place where each observation could easily turn into a production thanks to the photogrammetry. The space generating part was also totally dominated by the digital process. Three-dimensional modeling software was used to create scenes which tell the stories they gathered from the urban context.

The Discussion

The workshop Digitalized Urban Tales has been an area of discussion in the field of narration and digital technologies. Both narration and the technique of photogrammetry serve as space generating media. Spatiality is reconfigured by merging fiction and reality, thanks to the practicality of the method. The idea of collecting stories from urban context is not new, but the idea of collecting the places themselves is a contribution to the technique of photogrammetry.

Another game-changing aspect of digital techniques is the possibility of sharing digital models online without losing any of the data simultaneously. This feature augmented the collectivity and defined a new version of it in the studio environment.

The workshop D.U.T offers plenty of ideas to be followed in future experiments. The use of the photogrammetry technique more as a tool of creation instead of a tool of documentation has been an inspiring process which leads to a deeper understanding of the dynamics between technology and society.

IMAGES, CHARTS OR GRAPHICS LEGENDS

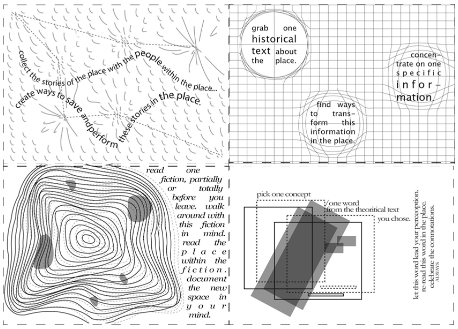

Image 1 - Flyers of ‘the lonely objects’:

Image 2 - Fivecones: *Buğra-Dila-Gün-Hamit*

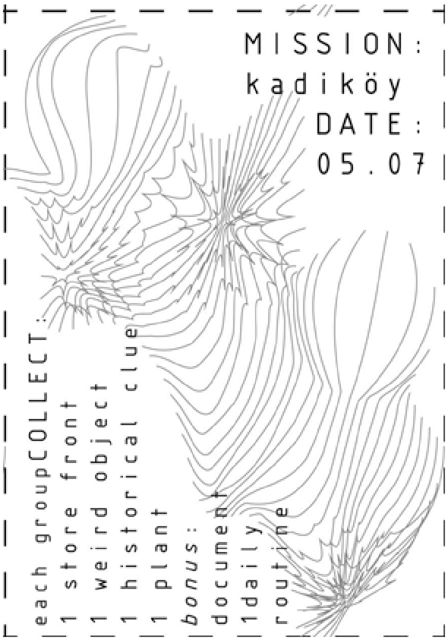

Image 3 - Flyer for the ‘mission: Kadıköy’**:** *Hilal Menlioğlu*

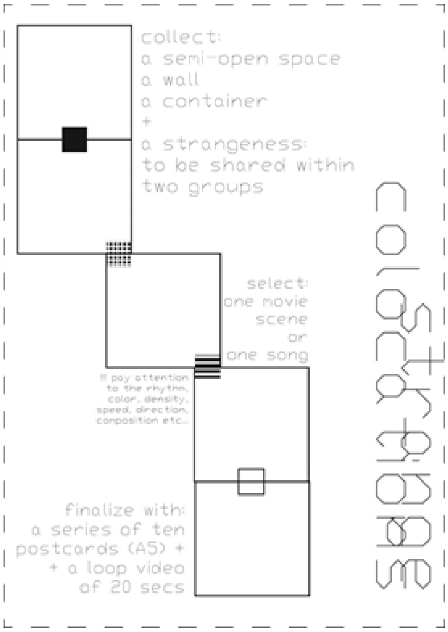

Image 4 - ‘strange colocations’ project flyer: *Hilal Menlioğlu*

Image 5 - Screenshot from the video Historizza, *Ceren-Farah-Ensar-Müge*

Image 6 - Screenshot from the video The Cat, *Beril-Cem-Kağan-Semiha-Yağmur*

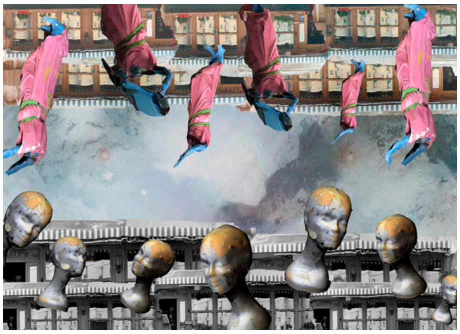

Image 7 - Screenshot from the video Universal, *İnci-Barış-Özgün-Yaren-Gülce-Alara*

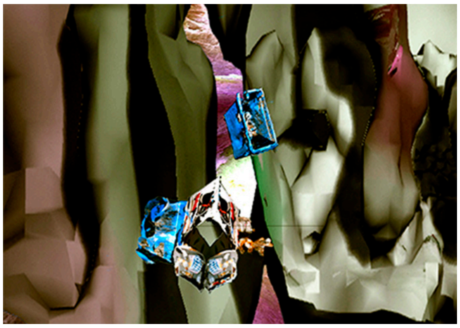

Image 8 - Screenshot from the video The Ship, *Nilsu-Sahra-Omar-Mertcan-Hüseyin*

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BIO-INSPIRED APPROACH TO FORM-FINDING EXPERIMENTS THROUGH MATERIAL BEHAVIOUR

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ABSTRACT

Form-finding studies evolved into more complex design studies involved by the technological improvements in the design tools. This new experiment area provides new aspects to design approach by giving material precedence equally with structure and form. Nature has one of the significant examples of material wisely usage in structures form generation process. Materials remaining lightweight features in nature while at the same time providing structures to be rigid and stiff also structural forms are directly generated through environmental influences, such as wind, gravity, and generation of forms are provided through material distributions.

This paper discusses a shell structure design inspired by the nature's material process to find optimal form for a structure through utilizing material behavior and computational tools. This structural form-finding study conducted to provide an alternative design methodology for shells also reveals the material behavior and structural behavior relation through form experiments. In this respect form-finding experiments explore the three different materials with same form and structure in computational design environment. Obtained results from the computationally produced shell structures are compared with regards to material behaviors and structural efficiency. In this paper studied shells offer a design process, which uses material parameters and constrains as design inputs in the very early stage of the design phase. Expected result of the form finding for shell experiments to obtain more efficient, rigid, and stiff structures therewithal, saving time and cost by need of minimum energy and material usage.

KEYWORDS

Material behaviour, shell structure, form finding, bio-inspiration, shape optimization

According to the digital developments on computer design environments, algorithms in architectural design and simulations enables to create complex geometries by forming materials freely. This new materialism had led to understand more precisely complex shell structure through digital technologies by material computation, also enables physical prototyping that was once very preferred to see the feasibility of the projected design (Kolarevic, 2003; Weigele et al., 2013). Thus changing paradigm in design methods requires new strategies and approaches to the architectural design process. The new approach to form finding studies gives equal precedence to material, form, structure, and provide material integration to the design process in the very early stages. Form generation brings together a process design in which material and structure are considered together. Reflection of digital tools to architecture had led to deeper investigation to material exploration and considering material with its internal and external forces caused by the environment. Oxman states this relation as; the geometry of the form emerges from the relation of the material and its environment (Oxman, Mitchell, Arts, Supervisor, & Beinart, 2010).

This paper presents design approach to shell structure feasibility with natural material properties by utilizing material behavior and computational design tools. In this respect abstraction of natural strategies to form finding by material efficiently usage translated to computational design tools. Thus in the context of the effect on the structural performance, a design process aimed to accomplish by incorporating the constraints of the forces acting on the material and the parameters of the mechanical properties by taking into consideration in the early stages. In the presented paper, an alternative design to the complex structure of the shell by utilizing material behavior proposes minimum material usage by optimal geometry promises less energy usage thereby more efficient and sustainable lightweight structures.

Finding Optimal Form for Shell

The new design phenomenon obligate to rethinking of material-form relation in form generation processes and brings new definitions to form finding. One of the definitions of form finding in new design culture is defined by Bletzinger as; finding a shape of equilibrium of forces in a given boundary with respect to a certain stress state (Veenendaal & Block, 2012). Another description of form finding is a forward process in which parameters are directly controlled to find an 'optimal' geometry of a structure which is in static equilibrium with a design loading (Adriaenssens et al., 2014) In this respect, form finding always remaining an optimization process and advanced technology in design tools provides to make difficult mathematical computations rapidly, iteratively, allows simple control over parameters in shell optimization process.

Shell is a unique structure that material and form is directly effects on its load-bearing behavior due to needs delicate and elegant design strategies(Adriaenssens et al., 2014). The study aims the integrated design process incorporating material behavior and structural behavior relation previous steps in the design phases. The design process suggests a shape optimization in order to find optimal geometry for the structural form of shell. In this aspect, the study investigates a biological model to take inspiration of its material behavior and translates it to computational design parameters thus offers alternative form-finding strategies for shells.

Analysis of Natural Analogy

In terms of shells structural equilibrium, self-weight and material strength become an important task. This complex inherent structure allows exploring new materials, which can provide multi-functionality. When it comes to efficiency and performative material in structures, nature has a variety of examples. The focus of the study is the natural material fibres in particular bamboo fibres because of containing stiffness and high elastic modulus, proposes reducing synthetic material usage for more sustainable structures. The natural material bamboo fibres robustness provided by composites to obtain a lightweight and rigid shell. The robustness on the bamboo fibres comprising various alternatives such as polyester, polystyrene, and epoxy resins has been comprehensively studied. The research aims to show bamboo fibres can replace of glass or carbon fibres without lowering mechanical properties of that synthetic fiber based composites (Abdul Khalil et al., 2012).

In this study, the mechanical behavior of the bamboo culm is formulated to the structural behavior of the shell. Material behaviors of the bamboo culm; elastic and shear modulus, specific weight, yield strength values are transferred to digital design tool as input parameters. Bamboo mechanical properties introduced as a biological role model provided by the form, which is shaped by forces acting on it, represents a behavior and organism level (Zari, 2006) of biomimicry.

In order to obtain structural efficiency mechanically, the choice of materials forming the columns is very important given the strength and robustness of the beams and plates or buckling resistance. In this context, wood, palm and bamboo are the most efficient materials in nature (Ashby et al., 1995). Comparing structural materials in terms of strength, concrete is the least strength after then timber.

Bamboo is second strength material and steel has the best strength. When it comes to stiffness, bamboo is the stiffest material followed by steel, timber, and concrete (Janssen, 1981). All of these characteristics reveal the potential of bamboo for architectural and structurally sustainable applications.

Bamboo shell fiber density varies according to its thickness that it is denser on bottom rather than top and middle. Fibres are concentrated near outer skin, which shows when culm subjected to wind, or external stresses induce gradient fiber distribution (Ghavami, 2005). Thus, culm can resist maximum bending stress and self-weight caused by the wind and forces in its natural environmental. The different fiber distributions according to self-weight and the external forces acting on bamboo, can serve as a model for the distribution of structural elements to form the shell.

Bamboo culm has nodes and internodes and internodes have hollow part covered by culm wall. This hollow tube form of bamboo provides buckling resistance and minimizes self-weight (Erdine, 2013; Ghavami, 2005) (Image 1). During natural formation of bamboo material efficient use and mechanical properties that resistance of environment forces, promises properties to improve the mechanical efficiency in architectural structures.

Experiments of Material Behavior on Shell Structure

In this presented study, a Grasshopper-Karamba plug-in of the Rhinoceros three-dimensional design program is used and a process based on the performance of the material was conducted through the shell structure. Aforementioned all parameters and constraints, studied in a model in the context of material-performance. The anticipated design process by Voronoi geometry, aimed to find the optimal geometry of the shell under defined loads. When it comes to structure fitness function of the optimization is generally its mass and displacement of the structure. By taking into consideration of the characteristics of shell that its self-weight have direct effect on its form, which differentiate the shell from other structure; fitness function is defined as to minimize the total mass of the structure and its displacement due to the tension of the material.

Material properties that directly affect the structural behavior of the shell are defined and added to the model. Mechanical properties of bamboo Young's (E) and Shear (G) modulus, specific weight and yield stress values are defined to digital design tool and shape optimization is achieved. Obtained structural geometry from optimization process is compared with the same structural form only by changing materials. Thus bamboo material behavior direct effect on structural behavior can be observed.

Obtained result from bamboo material behavior is; structure displacement reduced to 0.56 m while wood 2.27 m and concrete is 0.86 m with the same form. Another fitness function structural mass is 474 kg as an input bamboo material properties, wood is second in terms of minimizing the material 3421 kg and according to concrete mechanical properties 14256 kg (Image 2).

According to experiment of bamboo material mechanical properties, structural mass and displacement of the shell structure considerably reduced considering wood and concrete. Thereby the study promising with low cost and low energy, efficient structures can be produced by renewable resources and non-polluting materials.

Conclusion Remarks

Shell design process conducted by material behavior, and including constraints of material in the early stages of the design process shows that structural displacement and mass can be reduced. Obtained results of the experiment material minimum usage and energy efficiency promises more rigid, stiff, and sustainable structures. The output of the simulations should be considered as a foundation to further studies. Outcomes of the analysis can be conducted with any other materials, parameters and structures to explore new material behaviors. Presented shell structure serves as a base study for further understandings and enlighten the studies on building scale. Also in the scope of this studied model in order to achieve more efficient building materials, reinforcement of bamboo fibres and concrete combination can be offered.

In this investigation findings and outcomes from simulations by computational design tools reveals an integrated design process of material, structure, and form. Thus prevent any surprises during the fabrication process. The study illustrates modeling inside the digital design environment and it can be fictionalized a process that contains computational fabrication of the model by integration of all the constraints and parameters in the beginning of the design process.

Nature has different and wise solutions for structural systems by managing material-structure-form relation. Biomimicry approaches on structural design study creates a spectacular research area to inform effectively use of computational design tools. In this respect, the study explores fibrous structure behavior by the biological model thereby eliminate any other heavy and expensive formwork or surface mold also proposes to use of natural fibres as a composite material. The study emphasizes natural material importance and increasing natural fiber composite usage as a reinforcement material, investigates of feasibility to obtain efficient structures.

IMAGES, CHARTS OR GRAPHICS LEGENDS

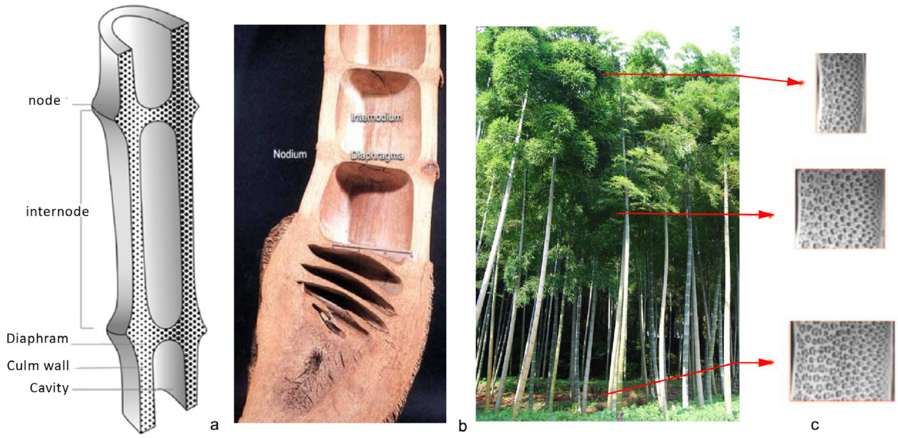

Image 1 - Bamboo details (Erdine, 2015; Lee et al., 2010): a) Bamboo cross-section detail. b) Cross section of bamboo c) Different fiber distribution along the stem.

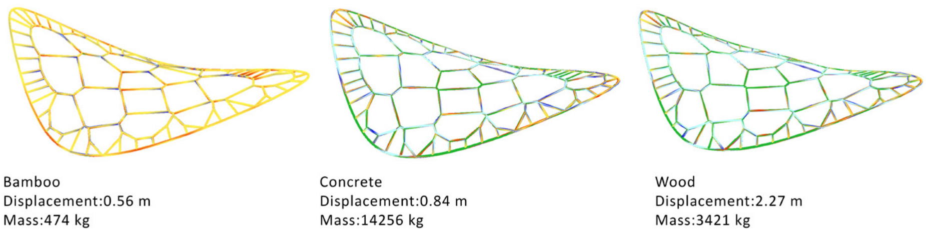

Image 2 - Comparing bamboo, concrete, and wood material behavior and its effects on structure.

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RESEARCH BY DESIGN: INTERDISCIPLINARY EXPLORATIONS WITHIN ARCHITECTURAL DESIGN, STRUCTURAL DESIGN AND MATERIAL LAB TO DEVELOP INNOVATIVE BIO-BASED MATERIAL PAVILIONS.

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ABSTRACT

The Netherlands are at the forefront of an ambitious agenda: to make the building industry fully circular by 2050. In this context this interdisciplinary 'research by design' master project explored, tested and experimented with bio-based composite materials and innovative design strategies through the development of a pavilion situated in the park of the former Zoo in Emmen/Netherlands. From the outset this project was a collaboration between the chair Architectural Design and Engineering (ADE), the chair Innovative Structural Design (ISD) and the SPARK smart industry field lab.
In the first project phase this project explored in groups the foundation: bio-based materials, bio-based structural principles, the site, and the typology of the pavilion. In the laboratory students produced mycelium based, hemp-crete and flax-composites bio-materials to gain insights on tactile, on architectural material properties, on structural, strength and stiffness material properties by performing bending and compression tests. This project developed three masterplans and eleven individual bio-based design proposals for the specific locations of the former zoo through model making exercises. These pavilions were designed as 'monolithic' objects, made of a single material or composite, and developed in concept, form, use, structure, detailing and performative qualities.
In the second phase the project developed three pavilions each of different bio-based materials in detail through large scale models and 1:1 mock-ups. Results of the project were presented as book and exhibition, showcasing 3 elaborated designs through diverse models with the aim to help shaping the future directions of bio-based design.

KEYWORDS

Design, bio-based materials, architectural design, structural design, interdisciplinarity

Introduction

This paper describes the design and research process of the graduate student project "Bio-Based Composite materials in Pavilion and Canopy Roof Design" developed at the Department of the Built Environment, Eindhoven University of Technology (TU/e), between September 2018 and February 2019. This paper highlights three central elements of the project which contribute to its transformative and future oriented education: Research by design, interdisciplinarity, and bio-based materials.

First, 'research by design' is an approach that has received increased attention within the last two decades and there is still debate of what constitutes this form of inquiry. A distinctive characteristic of 'research by design' is that architectural design and production form the central means to develop new understanding, knowledge, and practices (EAAE, 2012). 'Research by design' is less about analytical exploration in the narrow sense, "but rather about exploration - that is, searching […] to find new insights and aspects of architecture" (Verbeke, 2013, p. 157). In this project research, making and experimentation was not used to inform the subsequent design process, but instead from beginning embedded in the design process itself as a form of feedback and continuous back and forth between different forms of inquiry.

Second, architectural design practice brings together and is shaped by heterogenous actors, elements, multiple spatial and temporal scales. In order to address the complex world of design interdisciplinary collaboration is of strategic importance to develop innovative solutions for the real world. From the outset, this project was conceived as collaboration of the chair Architectural Design and Engineering (ADE), the chair Innovative Structural Design (ISD), and the Spark bio-based materials field lab in Rosmalen, the Netherlands.

Third, the Netherlands are at the forefront of an ambitious agenda: to make the building industry fully circular by 2050 (Rijksoverheid, 2018). The concept of the Circular Economy (CE) received much attention within the last years calling for radical and systemic transformation of current linear business models and practices (cradle to grave). There are many definitions of CE, one way is to understand it through four of its essential characteristics: Reduce, Reuse, Recycle, and Recover (Kirchherr, Reike, & Hekkert, 2017). Bio-based materials can be related to all of these aspects. For instance, bio-based materials contribute to reduce resource depletion (as they are from renewable sources), to limit embodied energy consumption and CO_2 emissions (as they are typically low energy neutral in production), or to recycle (as they typically do not contain elements that are problematic in closed loops). Designing with bio-based materials opens up a lot of questions and this project focused on experimental research into three bio-based materials: hempcrete, bio composite resin and fibres, and mycelium. The aim of this research and design project was to contribute to a more bio-based and circular building industry, which is one goal of the Dutch National Science Agenda: "Energy and raw materials: Circular economy".

In the following this paper describes the two key phases of this project. The first phase 'concept design' carried out research into key themes related to the project and kicked off with a making workshop in the Spark bio-based material laboratory. The project participants developed 3 masterplans and 11 individual bio-based design proposals through model making exercises. The second phase 'design development and materialisation' developed three pavilions each of a different bio-based material in detail through large scale models and mock-ups. The paper concludes with discussing key findings of the project.

First phase: concept design

To explore new opportunities in architectural and structural design the interdisciplinary project group in the first project phase explored the foundations of this project that bridged different scales and domains. The project started with the following initial research themes: the site, history and typology of the pavilion, bio-based architectures, bio-based structural principles, and bio-based materials (due to the focus of this paper some of these themes are not covered, more information see Blok, Kuit, Schroeder, & Teuffel, 2019). The site, the recently opened Rensenpark, located in the former Zoo in Emmen/Netherlands was visited and analysed to develop masterplans as context for the pavilions to come. The experimental material research focused on three bio-based materials: hempcrete, bio composite resin, and mycelium.

The material explorations mainly took place in the Spark material laboratory by experimentation. Making, experimentation, craftsmanship, knowledge exchange and innovation are central objectives of the Spark laboratory (see Figure 2 to Figure 4). Here students in exchange with lab members gained insights on tactile, on architectural material properties, on structural, strength and stiffness material properties by performing bending and compression tests. The project group was introduced to design constrains like material costs, production possibilities, feasible dimensions, time constrains as shaping forces of the design process. Through mutual exchange architectural students began learning from structural students and structural students from architectural students.

The project members developed three masterplans and eleven individual bio-based design proposals for the specific locations of the former Zoo through diverse model making exercises. These pavilions were designed as 'monolithic' objects, made of a single material or composite, and developed in concept, form, use, structure, detailing and performative qualities. In parallel to the concept design different material properties were further investigated and tested and preliminary structural solutions proposed.

Hempcrete is a material in which hemp is used with other natural products like chalk to make elements which can be used in among others buildings and furniture (Figure 2). By varying the amounts of chalk and hemp fibres, it is possible to make hempcrete with different strengths. There are multiple ways to produce, use and shape hempcrete. In the current building industry applications for hempcrete are rare. Mostly the material is used for insulation for walls and roofs. Hempcrete has a high density, is incombustible and has good acoustic properties. Hempcrete is not used as a structural building element yet. When the material will be used in this way, it is important to consider some aspects. Hempcrete itself is not resistant to water. This means that the blocks must be dry the enduring lifetime of the building. It is also possible to treat the blocks with a natural oil to make them water resistance. The strength of hempcrete depends on the composition of the final mix. The more chalk is mixed into the hempcrete, the stronger the material gets. With increased chalk ratio the question is whether the material qualifies as bio-based. Multiple studies into hempcrete and its strength were executed. From these tests, it become clear that the higher the density, so the more chalk in the composition, the higher the compressive strength gets.

The application of bio-composites in the construction industry is still an emerging field (Figure 3). The wide spread adoption of bio-composites as structures is restrained by high cost in comparison to traditional materials such as brick, steel and concrete. Bio-composites are produced by combining resin and fibres – of biotic origin – to create an element which is capable of transferring loads in a similar manner as traditional building materials and synthetic composites. The role of resin in the composite is to bind the fibres (transfer the load to) and give the element compressive strength. The most effective method, currently, is making a bio-polymer based resin. Currently fully bio-based resins are too expensive and are not available in quantities that make their use in composites, in a structural role, viable. Therefore, resins used in composites often use both renewable and non-renewable polymers. The role of the fibres in the composite is to give the element tensile strength. Fibres can find their origin in various naturally biotic and a-biotic sources such as hemp, flax, cotton or glass. The tensile strength of the composite is heavily dependent on the type of fibre that is added to the resin. Bio-composite as a structural material is suitable for many purposes, e.g. framing, flooring, panelling and cantilevering in construction.

Mycelium is a material that consists of the roots of fungus and mushrooms (Figure 4). The thin wires form a network. To form this network mycelium needs a substrate to grow. There are multiple materials/substrates that can be used with specific benefits and barriers. For example, for a quick growing process, it is best to use a substrate with a high cellulose level. To achieve a high compressive strength a compact substrate is beneficial. An important aspect for the production of mycelium is that both the mycelium and the substrate need to be sterile. When this is not the case, there can be infections from other bacteria and the mycelium will not grow or grow less and form a less compact network. To use mycelium as a structural element, there are a few important aspects. Mycelium is not water resistant. To build in a wet environment the mycelium blocks have to be treated with an (natural) oil. Mycelium is a flexible material. When it's compressed and the compression is taken away, the mycelium will rebound.

Because of the low stiffness and low strength structural spans are difficult. The strength of the mycelium bricks depends on different aspects: its density (through pressing cold or warm), the kind of substrate and fungus, and its sterile conditions during growth. The more the mycelium is compressed, the more the stiffness increases. Compressing the mycelium while heating to increases the tensile strength. Using vacuum when the bricks are finished increases the tensile strength and makes the mycelium bricks water resistant.

In the Spark laboratory students learned and worked with the bio-based materials to understand their properties. With the knowledge gained and hand on materials, the individual design of students took shape with bio-materials as their building structure. Emphasis was given to have material properties drive building form and constructions principles. Figure 5 displays the astonishing range of different designs proposals that students created.

At the end of the second project phase three most promising concept designs were jointly selected for further elaboration into final detailed designs, both on an architectural level as well as on a structural detail. Selection criteria were based on architectural quality, its potential for structural elaboration, representation of the applied material and typology.

Second phase: design development and materialisation

In the second phase three interdisciplinary teams of four to five students developed each one pavilion with a distinct bio-based material in detail through material samples, large scale models, and 1:1 mock-ups with the ambition to contribute to the future directions of bio-based design. In a mixed media approach knowledge and understanding was developed through switching between different modes of inquiry: Drawing, material testing, structural modelling, sample production and many others.

Many options were produced and choices made to generate process (see Figure 6, Figure 7 and Figure 8).

The Hempcanyon Pavilion (Figure 6) is conceived as a place of passage in which it is possible to walk through, discover and experience the transparency and enclosure of the space simultaneously. The structure consists of three elevated and curved walls that are constructed from hempcrete blocks. The composition of blocks is based on a process of shifting and opening in order to create that peculiar curvature and inclination of the walls as well as the gaps between each of them. These gaps allow to experience the pavilion inside out and vice versa, giving the project a sense of permeability from each side. The three walls partially come together at the top in order to give a sense of a unified whole to the composition but still leaving the visitor the freedom to wander. Hempcrete is used in the form of blocks that are grown separately in modular moulds with some exceptions (non-modular) for the top layer pieces. The whole composition comes together by using interlocking system that shifts with every block. The structural calculation conceives the pavilion as a series of shell elements assuming that the elements are connected vertically. When this pavilion is built as calculated, there must be stiff moment connections between the elements. This can be achieved with a glued connection or with pins which connect the blocks in a vertical manner.

The UpLook pavilion is designed to work with a subtle masterplan redesign of the former zoo, the pavilion should help retain the memories of the site while acting as a new exhibit in its own right (Figure 7). At the rear of the structure is a scrambling wall that enables visitors to experience a different perspective of the new Rensenpark. Raised four metres above the ground it is possible to look over the existing rocks of the old elephant enclosure and observe the new activities of the park. The angular form of the pavilion acts in contrast to the free-flowing design of the park.

The use of glue laminated mycelium panels informed this shape but also enabled this new type of material to be tested to its limits. Structural calculations begin by looking at the architectural model and then determining an easy but correct simplification of the design into a representative structural model. The spatial design already went through a few design iterations and due to this, the structural scheme was difficult to alter in this later stage. Between the start and the end of the project, the most important change to the structural principle was the transition from a structure loaded primarily in bending to a structure that is mainly loaded in compression. The structural model makes use of shell elements in its calculations. The architectural model is cut up in multiple triangular and quadrangular plates. These shell elements are part of the Finite Element calculation Method (FEM). In principle, this method uses a discrete system of small elements which are linked together at the nodes. Using a large set of algebraic equations and matrices it is possible to calculate the forces and displacements in the structure.

The Flight of the Birds Pavilion showcases the potential of bio-based materials through the use of bio-composite panels that form a self-supporting structure (Figure 8). The angular panels are connected using an interlocking system without bolts or other connections. All panels are identical, so only one mould is needed and the pavilion construction will be simple, which saves time and resources. As the panels are all angled and also connected under an angle, this introduces a play with density and light, offering shade and relaxation place for visitors. The structure is made of bio-composite material and consists of hemp fibres and polyethylene which harden together to form a strong material. The bio-composite is made from natural raw materials which is then bound by a resin. The making process was as follows; a solid negative mould was made with the dimensions of the element first. Then a layer of foil was drawn over this mould on which a hemp fibre was laid. Then a second layer of foil was laid on top and a supply and discharge valve were inserted and the edges of these foils. The edges of the foils are then sealed airtightly. Then through vacuum infusion vegetable resin was drawn into the sealed foils.

Through underpressure the resin was then sucked during the vacuum process over the shape of the mould and expanded into the hemp fibres. This resulted in a stiff element that can be used for the last process step which was to implement the necessary notches for the sliding principle. The sliding principle, as it was constructed, created sufficient strength and stiffness in the construction, so that the material not only serves as a finish, but also as a construction. To model the complex arch structure SCIA engineer was used. For this program, the dimensions of the structural elements were estimated and the different properties of the material included. The plates needed to be modelled in SCIA in a way that they would transfer loads the right way through the material. The connection had to come as close as possible to sliding the plates into each other. In this case, it was done by simplifying the plates into a framework. The challenge was to transfer the loads through the material plates. Thereby SCIA developed a good understanding of the different forces and deformations of the pavilion. The biggest stresses and deformations were investigated for plates with a thickness of 25 mm.

Conclusions

In the introduction this paper highlighted three central elements of the project which contributed to a transformative and future oriented education. The research by design approach of this project enabled to extend horizons, boost curiosity and stimulate exploration. It contributed to developing alternative perspectives and advance the possibilities of making architecture. Research is creative process of systematically contributing to new knowledge. Besides explicit knowledge creative processes built also on tacit knowledge and the question remains how these forms of knowledge can be understood and communicated. The project members learned how to translate knowledge from one domain to another.

In design practice the mutual learning between architectural and structural designers is of central importance to develop better solutions for our futures. To understand having different forms of education, perspectives and responsibilities within the design process is essential to contribute to a productive interdisciplinary collaboration. The cooperation between structural design students and architectural students made students aware of initially the different viewpoints and different responsibilities, but grew more and more into close cooperation towards the common goal of improving and realizing the final designs, book and exhibition.

The students started off with very little to no knowledge about bio-based materials. The initial workshop at the Spark bio-based material laboratory functioned well to kick start the project and raise the necessary momentum. The lab enabled students to experience the whole process from material research, design, to materialized parts and models. In consequence group members were aware and better equipped to overcome difficulties in detailed solutions, connections and the actual realization. With more time and funding a 1:1 scale realization of one or more pavilions would have strengthened this awareness and the tactile material knowledge. By producing the materials, samples and models themselves and also by performing structural strength and stiffness test on the materials made them (and especially the structural students) aware of the often the limited strength and limited stiffness of in particular hempcrete and mycelium-based materials. Further the production process of these bio-based material samples was often more complex than anticipated (parts of the sample production proved unsuccessful) and an important part of the learning process. How to define what constitutes bio-based materials requires further elaboration. The project developed innovative solutions, for instance by producing the first samples of laminated mycelium boards.

IMAGES, CHARTS OR GRAPHICS LEGENDS

Image 1 - Experimental research into three bio-based materials: hempcrete, bio composite resin, and, mycelium (collage: contributors 2018)

Image 2 - Exploring design possibilities with hempcrete in the Spark laboratory (authors 2018)

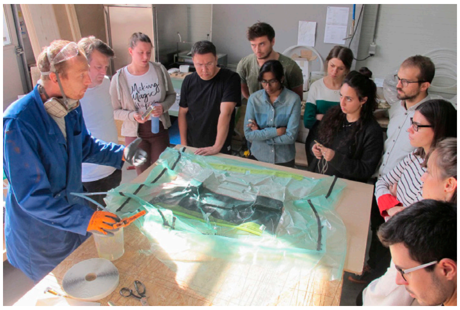

Image 3 - Exploring design possibilities of the vacuum infusion procedure with bio-based resign and hemp fibres (authors 2018)

Image 4 - Exploring design possibilities with mycelium in the Spark laboratory (authors 2018)

Image 5 - The eleven pavilion concept designs at the end of the first project phase (authors 2018)

Image 6 - The Hempcanyon Pavilion (authors 2018)

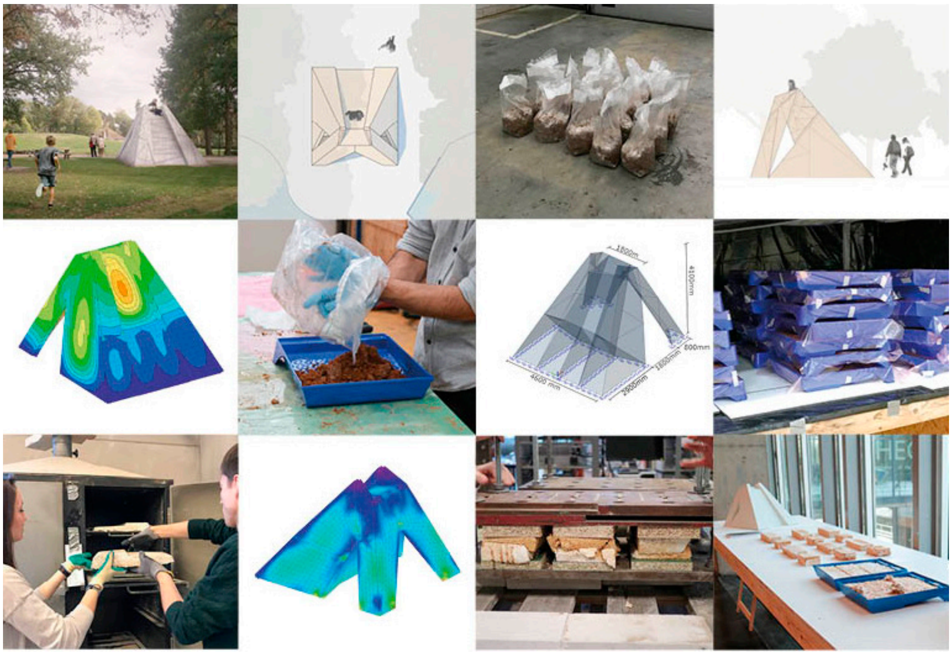

Image 7 - The UpLook Pavilion (authors 2018)

Image 8 - The Flight of the Birds Pavilion (authors 2018)

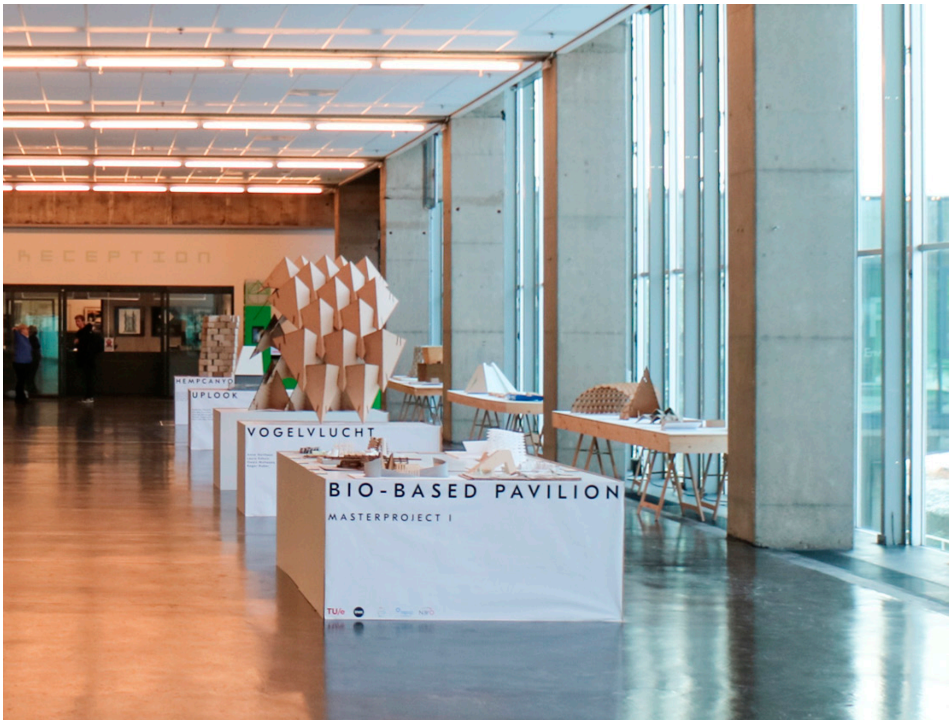

Image 9 - Exhibition of the project results at the Eindhoven University of Technology in February 2019 (authors 2019)

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ARTIFICIAL ECOSYSTEMS FOR BUILDING ENVELOPES // THE PROCESS OF EXPLORATION OF POTENTIAL OF BIOMATERIALS FOR LIVING ARCHITECTURE

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ABSTRACT

Nowadays we can observe the shift from rigid and static built environment towards more responsive, sustainable and bio-inspired architecture, which requires the participation of professionals from different fields bringing the scientific knowledge and experience in the design process.
"Artificial ecosystems for building envelopes" is an ongoing interdisciplinary research project on the intersection of architecture, biology, and chemistry. The project investigates the possibilities of using unconventional architectural materials (microalgae cultures encapsulated in 3d-printed hydrogel medium) on buildings' facades for air purification purposes.
This paper aims to describe methods of the experimental process involving applied material research and computational design strategies in order to better understand how living architectural systems can help to solve environmental issues.
It develops a workflow consisting of a series of steps, such as laboratory experiments, computational design, digital fabrication, data analysis, and digital simulation.

KEYWORDS

Micro-algae, 3d-printing, living architecture, bio-materials

Introduction

Today climate change seems to be one of the fundamental design problems.

And unfortunately buildings are hugely complicit in this (even more than the transportation sector) since they consume approximately 40 percent of the energy annually, and emit nearly half of the carbon dioxide (through greenfield development, cement production, and the burning of fossil fuels such as oil, gas, and coal).

This makes architecture highly responsible for proposing new ways of how we design and construct buildings.

One of the novel approcahes to tackle this issue is to turn to sustainable natural processes and take inspiration from biological systems. It is logical that architects look for solutions in nature, which in this turn leads to the emergence of a new field – living architecture.

But what does this mean for architecture to be alive?

In the 20th century we can observe a significant change in relationship between nature and architecture – from blind imitation of natural forms and attempts to apply natural principles in design to actual incorporation of living systems into built environment, when buildings are no more seeing as inert objects, but as dynamic systems.

The shift of architectural paradigm towards more responsive and bio-inspired architecure requires involment of professional from different fields – architecture becomes more scientificly-oriented. And this leads to the change of methodology which is applied for building design. The threshold moment when designers should be much more familiar with life sciences than they are now.

The paper will be using an ongoing research to illustrate the design methodology.

"Artificial ecosystems for building envelopes" explores various pathways of experimenting with biology and architecture by combining algae and hydrogel. Thus, creating a system that doensn't occure in nature – 3d printed algae encapsulated gel for the purposes of air purification. It is planned as an experimental building facade system that combines living organisms and sensors and can regulate outdoor oxygen levels.

The key base of the research is a process lying on the intersection of disciplines – architecture, biology and chemistry.

Materials and Methods

The decision to 3d print algae encapsulated hydrogel was taken due to the constraints posed by traditional photobioreactors:

- most of them limit the entry of light throughout the photobioreactor,
- the mixing technique to attain a homogenous mixture throughout the photobioreactor is not yet achieved,
- the injection mechanism of CO2 and other nutrients needed for optimum growth of microalgae is not yet perfected

In addition, for the past decade additive manufacturing of hydrogels has become a rapidly evolving technique to produce nano-featured biocompatible tissue scaffolds for tis¬sue engineering purposes, as well as research done on 3drinting algae for organ transplant led to the idea of application of this technique in the realm of architecture, thus simplifying the process of algae adaptation.

And considering the fact, that the major factors for the maximal growth of microalgae are light and CO2, the potential of application of additive manufacturing technique becomes obvious.

Primary research

The initial part of the research was carried out at the IAAC (Institute for Advanced Architecture of Catalonia) as a master thesis in 2015, which subsequently served as a proof of concept (Image 1).

In order to to maintain the algae alive, 2 types of medium were tested:

1. Agar agar medium (a jelly-like substance, obtained from algae, it is indigestible for many organisms so that microbial growth does not affect the gel used and it remains stable)
2. Methylcellulose (powder hydrogel) with sodium alginate (Image 2).

Methylcellulose is a chemical compound derived from cellulose. It is a hydrophilic white powder in pure form and dissolves in cold water, forming a clear viscous solution or gel. Like cellulose, it is not digestible, not toxic, and not an allergen.

Sodium Alginate is a gum, extracted from the cell walls of brown algae, through binding with water it forms a viscous gum. The chemical compound sodium alginate is the sodium salt of alginic acid, also called algin or alginate.

The first showed good algae growth rate, but some constraints were identified – such as extrusion temperature and algae insertion, which can be only done after having completed the printing of the medium. The second medium, on the contrary, forms a homogeneous mass that can be extruded at room temperature, having added the algae to the mix prior to printing.

Current research

In the context of the ongoing research, the studies are focused on deppening the knowledge obtained previously, and working in tight collaboration with the proffesionals in the field of analytical chemistry and tissue engineering.

The research is subdivided into a series of steps (Image 3) forming a loop, which represents a spiral model research methodology when research processes are consequently repeated using the results from previous steps for further development. On a general scale, the research implies the development of 4 stages as follows:

Laboratory experiments

The essential part of the project is conducting a basic research in bio-lab facilities, which helps to achieve precise measurment of the results of the experiments. For the primary research aquiatuc (one of 5 types of lagae that needa constant flow ow water) type of algae (*Chlorella Vulgaris*) was used. For the current research the decision was taken to conduct experiments using aerial type of algae, which are normally found upon trunks of trees, walls, fencing, stones, rocks and animals. Also aerial algae obtains very similar properties in terms of photosynthesis comparing to aquatic algae, but does not need constant flow of water - although a certain humidity level must be maintained - in order to stay alive. Another interesting feature of algae is that when environmental conditions are adverse, algae goes into a form of hibernation until conditions are once again favorable. With this being said, aerial algae is much better suited for use in terms of maintenance and have potential to be used in built environment.

Digital Design (Pattern formation, 3d surface design)

Digital design is based on data collected and analyzed during lab experiments and implemented for the design both of 2d and 3d options for the building envelope.

a) Different types of patterns generated taking into consideration humidity levels and sun exposure. As well as paying attention to the opacity of desired envelope (Image 4).

b) Another important part preceding digital fabrication is generation of **3D surfaces** with patterns on them using solar exposure, humidity levels, temperature, maximum/minimum surface area and area covered with algae- based gel as inputs for pattern generation.

Digital fabrication / Robotic fabrication

Digital fabrication is the stage of the research following after abovementioned two – lab experiments and digital design. It includes generation of 2d and 3d patterns based on environmental conditions – sun exposure, humidity levels and acceptable opacity of the envelope.

Data analysis and digital simulations

Through the analysis of the data obtained in the laboratory and during digital fabrication stage, it would be possible to create digital tools (through computation and programming) in order to simulate the performance of a building, so that the desired performance can be achieved.

Results

The tests on algae growth showed positive results (Image 5), proving the statement that algae could grow in gel substances with nutrients added to the mixture. The fact that algae are able to reproduce in biodegradable polymers, thus forming a synthetic ecosystem creating a synergy doesn't occur in nature, is one of the most valuable result of the research.

Also, this experiment raises the inevitable question of a life cycle of living organisms. Unlike traditional architectural materials, bio materials operate within a different set of variable states, when the dimension of time, variation, and decay become new material-defining properties.

Further Work and Conclusions

Survival – the only criterion of success in biology – is largely about adaptation to surrounding conditions and change, both local and global. We need methods – technical or biological – of designing processes of adaptation that can make and maintain successful structures. (Julian Vincent)

As it is stated by various ressearchers in the field of living architecture *"Biological solutions are cost- and energy-efficient, multi-functional, long-lasting and environment friendly"* which makes this area of resaearch a very promising tool for solving environmental issues (such as air contamination) through the means of architecture, in this case so-called building envelopes or skins. The nature of bio-materials allows to think about interaction between them, human beings and environment. Since the combination of their properties (time variation, life-span, decay) allows them to efficiently interact with their environment.

Here we can start talking about materiability which is not based on "sandwich" but with embedded variety of functions (natural intelligence). It also makes them fantastic role models for a new bio-inspired architecture in which living and non--living matter may eventually be combined.

And this goal can be achieved only through the cooperation between professionals from various scientific disciplines as well as application of scientific research methods in the field of architecture.

IMAGES, CHARTS OR GRAPHICS LEGENDS

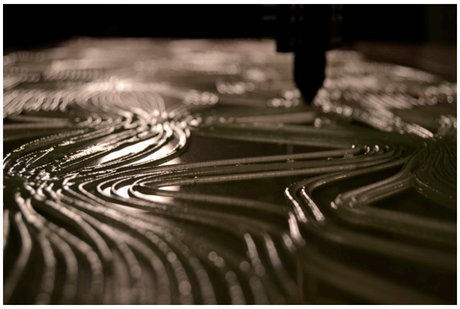

Image 1 - Robotic fabrication of algae (Irina Shaklova): *Final print of the master thesis "Living Screen. Robotic fabrication of algae-based gels", IAAC, 2015*

Image 2 - Material preparation (Irina Shaklova): *and algae*

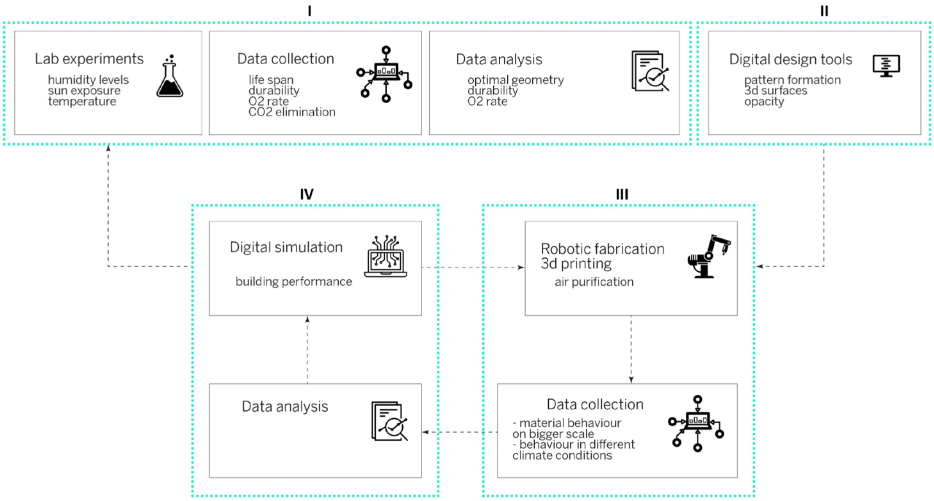

Image 3 - Methods (Irina Shaklova): *Steps of the research.*

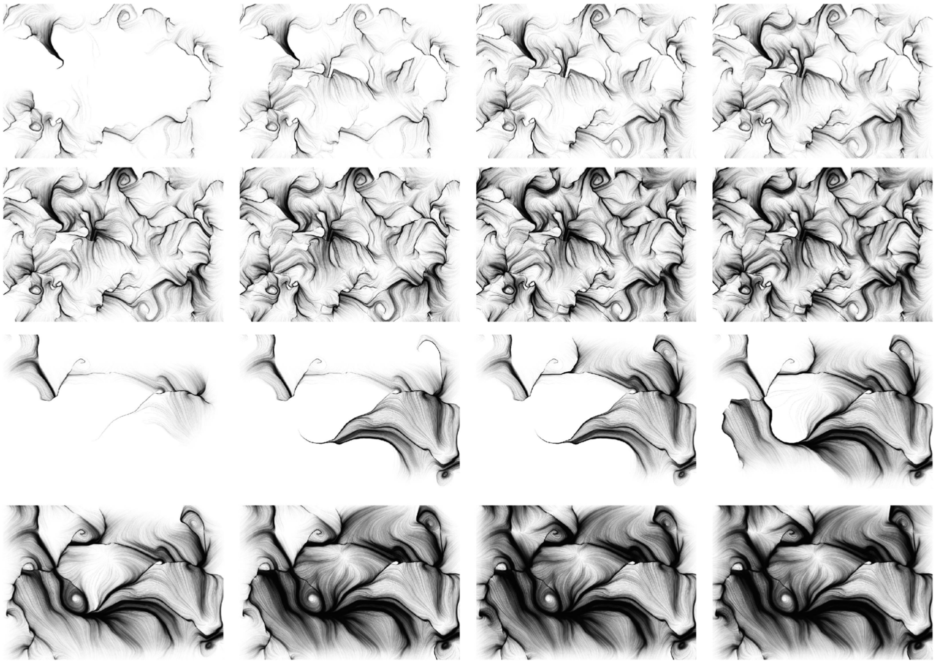

Image 4 - Pattern formation (Irina Shaklova): *Possible variations of algae growth and distribution*

Image 5 - Algae growth test (Irina Shaklova): *Algae clusters in hydrogel (Methylcellulose with sodium alginate)*

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GROWABLE ARCHITECTURE: MYCELIUM AS BLOCKS AND MORTAR

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ABSTRACT
Over the last few years, emerging research on bio-design has blossomed into a sustainable method for producing bio-materials. One sector of research has explored the potential of mycelium, the white fibrous root system of mushrooms, across a spectrum of design from packaging manufacturing, to furniture design, to building materials. This paper explores the cultivation and use of mycelium as a building material, both as blocks and as the mortar joining the blocks. Our objective is to develop a holistic process of cultivating mycelium blocks, as well as the development of a mycelium paste which can be us`ed for both mortaring of the blocks and repairing cracked or damaged blocks. The intent is a wall or small structure, which is completely biodegradable. We strive for an architecture which completely embodies the "cradle-to-cradle" concept, where the building material is grown, built, used, and then composted becoming nutrients for other organisms. In this paper, we present the process of our material exploration and the prototypes that we have grown. We contribute to a discussion regarding sustainable and renewable building materials in architecture, building on the existing studies on the use of mycelium in an architectural context.

KEYWORDS
Mycelium, bio-design, bio-materials, building blocks, masonry

The increasing population growth on the planet brings about an increasing demand for construction and production. Yet, the existing paradigm of "produce, use, and discard" has long proven itself to be unsustainable as natural resources are becoming scarce and the population is exponentially increasing in urban areas (Heisel et al., 2017). We believe that the fourth industrial revolution can instigate a change in the way we produce and use things, letting us leave the discard culture behind, and focus more on ways to re-use our resources. This would necessitate a search for alternative materials and approaches to production and construction. Over the last few years, emerging research on bio-design fields started to offer innovative solutions for the environmental problems and crises that we are facing today. Collaborating with biologists and material scientists, architects and designers have started to explore designing with bio-materials: materials that are grown, rather than manufactured (Zolotovsky, 2017). They began expanding their tools of the trade "beyond hard and inorganic material" to explore how they can incorporate living materials to projects of various scales (Yao et al. 2015). One track in these studies is investigating the potential of mycelium, the white fibrous root system of mushrooms, across a spectrum of design projects ranging from packaging to furniture design, to building materials. With the aim to explore an architecture that completely embodies the "cradle-to-cradle" concept (McDonough and Braungart, 2002), where the building material is grown, potentially kept alive, and later composted to become nutrients for other organisms when the structure is demolished. We present a study where we use mycelium to grow building blocks, as well as the mortar that binds the blocks.

Building blocks fabricated from mycelium can propose a renewable and biodegradable alternative for the construction of small structures. There have been a few architectural projects built using mycelium blocks over the past couple of years, among which are the Hy-Fi Tower, the Mycotecture Alpha, and the MycoTree. The Hy-Fi Tower, designed by David Benjamin was a temporary exhibit built in the summer of 2014 at MoMA's PS1 courtyard. The tower was designed to be in the form of three intersecting circular chimneys, 40 feet tall. The structure consisted of 10,000 mycelium blocks, which took about 5 days to grow, and an interior wood beam structure to hold up the vaults near the top (Slavin, 2016). The other mycelium structure, Mycotecture Alpha, was designed and built by Phil Ross, the co-founder of MycoWorks, which is a San Francisco based company that studies mushrooms and their potential for practical applications. In comparison to the Hy-Fi Tower, the Mycotecture Alpha is a modest structure only about 5 feet tall and 5 feet wide, using around 350 blocks in total. The structure consists entirely of mycelium blocks, with a mycelium floor, and a simple barrel vault that holds the structure entirely by the compressive strength of the blocks (Karana et al., 2018). Finally, MycoTree is the result of collaborative work between Karlsruhe Institute of Technology and the Block Research Group at the ETH Zurich, exhibited at the Seoul Biennale of Architecture and Urbanism in 2017. It is a spatially branching structure that makes use of the load-bearing capacity of mycelium blocks under compression. The branching geometry is designed in the computer in order to optimize its structural stability. Mycelium blocks are then grown in digitally fabricated formworks. This project shows "how regenerative resources in combination with informed structural design have the potential to propose an alternative to established, structural materials for a more sustainable building industry" (Heisel et al., 2017).

The above projects exemplify innovative architectural applications for mycelium, mainly in the form of building blocks. In these explorations, in order to gain compressive strength, living mycelium is exposed to high temperatures, mainly through baking. When exposed to high temperatures, mycelium organisms die causing growth to stop, a process which turns the paste-like substances within the formworks into solid and firm blocks. There are not many studies in the field of architecture that explore the living mycelium's ability to grow within a mycelium masonry wall so that it can self-bond and self-heal. In this research, we aim to fill this gap by developing a framework for the cultivation of mycelium and the growth of blocks in an architectonic wall system. We investigate the possibilities of cultivating mycelium using simple tools and materials, as well as, the use of living mycelium as the mortar itself to permanently bond the mycelium blocks together, resulting in a more sturdy and permanent construction, which also can self-heal by patching holes or cracks.

With this aim, we conducted material experiments and explored sustainable methods of cultivation and production. Our objective is to develop a consistent method of production that starts from harvesting the mushrooms locally and extracting pieces of prepared mycelium and continues through cultivating the building blocks, and finally composting the grown materials to complete their life cycle. This involves the cultivation of mushrooms in small containers combined with water and flour, allowing the mycelium to spread throughout a substrate, forming a "mycelium paste". Once significantly developed, the mycelium can be placed into formworks to harden. Mycelium only stops growing when it completely dries, where it waits for ideal conditions to continue growing (Appels et al. 2019). We aim to demonstrate that the mycelium can also act as the bonding agent between the blocks; as it hooks its fibers from block to block, the connection of the wall can be made more secure. This can be an alternative use for the mycelium paste previously described and would allow the mycelium to act as both the brick and the mortar, providing a single material throughout the whole masonry construction.

Therefore, our explorations also involve the production of blocks that can continue to grow and repair themselves if the health of the mycelium is sustained. In this paper, we present: 1) our systematic material exploration for cultivating mycelium, 2) the processes to growing mycelium masonry blocks, and 3) the mycelium masonry wall segments built using mycelium as the bonding agent, as diagrammatically represented in Image 1. Based on our explorations so far, we claim that mycelium as a building material can support the "cradle-to-cradle" concept in architecture, and with further research in the field and with smart geometries, can allow for renewable, biodegradable and more sustainable alternatives for small-scale architectural constructions.

The first step of this research was to cultivate mycelium. In this project, we have tested several methods of producing mycelium and assessed the viability of different means of mycelium cultivation. Our three methods of producing mycelium are: 1) cultivating harvested wild mushrooms, 2) growing a block of brown oyster mycelium, and 3) continuing the life cycle of a premixed bag of mycelium purchased from Ecovative.

Our first method was to grow mycelium by harvesting local mushrooms. The mushrooms were harvested from a nearby wooded area and subsequently eviscerated. This was done to produce an even distribution of mushrooms across a substrate. The substrate in this experiment was cardboard, soaked in water for at least thirty minutes. This provided the food for the mushrooms. The mushrooms were placed into plastic containers in alternating layers with the cardboard, providing both the moisture and a food source needed for the mycelium to propagate. It is important to place the mushrooms onto the corrugation side of the cardboard to allow for air transfer. This process allows multiple pieces of mushroom to grow at once, as the mycelium spreads across the cardboard. After the mycelium grows through the cardboard, it is ready to be transferred to a bag containing a substrate for it to continue to grow through. This allows the mycelium to grow further. For our research, we used cedar shavings as a substrate. For this method, not every mushroom successfully grew through the cardboard. Therefore, only the mushrooms that propagate were usable for this experiment.

The next method was to harvest mycelium from a block of brown oyster mushrooms. This is a product that grew brown oyster mushrooms, provided it is watered regularly. For the purposes of this research, this mushroom block was shredded and distributed directly into a substrate for propagation; there was no need to wait for this product to grow through cardboard first as there is already enough mushroom material. The block is made of mycelium and was able to spread freely when properly fed, watered, and agitated because the mushrooms begin to grow when agitated.

Finally, we purchased a bag of premixed "grow it yourself" mycelium from Ecovative. This bag contained a blend of mycelium and biological waste. The instructions specify to mix the contents of the bag with water and flour. This agitation, water, and food activated the mycelium and it begins to spread throughout the bag.

For the wild mushrooms and brown oyster mushrooms, the prepared mycelium was placed in a bag with cedar shavings, flour, coffee grounds, and water to further support the growth of the mushrooms. The mushrooms were left to grow for two weeks. Once the mycelium had grown, the mix was broken up and combined with more flour. Image 2 shows a bag of brown oyster mycelium growing through cedar shavings.

After the mycelium has spread through the substrate, the mycelium paste was then transferred to a block formwork, establishing the next phase of the project. A 4" x 6" x 3" rectangular formwork is used to create 3" x 5" x 2.5" blocks. It took another five days for the mycelium to harden in the formwork. Once it solidified into the shape, it was baked at 200 degrees Fahrenheit for forty-five minutes to dry out the block. This prevents the mycelium from growing further. After this process, the dried mycelium blocks are ready to be placed together into a wall segment. Since we used the cultivated mycelium to make the blocks, we added the missing amount of substrate back to the bag to make more mycelium. This way, we explored a sustainable means of cultivating mycelium, as the mycelium continued to grow into itself.

Experimenting with the Living Mycelium as Mortar

Finally, we explored using living mycelium to repair the blocks and to bind the blocks together. We arranged the blocks with a standard half step coursing with two layers, the first with two blocks and the second with one block. Between the layers, we placed mycelium paste, like brick and mortar. The aim was to explore how well this process would bind the blocks together, and to determine the quality of the connection between cured mycelium and living mycelium paste, as can be seen in Image 3.

To continue this experiment, we applied mycelium paste to a damaged block to repair and patch the coursework. Image 4 shows this exploration. These two experiments were done in order to determine whether living mycelium can continuously be used to repair itself in an architectonic context.

Our greatest limitation in these explorations was time: the cultivation of the mushrooms is initially slow, and they require further curing as they are turned into a block. This reduced the size of the wall and blocks that we could experiment with. Additionally, we were limited only to the types of mushrooms that were immediately available. These factors narrowed the scope of the project down to a wall segment with only one type of mushroom species being tested.

The mix from Ecovative produced several successful blocks. However, as the provided mix diminished, it was replenished with more cedar substrate and flour. After two cycles, the mycelium ceased to grow, likely due to contamination, as suggested by mold growth. Additionally, the blocks from the third cycle began to produce mold after some time. Because of this, the subsequent experiments utilize the other mycelium mixtures as binding agents. The following experiments test the applications of brown oyster mushroom mycelium and wild mushroom mycelium on the blocks that were made from the Ecovative mix. This serves as a foundation to compare our blocks and mycelium to. These blocks were stacked together and artificially damaged and repaired.

Two of the mushrooms harvested from the wild began to yield mycelium growth. These two mushrooms, along with the brown oyster mushroom block, were each placed into one-gallon bags with cedar, flour, coffee grounds, and water and allowed to grow. Unfortunately, only the brown oyster mushroom bag began to propagate mycelium throughout the cedar shavings. Therefore, it is the only mushroom that produced a reliable means of producing mycelium paste so far. Because of that, this research was unable to compare the performance of different mushrooms. However, it can be said that the brown oyster mushroom block can produce mycelium and continue to grow throughout cedar shavings when provided with flour, water, and time.

After the brown oyster mushroom mycelium had spread throughout the cedar, determined by the white color the bag began to take on, the paste was ready to be used. It was then applied to the three experiments outlined in the methodology. First, it was packed into a mold to create blocks. Second, it was used to bind together blocks made from Ecovative mycelium. Third, it was used to repair a damaged area of a block made from the Ecovative mycelium.

Unfortunately, while the brown oyster mushroom managed to produce mycelium clusters throughout the cedar substrate in a one-gallon bag, the mycelium failed to continue growing in the block molds and the block repair, as seen in Image 5 and Image 6. This could be for several reasons. Most likely, the mycelium required additional water prior to being applied in the experiments, as suggested by the dry crumbly nature of the mycelium and cedar mixture. It briefly retains its shape, yet quickly crumbles apart into pieces under slight pressure. Another potential issue could be a lack of food. Additional flour could have been required before mycelium application in experiments. Lastly, the mycelium could have needed a more finely ground substrate and, as a result, had a difficult time growing through the large pieces of cedar.

However, the mycelium did take hold in the mortar experiment, as seen in Image 7. Yielding a strong connection between three blocks in a half-step course.

This suggests that the mycelium can be applied beyond masonry blocks, providing the mortar for a wall.

The one-gallon bag of cedar and mycelium was refilled to test for consistent cultivation, yet mold has begun to grow in place of the mycelium, suggesting easy contamination. This suggests that stricter lab conditions will be required to grow mycelium blocks. These findings display the difficulty in producing mycelium for the use of blocks in an architectural context, yet, they reaffirm the potential for mycelium to be used as an architectonic material.

Our findings imply that mycelium can be utilized in an architectural context, yet more research in lab settings is needed to refine the process of mycelium cultivation and advance the application of mycelium as an architectonic material. The adherence of the mycelium and cedar mixture to the blocks, despite dryness, suggests that it can potentially retain its form and serve as a mortar for mycelium masonry. Additional research should further explore the mycelium paste's applications as mortar.

These experiments contribute to a discussion around both sustainable production of building materials and the application of mycelium in an architectural context. The process described here can be utilized as a foundation for future research in the field. This research has provided a framework for the cultivation and fabrication of mycelium blocks, and the information provided can be used to develop mycelium block of various forms. Additionally, this research provides a foundation for other researchers exploring mycelium as a structural material. Provided more reliable means of producing mycelium paste, further experiments with this method could enable larger scale productions of the mycelium blocks and mortar to facilitate greater structural testing. Additionally, further studies can expand this research by experimenting with different mushroom species, substrate type, and wall size.

While further research is needed to optimize the process, mycelium is potentially capable of revolutionizing small-scale sustainable construction. The long-term reliability of a mushroom-based wall is currently uncertain, however, the properties presented in this research suggest that mycelium can certainly be repeatedly cultivated and is a worthy contribution to masonry construction systems.

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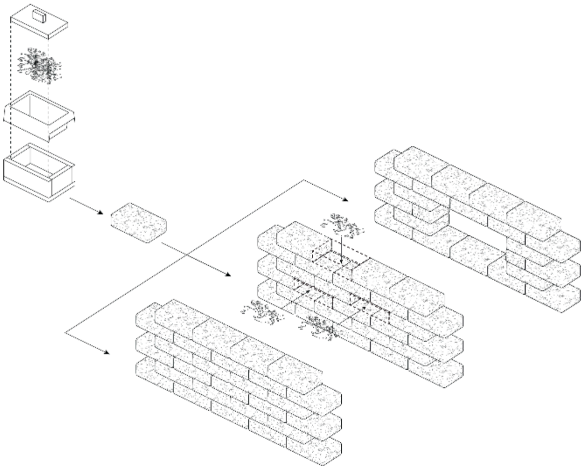

Image 1- Mycelium Wall Concept: The diagrammatic representation of the proposed use of the mycelium.

Image 2 - Mycelium bag: This is a bag of brown oyster mycelium growing through cedar. The mycelium grows through the biological waste substrate and begins to turn the bag white.

Image 3 - Mycelium block coursing: The mycelium blocks arranged as a half step masonry course with mycelium paste applied as mortar. These blocks measure 3" x 5" x 2.5".

Image 4 - Mycelium block repair: A block that has been artificially damaged and then had mycelium paste applied to the damaged area.

Image 5 - Brown Oyster Mushroom Mycelium and Cedar Shaving blocks: These blocks turned out to be very loose and would not retain their shape.

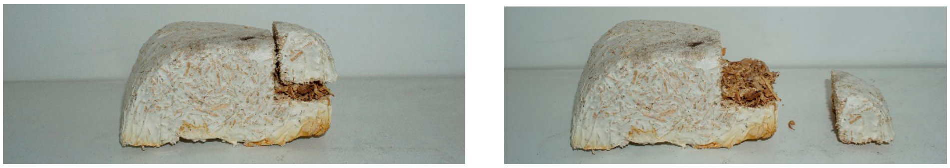

Image 6 - Damage Block Repair: The mycelium paste used here did not adhere to the block, allowing the repair piece to fall off. Potential issues could be related to a lack of mycelium formation in the paste applied, resulting in no growth of mycelium on the block. Additional testing will be required to confirm this, as it directly contrasts the findings in the mortar experiment.

Image 7 - Mycelium paste being used as mortar: In these pictures, the success of the mycelium paste being used as mortar to bind together mushroom blocks is displayed. The mycelium paste has hardened and hooked into the blocks, allowing for the blocks to bind together. This proof of concept suggests further uses of mycelium in masonry construction.

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CONSTRUCTING VORONOI CELLS AS A BUILDING FAÇADE USING PERFORATED MATERIAL

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ABSTRACT
The Central Laboratory building, planned to be built in a university, will bring research laboratories in one building. Within the context of design, it is tried to fulfil different requirements of each laboratory space. Meeting technical requirements, controlling heat from sunlight and creating well-lit spaces are the main design goals. A perforated material, which has different sized holes on it, is decided to be used as secondary façade skin to satisfy these needs. Holes' sizes are controlled by parameters to get the best solution for the defined design problems. Frames of this material is designed as voronoi cells to avoid the linear visual. Thus, the linearity of the building can be softened with this nonlinear secondary façade.
Within the context of outlined design problems, the composition of different sized holes makes the design complicated. Perforated material is divided vertically into three zones on each floor. Up and bottom parts are reserved for small sized holes and the middle part is for big sized holes.
In this study the difficulties in the construction process will be shared. Different material options are considered for the perforated façade. These materials are juxtaposed according to their positive and negative effects. The construction process and application detail of the perforated metal will be discussed.

KEYWORDS
Voronoi, façade, perforated, construction, computational

Introduction

A façade gives information about the building's architectural style, function and its period. Within the context of this study a central laboratory façade's design, material choice and construction processes are discussed. The central laboratory building represents a computational design process with its secondary façade. Computational design has brought new perspectives and discussions to architecture. By means of parametric design any possible solution for a design problem can be evaluated. Every changing parameter comes up with a new design possibility.

Imagination and creativity are the essences of a design process. The designer creates a photographic image / scene about the design problem, which shows the imagination about the relation between design problem and its context. Although this photograph is a prediction, it contains many decisions and details including the material that may change in the process. The designer is supposed to give the right decisions and specify the right details in order to realize that photograph. Within this context, the design process refers to a feed-back process between the imagination and final product. This study aims to discuss this feed-back process within the context of material selection. This process can be analyzed under these titles:

1. The Design | The Imagination
2. The Material | The Potentials
3. The Application

Within the context of this discussion The Central Research Laboratory building's façade is chosen as a case study.

The design | the imagination

The laboratory building was built in Karadeniz Technical University Campus in 2018 (Image 1). It was built to meet the need of gathering various laboratories in one building. The laboratories focus on research, science and technology. All these concepts create an image in the human mind. From this point of view, it was decided that the building may reflect this image. Thus, Voronoi diagram was chosen as the main geometry of secondary façade. In this way, this façade design serves to design concept.

The secondary façade's main role in design process is to hide the technical equipment of laboratories, such as engines, pipes, etc. In doing so, it is important to create bright spaces inside. Various sized holes idea was the very first idea for the façade design. It was decided to create small sized holes on the parapet levels and big sized holes on the eye level (Image 2). The second façade's material was chosen to meet all these needs.

Computational methods have changed the role of computer in design process. Very first use of computers in design was only for drawing and representation. Later, they have become a part of design process. Today, designers use computers as almost a co-designer and sometimes as a decision-making mechanism. Therefore, the interaction between designer and computer plays a crucial role to choose the most possible alternative from the design solution space. Oxman (2006) claims that designers still have a central position in design process, and they acquired new roles, such as being a tool builder. From this point of view, it can be said that designers design not only the final product but also the design process. As the design process and the design becomes complicated, the selected material becomes important.

Within the context of determined design problems, the composition of different sized holes makes the design complicated. To control the complex relations of variable sized holes between each other and laboratory spaces' functions and needs, the parameters are defined on Grasshopper. Façade is divided into three parts. For every store, up and bottom parts are reserved for small sized holes and the middle part is for big sized holes.

The material | the potentials

Choosing right material for the façade in terms of cost, durability and easy installation plays a crucial role. From this perspective, various materials evaluated with their pros and cons on visual effects, technical and functional specifications. Four materials, textile membrane, glass, mesh and aluminum, are taken into consideration.

According to their visual effects, materials are assessed with their opacity, color and texture properties. On the technical side, material's sheet size determines the panel sizes on the surface. Structural connections, durability and weight are the key criteria for the selection of the material. For the functional specifications, the second façade is designed to hide any mechanical devices behind it as much as possible and allow users to have a clear vision of outside on eye level. Moreover, materials are also assessed on sunlight control, daylight allowance, and securing space behind it.

Textile

Textile membrane is suggested to be used in two choices. First option is printing Voronoi pattern directly on the textile surface and stretching it between two metal edge profiles on bottom and top (Image 3). In the second option, manufacturer offers double layer system which has steel Voronoi structure on the front and textile on the back layer (Image 4). However, textile does not allow to have multiple holes on the surface due to its stability.

Glass

Glass is also offered to be used in similar combinations. In the first option, a Voronoi printed translucent folio cover finish with trimmed big holes is suggested to be applied on curtain wall glass surface. The second option is proposed as a double layer system similar to the aforementioned double layer textile membrane façade. Instead of printing Voronoi pattern on folio cover, a steel Voronoi structure is proposed in front of the curtain wall. This option gives a heavy load to main structure due to weight of the curtain wall system.

Mesh

Mesh material is considered as the material to go with in the beginning. It also offers many predefined opacity choices according to its hole size and density. However, producing Voronoi shaped panels or trimming big circles on the surface leaves undesired jagged edges.

Aluminum

Aluminum offers opportunity to give any texture on it by punching out holes according to desired design. Initial design projects a structural grid and panels that are shaped by Voronoi diagram (Image 5). 140 cm width size of the aluminum sheet is one of the problems that lead the change of the panel sizes (Image 6).

The Application

Voronoi patterned structural grid requires particular connection detail in every joint (Image 7). Keeping Voronoi panels, although giving up on Voronoi patterned structural grid, requires each panel to have at least 3 connection points with a rectangular structural grid (Image 8). Instead of using Voronoi shaped panels, panels are converted to rectangular shape and Voronoi texture is produced by punching out holes. Thus, panel installation and connection details become easier. However, Voronoi shaped structure is converted to a visual texture.

Results

Within the context of this study four materials are discussed and these materials' pros and cons are summarized in Table 1. As a result of material research process aluminum was chosen. Because it was the best choice for the visual effect, and it was easier to install than the others. Material selection is a crucial part of design process, because it has a direct impact on final product.

As is seen in the Image 9 the design, material selection and application relationship could be summarized in four cycles. In the first cycle; design, material selection and application processes are carried out in succession, and the application is fulfilled smoothly. This cycle shows the ideal way of a design and application process. But in general, design – final product cycle does not occur this way. In those cases, the second, third or fourth cycle occurs.

In the second cycle, the design and material selection processes feed each other till the right material is selected. As soon as the favorable material for the design idea is chosen, the application phase is started, and final product is built. In this cycle the material research plays a key role. The designer searches for a material that makes his/her imagine about the design become real.

In the third cycle, material selection and details & application processes feed each other. In some application processes the selected material may not be the best solution for the application process. In those cases, the material selection and its details are reevaluated. This cycle ends with the material – detail harmony which the designer wants to see.

In the fourth cycle the design process is reevaluated. The selected material may not meet the design problem due to detail solutions. In that case, the design process is performed again.

KTU Central Laboratory façade design can be evaluated within the context of third cycle. In this design process, the designer searched for the right material that makes his imagine about the second façade becomes true. Thus, within the context of third cycle various materials were considered. And finally, the perforated aluminum material was chosen.

Within the context of the feed-back cycle processes, it is important to preserve the design idea and the photographic image. As the design idea is developed, it may change and transform. But if the revises change the main idea, architectural style and perspective; it means that the right material and details has not been chosen.

IMAGES, CHARTS OR GRAPHICS LEGENDS

Image 1 - The Central Laboratory Building

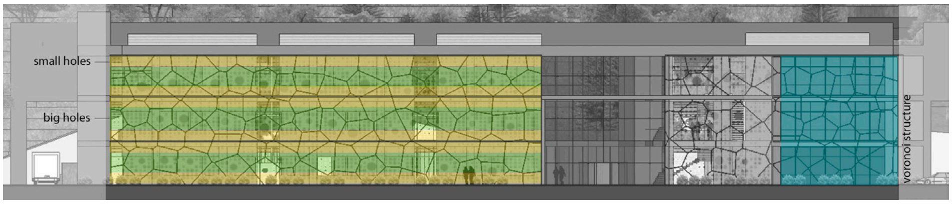

Image 2 - Small holes and big holes of the façade

Image 3 - The detail of membrane textile

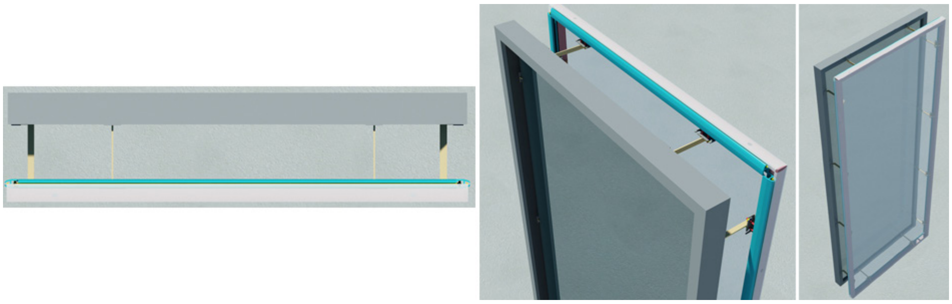

Image 4 - A detail of membrane structure

Image 5 - Aluminum material

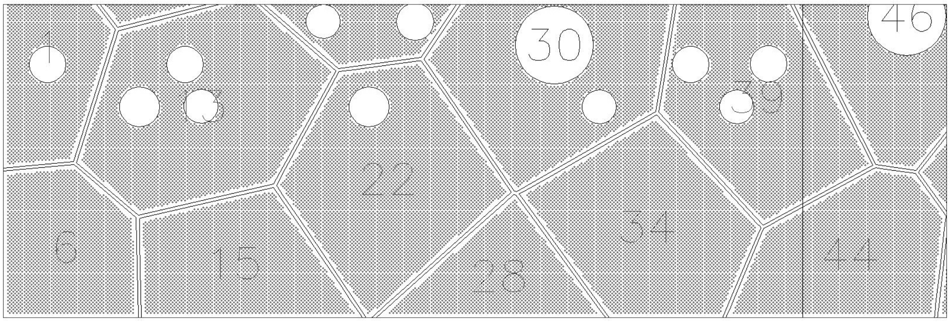

Image 6 - A section of voronoi structure

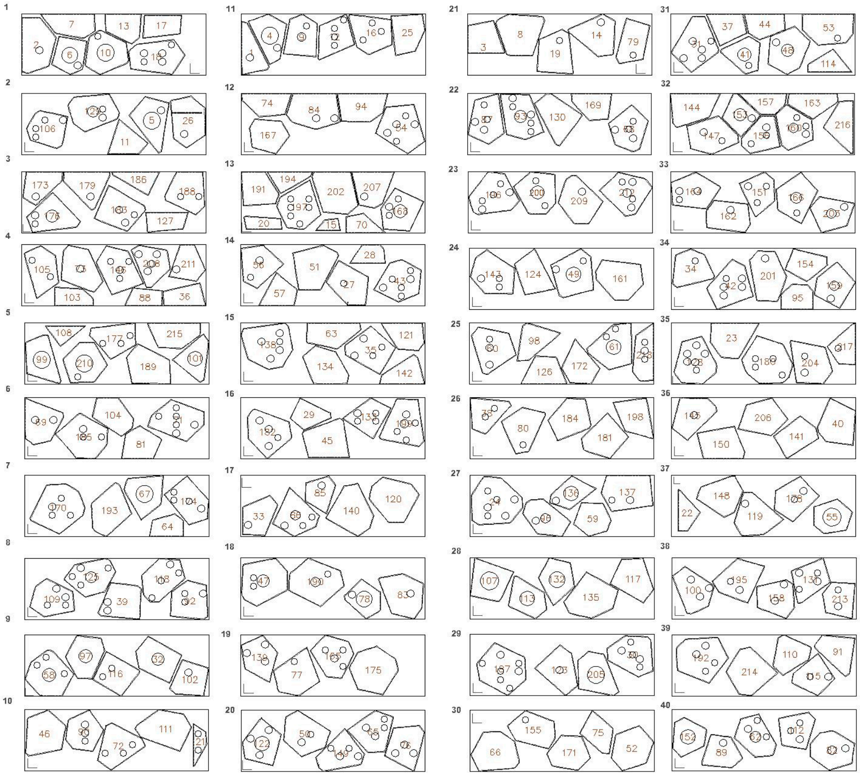

Image 7 - The numerated voronoi structure

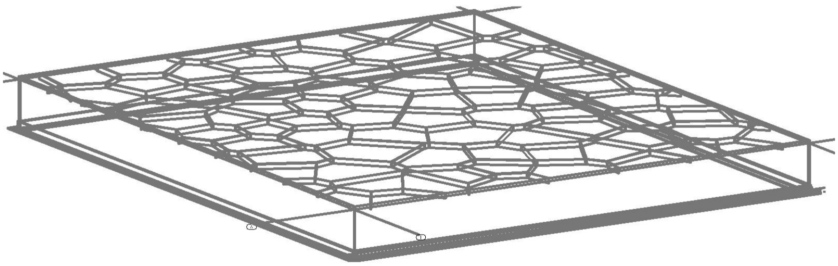

Image 8 - The unimplemented structure

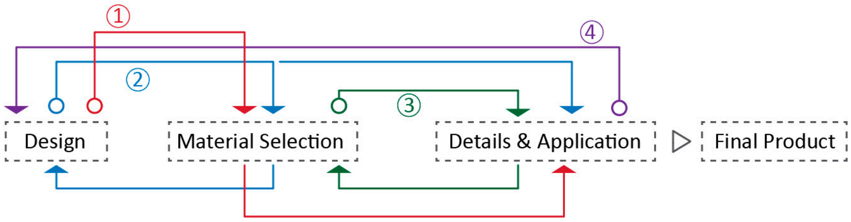

Image 9 - The design, material selection and application relationship

PROS	CONS
Membrane Textile	
Lightweight structure Prevents heat from sunlight Easy installation	Easy to be torn Discoloration may happen due to sunlight
Glass	
Daylight allowance Blocks outdoor environment	Greenhouse effect Heavy Cost
Mesh	
Predefined opacity choices Lightweight structure	Trimming circles on a pre-punched surface leaves undesired jagged edge
Aluminum	
Desired visual effect Easy installation	Limiting width size of aluminum sheet

Table 1 - The materials' pros and cons

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DIGITAL MAKING AND CONTROL IN CRAFT

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ABSTRACT
This paper reports on the current stage of an ongoing research exploring the potentials of direct control and manipulation of tools in relation to material behavior, aiming to implement material and tool behavior properties in the early design phase. Exploratory processes in craft practice combine the tool building and design with a deep understanding of the material and result in novel outcomes of technique. We examine clay and pottery making techniques and translate the outcomes through digital interfaces. The aim is to support approaches where the tools can become more transparent through the design process, therefore enabling designers to gain continuous control over the workflow. Observations and outcomes of the developed techniques will be discussed regarding the material, tool, and method.

KEYWORDS
Digital making, clay printing, tool building, craft

Introduction

D'Arcy Thompson (1968) defines the form of an object as a "diagram of forces". The form, and its growth, is a mechanism that is actively responding to environmental and internal forces until it reaches equilibrium. Material-based design studies evolve from this concept, as the form is no longer perceived as the sole end-result that all other agents are forged into, but a process emerging through the interplay of material, its behavior, and environmental factors in relation to fabrication strategies. With this approach, form, structure, and material are all involved in the preliminary stages of design playing matching roles. Kennedy (2010) defines this approach as a vertical model contrary to the traditional horizontal model, which emphasizes synthesis of new techniques, technologies and experimental models of design. This bottom-up approach positions the digitally generated form not as a dictating factor, but more of a flexible framework that constantly evolves through enriching material, tool, and production input.

Barkow (2010) describes material-based design as the integration of digital design, materialization and, fabrication. Rapid prototyping and digital fabrication technologies are key elements for the integration of digital design and materialization, enabling data-driven manufacturing, which corresponds to the concept of custom treatment for various kinds of material characteristics. Digital fabrication technologies and the fact that they are respectively accessible by designers today, made it possible to explore the potentials of material-oriented approaches. On the other hand, the integration of material behavior to this data flow made it possible to focus on the tectonic potentials, creating unique techniques, applicable in various scales, that evolves through the interplay between the material, tool and, the geometry.

It is evident that the wide integration of digital fabrication tools in practice and education is highly beneficial. But, as the tools are becoming more complex with the rapid evolvement of technology, the designers' role and control over the medium becomes more defined and limited. To fully benefit digital fabrication tools, precision is the key both in terms of design and operation. And the concept of precision usually eliminates the experiential aspects of the process, depending on buildability and the skillset of the designer. There is a very limited space of discovery for the average user as the tools are usually working in a closed loop system and run by optimized algorithms. This brings out the question of transparency of current tools, be it software or hardware, in the design process in regard to control in digital making.

To better understand and explore the interdependent relations of digital fabrication technologies, material know-how, and novel techniques transpiring through this interplay, the term *digital making* should be discussed. The alignment of material systems with digital fabrication technology and tooling processes have led to new terminology such as "digital craft" and "digital making". Both terms imply a relationship between craft and digital design and fabrication (Loh, Burry and Wagenfeld, 2016). As the name suggests, digital craft draws parallels to craft practice in terms of handling the raw material through tools, to create novel outcomes.

In this scope, this research evolves through the concept of workmanship of risk (Pye, 1978) to examine the fluid relations of tool, material, and technique in craft, and translating the discoveries digitally. Here, risk taking implies exploratory relations with the medium, but in order to, so to speak, turn a mistake into a potential technique or discover new ways to handle a material, one needs to have a sufficient skillset, and understanding of the medium as well as constant control of said medium.

Referring back to Thompson's definition of object as a "diagram of forces" and positioning the maker as one who "joins forces" with them (Ingold, 2013). The aim of the research is to investigate ways of enhancing exploratory aspects of digital making by examining craft and its making processes. To do so, the study focuses on how one *makes*, as part of designing rather than making a particular object in a particular way (Ozkar, 2007). As minds and things are continuous and interdefinable (Malafouris, 2013), to understand and improve the relations between exploration, risk taking, and control in early design phases, we need to study how things are made, or how one *makes* rather than studying the final object.

To achieve this, a systematic approach is proposed consisting of three phases that are namely *observation*, *adaptation*, and *application*. The intention is to design a holistic process that focuses on the interdependent relations between the tools, geometry and, materials, since the technique and genuineness of the outcome evolve through this interplay. In the first phase, the throwing technique in pottery making is examined, where the shaping is a continuous process and the hand is the primary forming agent, directly in contact with the material along with the constant rotation of the turning wheel. Here, the hand is significant in both creativity and material culture as the hand-held objects becomes an extension of the body and practical activities blurring the difference between subject and object (Simmel, 1965).

In this paper, the focus is on the rhythmic motion of the potter and translating these observed motions digitally to create an alternative design process that can be applicable by clay printing. In the adaptation phase to follow, the aim will be to create an algorithm to introduce these observations along with the material and selected tool inputs to produce informed toolpaths, referencing the continuous forming of the potter. In the application phase, with the notion of transparency in tools, generated toolpaths will be tested through clay-based additive manufacturing and the outcomes will be discussed in terms of process, scale, and further potential applications.

Craft and Rhythm

Pye (1978) defines craft through workmanship and technique. For the classification of the quality of the workmanship, he compares the intent of the designer and the execution of the work. As in, if the product is aligned with the intended design, the workmanship executed can be classified as good and vice versa. This approach brings the notion of control and skill in making. McCullough (1998) suggests that continuous control of the process is at the heart of tool usage and craft practice. And as the basis of digital craft, he references Ben Shneiderman's use of the term "direct manipulation" in relation to control of the craftsperson.

The other factor in Pye's definition of craft is technique, which he directly relates to the level of risk the maker takes through the process, hence the *workmanship of risk*. On the other edge of the spectrum is the *workmanship of certainty* which represents the industry. Even though the workmanship of risk implies having ineffectual outcomes from time to time, the risk taking here actually resonates with improvisation and experimentation of the capable craftsperson, sometimes born out of necessities (shortness of material, time etc.) and sometimes for the sake of pushing the boundaries of the given medium. Adamson (2013) suggests that craft takes place in the middle representing an ideal and intelligent balance between risk and certainty.

Within this framework, we examine pottery making techniques in relation to control, technique, material, and tool relations. Through the continuous rotation of the turning wheel, the potter starts her/his process by shaping the basic geometry and working her/his way through to forge the final form through a series of rhythmic motion. (Image 1) Hand held tools, in this case works as an extension of the body, enabling direct feedback between the form, material and craftsperson's intended and calculated motions.

Though these motions seem repetitive, they differentiate by the nature of the task. The repetitive and constant motion of the craftsperson has rhythm(s) and can be explained as measured, significant recurrence, marked by time and force (Fogerty, 2010).

In the case of pottery, the form emerges by pulling and pushing the material in varying axes through the constant rotational movement of the turning wheel. The frequency and varying force of the motion shapes and differentiates the product. The interplay between the calculated and designed motions, material behavior and creating reference points within a fluid process are key factors. While the motions are rhythmic, the force applied and the directions change in following and shaping the surface while controlling the shell thickness.

Upon these observations, we translate into digital parameters these analog agents such as frequency and variety of the motion and applied force, changing axes of defined forces, creating reference points for these factors and having material input in process.

Through constant rotation, the applied forces change between the X and Z axes. After centering the piece of clay, the potter pushes into the material to create an opening and works her/his way to shape the form via pulling the clay in the Z direction while controlling to give height. In order to create different surface properties, one hand acts dominantly to shape the material while the other creates support to control the *wall thickness.* By changing the positions of the dominant and supporting forces the potter is able to morph the surface (Image 2). The motions carried in the X axis control the width and are used for surface manipulation. Another factor here is keeping the clay wet enough to maintain plasticity while controlling the overall shape. The consistency of the material affects the ability to manipulate the surface, while it is essential to understand and react with the material behavior to prevent collapsing.

From here on we focus on analyzing the steps of forming the clay on the turning wheel and breaking them into steps to apply the discoveries in a digital interface through a developed algorithm.

Adaptation: analog to digital

In the adaptation phase, we selected an asymmetrical sample that has changing surface properties (Image 3). The aim here is to emphasize more on the effects of the ever-changing rhythmic motion on the surface properties while preventing collapses, and how to apply these in digital making by pushing limits of the additive manufacturing process and material properties.

To do so, first, we asked the potter to represent her intentions of making, through sketches. We gave the basic instructions of representing the overall intention of the final form while including the necessary vectorial input (push and pull motions) altering along the Z axis (Image 4). Here we noticed the sketches were only partial due to symmetric properties given by the turning wheel hence the predictability. But when it comes to the last row, which is asymmetrical, the potter still chose to represent her intentions of form through a partial section. This time, the reason was due to unpredictability, since the rotation speed of the turning wheel and the momentary action of the potter in relation to the material are the decisive factors. As the process becomes more exploratory the abstraction process works as mapping out and planning the sequences of forming. Hence the workmanship of risk.

To be able to translate the active motion in the X and Z axes to the X and Y axes, we divided the selected sample into segments. To represent the motion in 2D, a simple square boundary is used as a reference frame. Then, the action points and possible ranges are marked on the boundary (Image 5). The bottom side of the boundary represents the surface relations, therefore, the corresponding action points cannot cross pass each other.

At this stage, a Grasshopper algorithm that works with reference input action points is created. Instead of designing a final object, here the focus was to create sequential, closed curves based on these action points to control the radius in every layer, hence the potter's approach to the process. Here, the frequency of action points and applied forces (forming vectors) are defined by the user.

Rotational parameters are also integrated, through creating layers in Z-axis, again referencing the process of the potter's motions to manipulate the surface. Another aspect at this stage is implementing various vectors to alter the force applied along the path (Image 6).

The outcomes of the algorithm were consecutive layers which can be used as toolpaths.

Based on the outcomes, the algorithm developed further to be able to use any reference geometry configured within the defined boundary. And potentials differentiating motion representations are explored through a series of application.

While it is important to further develop the geometrical relations of the generated toolpath, without embedding physical properties digital outcomes remains as representations. To further develop the algorithm material tests were held to integrate into the early design process.

Application: Clayprinting

In additive manufacturing, the effect of material investigation on the design process increases since within the medium of printing paste-like materials the contents of the mixture directly influence the end result. Achieving the right consistency and viscosity is crucial as well as understanding the optimal values (speed, heating, deposition rate) to have eligible outcomes. The implementation and visualization of material properties at this stage aids to produce realistic representations of the final outcome, in digital design. Initial material tests are made to observe the viscosity of the clay and to integrate these findings into a material simulation that will be implemented to the existing grasshopper algorithm. The aim is to inform the design process and to create constraints in terms of buildability.

The factors to be applied to generated toolpath are viscosity properties of the material, gravity's effect on the spanning layers, and solidifying time of the material. For this, a loop system is created to inform each consecutive layer to define the interchanging anchor points in relation to intersected coordinates of the previous layer. This enables the system to serve as a troubleshooter as well since the spanning factor of the layers is significant in terms of buildability and if ignored collapsing may occur during the printing process (Image 7). This step helps to define spanning constraints to avoid failures in the production phase.

At this stage, with the addition of material input to the algorithm, we worked on the toolpaths necessary for production. Next, we designed a system using an air compressor for the extrusion of the clay and an end effector that can be integrated to a robotic arm. After several tests of air pressure and the viscosity of the material, we were able to produce the first set of developed toolpaths. At this point, we implemented additional parameters to the algorithm such as, gradual changes to the applied force, the range of action points, and variation range of each consecutive layer to build upon the observations made with the analog samples (Image 8).

The printed result, though based on the discoveries of the analog process, carries its own surface characteristics due to layered production. The speed of extrusion highly affects the surface quality as the material shrinks and changes weight in time. Therefore, the pressure value and the extrusion speed are as effective as the viscosity of the prepared mixture for printing. To test the above-mentioned spanning limitations regarding consecutive layers we introduced a change of direction on the flow of the surface. While the analog version has a continuous surface morphology following a single direction, we introduced change of directions in the printed version. We were able to test the material properties and spanning limits based on the analog version. To further explore the surface properties of the initial sample, the vectoral inputs used for the toolpaths were altered to create varied depths on the surface of the printed sample.

Conclusion

The rapid development of technology allowed designers to access a wide range of production and design tools, which also altered the way we interact with material and form through production processes. While most of the design process today occurs in digital environments, this study focuses on craft and its techniques to discover ways of enhancing the exploratory aspects in digital making. Through the phases of *observation*, *adaptation*, and *application,* a holistic approach that focuses on relations between the tools, geometry, and materials is proposed.

The current stage of the research aims observing the process of a potter using the turning wheel and translating the discovered rhythmic actions through a created algorithm, in relation to control and material inputs. First outcomes of designed toolpaths that are informed with the above-mentioned parameters are presented. While the initial attempts of analyzing and adapting the motions are matching the reference sample for surface manipulation, more study needs to be done to further develop and elaborate the possible application scenarios.

Next phase will be to enrich the observation process, to create a design library that can be used as an input for the existing algorithm. Also, more elaborate material simulation is needed to create reliable toolpaths. A further study will be to explore ways of implementing the discovered potentials in a larger scale with different tooling experiments while pushing the limits of the material.

IMAGES, CHARTS OR GRAPHICS LEGENDS

Image 1 - The motions' effect on the form.

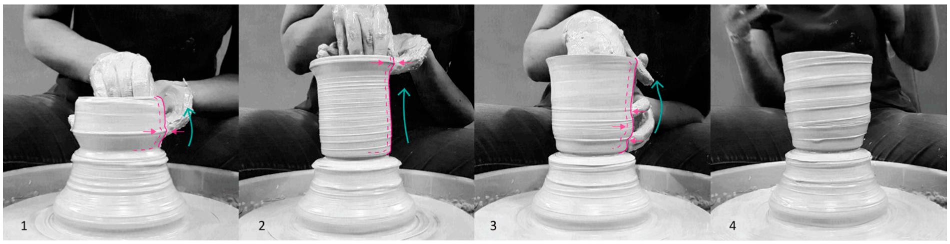

Image 2 - Sequential changing of the forces through the forming process. While the horizontal arrows represent the forces always applied in X-axis, the green arrow represents the flow and pulling action.

Image 3 - Selected sample for further study.

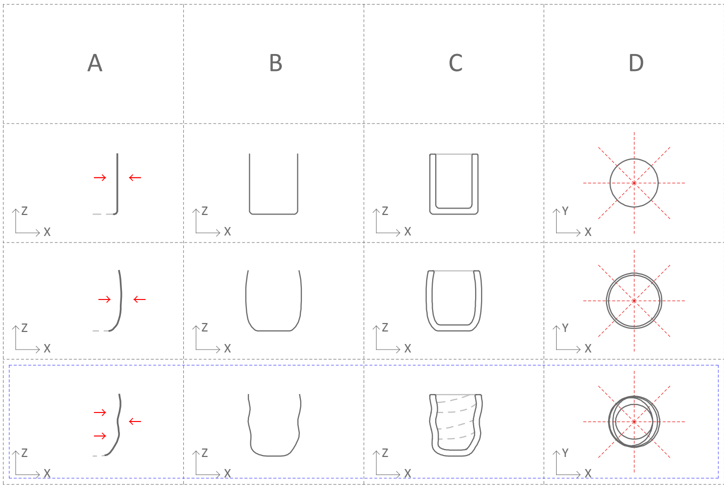

Image 4 - *A- abstract section drawings and forces made by the potter. B- complete section showcasing the asymmetrical property of the third raw. C- section with wall thicknesses. D- plan view. Bottom row represents the selected sample.*

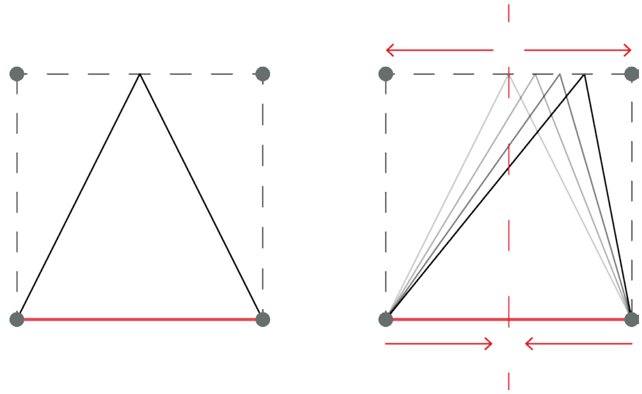

Image 5 - *Reference geometry and action points in relation to the defined boundary.*

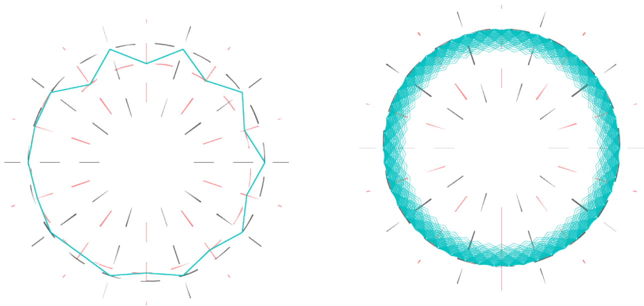

Image 6 - *Iterative process of applying different frequency and varied force upon the defined action points.*

Image 7 - *Result of a collapsing test.*

Image 8 - *Comparison of analog outcome and the printed outcomes.*

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MATERIALITY IN ARCHITECTURAL EDUCATION

WORD ARCHITECTURE

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ABSTRACT

How might we, based on the poetic process, bring into communication two different discursive genres and two different orders of materials? Namely, architecture and literature and their respective building blocks, which in the case of literature consist of words? In the present text I discuss the creation of space and architecture by means of words and writing, in the course of teaching the Space and Poetics seminar at the Department of Architecture of the University of Thessaly.

What the class focuses on is the architecture of the text, its position in space and, also, the spatiality produced by the text itself, as content and as inscription. During the course, the students become aware of the multiple dimensions of the relation between text and space, and the material constructional aspect both of these possess; they also come to understand the spaces and the spatial atmospheres which a text creates (to use as the background for the plot or simply by the spatial significance of the enunciation) as well as the multiplicity of writing voices: all of the above can then be used as tools that enrich architectural design. By semester's end, the students compose and create their own books or objects, which are designed as performative reading objects. Thus, to the construction of a text that refers to space, is added the design of a physical object (with the space that is appropriate to it) whose function/use is the performance of its reading.

KEYWORDS

Construction, synthesis, estrangement, writing, voices

Introduction

How might we, based on the poetic process, bring into communication two different discursive genres and two different orders of materials? Namely, architecture and literature and their respective building blocks, which in the case of literature consist of words? In the present text I will undertake to discuss the creation of space and spatial conditions (or architecture) by means of words and writing, in the course of teaching the *Space and Poetics* seminar at the Department of Architecture of the University of Thessaly.

What the class focuses on is the architecture of the text, its position in space and, also, the spatiality produced by the text itself, as content and as inscription. During the course, the students become aware of the multiple dimensions of the relation between text and space, and the material constructional aspect both of these possess; they also come to understand the spaces and the spatial atmospheres which a text creates (to use as the background for the plot or simply by the spatial significance of the enunciation) as well as the multiplicity of writing voices: all of the above can then be used as tools that enrich architectural design. In the first class sessions of this weekly, three-hour elective course, taking the form of a seminar workshop and lasting for one semester, certain primary matters are extensively discussed in the classroom, that have to do with reading spaces. Reading is considered an activity which, apart from the book and the computer screen and the mobile phone, exists at every point of the modern city (the ancient one too) as well as in many objects. The significance of the position of recitation is also analyzed and some historical reading practices through the centuries are presented, especially the early period of reading out loud.

Next, in the course of the semester, selected theoretical texts on poetics and literary criticism are presented and analyzed, while in every class texts of poetry or literature are read and critically discussed, ending in a ten minute writing exercise for all participants. Each class concludes with reading out loud the texts produced, followed by group discussion. Subsequently, by semester's end, the students compose and create their own books or objects, which are designed as performative reading objects. Thus, to the construction of a text that refers to space, is added the design construction of a physical object (with the space that is appropriate to it) whose function/use is the performance of its reading according its content.

The Assemblage and Composition of Words as Building Construction

Already among the very early essays about writing, we encounter the simile of the text as a building: "I consider that the science of composition has three functions. The first is to observe which combinations are naturally likely to produce a beautiful and attractive united effect. The second is to judge how each of the parts which are to be fitted together should be shaped so as to improve the harmonious appearance of the whole. The third is to judge whether any modification is required in the material used - I mean subtraction, addition or alteration- and to carry out such changes with a proper view to their future purpose. The effect of each of these process I shall explain more clearly by means of analogies drawn from the productive arts which are familiar to all - house-building, ship-building and the like. When a builder has supplied himself with the materials from which he intends to construct the house - stones, timber, tiling and all the rest - he proceeds at once to put together the building from these, paying close attention to the following three questions: what stone, timber and brick is to be fitted together with what other stone, timber and brick; next how each of the materials that are being so joined should be fitted, and on which of its sides; thirdly, if anything fits badly, how that very piece can be pared down and trimmed and made to fit well. .. Now I say that those who are going to put the parts of speech together effectively should proceed in a similar way." (Dionysius of Halicarnassus, (1985).*On literary Composition*, 6. Cambridge Massachusetts and London: The Loeb Classical Library. Translated by Stephen Usher)

This excerpt introduces the notion of a harmonious construction of a discursive work by analogy to the material construction in which the 'creative arts' engage, with house- and ship-building offered as exemplary cases. It comes from a work by Dionysius of Halicarnassus, a Greek teacher of rhetoric (c. 60BC- after7BC) titled *On The Composition of Names*. The aim of that work was to examine the ways, usages and combinations of words, expressions and names by means of which a beautiful speech is to be constructed, whether by an orator, a politician or a poet.

The English rendering of the title, *On literary Composition*, by the use of 'literary', misses out on the all-inclusive reference of 'onoma' which in ancient Greek means "name, phrase, expression, word, noun".

In the text, the constructability of the speech by analogy to a building and any other constructed object, is rendered as a conjunction of material units, a conjoining of constituent parts. It is defined in the word 'synthesis' of the title, about which the text's translator, Stephen Usher, remarks: "The word σύνθεσις means literally "putting-together' and may hence be rendered in English by "composition" only if a purely technical sense of that word is understood." (Dionysius Halicarnassus, Critical Essays, Loeb Classical Library, Cambridge Massachusetts and London, 1985, translated by Stephen Usher, p.5).

Synthesis, then, as a technical term, is the way to find the position, though not a single, unique one but, rather, "positions-in-relation-to", in a whole which is the work as a construct.

In ancient rhetoric, as in poetry, as in the arts, the highest form of construction is guaranteed by the appropriate joining, the fitting together of words and materials alike. Properly choosing construction materials, paring them down and preparing their appropriate form so that they can be fitted together, results in a new being which behaves monolithically, whose articulations and joints are made invisible thanks to the constructor's craftsmanship. According to Dionysius of Halicarnassus, stones, plinths, timber are the words of the orator or poet, the composers of texts, whether prose or poetry, written or recited. The paring down of the joints and perfect fit of the segments appears here as the most important consideration in the construction. Possibly because in building, a perfect fit is the one constructional feature that may vouchsafe immortality of the material work, through its resistance to time and weather conditions, particularly wind and rain. In the ancient societies of Greece and Rome, a work's immortality was a paramount virtue and, so, the Latin word *ars* derives from the Greek root **ar-* of the verb 'αραρίσκω', meaning to "join and fit together, connect and adjust" (Giannisi, 2013). A prevalent concept, then, the joining together, out of which etymologically the word 'harmony' also derives, a term used especially in music, but also in a political and social context, as the way in which the crowd may coexist. A concept pointing to a monolithic construct, with a body that has discernible but fully realized articulations, a living creature, according to Aristotle.

A body, its constituent parts and its joints - there is a concept about the architecture of words, one that focuses more on matter and its features and where the one emerges as the conjunction of the many through fitting together.

This concept of Dionysius of Halicarnassus of the assemblage of members takes us directly into Word Architecture, insofar as it uses architecture the departure point for arriving at the word. The well-made material construct is the primary metaphor for the edifice of language, which we may have called immaterial in the past, but which I want us to understand as also material, simply of a different order of materiality.

Materiality of language - Estrangement and Aphasia

Which is the materiality of language? We may gain an understanding of the materiality of language through analogies and particularly through an understanding of the sense of the linguistic unit and linguistic sets. We gain an understanding of the materiality of language through the appraisal of proper understanding and slips. In the discussion of these matters we refer to the texts of two formalists, one by the linguist Roman Jacobson ("Two Aspects of Language and Two Types of Aphasic Disturbances", in *Fundamentals of Language*, Roman Jacobson and Moris Halle, Berlin-New York, 2002 (1956) pp. 69-96) and the other, "Art as Device" (1917) by Victor Shklovsky (trans. Alexandra Berlina, Poetics Today 36:3 (September 2015).

Let us start with the latter. In this text Shklovsky distinguishes between the purely communicative function of everyday language and the ascertainment of the automatism of everyday experience, while emphasizing the revelatory aspect about the nature of things created by poetic language. Shklovsky writes:

"If we start to examine the general laws of perception, we see that as perception becomes habitual, it becomes automatic. Thus, for example, all of our habits retreat into the area of the unconsciously automatic. […] A thing passes us as if packaged; we know of its existence by the space it takes up, but we only see its surface. Perceived in this way, the thing dries up, first in experience, and then its very making suffers; because of this perception, prosaic speech is not fully heard […] and therefore not fully spoken [.] …Algebrizing, automatizing a thing, we save the greatest amount of perceptual effort. […] This is how life becomes nothing and disappears. Automatization eats things, clothes, furniture, your wife, and the fear of war. If the whole complex life of many people is lived unconsciously, it is as if this life had never been.

And so this thing we call art exists in order to restore the sensation of life, in order to make us feel things, in order to make a stone stony. The goal of art is to create the sensation of seeing, and not merely recognizing, things; the device of art is the "estrangement" of things and the complication of the form, which increases the duration and complexity of perception, as the process of perception is, in art, an end in itself and must be prolonged. Art is the means to live through the making of a thing; what has been made does not matter in art." (161-162).

For Shklovsky and the formalists, the hampering and elongation of the time of perception equals the revelation of a renewed vision regarding life and things, and that is taken to be the defining characteristic of art. In terms of semiotics, this hampering may be seen as the showing forth of the signified under a different light, brought about by a synthesis and use of the signifying signs in a manner that is unfamiliar or alienating.

I would claim that this is an emphasis on the materiality of language itself. This emphasis may certainly be used by analogy to refer to all art forms (hence Shklovsky's use of the term 'art', rather than just literature), including the subject's architectural experiencing of space.

Shklovky's text points us in other directions as well.

One such comes from the examples in Tolstoy's texts and the tropes they introduce. I quote:

"Tolstoy's method of estrangement consists in not calling a thing or event by its name but describing it as if seen for the first time, as if happening for the first time. While doing so, he also avoids calling parts of this thing by their usual appellations; instead, he names corresponding parts of other things. In one case, "Strider,"the narrator is a horse, and things are estranged not by our own perception but by that of a horse." (163-4)

How can one describe something as if seeing it for the first time? In the example of Strider, the manner concerns the speaker's transformation into another being, different to himself, a speaking horse. This manner is an exercise used by students, after an literary excerpt has been read and discussed in class, often from Dostoyevsky. The students rewrite the scene in question through the perspective of a different subjectivity of their own choosing, for instance, a chair on which one of the protagonists sat, or a mouse present in the room. It is certainly clear that these exercises aid architects not only as an introduction to the issue of the multiple subjectivities and genres which architecture hosts, but also that of the active detailing of the constituent parts of space and the sensuousness therein.

This particular method leads into Mikhail Bakhtin's related discussion of polyphony. Mikhail Bakhtin refers to polyphony and polyglossy as basic characteristics of the novel. I will not venture here into an extended presentation of the Bakhtinian view, that we read extensively in class. I will merely refer to polyglossy as a condition where in the same text are inserted multiple voices and tongues, i.e. multiple differentiations of kinds of discourse depending on the writer's intention and the speaker's traits relating to origin, line of work, social class, national or other minority etc.; throughout the work as a whole, these compose a multifaceted language with multiple, simultaneous world-views. In the course, by analogy, polyphony aids in the understanding and exploration of the multiple dimension of space for the many subjects experiencing it, as well as the numerous narratives that spring from it. Though a novel may be polyphonic along the line of its temporal development, diachronically, a space is constitutionally polyphonic due to the possibility of the co-presence and interrelation of many subjectivities at the same moment, in synchrony.

Let us now move on to the second text which introduces students to the materiality of language. Roman Jacobson's renown essay presents the materiality of language through its distortion and defamiliarization. In his essay, Roman Jacobson analyzes the two types of aphasic disorders which demonstrate the two basic axes of language, the axis of selection and the axis of combination. Jacobson writes: "Speech implies a SELECTION of certain linguistic entities and their COMBINATION into linguistic units of a higher degree of complexity. Any linguistic sign involves two modes of arrangement." Let us briefly see how he describes the linguistic functions of the two types of aphasics.

The first: "For aphasics of the first type (selection deficiency), the context is the indispensable and decisive factor. When presented with scraps of words or sentences, such a patient readily completes them. (77) Words with an inherent reference to the context, like pronouns and pronominal adverbs, and words serving merely to construct the context, such as connectives and auxiliaries, are particularly prone to survive. […] Thus Goldstein's patient never uttered the word knife alone, but, according to its use and surroundings, alternately called the knife pencil-sharpener, apple-parer, bread-knife, knife-and-fork (p. 62); so that the word knife was changed from a free form, capable of occurring alone, into a bound form. (79) […] "It could be predicted that under these conditions any semantic grouping would be guided by spatial or temporal contiguity rather than by similarity. Actually Goldstein's tests justify such an expectation: a female patient of this type, when asked to list a few names of animals, disposed them in the same order in which she had seen them in the zoo" (83) Of the two polar figures of speech, metaphor and metonymy, the latter, based on contiguity, is widely employed by aphasics whose selective capacities have been affected."

Let us now see what he writes about the second type of aphasia: "This contexture-deficient aphasia, which could be termed CONTIGUITY DISORDER, diminishes the extent and variety of sentences. The syntactical rules organizing words into higher units are lost; this loss, called AGRAMMATISM, causes the degeneration of the sentence into a mere "word heap", to use Jackson's image. Word order becomes chaotic; the ties of grammatical coordination and subordination, whether concord or government, are dissolved. As might be expected, words endowed with purely grammatical functions, like conjunctions, prepositions, pronouns, and articles, disappear first, giving rise to the so-called "telegraphic style".(85-86) The patient confined to the substitution set (once contexture is deficient) deals with similarities, and his approximate identifications are of a metaphoric nature, contrary to the metonymic ones familiar to the opposite type of aphasics. (86) A typical feature of agrammatism is the abolition of inflection: there appear such unmarked categories as the infinitive in the place of diverse finite verbal forms, and in languages with declension, the nominative instead of all the oblique cases. (86-87)". The writer continues the study of the two types of language by treating the metaphoric and the metonymic function in literature: "Following the path of contiguous relationships, the realist author metonymically digresses from the plot to the atmosphere and from the characters to the setting in space and time. He is fond of synecdochic details. In the scene of Anna Karenina's suicide Tolstoy's artistic attention is focused on the heroine's handbag; and in *War and Peace* the synecdoches "hair on the upper lip" and "bare shoulders" are used by the same writer to stand for the female characters to whom these features belong." (92)

The two types of aphasia are another way in which we may understand and create the estrangement of language. They work as tools revealing lack and error, and demonstrate the materiality and constructionally of the parts of language as elements in a set that operates as a whole. What this concerns is the set of the parts' relations amongst themselves. Language as a pile of words, language as metonymic description, these are various forms of the incomplete materiality of language, while the metonymic function, with the paramount role of context, determines the understanding of verbal space as the framework of the stage in relation to its content.

Although there isn't the time to devote to this consideration, it is abundantly clear that space as the framework of the plot is an immense subject in literature. In the seminar, the ascertainment of the spatiality of the text that has been read, the relation of action to its framework, the manner in which the writer introduces space as it relates to the subjects, whether in a metaphoric way or metonymically, as in the example of Anna Karenina, are standard concerns during the readings of the literary texts; through this exploration, the students comprehend matters that also bear on social attributes, the uses of stereotypes and symbolism, as well as the sensuousness or atmosphere which a space may create.

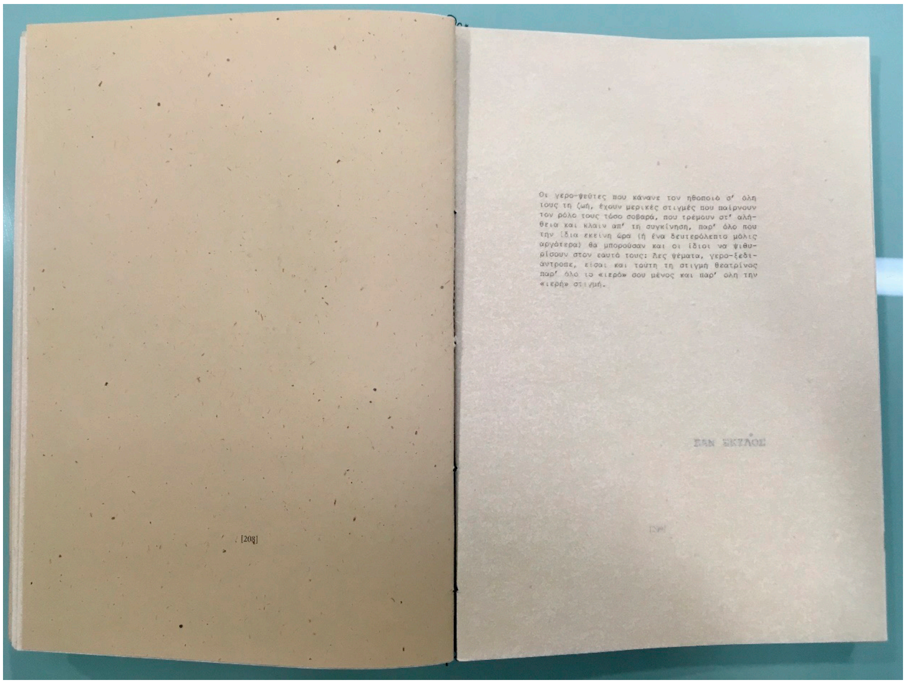
Finally, the use of one or the another form of aphasia as a tool for transforming a given text, can make the linguistic functions suddenly visible, defamiliarizing at the same time the text for the reader. In this exercise the students intervene by erasing, deleting, correcting and rewriting the texts. Precisely these interventions on the space of the page, showcasing the white and the black, the space of the letters and the gaps, lead onto a further step: apart from the materiality itself of language, we are transferred to a new understanding of the reading performance of a text's space. Specifically, the space of the two-page spread becomes an architecturally designed space which leads into reading much like a building's architecture leads the stroller inside it. According to the above, a book may be changed into a reading object or into a spatial writing which dictates a particular spatial performance of the reading process.

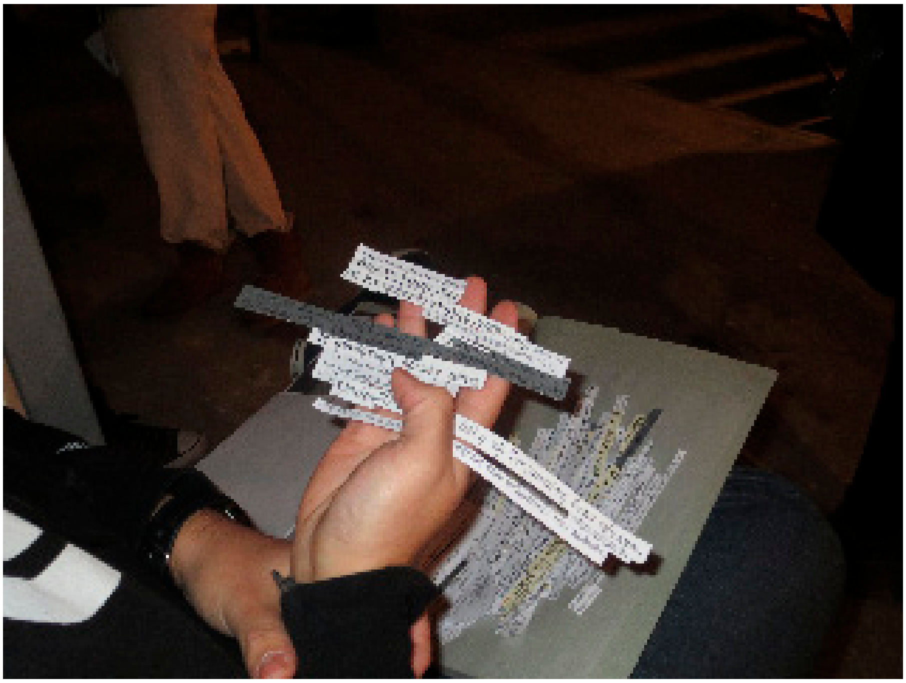
The Process of Reading and the Composition of a Performative Object of Writing

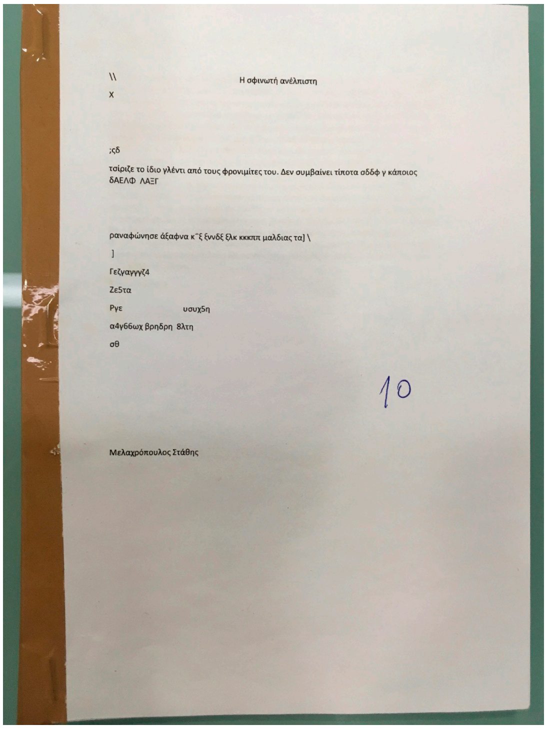
"The action of walking is to the system of the city what the speech act is to language or to uttered enunciations", writes Michel de Certeau. Throughout a whole chapter, he presents the stroller by analogy as an orator, and walking practices as rhetorical tropes (with prevalent among them the synecdoche and the non-sequitur) which may be seen in parallel with the two forms of aphasia we considered earlier. The analysis of reading as a walk on a plot of land is another metaphor by de Certeau which showcases the spatiality of the text itself. The reader's eye may wander somewhat freely /more unpredictably over the space of the page, when that is not constructed by the rules of prose, or follow the line of reading all the way to the end of the book; in either case, the eye and mind of the reader walk along the route of the book. To the constructionality of the word as orality and recital, is added the constructionality of the written text. The written text is not only constructed but, by contrast to oral discourse, it "encompasses", creates and occupies a space of its own. That space, however, is but the score for the performance of the reading act. In this manner, the poet/constructor may construct a reading space that circumscribes her own performances. A book as a performative reading object.

Everything comes down to a question of syn-thesis, that is to say, "choices of the positions-in-relation-to" of word architecture on the empty space of the page, the two-page spread or the entire reading object.

IMAGES, CHARTS OR GRAPHICS LEGENDS







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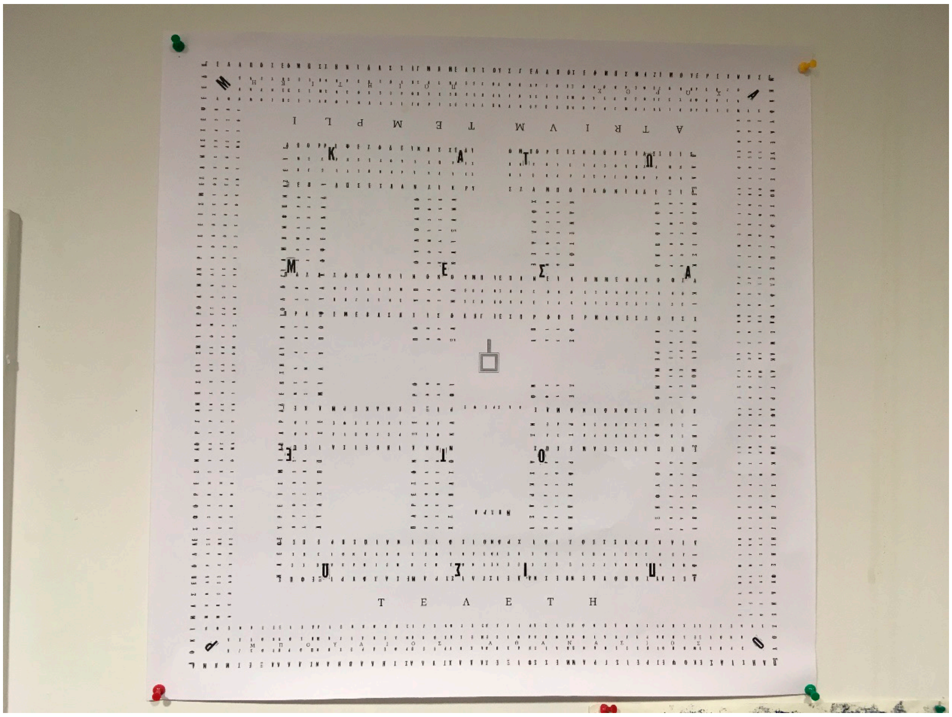

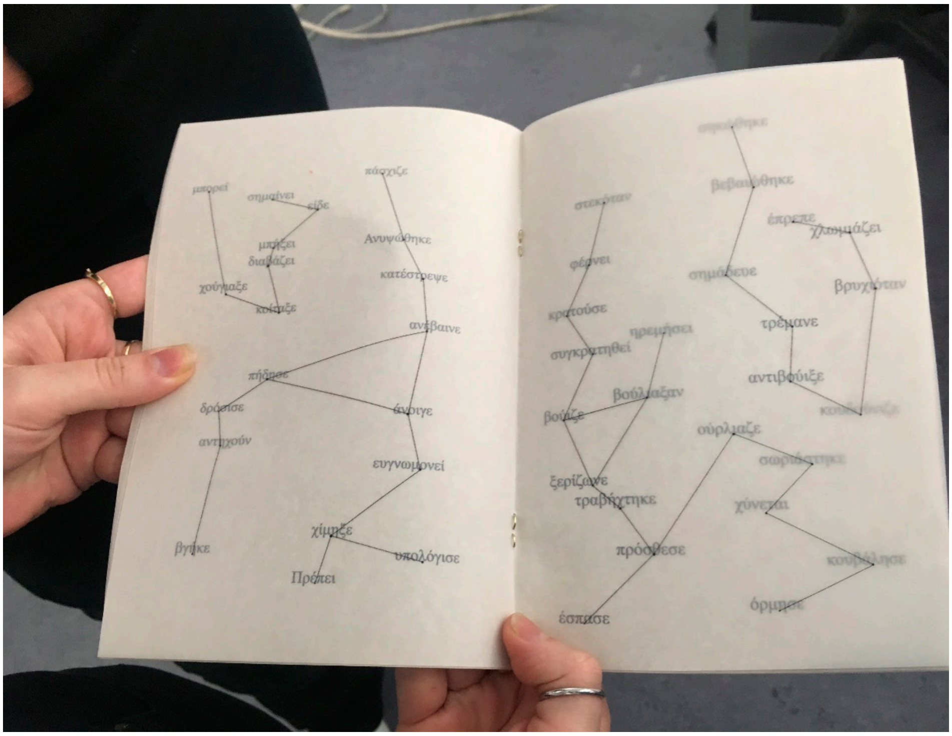

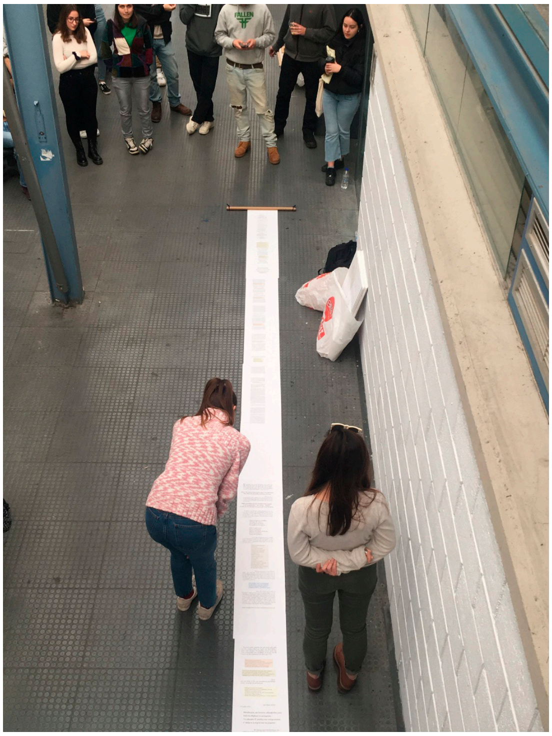

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BLURRING THE BORDERS BETWEEN HISTORY AND DESIGN: A COMPLEMENTARY APPROACH IN ARCHITECTURAL EDUCATION

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ABSTRACT
The subject matters, scope and methods of architectural history have been a matter of discussion for decades. It has been long considered something different than the history of spatial and tectonic typologies that has been regarded as canon or further beyond a bunch of architectural knowledge operating as a supportive kit to increase the quality of architectural education. Architectural history, positioned within the Department of Architecture since 1960s, has tended to define itself as an autonomous field by dissociating from architectural design. The answer of the following question is contradictive: "Is history an autonomous discipline or a 'service'?" In that sense would it be possible if one calls architectural history courses neither autonomous nor service by blurring the borders between those two? Could architectural history be a basic, inseparable and complementary component of architectural design and theory? This paper is based on an academic trial that has been practiced through the first year undergraduate students in the school of architecture that I am affiliated with. The model is formulated to customize and carry out architectural history courses together with Basic Design Studio. What two courses suggest is an integrated model that relies on theory, history and design. This model also attempts to initiate a new relationship with other disciplines like history, archaeology, philosophy and many others. In the overall, this paper tries to discuss the potential of a new form of learning that reveals permeable and intimate relationship with other design and other related disciplines by blurring the borders between fields.

KEYWORDS
Architectural history, architectural education, interdisciplinarity

The subject matters, scope, and methods of architectural history have been a matter of discussion for decades. It has been long considered something different than the history of spatial and tectonic typologies that has been regarded as *canon* or further beyond a bunch of architectural knowledge operating as a supportive kit to increase the quality of architectural education. The answer of what architecture history is rather crystallized today, but stance of history in architectural education and particularly its engagement with architectural design is still being discussed. Architectural history, positioned within the Department of Architecture since 1960s, has tended to define itself as an autonomous field by dissociating from architectural design. Anderson's reasonable question is worthy of notice: "Is history an autonomous discipline or a 'service'? If the former, is it nonetheless valuable as a source of critical insights into the position of architecture in society? If the latter, is it a trove of available forms, an array of formal paradigms awaiting transformation, a breeding and testing ground for architectural hypotheses, or...?" (Anderson, 1999, p.282) Moving this point onwards my first concern on this paper is to search the stance of history in architectural education and discuss the point in depth through a question of if there is any way that one can define architectural history neither autonomous nor service? but instead calling it rather a basic, inseparable, and complementary component of architectural design and theory by blurring the borders between them? Based on my professional experiences it seems very problematic for students to associate architectural design with history. Due to the distinctive format and objectives of those courses the students do not have a tendency of perceiving those two as complementary courses. Architectural history is mostly regarded by students that buildings/sites happened/built in the past and irrelevant to architectural design of today. In relation to this point my second concern is the close link of architectural history, not only within architectural field, but also with other disciplines. The ways of increasing the transparency and mutual efficacy in the production of knowledge should be seen vital in that sense. Thus, the following question is inspiring that to what extent some other disciplines like history, archaeology, philosophy, sociology, geography and many others are integrated to architectural history education? An academician who has an expertise on Indian philosophy would contribute a lot on the course when teaching ancient Indian architecture. Those two concerns tackling my mind are the motivations of this paper as well as the thoughts behind for adopting an educational model (to be more precise an academic trial) in the way of developing a collaborative model for the undergraduate students in the architectural school where I have been teaching.

What is Architectural History? Who is an Architectural Historian?

Trying to understand what architecture without knowing architectural history bears a potential of deficiency. For a few decades architectural history has been widely accepted as an integral component of architectural education. However, through the journey up until 1960s history's relationship with architecture, and its status in architectural curriculum had changed in time and remained unstable. Until 1930s architectural history was an inseparable part of architectural education dominated by the Beaux-Arts, even if the historical knowledge on architecture was based on *canonized* western narratives by neglecting the *other*. In 1930's architectural history encountered a criticism of the modernists in Europe of which resulted in with exclusion of history courses from Bauhaus schedule. Since 1960s architecture schools in Europe/America have included history once more in their architectural curriculum by embracing it as an autonomous discipline. (Anderson, 1997) By 1960s as well as the internal dynamics that ensured architectural history to be included in architectural curriculum, there were powerful external dynamics exerted on architecture. The changes occurring in the historical studies, critics of modernism, and post-colonialist theories triggered criticisms towards architecture. In the light of new perspectives, architectural history/historiography has undergone a significant change with the discovery of cultural "other" that expanded the borders of the discipline. Those developments moved the pay of attention taking from the objects to social context and ideology (social power, feminism, and psychoanalytic theories) of architectural production. Those developments called forth a new kind relationship that to be developed between the fields of architecture as well as with the other fields.

Architectural history has a changing nature of history (aims, tools, methods and all pedagogical approach) in time. An ancient quote of Greek philosopher, Heraclitus, reminds us "the only thing that is constant is change" also verifies that change is not only peculiar to architectural history. Neither the definition of architecture nor the pedagogical format of architectural history remained the same in years. Today the definition of architecture and tools of architectural history is something different from what Pevsner commented in 1940's "a bicycle shed is a building; Lincoln Cathedral is a piece of architecture." A new critical look has begun to develop since 1960s. Architectural history has been no longer focusing on the western oriented narratives, architects, or buildings. Kostof's eminent book, *A History of Architecture*, (1985) is a challenge to this approach having a great awareness to the "other" that might be regarded less Euro-centric and more cross cultural in that sense. Giedion's farsighted comments shed light on potential problem of history by saying "history is not static but dynamic", and "history is changed when touched". (Giedion, 1967) If history is inherently such a subjective term then historical dimension of architecture should ascribe it a subjective meaning. A historian's professional background, field of training, and own concerns might lead him/her to adopt a certain method for practicing architectural history. Those parameters might be so effective in creating a tendency of either neglecting or revealing some of the materials (two dimensional documentary evidence and 3 dimensional buildings) and construing his/her architectural pedagogy. Rendell starts her article by saying her mobility in her professional career between architecture/architectural history/art: "my journey through art changed me and the way I write architectural history" by pointing out such point: "how architectural history is spatialized practice, a mode of writing, which constructs, and is constructed by, the changing position of the author." (Rendell, 2006, p.135)

For sure there is no specific/standard/absolute way of teaching architectural history. But at that point it would be useful to clarify some of the concerns by asking what is architectural history? and what is the role of historian today? Michael Hays states as follows:

> "The role of the historian is not principally to describe buildings or architects, to produce biographies, explications, and specialized commentaries -though we do that, too. The role of the historian is rather to be concerned with the larger conditions on which architectural knowledge and action is made possible; with the multiple agencies of culture in their ideological and historically and worldly forms." (Hays, 2007, p.23).

Today the architectural historian has been moved away dealing with the limited world of particular buildings, architects and tends towards a position that embraces the built environment within its wide context. As Giedion expressed decades ago architecture "is the product of all sorts of factors social, economic, scientific, technical, ethnological." (Giedion, 1967, p.19) Since it is a broad field that has been the focus of many fields, such association leads up emergence of new engagements between architecture and social, cultural, political studies. Recent studies have a tendency of taking up architecture in an interdisciplinary context. From an architectural historian perspective in order to provide a critical evaluation, architectural history discipline utilizes the knowledge produced not only in architecture but also in history, archaeology, geography, and other similar disciplines within their contexts. As Steiber notes:

> "Architectural historians should be engaged in a dialogue with cultural geographers, anthropologists, and literary theorists who have been writing about space, cities, and architecture, and should be contributing in essential ways to the trans-disciplinary discourse of space. This will be easier to accomplish if the field sheds the narrow and parochial purviews of traditional art

> historical concerns, if its queries are defined in terms of the cultural and social work that architecture does, and if the centrality of the visual language of architecture is emphasized." (Steiber, 2006, pp.179-180).

The ability to develop creative and original architectural designs requires adequate knowledge of the history and theories of architecture and the related arts, technologies and human sciences. Space is a subject of a variety of disciplines, for that reason rather than intending to draw its disciplinary boundaries, it would be better to make contribution by expanding architectural history scholarship as much as possible.

> "In these narratives architecture becomes the ultimate document; not only it represent, but it contains, codifies, and shapes behavior and therefore cultural and social practices. These new perspectives have been very fruitful for architectural history in giving a new orientation and impetus to building- type studies." (Payne, 1999, p.296).

After having touched on the dialogue of architectural history with other fields one should put forth literal discussions on the first major concern of this paper, the relationship of history with/within architecture.

History With/Within Architecture

Vitruvius in his renowned book, *De Architectura*, describes the architect as a person who should have a wide knowledge of theory and history of architecture. (Vitruvius, 1960) Such a belief should be evaluated as a prominent comment for ancient period. During the Renaissance, beyond architects' traditional duty of building they gained a new status that they could draw (depicting three dimensional world) and write. Serlio and Palladio, prominent figures of that era, began to theorize architecture through their drawings and books. That might be regarded as the beginning of architectural criticism -widely known as something associated with words (instead of buildings) and the writer (instead of the designer). Le Corbusier, and many others soon after followed this in recent times like Bernard Tschumi and Rem Koolhas. It should be noted that those critical architects inspired from the intellectual mind of the late 1960s and early 1970s that Tafuri became a distinguished figure in this period as a Marxist critic and historian (Hill, 2007). But before proceeding to the fruitful period of 1960s one should look into the relationship between history and design.

If history has been accepted an integral component of architectural education one should discuss why does an architect need to learn architectural history? Or what does an architectural historian do in order to be useful for an architect? The former question may indicate equivalence of both disciplines, however the latter signifies the agency of architectural history for architects. The relationship of history with/within architecture and architectural design has been especially questioned towards mid 20th century. Turpin Bannister asks this question in 1949: "what then are the legitimate functions of history in educating a modern architect?" and he lists "five types of contributions which makes history and indispensible discipline in professional education." (Bannister, 1949, p.25) Similarly, Hudnut who taught architectural history in MIT says: "in our schools of architecture the teaching of architectural history has, or ought to have, only one important function; that of affording the students an experience of architecture and, especially, an experience of excellence in architecture." (Hudnut, 1957, p.6) It should not be wrong to observe those people's tendency of evaluating architectural history as instrument in the late 1940s and 1950s. But 1960s is the period which the relationship of history with architectural design had become the issue of hot debates. Three prominent figures discussed on this topic. Bruno Zevi, one of those, defended a kind of instrumentalized architectural historiography in the 1950s. Zevi thought that history carries a potential in guiding the architects towards a new architecture by giving a guiding role to historians for this important mission. (Leach, 2010, Keyvanian, 2011) Henry A. Millon, another figure on such discussion, in his book titled *History, Theory and Criticism* (1964) expands the borders of architectural history by asking similar questions such as "why does a man teach architectural history and how useful can it be? What does the teacher hope to pass on the student? Is history a new tool for fashioning better architects?" (Leach, 2010, p.106) Tafuri, other leading figure who wrote a book titled *Theories and History of Architecture* (1968), signified a new approach on such relationship by accusing modern movement's historians calling them as "instrumental historians" and as opposed to it he developed a method called "operative criticism". Tafuri separated history from design by suggesting those two as autonomous disciplines. Tafuri thought that history has its "own methodological aims and tools, not a practice to design". (Keyvanian, 2011, p.25) He expressed that "architectural historians should write architectural history and architects should know what to do with it" (Leach, 2010, pp.111-112). Leach splendidly summarizes those three prominent positions; for Zevi "architecture within history and for architecture", for Millon "architecture alongside history and for culture", but for Tafuri, "history against architecture, and for architecture". (Leach, 2010, p.112, Leach, 2007, pp.16-17.)

1960s hot debates on design/history relationship have been still going on today. Vidler's questions in his recent book point out such concern:

> "What, in short, does the architectural historian do, not qua history, but for architects and architecture? Or, to put it more theoretically, what kind of work does or should architectural history perform for architecture, and especially for contemporary architecture? This of course is a version of the commonplace refrain, how is history "related" to design? Is it useful? And if so, in what ways?" (Vidler, 2008, p.3)

Keyvanian's inspiring article (2011) opens also a clear perspective for us to discuss. She draws our attention to the distinctness of the objectives of history and design in architectural curriculum. She voices a legitimate and common reproach as follows:

> "Those of us who are historians frequently read in the eyes of our designer colleagues the unvoiced (and sometimes voiced) question concerning our usefulness in educating student architects in the twenty-first century. Why should students spend precious time learning the classical proportions of Greek temples when they will, in all likelihood, be called upon to design the skin of a skyscraper whose rippling surface is formed by photovoltaic cells moving to trace the path of the sun and produce sufficient energy for the building ?" (Keyvanian, 2011, p.26)

Today, even if the problems on this issue have not been solved institutionally yet, the situation may not be regarded as dramatic as it was like in the Bauhaus which sees the history as an obstacle for a creative design. Bozdoğan's words are quite worthy by presenting a panoramic view over the points that has been discussed so far, thus I haven't seen it inconvenient to give a long quotation.

> "What we thus see is a widening gap between an architectural history that is increasingly more interested in culture, context, and politics and an architectural design culture (and an architectural design criticism) that privileges form-making and creativity. This unnecessary dichotomy needs to be problematized. It is true that architectural history is a distinct discipline with its own intellectual and analytical tools, its own scholarly community (of art and cultural historians) and, most significantly, without any direct instrumentality or operative charge for design. It is no longer a service discipline for professional programs in architecture, nor a justificatory account of the past from a privileged vantage point or theoretical position. Yet, precisely because of this critical distance, architectural history is even more important for the education of the architect today. It is a critical exposition of how buildings, projects, and architectural ideas are produced and reproduced in historically specific times and places, within given cultural, political, and institutional contexts. It is the exposition of why, for example, even Gehry's Bilbao Museum has *everything* to do with politics, culture, and context." (Bozdoğan, 1999, p.207)

Design, history, and theory are the inseparable components of architecture. Such intricate relationship is explained by Hill as follows: "architects, especially influential ones, tend to talk, write and draw a lot as well as build. The relations between the drawing, text and building are multi- directional. Drawing may lead to building. But writing may also lead to drawing, or building to writing and drawing, for example....” (Hill, 2007, p.166) This presents us how architecture is complementary with contribution of all. If those are interlocked under the roof of architecture all should be well organized in the educational curriculum. That point is critically important for the format of architectural history courses. The architectural school that I am affiliated to has a survey course module titled *Architectural Theory, History and Culture* for the undergraduate students starting from the first year until their graduation in the fourth year. What is lacking in the definition of this module? is the design. Thus, it is critically vital to question and ask if is there any way that one can make a bridge with design and increase their coexistence in both courses?[1]

Building a Brige With Basic Design

This paper is based on an academic trial for an educational model that has been practiced through the first year undergraduate students in my school of architecture. It is formulated to customize and carry out architectural history courses (Architectural Theories, History, and Culture I-II) with the courses of Basic Design (Basic Design Studio I-II) by proposing joint projects to the students. Instead of suggesting instrumentality of architectural history in architectural education, rather it suggests an integrated model that relies on theory, history, and design.

With having such an attempt, last year a joint project was given to the first year students. As the final project of architectural history course, the students were asked to analyze the city of Venice which might disappear within 100 years. Against the threat of rising sea level the architectural heritage in the city is going to be studied and documented. The students are expected to analyze a particular building (also square and bridge) of Venice in terms of its context, form, material, construction technique, decoration etc. and make an evaluation considering current function of the building and potential threat in the city. This study led the students to look and analyze the architectural and urban character of the city in a different way. While being aware of global climate change the students tried to find the ways for sustainability of such cultural heritage as a whole. This view has added them a new vision of binding history with design considering of one of the current problems of the world. Another point that is stimulating is that having gained a new way of seeing. Architectural historians are believed to study the past only. To be able to comment on contemporary design or make predictions for the future seems inconvenient for them which originally creates an inherent contradiction. (Harris, 2015) With the aid of those kinds of projects the students start to analyze not only the time of its production but also the future of it by realizing that the building life is not ended. An experience of timelessness by blurring the time (past-present-future) might be helpful for students to internalize it as a whole. The topic of the Basic Design Studio was also about global warming and the students are expected to find new ways of coping with this global problem as an architect. The objections of two courses are well suited in that sense. The problem is a worldly one and the site is a world heritage that is related to all aspects of architecture. This model will also be applied through a variety of regions and problems. To analyze the architectural heritage in the Middle East that is under war/sporadic clashes where the looting is a serious threat for world heritage or historical regions/cities which have encountered serious problems of migration would be the other topics.

Conclusion

The current studies evaluate that architectural education is linked to history, theory, and criticism. In the definition of architecture those subjects are already existed in. As Rendell points out "architecture is a subject that includes history, theory, criticism and design as well as urban, technological, social and professional studies. As such, architecture embraces knowledge, understanding and modes of operation particular to a number of disciplines ranging from the sciences through to the arts and humanities". (Rendell, 2007, p.2) It is an umbrella term that includes many studies. "Architecture is a multidisciplinary subject, which can operate in an interdisciplinary way". (Rendell, 2007, p.2) In this framework, architectural history courses should help to build a framework indicating an intimate and permeable relationship between design, history and theory. The current investigations and new methods influencing architectural history studies has shown that teaching architectural history is always open to new discoveries and will be nourished with fresh and new form of learning. Rather than drawing borders to define architectural history the historians should blur the borders and find ways for more transparency inside the field and more collaboration with the other studies. The studies for design and what is designed should go hand with hand for its pedagogical advantages. Besides, to enable undergraduate students to increase the visibility and value of their knowledge, skills and competences acquired outside formal education where-ever they go. Architectural historians should provide the students an individual and experimental education, not making generalization of way of learning. So, would it be possible in architectural history courses to discover and reveal such permeable and intimate relationship with architectural design and other related disciplines and suggest a new form of learning that may benefit all disciplines though the re-format of architectural history course?

ENDNOTE

1 Construction and Basic Design Courses as a tool for expanding the limitations of architectural thought have also developed similar methods and contents similar to basic content and claims of this study. This framework is important for the individual perception of the way of construction. (For further information please see Sönmez, 2019)

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ALTERNATIVE PEDAGOGIES INTEGRATING ARCHITECTURAL DESIGN AND TECHNOLOGY

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ABSTRACT
Realization of an architectural design requires a proper structural design, suitable materials, and construction technology. Possibilities and restrictions of construction technology have always had a decisive role in materialization of architecture. Accordingly, architects need to be knowledgeable about structures, materials, and technology. For this reason, curricula of schools of architecture include a set of technological courses such as statics, strength of materials, basic structural analysis and related topics of building science. Most of the students, while they are struggling with calculations, fail to understand the meaning of all this knowledge to a design. Because they can't find any design relevance, students question that if this learning is ever needed by the architect. Therefore, knowledge gained is not engaged in architectural imagination. This paper briefly addresses why "design" and "technology" fall apart in architectural education and then presents several examples of alternative pedagogies including the one conducted by the author to constitute a link between technological courses and design practices.

KEYWORDS
Architectural design, alternative pedagogies, technology

Realization of an architectural design requires a proper structural design, suitable materials, and construction technology. Possibilities and restrictions of construction technology have always had a decisive role in materialization of architecture. Accordingly, architects need to be knowledgeable about structures, materials, and technology. For this reason, curricula of schools of architecture include a set of technological courses. However, most students have difficulty to integrate contents of these courses to their design practices. This paper briefly addresses why "design" and "technology" fall apart in architectural education and then presents several examples of alternative pedagogies including the one conducted by the author to constitute a link between technological courses and design practices.

In the ancient times, an architect was also a mathematician, a physicist, and a construction engineer. Marvels of ancient time were experimental structures. Their builders were competent to apply traditional techniques. Yet, they did not have advance computation techniques and comprehensive theories, they relied on their intuitions developed through observation. They also empirically knew that different materials responded loads differently; loads were shared between elements of structure according to their shape, size and materials. They dared to build higher and larger by trial and error method. In each time, the builders tried to exceed the existing example by taking a little risk until they faced the failure. By the failure, they knew that they beat the limits of the system. For instance, the dome of St. Sophia which was one of the most daring structures of the ancient time fell twice before it finally stood (Salvadori, 2002, p.19). Throughout the centuries mathematical theory of structures developed. Theory and the related comprehension of structural behavior were the outcomes of the discovery of the rules of nature. In the late seventeenth century, notion of forces and their conditions of balance understood. In the eighteenth century, structural analysis started to be used to evaluate the safety of an existing building. Over the three centuries, structural theories were derived from theories of physics and mathematics and used for new designs. First, the behavior of masonry arches and vaults were examined. By the mid-nineteenth century simple calculations proving how old structures could bear to gravity, wind and other loads were developed. Then new analytic tools were used to design with iron, steel and reinforced concrete (Mainstone, 1997, p.316). Today, thanks to advance computation software, structural analysis of sophisticated designs, previously unconceivable, are possible.

Until eighteenth century, the architect was responsible not only for the architectural and structural design of the building but for the whole construction process. By the nineteenth century, new building types such as railway stations, factories, offices, and specialized hospitals which were also adorned by technical innovations in heating, lighting, hot water, drainage were introduced. Because structures, their materials, and construction technologies became complicated, a need for experts in different stages of construction was born. Distinction of jobs affected architects to envision their design holistically. Contemporary architecture requires co-operation between a group of specialists. The architect leads the design in the studio and the construction team in the site. Accordingly, they must have knowledge of structures, materials and engineering technology in order to make creative design and communicate intelligently with their technical partners. For this reason, curricula of architectural schools include technical courses such as statics, strength of materials, basic structural analysis and related topics of building science. These courses are often taught by engineers. However, engineers are not usually familiar to essentials of architectural design. Calculations, a set of mathematical equations derived from some diagrammatic abstractions, which are alien to an architectural student are taught. Most of the students, while they are struggling with equilibrium equations of force and moment, fail to understand the meaning of all these calculations to a design. Because they can't find any design relevance, students question that if this knowledge is ever needed by the architect. Therefore, knowledge gained is not engaged in architectural imagination. An architectural student might learn how to calculate bending moment in a beam and compression or tension in a truss element but will not deduce how the loads are transmitted safely through the structure. A design can look impressive on the paper yet the crucial questions are how can it stand up and how can it be built. Are they questions to be solved after passing the design to an engineer?

It is a common misconception that the term design is understood by its limited connotations of aesthetics and theoretical concepts rather than the holistic nature of the process. (Ernest L. Boyer, 1996, p. 73). The problem which is "designing" architecture is disintegrated from "making" architecture has been discussed for decades. As Donald Watson states "few architectural educators deny that "technology" is part of architecture, but few embrace the dialogue that should result between design imagination and technological knowledge" (Watson, 1997, p.119). Design and technology courses are not interrelated in many architectural schools. This gap between design and technology continues after graduation by causing insufficient technological exploration in design process. Observing that architecture is so busy with literary and graphic problems, Tom Peters writes in 1991 that some architects become aesthetic consultants (Peters, 1991, p.24). Today, this observation is still valid. To design structurally advance buildings which meet contemporary technology and culture, architects need to use potential of structures and engineering as well as innovative material applications.

Architecture encompasses technology in several aspects; the characteristics of materials, the theory of structures, the techniques and technology of construction, the sequence of works, the organization of the construction process. Since the 1990s, delving into the problem and its possible solutions, increasing number of studies have appeared. Books devoted to teach structural analysis and technological thinking to architects have been published. Much efforts have been devoted in schools of architecture to integrate technical knowledge and the design studio. Alternative pedagogies have been proposed and applied through decades. Here, several examples obtained through a literature review will be presented in order to exemplify different formulations generated to solve to this problem.

To encourage students to design by considering the wholeness of process, design and technology have been integrated in studio, in laboratory, and on-site (field based) experiences. Observing that students learn technical issues more efficiently when they need them during ongoing design projects, one method is to conduct the studio which encompasses solutions of technical problems. There are different studio formulations based on this approach. In one example, proposed by Edward Allen at Yale University, technical courses are totally abandoned and replaced by two technically oriented studios. One of these studios, specific technical issues are introduced to students. Through the course technical knowledge is lectured when it is needed. In the second technical studio, students are given particular design problems. They concern with space, form, light, circulation, climate but they also asked to design structural and technical systems of the building (Allen, 1997). In this example technical courses are replaced by technical studios. However, in many cases, technical courses are conducted as a teaching module but additional efforts are spent to integrate them into design studios. Another approach is experimenting materials and structures by making installations, models or some full size structures. Making installations helps students to improve their structural intelligence and intuition. First year design studio of Illinois Institute of Technology proposed by Catherine Wetzel exemplifies this tactic. As Wetzel explains the aim is to encourage "students to inform their design decisions with an understanding of material properties, structural systems, and spatial definition in equal measure" (Wetzel, 2012, p.107). The studio starts with the lectures introducing basic terminology and theory of structures, four primary forces, bending, axial, torsion, and shear. Sample structural systems in the nature and built environment are examined. Then, a broad range of structures, shells, domes, truss, tensegrity systems are studied through case studies of significant examples such as the shells of Eduardo Torroja and Eero Saarinen or tensile structures of Peter Rice and Santiago Calatrava. Students build models demonstrating the flow of forces across structural members. After these studies, they build structurally determined installations in large-scale. All models are tested to reveal the force flow, design weaknesses, and material efficiencies. Through an iterative process, students test their structural and material knowledge (Wetzel, 2012, pp.107-110). Another method is that students gain first-hand experience by building real-life projects. In some programs, students design and build small buildings in or around the school as in the case described by Chad Schwardz at Southern Illinois University Carbondale. Here, a sectional drawing of a single-story house of wood light frame construction is given to students. The students are required to develop a strategy for building a part of the wall by considering all details. Each group completes the design of the wall, makes a part lists from their design, estimates the cost from the parts lists and finally makes a storyboard showing the construction sequencing and scheduling. After their approval by the faculty, the students build their wall sections in full scale in an outdoor space in the campus (Schwartz, 2015).

In addition to making and experimenting physical models, in advance courses, computer models are also used as pedagogic tools to improve technological understanding. For example, a real building is modelled with a computer program and tested by applying a combination of forces. Structural performance and deformations are observed and measured. Some programs animate structural performance under different parameters. Such visualization is also effective for gaining an intuition.

In department of Architecture at TOBB University of Economics and Technology of Ankara, a series of technology courses are conducted. The series starts with two technology studio courses which are given to first year students. Arguing that the content and method of technology courses should be reformed, Murat Sönmez formulated these courses He emphasizes to design by making. (Sönmez, 2018). Throughout the first studio, students make inquires and productions to develop solutions of the given problem. Each semester, students are asked to construct an object which has a specific form such as giraffe, a spider, an elephant, a centipede. [Image 1]. Initially, students inquire components of this form then they design its structure. They make their object from any material which they choose without using adhesives. Accordingly, they need to design joints and to solve the problem how the parts constitute a whole. At the end of the course, it is aimed that students comprehend how the original architectural thought can be developed, how an abstract design idea can be materialized by using structural tools. It is also intended that they learn to distinguish and to reproduce the qualities and quantities which constitute a structure. The second technical studio focusses on the prime elements (context, ground, action, cover, wall) that constitute the space. Being familiar with the concept of "making," students investigate how the structural elements such as base, surface and cover can be transformed into specialized parts as floor, wall and eave. Throughout the course, how students understand materials and how they use them to produce space are examined. The tripartite relationship between spatial-structural tools and actions is also investigated. At the end of these courses students acquire conceptual and structural tools to produce particular solution to a design problem (Sönmez, 2018, pp. 71-72).

Material-Form-Structure I-II are two consecutive elective courses given at TOBB ETU. They were formulated by the author who is a civil engineer and architectural historian. The courses put emphasis on the form defining role of materials and structures. The course is not intended as an extension or a substitute for any technical or design course. Rather, by adopting an interdisciplinary approach, it creates its own peculiar area at the intersection of history of structures and history of construction technology. The aim of the course is to help students to develop their understanding of how structures, materials and technology, affect design. It is also presumed that if students comprehend how technology and design are integrated to each other, they will develop a holistic understanding and be inspired to apply this understanding to their own designs.

Apart from all conceptual, intellectual, and aesthetical discussions, it is mundane yet vital that form follows forces applying on it. The structure ensures that the building stands up safely. It is important to apprehend the role of structures in order to understand architecture. To interpret a building as a structural system, it is necessary to distinguish structural parts from non-structural parts. Structures are governed by the rules of the nature which are formidable forces that any design cannot ignore. Since the laws of nature do not change, basic structural understanding can be gained through observation. If something is dropped from the height, it falls; the branches of the tree lean as the fruits ripen; a small child cannot carry a weight as a healthy adult; people can walk on the frozen lake but they sink in the swamp; the branches of the tree break in the wind but grasses touch the ground and then lift back. Hence, similar to ancient builders, through observation and experimentation, architectural students can learn basic rules that govern structures. After gaining the basic understanding of structural mechanics, students can easily improve their awareness and skills by using theories and calculations.

A knowledge of material properties and applied sciences is needed to comprehend the effects of the forces acting on any element and structural system. Hence, in the first weeks, the instructor gives an introductory lecture on structural forces at the scale of the unit, the structural member, and the system. The lectures include basics of statics, forces in equilibrium, loads and the four primary forces, bending, axial, torsion and shear; definition of determinate and indeterminate structures. Basic knowledge of mechanics of materials, material properties, stress and strain, material behavior modes, and failure theories are other topics included. During lectures, visual materials such as videos of material lab experiments, real-life videos and photographs showing different modes of structural behavior and structural failure are used. Students model with string, paper, wood, cork, sponge or any other available material to demonstrate and to experiment structural notions such as how the intensity and location of loads affect a structural element; how support conditions and connections of elements alter the transmission of forces; how different materials respond differently under the same forces; how lateral and vertical forces affect the system; how geometry and arrangement of structural elements govern the systems' behavior. There are no calculations or exams.

Towards the middle of the semester, each group of three to five students is expected to make several simple structures spanning 20-30 cm opening. For each structure, they are asked to change one parameter such as support conditions, stiffness, materials, sections, etc. A single force or an equally distributed force is applied. They load their structures until they fail. [Image 2]. They take photographs of their experiments. Before loading their models, the students predict how the load will be transmitted, which elements will fail, and how will they fail. They discuss the rationale of their predictions. After testing, they argue whether their intuition is true. If they are wrong, they discuss the reason. Then, they submit a report on their experiments. In their reports, they are also asked to draw simple diagrams and to use the structural vocabulary of bending moment, axial force, shear force, shear failure, torsion, buckling.

Throughout the courses, range of structures such as vaults, domes, frames, truss, tensegrity and tensile systems are addressed by examining historical and contemporary buildings. Examples are chosen to demonstrate students how materials have decisive role on the design of structures. Significant changes in architecture occurred when a new material and technologies came into the scene. For instance, the invention of reinforced concrete, developments in the steel industry radically affected the built environment. Not only new materials but also new technologies improving flaws of old materials brought new possibilities of design and their constructions. Accordingly, properties and technologies of a range of structural materials, stone, wood, mud, concrete, reinforced concrete, iron, steel, plastics, and polymers are discussed through examples. Documentaries on history of materials and construction technology or on any relevant subjects are watched and discussed in the classroom. At the end of the semester, students pick a specific material and make a group presentation. They examine past and present uses as well as future possibilities of the material. They discuss different structural uses, pros and cons. Then, they made an exercise by choosing an existing building. They speculate what would happen if they replace material of a specific part of the building by the material which they presented. In this exercise, students speculate not only structural requirements but also climate, light, availability, program requirements, economy, technology. At the end of their presentations and the class discussions, students write a short essay about the exercise. At the end of these courses, it is expected that students improve their structural awareness; they develop a holistic approach to a design process and they enhance their technological imagination.

Conclusion

By referring to Gottfried Semper's definition of architecture in terms of its material components-hearth, earthwork, framework/roof, and enclosing membrane, Kenneth Frampton defines architecture as both "poetics" and "tectonics" through which the design understanding incorporates construction and material culture (Frampton, 1995, p.85). Tectonic process of design entails both the design and technology. Alternative pedagogies are needed to help students to make designs which embrace "poetics" and "tectonic" of architecture. None of above examples suggests a flawless solution to the pedagogical problem of integration of design and technological knowledge. Yet, each one is a fragment of the our continuous quest for better practices.

IMAGES, CHARTS OR GRAPHICS LEGENDS

Image 1 - Different ways of doing

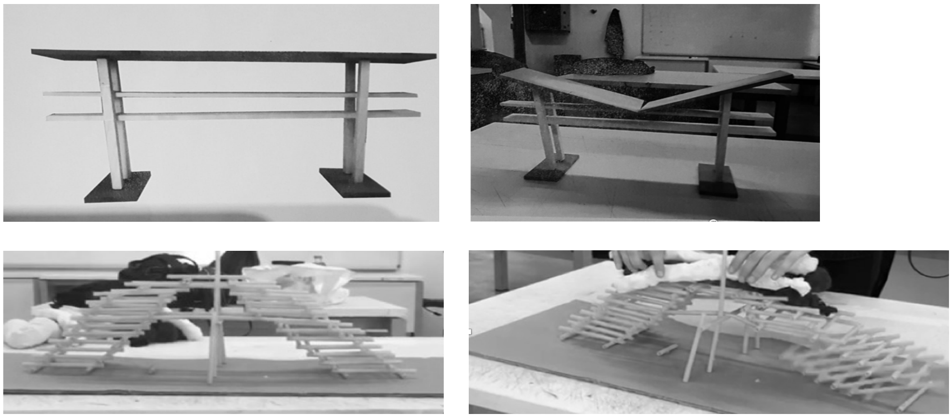

Image 2 - Experimenting with structures

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WALKING, INTERPRETING, SHAPING

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ABSTRACT

The paper focus on the work developed in the second semester of the first year design studio taught at the Lisbon School of Architecture of the University of Lisbon. The pedagogical approach of the exercise is based on walking as the first act of project and art, mainly proto-architectural sculpture, as the catalyst of Architectural composition. The approach to the overall project exercise was subdivided in steps, each one an elementary exercise with simple rules that stimulate student's creativity and autonomy within a precise code of representation and monomaterial model building in cardboard or styrofoam.

The coded representation of reality in white cardboard models allows reducing the complex nature of the city, extracting essential layers for its understanding and aiding students learn to interpret and to select the project composition themes by rational abstraction in connection with the induction of proto-architectural works of acknowledged artists.

The more detailed composition of the spaces is done in styrofoam models. Focus at this level of first year is placed in composition and lighting and the manipulation of styrofoam models allows to easily test different designs in comparison and to shape spaces through cuts, incisions and additions.

The exercises coding avoids students to get lost in fantasies and the domination and overcoming of rules promotes the generation of creative designs.

KEYWORDS

Interpreting, shaping, architecture, art, pedagogy

Ceci n'est pas une utopie. Phalanstery in the Dom Fradique Patio.

"*Ceci n'est pas une utopie. Phalanstery in the Dom Fradique Patio*" was the proposed theme by the coordinator, João Luís Carrilho da Graça, for the first year design studio at the Lisbon School of Architecture of the University of Lisbon in 2017/2018 school year.

Although the place is in a privileged position regarding the city, next to both the São Jorge Castle walls and the Ancient Wall of the city, Dom Fradique Patio is a long time ruined space.

The goal of the exercise was to design its transformation using as a pretext an elementary functional program with twelve cells and two common spaces: a kitchen and a water space. As Carrilho da Graça wrote: "This exercise aims to explore the understanding of the elements that characterize the territory and the integration of the architectural project in a specific place, approaching dwelling as the first condition of architecture." (Carrilho da Graça et alli, 2018)

The first year students abilities and needs.

The contemporary generation of first year students in the university generally are proficient in photography, but in the last decade their base formation in geometry and hand drawing has shown signs of weakening comparing to former students. Therefore, the pedagogical approach in architecture has suffered a few adaptations regarding student's abilities and needs in the first year.

In the beginning of the formation in architecture there is a need to develop architectural and general culture while earning competences in hand drawing, rigorous drawing and model building. This learning demands a considerable amount of work hours and commitment to the design studio work, thus it must produce beautiful works in order to keep students stimulated in this process of awakening to architecture. A challenge that must also lead to the confirmation or refutation of the path each one has chosen for the future.

Framing. The first semester of the first year.

The second semester follows the first approach to architecture that is developed in the first semester. In the first semester, the pedagogical approach uses mainly models to deal with the composition of space and the acknowledgement of values of architecture from an abstract point of view.

The first exercise consists in 5 photographs that illustrate each student idea of architecture and are sequently used in a class discussion about the definition and the values of architecture. Themes such as light, materiality, rhythm, structure and space are recurrent and this exercise is also useful to clarify common preconceptions and mistakes regarding architecture.

In the second exercise, individual masks are built based on how each student wants to be seen by the other and based on an architectural theme previously identified. By the end of the week, an exhibition of all masks is organized followed by presentation and critical discussion.

These first two exercises aim at establishing a common ground of understanding from which is possible to develop the main exercise.

In the main design studio exercise, Le Corbusier's Cabanon at Cap Martin is the pretext for each student to build his own Cabanon as an individual isolation structure. This first contact with the composition of an architectural space is an exercise with very simple rules and limited complexity.

The student's Cabanon must be inscribed in a cube of 3,66m x 3,66m plus exterior walls of 0,5m thick and must contain a working surface, a resting surface and a contemplation space. Dichotomical relations are used to frame the project: path / approach; arrival / ground; transition / entrance; interior / shelter.

The understanding of Corbusier's Cabanon and the Modulor proportion system associated with the construction of an individual dimension system per student was the base for the composition of the individual Cabanon in the natural context of Arrábida, a mountain near the sea, south of Lisbon. Le Corbusier's proportion system was used as a pretext for each student to know his or hers own body measures. In this sense, the development of "Le Cabanon in the Arrábida" from each student specific individual body measures also became a pretext for students to confront themselves with relation between Man and Architecture, particularly the needs and demands of the architectural space regarding the human body dimensions.

The placement and composition of the approach to the Cabanon in the specific context is part of the project [1:50 scale] and stereotomical studies are elaborated in parallel to the definition of the openings composition, based on each student individual dimension system [1:10 scale].

The second semester of the first year

Following the presentation of the second semester syllabus to students, each tutor had relative freedom to define the specific pedagogical approach within the exercise program limits. This paper addresses the work developed in two classes tutored by Sérgio Barreiros Proença and Sérgio Padrão Fernandes.

Regarding these two classes, walking was the first act of project. Walking is always the first human appropriation of a place as Francesco Careri writes in *Walkscapes*, when adressing the relation between walking and architecture, “Walking, although it isn’t the physical construction of a space, implies a transformation of the place and its meanings.” (Careri, 2016 [2002])

Walking

Walking a path from the Cais das Colunas, by the river, to the Pátio de D. Fradique, adjacent to the castle walls, consisted on the first appropriation of the site. 10 photographs registered the most significant framings for each student, creating individual, composed images of the context, from fragments. Students were asked to pay special attention to 5 concepts or binomials: focal points; positive / negative; interior / exterior; limits / transitions; mater / texture.

Interpreting

Complementary to this photographed mosaic, an interpretative model [1:1.000 scale] representing the public space of the walked path supported by the ancient walls of Lisbon was made. This model isolated two essential layers of reality through a process of “de-layering”, “a process which allows us to “see” certain formal configurations that are not perceivable in reality and, therefore, affects the way in which we see the city” (Gandelsonas, 1991).

In this case, the abstraction of reality allowed reducing the complexity of the site, revealing relations established between walls and path, vertical and horizontal, and created a base for the development of the project. While the walls of the city imply a limit, the ground of the path implies continuity and their interference implies the existence of transition spaces.

Following this interpretation, the work followed with the construction of a site model [1:200 scale]. Once again, there was a coded simplification of reality, a monomaterial model which allowed to acknowledge the juxtaposition and interlace of a set of elements deemed essential for the comprehension of the site and its transformation: the public ground (the public space of the city); the city walls (both as support and limit); the urban blocks limits and the Belmonte Palace (the appropriation of the wall); and finally, the doorways of the wall (the transition of the limit). Moreover, this model was particularly inspiring because it revealed possibilities of intervention and transformation of the site that were already present. Simple operations such as cutting, splitting, incising, aggregating and transitioning that may also be acknowledged in a significant number of 20th century and contemporary works of art.

The connection between the site models and the protoarchitectural sculptures and paintings of artists such as Alan Wexler, Gordon Matta-Clark, Eduardo Chillida or David Umemoto, among others who deal with a strong relation with spatial composition through excavation and geometrical abstraction was the focus of a lecture that allowed students to enlarge their cultural references lexicon and stimulate students interest in connecting arts.

Shaping

At this point of the semester, students were asked to inscribe a path and a patio/cloister in the site. The path should connect the different levels of the topography in presence and the patio/cloister would open up possibilities of aggregating programmatic spaces. Two simple elements defining a precise order for the site: a line for walking and a patio/cloister to rest and contemplate. Furthermore, these two elements revealed adjacent spaces along the faces of the path and the patio that could be appropriated.

The aim at this point was for each student to acknowledge the vocation of each part of the designed site according to the programmatic functions defined in the semester syllabus. The program was then distributed along the path ideally designing a *continuum* between site, path, shape and use.

The transformation into a place came with the spatial definition of each component of the project. Thus, for the composition of each individual space, the functions were translated into composition elements: the kitchen is a room with a chimney and a table for twelve commensals; each of the 12 cells is a room with a surface to rest and a surface to work, repeated and aggregated along the path or on the edges of the patio; the water is a simple tank housed in a significant space. The design work demanded each space for the elements to be found and composed not only internally but also in context with each other and the place.

The composition of the spaces was mainly done in styrofoam models. Styrofoam allows building very simple and light models with clean cuts and relatively fast assembly, with intense work but almost no strength involved. Focus at this level of first year is placed in composition and lighting and the instrumental manipulation of models allowed to easily test different designs in comparison and to shape spaces through cuts, incisions and additions, following the work previously developed.

Reaching the final of the semester, the final presentation of the project included models, a general section of the project in context and an atmospheric section of a single space of the project. These final representation elements were photographed, photographs were selected and an individual book per student was composed.

In synthesis, along the semester students earn dexterity in rigorous model building and representation drawing of architectural spaces in different scales while incorporating architecture cultural references in a learn by design process. Furthermore, students enjoyed the city and incorporated an instrumental method to decode it, designing projects in continuity with the place itself.

In the end, as Pierre-Alain Croset defends, it was an "elementary exercise, with very precise rules - as in all games, the more precise are the rules, the easier is to play them - because [students] must understand quickly that creativity doesn´t mean to be vague, and the best inventions are produced in the overcoming of the rules." (Croset, P.-A.; Peghin, G.; Snozzi, L., 2016)

IMAGES, CHARTS OR GRAPHICS LEGENDS

Image 1 - A Line Made by Walking (Richard Long)

Image 2 - Selection of student photographs (Julianna Costa)

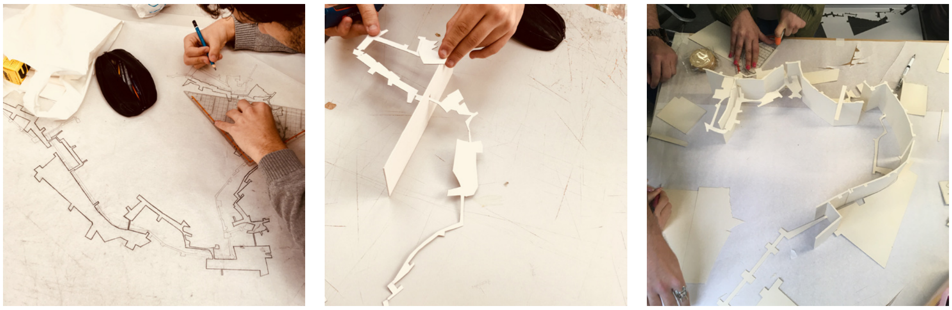

Image 3 - Students building process of the interpretation model (Sérgio Proença)

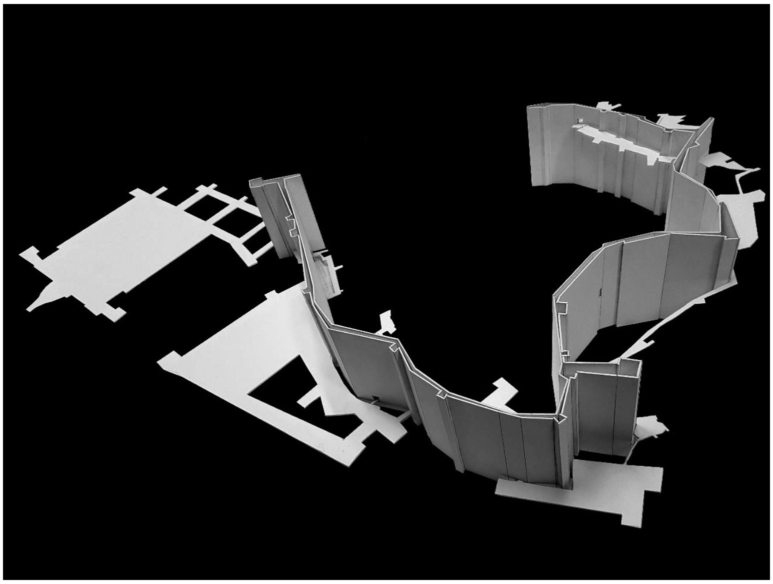

Image 4 - Interpretation model [1:1000] (Alessandra Pace + Julianna Costa + Julia Ienne)

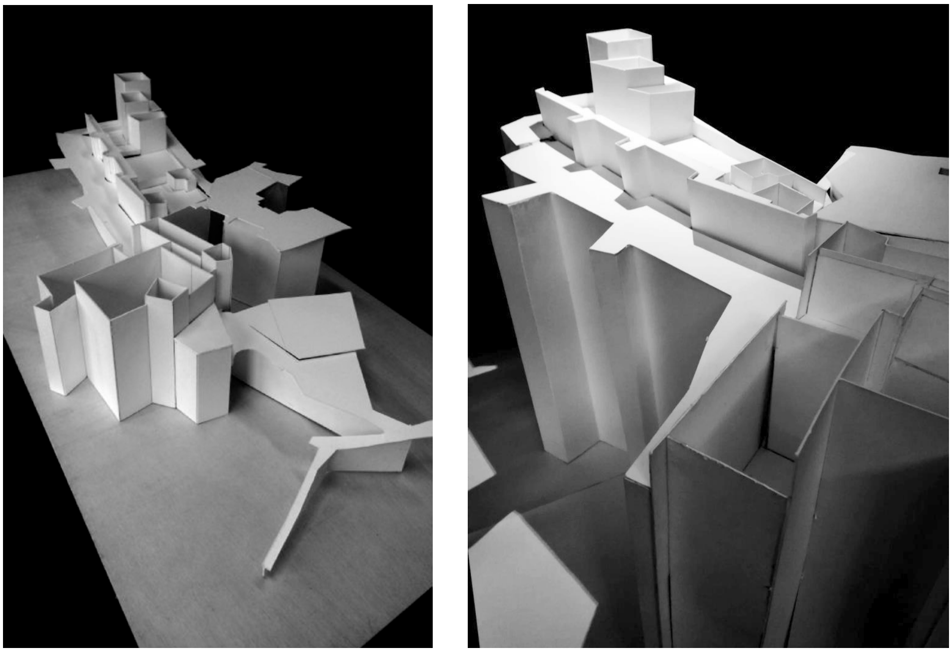

Image 5 - Site model [1:200] (Tiago Verdasca + Carolina Martins)

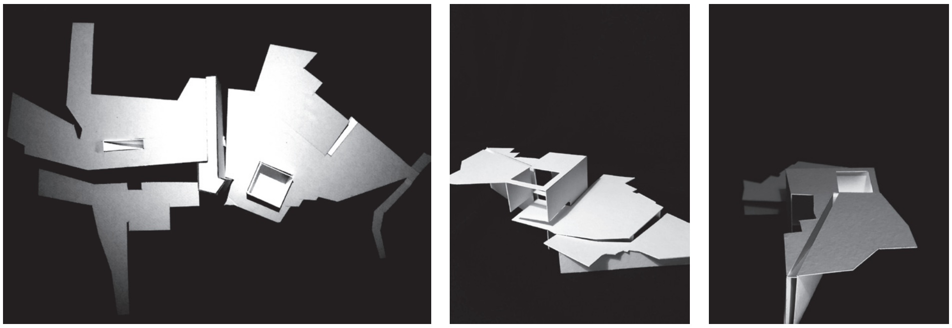

Image 6 - Path + patio site model [1:200] (Ana Beatriz Silva + Tiago Verdasca + Ana Catarina Nisa)

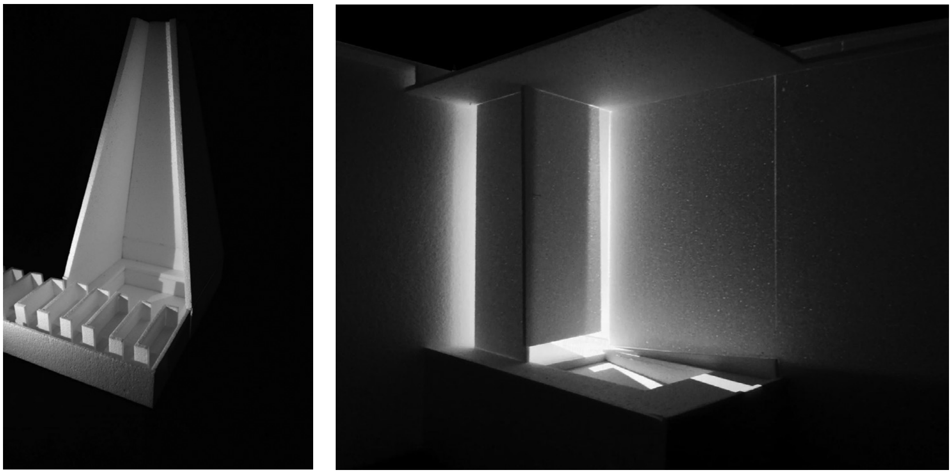

Image 7 - Individual spaces composition models [1:50] (Beatriz Cabral + Tiago Verdasca)

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THE DAILY WORKSHOP SERIES; CREATIVE THINKING, IMAGINING AND PRODUCING WITH "GAS.ARCH"

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ABSTRACT

The Daily Workshops Series (Günlük Atölyeler Serisi/gas.arch), is a series of workshops conducted by the authors and a group of volunteer architects who are academics and practicing. We run these workshop series with the aim to seek for an explanatory methodology for materialization in design process by looking at the alternative collaborative expansions that evolve over the changing conditions and the impact of common stereotypes that govern the architectural design process. These workshops were established in order to aim at strengthening/improving the design skill of the participants by providing an opportunity to work on alternative design making processes and conducting research on entrepreneurship in design. Every workshop itself can be considered as an alternative or critical process of the creative thinking, imagining and producing in design. In these workshops, we think and produce together with the participants from different schools and years of architecture education by putting aside the common stereotypes that govern the architectural design process so that they could realize and discover alternative design making processes. In the scope of this paper, we will present the rationale behind the development and execution of the workshops and their outcomes. We will discuss the outcomes in relation with the research looking into collaborative trials in the architectural design process with an emphasis on alternative interaction, sharing and ways of participation.

KEYWORDS

Workshop, alternative design process, collaborative expansion, creative thinking/imagining/producing

Introduction

Starting from the middle of the 20th century, designers have been aiming to discover and control design processes by systematic design methods (Asimov, 1962; Archer, 1964; Jones, 1970). It is believed that the design consists of two main processes of materiality: The first is the problematic that the designer produces according to his/her own background. The second process is the solution of this problematic. This idea was similar to post-positivist' approach, which regards the designer as a conscious processor (Akın, 1978). In design education, following this idea, students learn how to design mainly in the context of their design studio practices called as 'project'. They mostly develop solutions to hypothetical problems or reach the goals at the end of the design tasks counted as design activities. At the first stage, they encounter with the design problems and tasks rather than dealing with the materiality of the design process itself. However, these discussions neglected the designers' personal constructions of reality and their reflective conversations throughout the design processes (Dorst & Dijkhuis, 1995).

Teaching students how to design has been a major challenge in the architectural pedagogy for many years (Schön, 1983; 1987; Akın, 1978). Especially architectural design assignments are prepared to challenge the students to achieve design solutions for different functions, behaviors, experiences etc. through dealing with over-constrained problems (Schön, 1984). The tutors have so many expectations for the design projects of the students throughout the year and they want students to address these challenges. Because of the education system and the importance of the architectural design studio course in the curriculum, the motivation becomes - unfortunately – to get the excellent marks for the students. Therefore, the learning and teaching outcomes mostly do not meet the expectations for both sides.

Another fact that, the hierarchical system of orthodox pedagogies where the teacher is a giver/teller/sciential and student is a receiver/listener/as daft as a brush reflects and creates the major problem of teaching/learning design dilemma. This opposite position of teacher and student bring the gap between education and practice, and the limitations in design education into existence (Ellsworth, 1997). Because of the hierarchy, the critiques/reviews, which are given by the tutors to students, are mostly understood as approval or rejection of the design. The jury is also seen as an imposition of authority onto students by evaluating merely final products instead of learning and designing processes (Doidge & others, 2000). This understanding could only provide a commodified system, in which students are seen as training candidates to serve for the maintenance of profession. The hierarchical structure and understanding rarely produce intended learning and teaching outcomes regarding the process-based focus of design education (Nicol & Pilling, 2005).

There exists no certain strategy or set of tactics that guaranties reaching for a goal and achieving success in design education, we attempt to neither find nor offer a solution. In this paper, we address to some examples of the work carried out in our workshops to open up and search for the alternative ways of materialization in design process. We report about the approach and methodology that we have been taking in these examples. We explain the themes, contents and outcomes of the workshops, their organization, and the focus of materiality. We select and outline representative examples of the developed work/methodology to discuss the outcomes. At the end, we present what we have learned with/by the workshops.

The daily workshop series

Workshop culture as a principal focus of design education requires learning-by-doing based on the experience. The nature of the workshops plays a major role in the nature of the materiality of their experiences in designing activity. They form the initial ideas and conceptions about the nature of design thinking and phases of this activity. The rationale behind the development and execution of the workshops relies on the materialization in design process and performative act of designing.

In the daily workshop series, we enable participants to develop an understanding about the ingredients of design problems and task, even more so, begin to discover creative thinking, imagining and producing for materialization in design process. Here, it is not intended to produce finished self-selling items; on the contrary it is mattered that the self-describing product/material. In addition to hosting a number of different innovation and creativity, materialization of the design process also need to have the similar type of understanding (Cropley, 2001). In workshops that we produce on a daily basis, the participants try to realize that within a very short period. It is not easy to design and make this design understandable by counterparties in a very short time. Therefore, trying to materialize the idea in 1 day instead of a 16 week period of time in a normal studio both challenges and motivates them better to think fast, imagine and produce more inventively.

The workshops could be seen as alternative and collaborative expansions/trials as well as elucidative events of our modern and critical epoch. We question the concepts, vocabulary and organization of design process in reverse positions through the themes of workshop series. We discuss and talk about how the design process starts with the intermediary notions, in order to figure out how to discover alternative forms of idea generating the data for and through the design.

We believe that creating novel ideas depends on how to deal with the data entered into the materiality of the design process. Through our methodology, it is possible to intervene in design process by revealing the contribution of *motivating concepts*, *re-representation* and *alternative collaborations, which are 3 processes for data generating to stimulate creative thinking, imagining and producing in design process.* It means that those items that are large/complex enough to have a significant effect on the evaluation of the design process. They help to carry out some ideas in the subconscious minds of the participants and enable them to carry this accumulation unconsciously to consciousness when they produce in the workshops.

Motivating concepts may refer to units of information that designers stress as important during the design process. These concepts are noticed as arising as sudden illuminations from subconscious and emerged in creative leaps. Alternatively, *re-representation;* could be seen as re-establishing of links between figural and conceptual arguments or echo of each other. They are aimed at the representation of some other thing embodying the idea of meaning. It matters that the re-representation is mostly materialized in design phases as a search process. This kind of materialization is necessary for pursuing cognitive activity and developing a coherent network of ideas, but not for a satisfying outcome or finished product. This idea can contribute to open-ended and ambiguous representations leading to many possibilities of interpretations. Most importantly, *alternative collaborations* are like different conversations during the whole process. Communication of people and ideas serves as a primary vehicle for materiality of the design process. In the workshops, we think, imagine and produce together with the participants from different schools and years of design education by putting aside the common stereotypes that govern the design activity, so that they could realize and discover alternative design making processes. Remaining of this section outlines the themes, contents and objectives of the representative workshops and provides examples of participants' works.

"*Creative thinking*" workshop; an original designer could use and benefit from the intelligence, thought and imagination at the same time (Lawson, 2005). Designer begins with an idea; within that idea prepares for, forms and generates to ideate. The ideation is the skill of grasp and being able to conceptualize what you design, in other words, materialization of ideate. Questioning and taking a critical position may provide us to looking at the ordinary from different angle and creative thinking, imagining and producing in result of the process of idea, ideate and ideation could be improved and developed. In the workshop, brainstorming, creative thinking, imagining and producing techniques, goal-oriented idea development in design, and intellectual visualization were examined extensively. We worked on how to activate and challenge creativity in design progress by asking questions and doing small exercises/trials - such as "30 circles test" by Bob Mckim - about mental processes of creative thinking, imagining and producing. We discussed with the participants how to develop creative thinking, imagining and producing skills through the concepts of fluency, flexibility, originality and elaboration.

"*The ways of producing diagram*" workshop; diagrams are made of symbols and about concepts in flow of ideas. They externalize and visualize the data that is used in design process. The diagram is one of the ways to explain a design that is produced gradually. Apart from that, it is a very important form of representation, especially to describe only a certain point of the design. In the workshop, we talked and discussed about how to reveal the point they want to emphasize about their design. We produce diagrams with them by exercises in five phases.

"The space' expressions" workshop*;* In general dictionary meaning, the architecture is the art of solving problems with the space. In order to question this very common stereotype, the issues of perception, analysis, interpretation and expression of the space examined from different perspectives within a critical approach. We focused on how to better describe the materialization of the space, in particular, we discussed the alternative ways of expression in the process of the production of space and expression through the produced space. We emphasized the essence of the space, which has a very important role and effect in the materiality in architectural design process. We carried out the workshop with the aim to make participants think about and understand the meaning of our different senses and sensory qualities of space in our perception, interpretation and experience of them. We developed related exercises based on the themes of memory, experience and narrative.

"The spaces of the section" workshop*;* We questioned the concepts and meanings of the section in architectural design process by thinking, imagining and producing it in reverse positions through the themes of workshop. In order to figure out how to discover alternative forms of idea generating the data for and through the section, we discussed and talked about how the architectural design process starts with the section. We focused on how we can examine the data that is entered into the design through the cross-section and make it a part of the design process. We developed a collaborative exercise with these considerations. We expected the participants to generate a narrative data for building a dream of life for the people who live already there by creating space fictions in the cross-sections. Then we created an integrated cross-section to develop new ideas and perspectives on each other's design concepts, as well as narratives.

"*How to design a portfolio of design?*" workshop; A portfolio can be defined as a booklet with a person's works, workspaces, hobbies and personal information. The workshop focused on how to prepare and present the portfolio, both digitally and as a print, in which the person can clearly express his / her career and disciplinary knowledge and skills in the life of design activity. The workshop was very much interdisciplinary in which various topics, from the forms of expression of works to the consistency of graphic language and the forms of printing were discussed.

"*Q&A: Quote and Ask about design, architecture and space!*" workshop; The participants and we shared our questions and answers wondering about the quotations… in a common platform. Through a dialogical approach, participants both created new ideas with and learned from each other over variety of subjects in design, architecture, creative thinking, production, technology, material etc. During the event, the works of different architects and their materiality processes were examined in the context of the questions and answers.

What have we learned…?

There are many limitations created by commodified design realm reflected in design education, by the gap between academy and practice, and by the hierarchical structures. However, these limitations bring out some potentials by challenging both profession and academy for emerging new responses and alternative approaches. Designers are expected to become more skilled in social and cultural dimensions, more adaptable, flexible and versatile in their professional fields; and these expectations leads a *continuous learning* as a foundation of design education. This continuous learning approach could direct our future studies. We should more focus on process and experience as well as product and knowledge; in other words, listening more than telling in the performative act of designing.

We do not have an allegation to change the education system or to be part of it; but we want to question the system in a critical position and try to find the alternative interaction, sharing and ways of participation. We never call, introduce or show themselves, or behave like as tutors/conductors/teachers/professionals. These considerations provide us the opportunity of working, communicating and learning together with everyone in real and sincere collaboration.

We will continue to run these workshop series with the aim to seek for an explanatory methodology for materialization in design process by looking at the performative act of designing in the alternative collaborative expansions that evolve over the changing conditions. It might be also more productive for architectural design educators interested in understanding more about the performative act of designing to consult practices of innovation and creativity because they can provide more rounded and nuanced models of the design process.

We believe that the future of the design process is not additive, nor is it about machining or 3D printing, but rather about how to convert data to the object – likewise input to output in a computer generating system - with the people involved considering the changing conditions of design processes. Because alternative design making processes and new entrepreneurships in design are only possible by obtaining wide range of products/meanings comprehended and shared by counterparties in a global world.

IMAGES, CHARTS OR GRAPHICS LEGENDS

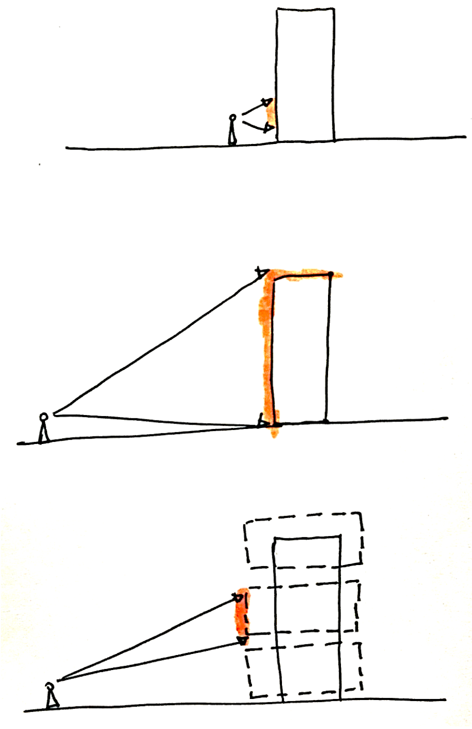

Image 1 - The diagram of generating data through grounding in concepts/ the skill of grasping (authors of the paper): *First, you can perceive a piece of the concept from the starting point. But if you see where the piece takes place in the whole then you can make sense of the piece and divide it into meaningful elements to grasp the concept.*

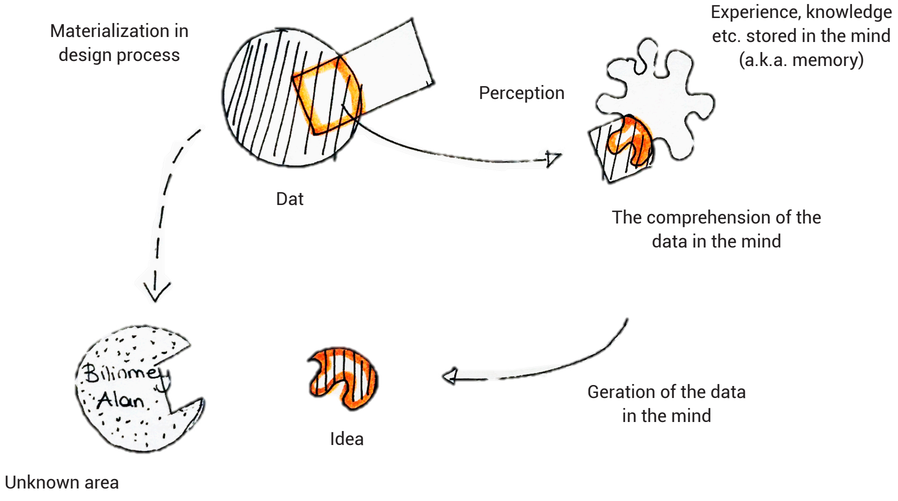

Image 2 - The diagram of the inferential data in cognitive process (authors of the paper): *A variety of data are displayed on information channels at the time of the daily workshop series to enable the participants to have a sudden enlightenment. It leads them to perform some idea constructions through working on the unknown area of the data which stays in the subconscious.*

Image 3 - "Creative thinking" workshop: *Critical process of the creative thinking, imagining and producing by strengthening/improving the design skills in XIII Urban Dreams Workshops: Space and Memory. Organized by Istanbul Metropolitan Branch of Chamber of Architects, July 3-28, 2017, Istanbul Metropolitan Branch of Chamber of Architects, Istanbul, Turkey.*

Image 4 - "The ways of producing diagram" workshop: *Materialisation techniques in design process, producing self-described drawings, alternative ways of diagrammatic expression in architectural design. Organised by Taskisla Architecture and Design Club, 17th November 2018, Istanbul Technical University, Turkey.*

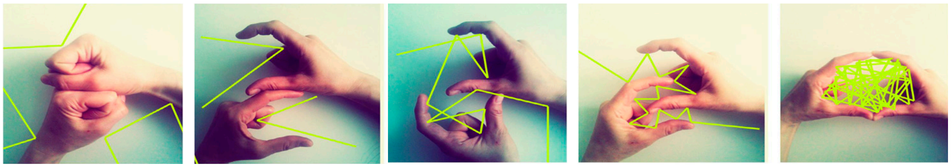

Image 5 - “The space' expressions" workshop: *One of the excercises for expressing the status of the space with hand gestures. 29th June 2018, Istanbul Metropolitan Branch of Chamber of Architects, Turkey.*

Image 6 - “The spaces of the section" workshop: *Alternative forms of design, materialisation in design process through sections, communication and sharing within design insights in “Good Design III-Izmir” event, organised by Izmir Metropalitan Municipality and Union of Universities in Izmir, 20th October 2018, Izmir, Turkey.*

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FROM VOID TO FORM OR APPLYING RHIZOME LEARNING TO TEACHING ARCHITECTURE

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ABSTRACT

This essay results from the analysis of exercises proposed to 1st year students of architecture.
This training intends to develop the ability to configure elements of architecture in "objects" that although not yet responding to a specific function can be considered "architectural objects". They are the result of the materialization of ideas that responds to the direct experience of the space of the city in its similarity to a forest. We will talk about the elements that configure these two different environments and we will represent the main architectural aspects that lie in these two different spaces (natural and artificial), so indispensable and so important in our lives. In-between these two environments we question different elements of architecture such as: thought / emotion, form / content, organic / geometric, light / shadow, closed / open, light / heavy, scale and materials. Psychological, compositional and formal aspects are apprehended and tested through a methodology that implies the constant dialogue between the immateriality of thought (reasoning, intention, memory, idea) and the materiality of representation (drawing, materials, and physical three-dimensional models). The relationship of reciprocity is tested in the passage of thoughts to forms - through the configuration and experimentation with different materials (pencils, inks, paper, cardboard, wires, cotton, plaster, cement, wood, wax, photography, sound, etc.) - and otherwise, through the reflections and ideas that arise from analysis of these objects (drawings and models). We call this phenomenological methodology Rhizome-Learning. These experiences seek to develop in each student the urgency of making their own ideas tangible - the inseparable link between thinking and constructing.

KEYWORDS

Ideas, representation, city/forest, art/architecture, learning/teaching architecture

Architecture, beyond the forms it assumes, is the idea that is expressed by those same forms.

Alberto Campo Baeza [1]

Proposition

This essay arises from the analysis of learning exercises assigned to 1st year students enrolled in the subject Elementos da Arquitectura I (Design Studio, 1st semester) at Universidade Lusófona de Lisboa. These exercises have an overarching theme: the *Architectural Florest*.

We think it's important that architecture teaching and learning begin with *reflection* on what is architecture, on how we inhabit the space that surrounds us, and how we can **record/communicate** the **ideas** on the spaces that we experiment and imagine. Stemming from the relation between **thought** and **action**, students are challenged to create drawings, models and objects, relating mental and manual activities, without recourse to restrictive rules and hard-set instructions.

The teacher promotes what is known as divergent thinking[2] (the thinking of artists, researchers and innovators), searching all possible solutions by an experimental methodology, by trial and error. **Creative activity** thus makes familiar what is strange and reveals what was thought to be already known to be often strange. The creative, transformative potential resides in this dynamics, as preconceptions are challenged, and the focus is set instead on the exploratory, scientific spirit, anchored in the idea of discovery.

For most of our students, architecture is still a strange place. Many arrive with preconceptions, others with wrong certainties, and others hesitating on their course choice – but all of them expecting to learn how to make *houses*.

To address this, and to free them from pre-set views on what is architecture, the first step of the *rhizome-learning*[3] concept is to place students in the unexpected medium we call "Architectural Forest". The aim is that students look for a **shelter** where they can take refuge, leading them to understand the importance of building an **identity** that allows them to face the challenges in architecture project, with the awareness that any construction begins by its foundation. Let's be clear: in face of the contact with the cities in which they are immersed, students must explore and develop their own concepts and tools for work and analysis of the space they inhabit.

The architectural forest

Our cities have become *forests* indeed. This is a concept that we can interpret according to the increasingly complex and often alienating urban spaces that we live in. Issues of scale, form, rhythm, time, overlap and dialogue with our inner space (our own dreams, expectations, values…), a hostage of the digital era that simultaneously seduces and entraps us in a virtual context that we do not master, fostering a feeling of insecurity. Zygmunt Bauman tells us about these issues in his *Confiança e Medo na Cidade*.[4]

Byung-Chul Han, in his *A Sociedade do Cansaço*, also warns us about the excess of stimuli and information to which we are daily exposed. Han establishes a parallel between current society and wild life, reaching the conclusion that man, like the animal in the wild, must be watchful about all that surrounds him. This is the reason why man is losing perceptive capacities, those left getting ever more fragmented and scattered, and instead developing a new form of awareness that Han calls *hyperattention*.[5] Proof of this is shown by the way students, and the general population, use the internet in a variety of devices to engage in multitasking and simultaneous conversations.

This does not favour the contemplative awareness proper to the creative and artistic processes. According to Han, the contemplative capacity can be only ransomed by art and by culture, both propitiating the *deep attention*:

"Paul Cézanne, a master of contemplative, deep attention, once remarked he could *see* the fragrance of things. This visualization of things requires profound attention."[6]

According to Bernice Rose,[7] Cézanne establishes the turning point from which drawing stops being just a preparatory medium for the work of art and constitutes itself as the form of its execution, that is, becomes autonomous through the *dynamics of doing*[8]. The fracture that Cézanne started, later taken to the limit by Cubism and Abstract Art, makes evident the two components of drawing, conceptual and autographical - we want to work upon the two.

On the other hand, *Forest* as a concept for the architectural space offers ample stimuli for *peripheric vision,* or the type of phenomenological vision that Pallasmaa defends to more truly apprehend space itself:

> "A walk through a forest is invigorating and healing due to the constant interaction of all sense modalities. Bachelard talks about the 'poliphony of the senses'. The eye collaborates with the body and other senses. One's sense of reality is strengthened and articulated by this constant interaction. Architecture is ultimately an extension of nature in the anthropogenic sphere, providing the ground for perception and the horizon of the experimentation and understanding of the world." [9]

Architect Sou Fujimoto is also interested in the relation between Forest and Architecture. At the *Arquitectura como Floresta* exhibition of his work at Centro Cultural de Belém, Lisbon in 2015, Fujimoto defends the idea that future architecture will resemble a forest: all will be harmonized in the diversity that will be the main character of this future city. This new space will emerge from the relation between order and chaos.[10]

By the light of this conception, Fujimoto shows a set of projects from the smallest, even microscopic architectures to colossal, 700m-high buildings and urban structures. Some have been built, others are still to be built, and many are representations of ideas. We want to reflect on the value of these last ones. (Image 1)

The exercise

Forest alludes to natural space, but also to the city space. The complexity of forms, sounds, colours, element repetitions, routes, heights, light, shadow, etc., are characteristics that we can find both in the natural forest as in the urban forest and that evoke diverse states of mind.

The exercise challenges the **students to think** on these **formal and psychological aspects** and to interpret them by selecting from their context the *motifs* that impress them the most. Either by imagining themselves in the natural or urban landscape, or, following the purpose of this exercise, **imagining themselves in a geometrical, abstract forest** – an architectural forest – it is expected that students will represent spatial or emotional conceptions proper to human relation with space through specific forms of conceptual and abstract communication: models and sketches, 3D and 2D representation.

Lastly, the exercise aims to showcase the work of several architects and thinkers on the international architecture panorama, since that, following the *rhizome-learning* concept that we defend, students will cross theoretical and practical knowledge, relating architecture to philosophy, the visual arts, cinema, history and other related subjects.

Process

Students are then asked to create objects that, though still devoid of function, can already be considered "architectural objects", being the result of the materialization of ideas answering a programme that sets as a problem, and thus enunciates, distinct architecture dimensions, such as: thought/emotion, form/content, organic/geometric, mass/void, light/shadow, light/heavy, path, scale, and materials.

The psychological, compositive, and formal aspects are perceived, experimented, and tested through a methodology implying the constant dialogue between the **immateriality of thought** (reasoning, intention, memory – *idea*) and the **materiality of the representation** (drawings and 3D objects). The reciprocal relation between **2D** and **3D** representations is tested so that, when passing from thought/idea to form, the representation capacities of both drawing and physical model are explored. The verification of the form that the object can acquire results from this dialogue between drawing and model. The purpose is to present, right from the first semester, the understanding of the importance of the conception of the *images* and *objects* that are created to represent the ideas in architecture, either drawings, models, or a written text. Also, to understand that these representations are charged with meaning and that if they are the attempt to materialize an idea, they also acquire autonomy and suggest new possibilities. It is this dialectic play of formal experiences – their analysis, showing, critique, interpretation, and reformulation – that consolidates the idea without which any architecture is void.

References

The performer and conceptual visual artist Esther Ferrer has developed a series of space installations, little known mostly due to the non-availability of means and space. Nevertheless, Ferrer developed her projects for years through **drawing** and **artisanal models**. (Image 2)

Ferrer considers "space" -- both natural and architectural -- as her "raw material", over which she works "three fundamental elements: time, space and presence". In her book *Maquetas e desenhos de Instalações*[11] Ferrer explains that when developing her

Proyectos Espaciales, *space* matters, not only when she is model making, but also when thinking about her own actions. She adds:

"Model making is an activity that gives me a lot of satisfaction, manual work relaxes me and the physical model allows me to work with much tranquillity: it is not a finite object, it is a project that evolves as I am conceiving it and that sometimes, happily, and due to the freedom that it allows me when working, takes me along pathways that I would have never imagined. When I am in the making process, I do not look for perfection, but instead to visualize an idea (…)" (Ferrer,2011:13)

That is, the model becomes tangible and thus real, and the artist declares:

"If I have the opportunity to build the model in a real space, great; but if not, that is not a problem (…) Actually, I never had a lot of interest in realizing my projects in a real, large-scale space; if the model I am making works, then for me the work is done." (Ferrer, 2011: 15)

Here we should note that we are witnessing a change in the traditional relation between reality and representation. Many artists and architects show by their work that we do no longer evolve from model to reality, but from model to model, recognising that both are real, and that by stopping to be polarized modalities they now work at same level. Olafur Eliasson, in his book *Ler es respirar, es devenir*[12] highlights the idea that *models* become *co-producers* of reality (Image 3):

"Previously, models were conceived as rationalized stations in the path to a perfect object. For example, the model for a house would be part of a time sequence, as a refining of the house's image, but it was considered that the real, true house was a static, final consequence of the model. Thus, the model would be just an image, a representation of the reality that was not real in itself." (Olafur, 2012: 68)

Thus, and resorting to these examples shown and discussed in the classroom, we are challenging the preconceived notion that most students have that the model, and the drawing as well, are media of representation that are posterior to the conception of the idealized object. If we want to apply the *rhizome-learning* concept, it is important to stress the fundamental role of the physical model as a tool for the process of conception/ideation.

In a similar way to the reflection suggested on the autonomy of the drawing, we too propose to the students, when developing these exercises, that they understand that models cannot be the translation of airtight ideas, since it is in the materialization/execution process that the idea appears with clarity.

Steven Holl, in his preface for *The Eyes of the Skin: Architecture and the Senses*[13], writes on the contact he had with Pallasmaa's architecture, namely Rovaniemi Art Museum and the wooden house on the rocky island at Turku:

"The way spaces feel, the sound and the smell of these places, has equal weight to the way things look." (Holl, 2011: 5)

This testimony shows that it is possible to reach the desired correspondence between ideas (and their representations) and built reality. Such correspondence results from a careful project research, the stages of which stimulate *phenomenological insights* – the concept used by Holl to characterize Pallasmaa's practice.

To resume, we want to stress the importance of stimulating the various senses in the training of project practice.

Answers

After problematizing the concept "architectural forest", it is asked of students that they visit a densely arborized natural space, referring to the idea of Forest, and also that they wander across the city of Lisbon (some of these visits are faculty-oriented group visits). In both spaces, natural and artificial, it is asked that students choose both a psychological/emotive aspect and a spatial/formal one, and that, out of the two, they make 2D and 3D representations, taking care that each is not the representation of the other one. (Image 4)

The complexity implied in selecting just one feeling and one physical aspect out of each visited environment compels to an exercise of careful analysis that is a consequence of the physical and intellectual experience of the visited spaces, thus promoting the individual, phenomenological[14] understanding of the sites. It is also proposed that students write a paragraph justifying their selections, and that they will present to the group. The presentation of their ideas and sensations in class generates a map of diversified concepts, revealing a number of aspects that characterize architecture. (Image 5)

It is asked of students that they materialize both emotions (such as fear, tranquillity, unrest, safety, claustrophobia, comfort, etc.) and spatial characteristics (such as labyrinth, diversity, rhythm, scale, symmetry, light/shadow, etc.) though free, intuitive experimentation of a number of distinct materials or matters (pencil, paint, paper, cardboard, modelling clay, metal wire, cloth, nails, cotton, plaster, cement, wood, wax, Styrofoam, photography, sound, video, etc.). (Images 6, 7, 8, 9, 10, 11, 12, 13 and 14)

Students will represent both emotions and space in drawing and in physical models, the model not representing the drawing, and the drawing not representing the model, both having in common only the search for the same formality for the same theme. The purpose is to acquaint the students with the distinctive possibilities of representation of an idea, and that they develop the abstract, sensitive capacity to find complementarities that reinforce the communication power of the concept that they want to transmit.

Can one have creative ideas, and the capacity to execute them, without the necessity of executing a single sketch or physical model? Conceptual art has affirmed the supremacy of the idea over material reality. Still, the necessity to communicate "thinking" necessitates some mediation. In this sense, we could interpret Duchamp's "readymade" as a mediation between Federico Zucari's "internal drawing" and "external drawing" concepts that Lino Cabezas proposes to be a division between the idea arising in the artist's mind and its plastic expression. [15]

At this formative stage, we think that the best way to bring on the students' understanding of this relation between the internal and external drawings lies on experimentation and artistic practice. Thus, architecture's complexity and the representation of its spatial and conceptual elements can be introduced at an early stage through plastic experimentation.

It is not by chance that Lino Gonçalves in his *A arte descobre a criança* declares that plastic expression widens the human capacity for understanding, thus concluding that "all people have the right to be educated according to their nature. Free expression constitutes one of the indispensable factors for the harmonious development of individuals". [16]

Thus, we do not set limits or rules for scale, colour or materials. Students are completely free to explore all forms and ideas that they decide upon, with complete freedom of representation. This freedom, justly so, constitutes the largest obstacle that students must overcome – they ask for more directive exercises with accurate indications on materials, specific scale, and other work directions that do not promote *rhizomatic learning* and the phenomenological focus.

By the end of the process, most students acknowledge the benefits of these experiments and learn to play (and this is a key verb) with the distinctive analogical tools that still are, in our opinion, fundamental in the development of the architecture project, despite the surrounding digital world, and justly so because it reapproximates students to a forgotten making by hand. As Juhani Pallasmaa comments:

> "Computer-aided image creation tends to reduce our magnificent capacity for simultaneous, synchronous, multisensorial imagination, by transforming the project process in a passive visual manipulation, a promenade in the retina. Computer creates a distance between the creator and his object, while both drawing by hand and the elaboration of conventional models put the creator in a tactile contact with the object or space. In our imagination, the object is simultaneously in our hands and inside our head, and the projected, created image is modelled by our bodies. We are at the same time inside and outside the object. Creative work demands an identification of body and mind, empathy and compassion." [17]

To this we should add the pleasure involved in making by hand, so evident in children's play and drawings, lost in the process of our ever more mechanized training.

Le Corbusier's testimony in his 77th year of age (the last of his life) showcases the importance of *playing* architecture every day with enjoyment:

> "Drawing is also playing. If you tell me that the secret of wisdom is to enjoy free time, I agree. I am permanently in a state of leisure. Play all day… both children and adults place all their seriousness in this." [18]

IMAGES, CHARTS OR GRAPHICS LEGENDS

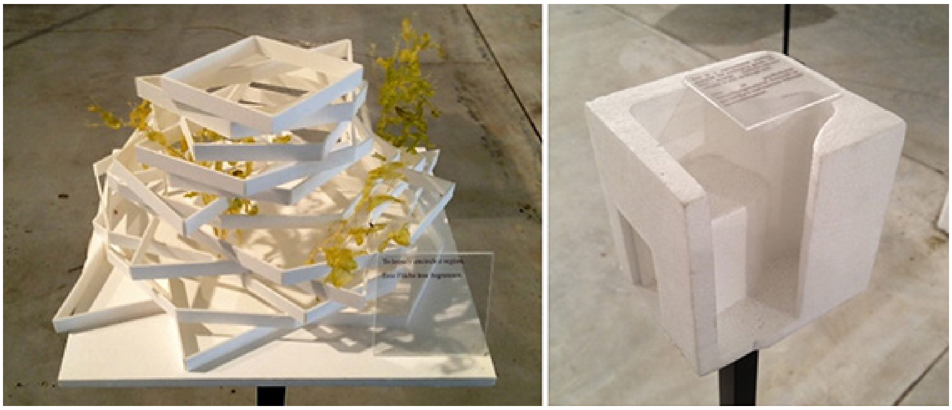


Image 1- Sou Fuzimoto models at the exhibition: *Architecture as Forest,* Lisbon, CCB (Isabel Barbas)

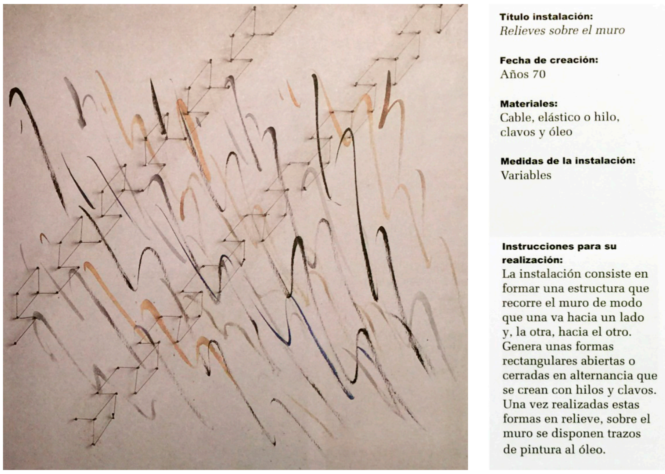


Image 2 - Esther Ferrer, *reliefs on the wall* (Esther Ferrer, Maquetas y dibujos de instalaciones, p.25)

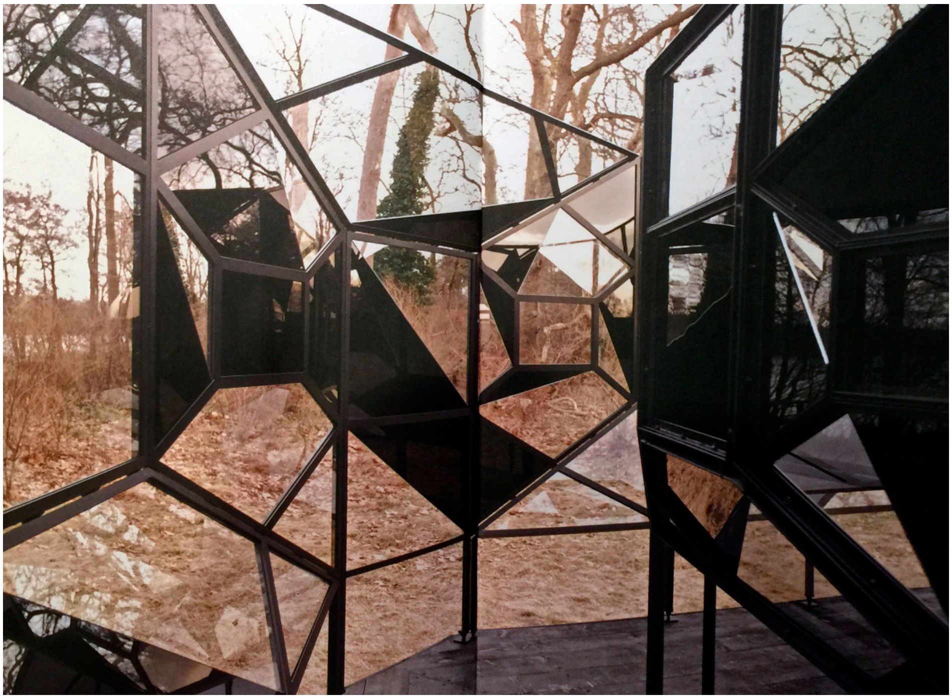


Image 3 - Olafur Eliasson, (*Leer es respirar, es devenir, escritos de Olafur Eliasson*, p.70-71)

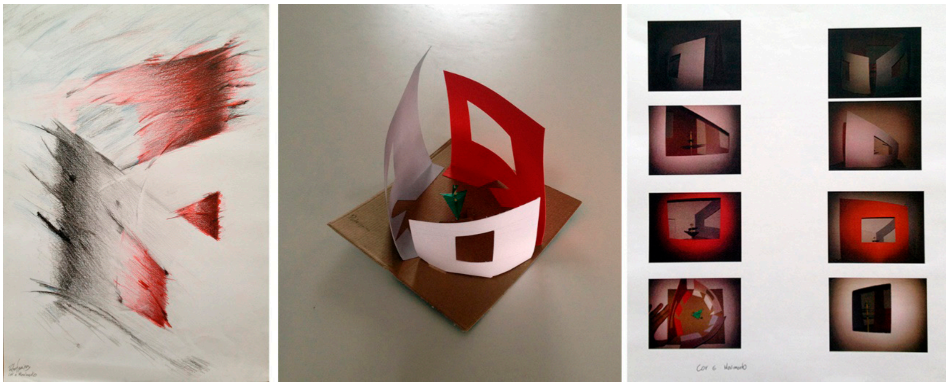


Image 4 - Student Pedro Figueiras: movement and color

Image 5 - From left to right, student**s:** Rosa: light; Rui Neto: labyrinth; Joaquim: density; Rita: loneliness.

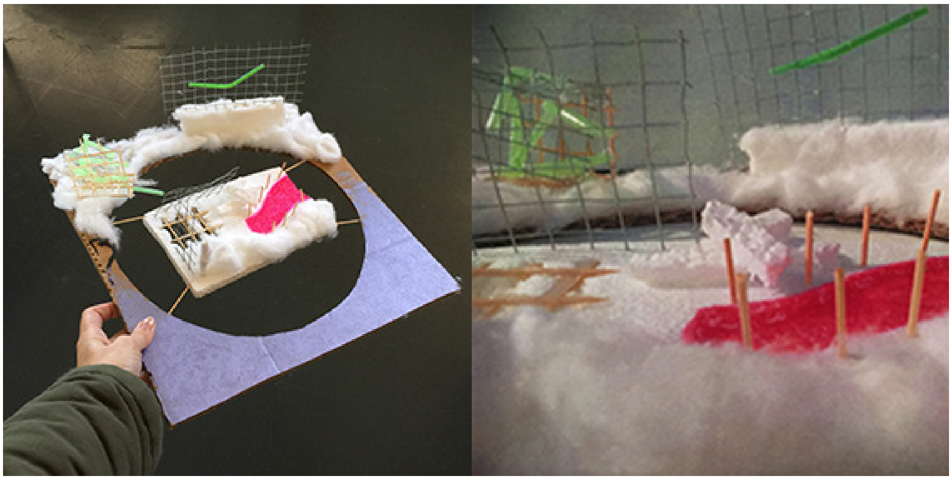


Image 6 - student Marta Manso: comfort.

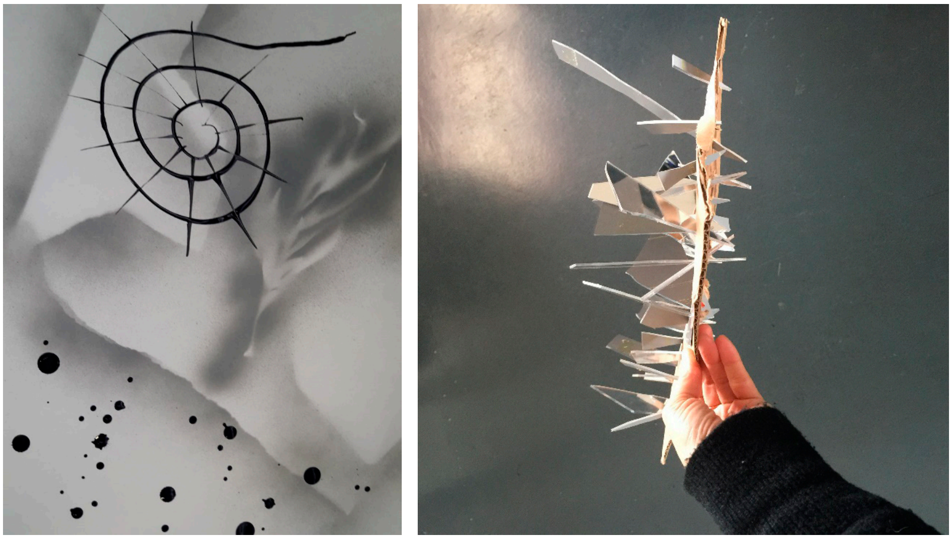


Image 7 - Student Diogo Moinhas: disorientation.

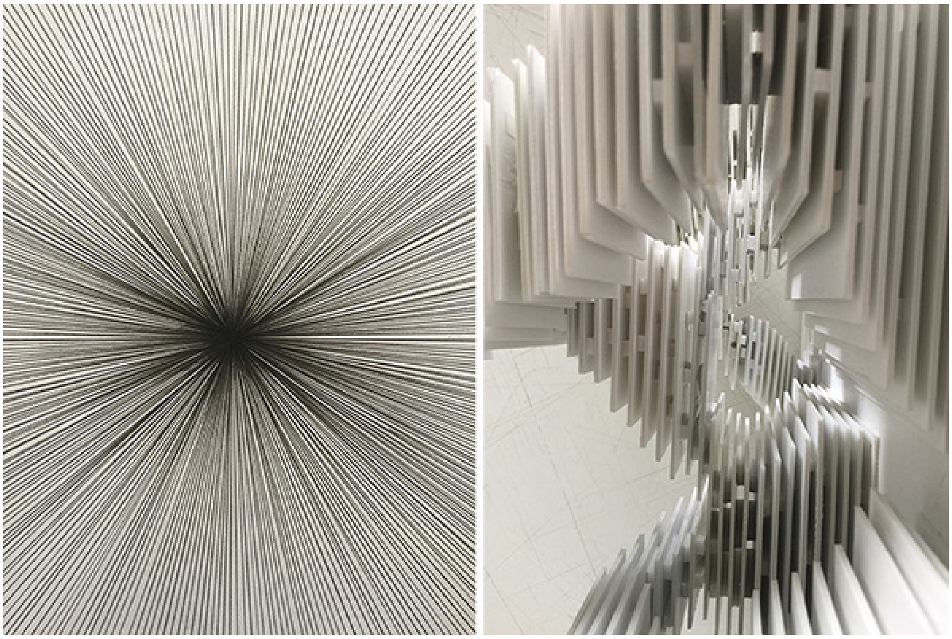


Image 8 - Student Inês Silva: anxiety.

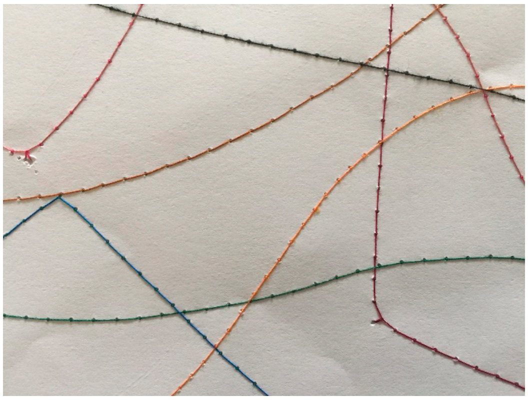
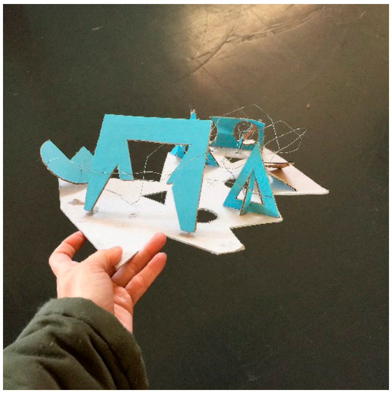


Image 9 - Student Sara: sound.



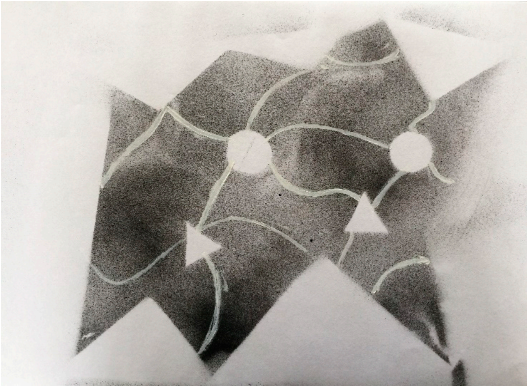
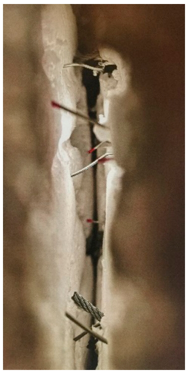
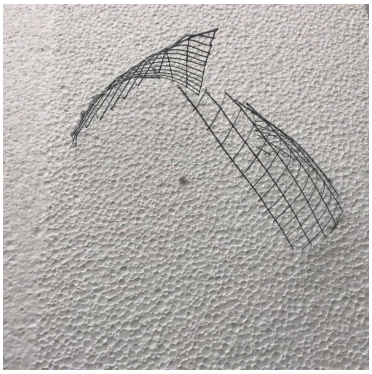


Image 10 - student Inês Silva: movement.





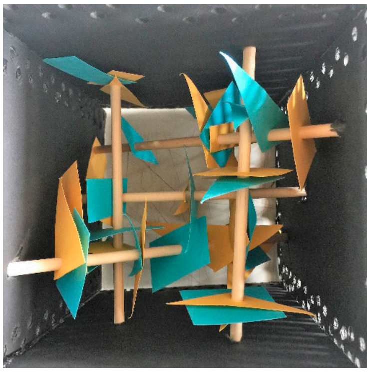


Image 11 - From left to right, students: Cristina Batuta: underground; Gerson Filho: lightness; Cecilia Seixas: joy

Image 12 - Student Ana Júlia freire: geometry.

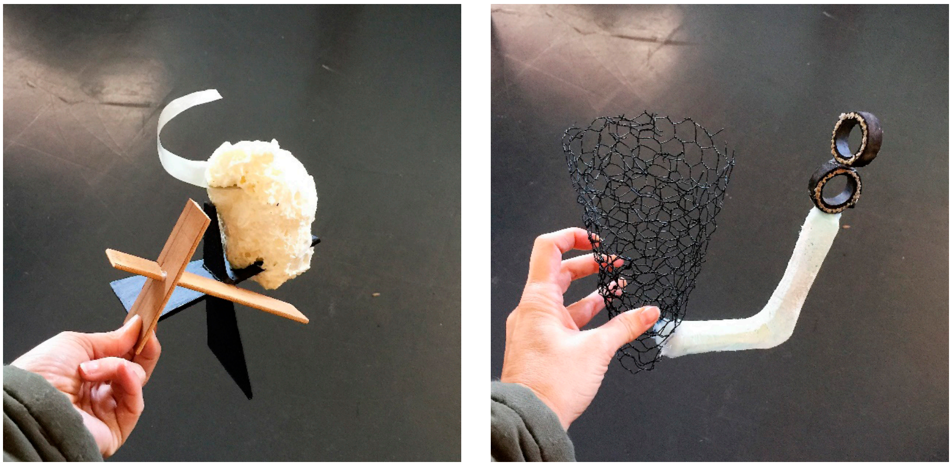


Image 13 - Student Vasco Moreira: disarray; rise.

Image 14 - student Joana Camacho: fear.

ENDNOTES

1 Campo Baeza, Alberto. (2008). *A ideia construída* [La Idea Construida]. Casal de Cambra: Caleidoscópio, p.9.
2 Cf., Gonçalves, Lino. (1991). *A arte descobre a criança*. Lisboa: Raiz editora, p.24.
3 This concept arises from Deleuze's notion of *rhizome*. Taken as a biology loan, we apply this concept to a multiplicity of approaches in the teaching of polymorphism. Cf. Deleuze, Gil;Guattari, Felix. (1980). *Mille Plateau*. Paris: Minuit.
4 Bauman, Zygmunt. (2009). *Confiança e medo na cidade* [Fiducia e Paura Nella Cittá]. Rio de Janeiro: JAHAR
5 Cf. Han, Byung-Chul. (2014). *A Sociedade do Cansaço* [The Burnout Society]. Relógio D'Água. Lisboa.
6 Han, Byung-Chul, *op.cit*., p 28.
7 Rose, Bernice. "Une perspective du dessin aujourd hui" in Segui de la Riva, Javier. (2003).*Dibujar, Proyectar (I).* Madrid:Cuadernos del Instituto Juan Herrera, p 4.
8 Emphasis mine.
9 Pallasmaa, Juhani. (2011). *Os olhos da pele, A arquitectura e os sentidos* [The Eyes of the Skin: Architecture of the Senses]. Porto Alegre: Bookman, p 39.
10 Cf. Fujimoto, Sou. (2013). *Arquitetura como Floresta – Textos, maquetas, fotografias* exhibition catalogue, Lisboa: CCB.
11 Vid. Ferrer, Esther. (2011). *Esther Ferrer: Maquetas y dibujos de instalaciones 1970/2011*. Madrid: EXIT Publicaciones.
12 Vid. Eliasson, Olafur (2012). *Ler es respirar, es devenir – Escritos de Olafur Eliasson*. Barcelona: Editorial Gustavo Gili.
13 Holl, Steven. "Gelo Fino" ["Thin Ice"] in Pallasmaa, Juhani. (2011). *Os olhos da pele, A arquitectura e os sentidos*. Porto Alegre: Bookman, p 5.
14 It is in this sense that we can recall Merleau-Ponty, when he declares in his *O Olho e o Espírito*: "To think is to experiment, to operate, to transform, with the reservation only of the experimental verification where only highly 'worked' phenomena intervene". The conception of our exercises relates to this thinking-in-action idea that Merleau-Ponty formulates. Cf, Merleau-Ponty, Maurice. (2000). *O Olho e o Espírito*. Lisboa: Vega, Coleção Passagens, p 14.
15 Cabezas, Lino. "Dali. Estrategia y escenificación", in AAVV. (2002). *Estrategias del dibujo en el ate contemporâneo*, coord. Juan José Gómez Molina. Madrid: Cátedra, p 230.
16 Gonçalves, Lino. (1991). *A arte descobre a criança*. Lisboa: Raiz editora, p 3.
17 Pallasmaa, Juhani. (2011). *Os olhos da pele, a arquitectura e os sentidos*. Porto Alegre: Bookman, p12.
18 Le Corbusier cited by: Cabezas, Lino, "Le Corbusier. Estratégia Y processo. El cuaderno de notas como viaje iniciático" in AAVV. (2002). *Estrategias del dibujo en el ate contemporâneo*, coord. Juan José Gómez Molina. Madrid: Cátedra. P 112.

"THE CLOUD" AN INTRODUCTORY EXERCISE TO A MATERIAL BASED DESIGN STUDIO

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ABSTRACT

This paper introduces preliminary exercise of 'Materiality & Interiority' Interior Design Studio and discusses it within a material-based design education framework. The studio concentrates on material- based design where students conduct hands on material experiments, explore material behaviour and design 1/1 scale material systems. The studio coordinated by the author adopts an unconventional approach to design education and pursues the following question "What happens when we invert the usual sequence of the design process – form–structure–material – so materiality becomes the generative driver?" (Oxman, 2010). Entitled 'The Cloud', the exercise was formulated as introductory to vertical interior design studio for 2nd and 3rd year undergraduate students at Bilgi University. The primary concern while developing the exercise was to create a studio environment where students would start hands-on experimenting with materials from day one. It was also important that the physical outcome of the work would be sole and designed for the studio space as a result of a collective work of the students. Tasks involved: 1. Creating a mold by piling up balloons which constitutes the overall form. 2. Covering the balloons with gauze dipped in gypsum and water mixture. 3. Preparing papier-mâché paste from waste papers and applying on top of dried gauze and gypsum layer. Ultimately after the balloons were removed, 'The Cloud' which is a composite shell structure was suspended in the studio. This paper will reevaluate the design tasks of the exercise and hands-on material experimentation in the context of a design studio.

KEYWORDS

Material-based design, material properties, design education, design pedagogy, hands-on learning

This paper introduces 'the Cloud', the preliminary exercise of 'Materiality & Interiority' interior design studio module at Istanbul Bilgi University conducted and coordinated by the author herself; cotutored with Burcu Gülmen, Onur Ceritoğlu in 2016-2017 spring term and Burcu Gülmen, Önen Günöz in 2017-18 spring term. The studio focuses on material-based design where material system prototypes are built with the know-how gained from experimenting with physical materials. Analog and digital fabrication techniques are borrowed as well as traditional methods to explore extrinsic and intrinsic material properties which are the driver of the design process generating material systems. By extracting different qualities from material systems, new interiorities are aimed to be explored. "What happens when we invert the usual sequence of the design process – form–structure–material – so materiality becomes the generative driver?" (Oxman, 2010). Starting with this question, the studio differs from conventional undergraduate design education approaches and concentrates on materials as originators of form. Design education is a complex cognitive process. We are in an era where also new construction methods with conventional/unconventional materials are being explored intensively. It is important to equip undergraduate students with the knowledge to think, analyze, criticize these new methods and develop new ones. Acknowledging that materials are the fundamental drivers of design and construction, students' way of thinking about the built environment and possible future environments can be improved.

As Reiser and Umemoto (2006) states: 'Mies' constraint of matter by ideal geometry is based on an essentialist notion: that matter is formless and that geometry regulates it, that geometry is transcendental and in some sense indifferent to the material that substantiates it. When freed from such essentializing conceptions, matter proves to have its own capacity for self-organization'. Exploring material behavior by hands-on experimentation and working in 1/1 scale is the key method of the Materiality & Interiority studio.

The exercise, entitled 'The Cloud' was formulated as an introductory to vertical interior design studio for 2nd and 3rd year undergraduate students. It was completed in the first 3 studio classes of the term. Being a vertical studio, students participating are equipped with different skillsets. 2^{nd} year student's know-how of building 1/1 scale material systems is fresh because of their intense basic design studio during their first-year studies. 3^{rd} year students are more comfortable with representation techniques and software compared to 2^{nd} year students due to previous interior design classes. This brings diversity in terms of production in the studio environment and is an advantage especially while working in groups. To enhance interaction between students coming from different backgrounds; 'The Cloud' exercise was designed as a collaborative work of all the students.

The primary concern while developing the exercise was to create a studio environment where students would start hands-on experimenting with materials from day one. Students were provided with a list of materials and equipment to be brought to the studio: balloons, gypsum powder, gauze, waste paper, white glue, immersion blender, fabric, bucket, plastic wash tub and tape. Gathering in the studio; each step of the exercise was explained to students so that studio environment was organized accordingly. To start with, students inflated balloons with different volumes of air to have range of sizes in order to use balloons as molds. They commenced experimenting with single and then combined balloons to understand how gypsum and water mixture works with gauze (Image 1). Students tested different types of gypsum powder (plaster) they brought to studio and decided to work with plaster of Paris (carton-pierre plaster) which sets much faster. They also concluded on the ratio of gypsum and water according to mixture's performance. Another parameter that affected the performance of the first layer of the composite shell was the content of gauze. While stretchable or elastic gauze types repel gypsum + water mixture because of their content; %100 cotton gauze fibers soak water, making it possible to create the layer on the balloons expectedly. This was a material behavior observed during the studio all together with students that the instructors also did not anticipate which underlines the significance of learning by doing and experiential learning which Kolb defines as "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience" (Kolb, 1984).

After testing on balloons and deciding what exact materials were going to be used, students started working on 'the cloud'. They were asked to create an installation for the studio space which was going to be suspended from the ceiling. They created the mold of the 'the Cloud' by piling up balloons in different sizes on a table by taping them which constituted the overall form (Image 2). An unconventional concept of mold was preferred for this exercise in order students to experiment with 'pressure' which is an intensive material quantity. Unlike extensive quantities which refers to magnitudes which can be spatially subdivided with which architects are most familiar with, lengths, areas, volumes; intensive quantities cannot be subdivided. (DeLanda, 2002). Students decided on the form and size while piling up balloons with the feedback from the instructors. It was important how the balloons were neighboring since they were going to be covered with gauze strips to create a surface and eventually a shell structure. Students paid attention to intersection of balloons in terms of slope and concaveness and they readapted the location of balloons accordingly till the whole mold is in equilibrium. The overall form was evaluated according to structural integrity since shell structures majorly depend on their form for their strength. There were also decisions made in terms of aesthetics and proportions due to location selected for the installation and bodily experience envisioned by the students.

After creating the mold with balloons, students started layering gauze strips dipped in gypsum and water mixture. They worked in shifts so they could experience each different task such as cutting gauze strips, cleaning wash tubs, preparing gypsum and water mixture and finally dipping and placing layers (Image 3). They placed gauze layer by layer in different directions so that it is structurally more intact (Image 4 & 5). Completing the first layer composed of gypsum and gauze, students were assigned to prepare material for the second layer of the composite shell which is papier-mâché paste. Tasks involved: collecting waste paper from the studios in the architecture faculty, shredding these papers in tiny pieces, filling buckets with water and finally adding the waste paper shreds in the buckets filled with water so that they start softening (Image 6). All these processes were completed in first class of the studio which is 7 hours. The rest of the work had to completed during the next 4 hours class since time is needed both for the first layer to dry and papers in water to soften. Second studio class started out with the preparation of the papier-mâché paste. Students used immersion blender for water and shredded paper mixture to create the pulp. Next, they filtered water from the paper pulp using pieces of fabrics they have brought to the studio. Ultimately, they mix paper pulp with adequate white glue to obtain finalized papier-mâché paste (Image 7). The amount of glue added was determined by testing paste's consistency and how it sticks to the first layer. The paste can't be prepared all at once because white glue hardens paper fast with time passing which makes it hard to apply. That is why students were assigned to work in shifts again: preparing paper pulp using blender, filtering paper, mixing paper pulp with glue and applying papier-mâché paste on top of dried gauze and gypsum layer. The amount of papier-mâché paste applied on the first layer varies in thickness throughout the structure. More amount of pulp was applied to concave sloped surfaces at the intersections of balloons which are stress areas (Image 8).

The cloud was designed as a two layered composite shell structure. First layer being gypsum and gauze was applied to be able to create a surface on top of neighboring balloons where surface normals change throughout the surface. Using strips of gauze was a method to create surfaces at the intersections of balloons. Papier-mâché paste which hardens as it dries, was applied on top of the 1st layer, for the cloud's structural integrity. It was expected for the suspended composite shell to bear its own weight load without breaking or deforming. By hands-on experimentation, students acknowledged the contribution of these two different layers and how they individually perform within the composite shell. After all the balloon surfaces were applied with the papier-mâché paste, 'the cloud' was left to dry till next class. Once the structure was dry, students removed the mold, composed of balloons by bursting them (Image 9). Some of the balloons were already burst during the drying process or while applying the layers due to pressure which were replaced with new ones. When shell structure was ready, students decided suspension points and drilled the shell and CNC cut joints to suspend the final structure in the studio with ropes. Since it is a composite shell structure; underneath 'the cloud', which is the first layer, is smooth and white because of gypsum and gauze while top of the shell is gray and textured as a result of the papier-mâché paste. This exercise was repeated once more next year and there were some changes in the execution of the second 'cloud'. The second years studio area has an open plan and it was shared with another interior design studio. Instructors and students agreed on building a bigger and longer structure with lighting fixtures that would be suspended between two studios. Another challenge in the second 'cloud' was to create openings within the surface. Some of the balloons in the mold were assigned as openings hence they were not covered with gauze strips. Neon fluorescent tube lamps were integrated in the cloud passing through the openings in the shell (Image 10 & 11). Students continued their studies through the semester under / next to 'the cloud' which tutors were aiming for since they consider it important for students to see and experiment their own 1/1 scale collective work (Image 12).

To conclude; Hensel (2009) points out; 'while architecture is a material practice, highly specific materials with carefully defined characteristics and properties are often chosen late in the design process" and "material is thus too often treated as a solution instead of a potential." Materiality and Interiority design studio focuses on material-based design where students are encouraged to experiment with materials to explore their properties. When working with materials it is essential to comprehend that material behaviour cannot be scaled and therefore, working with 1/1 scale is a requirement for this studio. The advantage of hands-on experimentation is not only about understanding the potentials of a material but also its limitations. 'The Cloud' a 1/1 scale composite shell structure, enabled the environment for the instructors and the students to start discussing these subjects from day one. Some of the students did borrow techniques they have learned during this introductory exercise and implemented in their future studies. Further explorations can be done by formulating new introductory exercises such as 'the cloud' that stimulates collaborative work and material-based design thinking.

IMAGES, CHARTS OR GRAPHICS LEGENDS

Image 1 - Experiments with combined balloons – Cloud #1 (courtesy of the author)

Image 2 - Taping balloons to constitite overall form – Cloud #1 (courtesy of the author)

Image 3 - Students working in shifts – Cloud #1 (courtesy of the author)

Image 4 - Applying first layer of gauze dipped in gypsum – Cloud #2 (courtesy of the author)

Image 5 - Applying first layer of gauze dipped in gypsum – Cloud #2 (courtesy of the author)

Image 6 - Preparing waste paper shreds (courtesy of the author)

Image 7 - Applying papier-mâché paste – Cloud #1 (courtesy of the author)

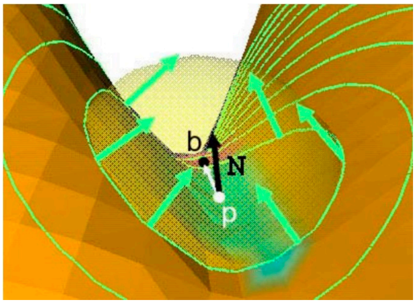

Image 8 - Intersection curve normals (Mortara, M. et al.)

Image 9 · Bursting balloons – Cloud #1
(courtesy of the author)

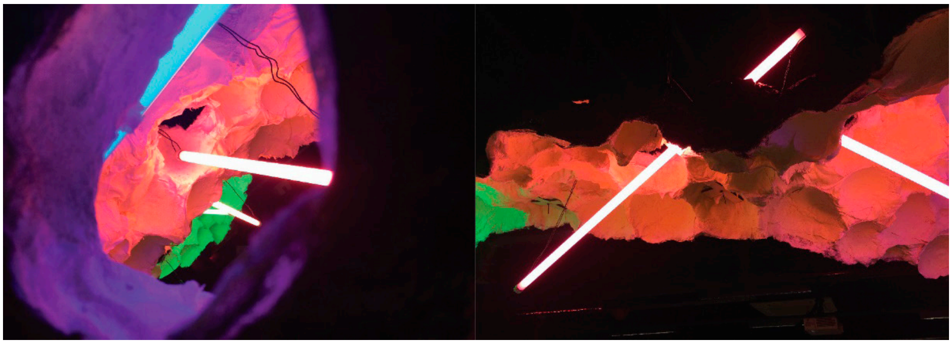

Image 10 · Neon fluorescent tube lamps and openings – Cloud #2 (courtesy of the author)

Image 12 · Finalized cloud #1 and cloud #2 in the studio (courtesy of the author)

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INTRODUCING THE COMPUTATION IN ARCHITECTURAL DESIGN: AN EXEMPLE OF A FIRST YEAR COURSE WITH PARAMETRIC AND VISUAL PROGRAMMING TOOLS

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ABSTRACT
An introductory course on computational design for architecture freshmen is described and discussed. In separate theory and lab hours, the course gives basic computing knowledge such as algorithms, computer numerical control in production together with the context and culture of digital design and manufacturing, a glimpse of the historical development of computational thinking and skills in application of computational thinking through solving conceptual design problems.

KEYWORDS
Design curricula, design teaching, computational design, parametric design, visual programming

Introduction

In early 2018, X University followed on its recently initiated mission of integrating computation skills into the first year's curricula of all programs. While a common course focusing on coding was offered to all undergraduate programs, the architecture program was among those that developed its own course based on the particular needs of its field. Four instructors and four teaching assistants teamed up to design and conduct the course for the first time in the Spring semester of 2018. The target student group was in their first year of architectural design education and their number was 167.

Digital design curriculum in architecture schools is currently not a new topic. The last two decades saw various examples of integration of digital design tools into the educational programs with few being discussed in literature (e.g. Duarte, 2007; Senske, 2014; Kara, 2014). Nonetheless, most of the attempts have been limited to the typical representational and analytical roles of computer aided design. Computational thinking in design, however, provides architects opportunities of designing within a whole new realm of creativity, and these opportunities are at the focus of a recent growing interest in vanguard architectural education. Accordingly, our initial intention was to expose students to computational thinking skills that would complement the thinking and making skills conveyed in the context of the design studio. With this idea in mind, we have developed and delivered an introductory course to freshman students in the Department of Architecture at X University.

The course was devised as having two parts - one theoretical and the other hands-on. The theory part comprised of weekly lectures given by the course instructors on a variety of topics, terminology and issues to establish a critical perspective and a primary level of knowledge computation such as algorithms and computer numerical control in production. The content was carefully designed to include the context and culture of digital design and manufacturing in order to give a glimpse of the historical development of computational thinking. The hands-on hours of the course were spent in computer labs where weekly tutorials informed and guided students on how to operate parametric tools and solve problems of 3D modelling and fabrication. Thus, students developed skills and knowledge of the application of computational thinking through solving conceptual design problems.

Reported in this paper is the context of the course and evaluation of the experience of students as well as a commentary on design outcomes they achieved while confronting computational design thinking. A comprehensive survey was developed and conducted at the end of the course for students to reflect and evaluate their learning experience. Based on our observations and the analysis of collected survey answers, this paper documents the issues that the students experienced during computational and parametric design tasks as well as in the process of fabrication. The paper also considers how this initiative prepares the new generation of architectural design students who are expected to advance their skills and knowledge on computation and manufacturing technologies.

Computation in Architectural Design

Beginning student of architecture may or may not have been equipped with a basic knowledge of technologies in their K-12 education or everyday life. An introductory knowledge of design technologies at this level primarily includes distinguishing these from building technologies, which involve structures, construction, and materials, students already may know from urban construction sites or start learning about in related courses, sometimes as early as the first year. Design technologies are not detached from these but are mainly tools of state-of-the-art designing methods. They constitute a broad range of approaches and techniques to design, and include visual communication techniques. Vanguard practices are known for integrating the variety of approaches in an interdisciplinary and research by design approach. For instance, Dana Cupkova's collaborative Epiphyte Lab blends research, practice and academics on matters of technology that one presents to users/inhabitants of space and that one uses in design. Since the 50s, design technologies in architecture comprise of, but are not limited to, smart environments, interactive spaces, internet of things, new technologies and materials as elements of design, augmented and virtual reality set ups as well as design thinking, design support systems, anticipation of design performance and maintenance of built design, and artificial intelligence. Whereas the first group is mostly in service of the users of design, the latter enhances designer's process.

Ubiquitous use of computers, computing devices embedded in everyday objects that can send and receive data, and internet, all connect gadgets and the human in a seamless system of connection and tracking. When the environment can anticipate behaviors and events, it is possible to learn from mistakes or less optimal solutions. New technologies and materials are now elements of design, and composite 3D printing points to a new future in the construction industry. In preparation and continuation of the construction work, drones can survey sites and construction, for faster, cheaper and safer processes (even to how the materials will arrive at the site most efficiently). Building Information Model (BIM) is a shared knowledge resource for all the information on a building project – before, during and after construction. It provides a set of interrelated and cross-referenced information. For example, objects in the model are linked to related information including manuals, specifications, commissioning data, photos and warranty details. Or, databases can assist with evidence and case-based decisions towards improved or optimized designs. Models can also help manage the time table and the large number of people involved in the field. BIM still holds further potential to provide new insights as the digital data of our built environment is compiled and AI software has the potential to learn from this data too.

In addition, manufacturing is more and more integrated into design as CNC, 3D printing and robotic fabrication are becoming more accessible and affordable. Celani (2018) outlines the state-of-the-art in architectural technology that debunks some myths in how designers should be trained. Our ambition was in part to compensate for the scarcity of design technologies in the formal curriculum of the following years. Jean Nouvel's Abu Dhabi Louvre Museum built in 2017, more classical examples such as Frei Otto's design for Munich Olympic Park from 1972, Frank Gehry's iconic Bilbao Museum and many more contemporary designs that exemplified parametric thinking in construction, plastic forms, complex systems and composite materials as well as 3D printing in 1:1 were some of the examples discussed in the lectures. Parametric detailing from Centre Pompidou in Metz by Shigeru Ban from 2010, and examples from current research in manufacturing design from prominent graduate programs and young architectural practices around the world were also shared with the students.

In the course, we focused mostly on the technology related to form finding and its making through examples of tools available by the day. We gave an overview of how modeling, programming, computing and prototyping define most common design technologies. These are used to govern complex geometries (parametric modeling), and processes of design are changing. In the theory part of the course, we set out to present the horizon that technologies offer to design fields in an introductory format to a cohort of beginning architecture students with an ambition that it may shape their perspective to the profession they are just starting to train for. As the profession demands so much more in lieu of technology, architects are expected to be trained as designers who are responsible performers of technology.

First Year Course with Parametric and Visual Programming Tools

As we structured the course, our primary goal in establishing the lecture sessions was to equip the students with a basic understanding of computational thinking, its various applications in architectural design including the various digital design, fabrication and manufacturing technologies utilized in architectural design practices. The lab hours were aimed at equipping the students with a beginner knowledge and experience in using up-to-date digital design and fabrication technologies. Accordingly, in developing the course plan, we took the activities/productions students would be engaged with in the hands-on sections as the basis for scheduling the lectures; we planned the lectures in a way to facilitate students' transferring/making sense of knowledge gained in the lectures to/in hands-on sessions.

We incorporated some in-class/homework assignments into our curriculum as well as a midterm and final project which would require the students to develop/model/fabricate design proposals by employing a computational design approach. The assignments were mainly related with the content discussed in the current lecture such as encoding their names with UniCode characters, writing the algorithm for drawing a given shape. The midterm assignment was to design and develop a parametric model of a structure with stairs, steps or ladders by using Grasshopper, a structure via which a person would be able to climb up within a cubic space with dimensions of 3*3*3 mt. The submissions had to include a poster expressing their design intent as well as the parametric definition of their structure in Grasshopper. In the final assignment, we required the students to form groups to work on a selected design proposal belonging to one of the group member's, develop it further and fabricate a scaled model of the proposal. We asked for the model and a poster expressing their design intent as well as a screenshot of its parametric definition in Grasshopper (an example of student work is shown in Image 1). We evaluated students' performance in the course primarily based on their midterm and final projects.

In the first quarter of the semester, we devoted the hands-on sessions to introducing the work environment of Rhino and some of its modeling functionalities to the students. In the lecture sessions, we first provided students with an overview of use of the digital design technologies in architecture, as given in the section above, in order to give them an idea about affordances of these technologies and their contributions to architecture design practice, how the practice has evolved with them. We then focused on issues/concepts relating to computational thinking. We covered topics such as Turing's universal machines, algorithms (what is required for an algorithm and its key features such as variables, procedures, sequence, selections, repetition), and Mitch Resnick's Star Logo and Turtle Bot with in-class play. We also introduced the generative specifications using visual rules (Stiny and Gips, 1971), Habraken and Gross's (1988) silent game to understand how algorithmic thinking might apply to the design context, and assigned visual computation examples to set a simple designerly context for algorithmic thinking.

In the second quarter, we focused on programming. In hands-on sessions, we introduced the students to the work environment of Grasshopper, and to a host of concepts, methods and operations through in class exercises and simple assignments towards equipping them with the knowledge and skills required for parametric modeling of simple spatial structures/arrangements. In the lecture sessions, we first introduced the students to functional components of a computer system and basic subjects/concepts relating to representation, storage and processing of data. We then introduced the students to basic concepts in programming by going over some simple algorithms and block-based programming examples provided at code.org. We required them to form a small program themselves for creating a pattern via the block-based programming language provided in artist application at code.org. in the last lecture of this quarter, whilst students were working on developing their design proposals, we provided students with an overview of the mathematical representation and methods for generating complex geometries such as curves and parametric surfaces. Students submitted their midterm projects at the end of this quarter as to be assessed during the spring break.

In the third quarter, we devoted the hands-on hours to students' work on their final assignments for them to be able to get feedback from the tutors when needed. In the lecture hours, we provided the students with an overview of the various computational approaches that are being employed in support of architectural design practices ranging from analyses to optimization to (multi-criteria) decision making and the areas of their application. We introduced them to software tools that are used for modeling/capturing different aspects of design intent, such as those supporting developing a BIM for architectural, structural, mechanical etc. purposes, or those for modeling/generating building geometry. We also introduced the main differences between these families of tools, as well as the suite of software applications of analysis, simulation, optimization etc.

The last quarter of the semester, the hands-on sessions focused on teaching students how to fabricate their design proposals by using laser cutting technology and assisting them in their fabrication process. The lectures provided students with an overview of the currently available digital manufacturing and fabrication technologies, examples of their uses in architecture. The last lecture was focused on the current and potential future uses of VR and AR technologies in service of making /experiencing architecture.

Evaluation of the overall course – learning

The course we designed and conducted is a required course of the second semester of the first year in the Department of Architecture curriculum. The other required courses include design and visual communication studies that are co-taught with the four other departments of the Faculty of Architecture. These common studios are a part of an interdisciplinary foundational curriculum that is unique to the school. In the first semester, architecture students are required to follow a design studio, a visual communication course, and a basic design course. Instructors from five departments are involved in the design and conduct of these courses. In the second semester, the design studio and the visual communication course continue and department led courses are introduced such as the one of subject matter here. All of the authors of this paper, who devised and ran the said course, are also involved in three of the four sections of these other required courses. This ensures a holistic view to the all course designs. Students who took the course were familiar with basic concepts of design from their first semester and the instructors had a general idea to the extent of this familiarity due to their involvement.

In the second semester, the course we describe in this paper ran parallel to the foundation courses. Issues conveyed in one, reverberated in the other. A limitation to a full crossover of issues between the courses was that architecture students comprised only a part of the student cohort in the foundation studios. Other departments offered different courses in addressing the integration of computing skills.

At the end of the course, we prepared a survey to get feedback from the students. 98 students out of the 167 who took the course responded to the voluntary questionnaire. Their expectations from the course in the beginning of the semester, prior to the first meeting, was mainly to learn commercial 3D modeling and visual editing software. But once they were acquainted with the course content, their expectations with regards to the subject seem to have changed. In response to what interested them most in the course, many students responded with parametric design and related software. The course instructors had not especially given attention to this topic, but the responses suggest that students found it to be the most relatable to their design courses. Some students stated that they used the modeling software in their design studios. Some other responses were related to laser cutting, AR/VR technologies, BIM and simulation software.

Students who thought they benefited from the course in terms of design skills or towards their architectural education, stated that they learnt to express design ideas with 3D models, or that they improved their analytical skills. Some specified that what they learnt in the course helped improve their design ideas. Some students voiced disappointment that more rigorous coding was not at the forefront of the course.

Students also voiced many concerns about the facilities. For the majority, despite the benefit to a few international students in the class, the course suffered from being taught in English. Although this is irrelevant to the scope of the subject matter of this paper, this fact had a bearing on how students related to the course. The comments regarding the limitations of lab hours, and the desire to have less theory and more practice through short term multiple problem sets, point to their interest in hands-on learning of techniques.

Concluding Remarks

Design education is involved with learning theory and its applications in the design of artifacts that are essential to the recent needs of society. Today, the emergent information and communication technologies and the concept of computation in design have brought both new opportunities and challenges to architectural design education, requiring us to offer new courses and pedagogies. This paper presents our experience in an initiation that aims to introduce computation knowledge and skills into the architectural design curricula focusing on the freshmen in x University. The main objective was enabling the students acquiring/building up computing knowledge and skills through being engaged with developing a design by employing a computational approach afforded by the chosen technology. Given this objective, there had to be times where the hands-on activities would not be directly related to the content that will be discussed in the lecture of the corresponding week. The theory courses that gave a picture of the state-of-the-art and the wide range of technologies did not find their counterpart necessarily in the lab hours. Besides the above evaluations regarding the learning and teaching computational design, the paper concludes with the following remarks based on our analysis and observation during the course:

For the purposes of engaging students, it is important to cite issues and examples that students can relate directly to some of their prior knowledge and expectations of the profession as yet. Primarily, students need to develop basic knowledge of the key concepts of design computation that include algorithms, visual computation of design, parametric modeling, and graphic coding. Similarly, it is important to have the lab hours for them to use their new knowledge hands-on. During the hands-on hours of the course, the students must be given a chance to employ the learnt computational knowledge by learning by doing mode in a design situation. Ideally, such courses would be integrated and run parallel to the main design studio stream by gradually increasing the knowledge and skills of computational design.

IMAGES, CHARTS OR GRAPHICS LEGENDS

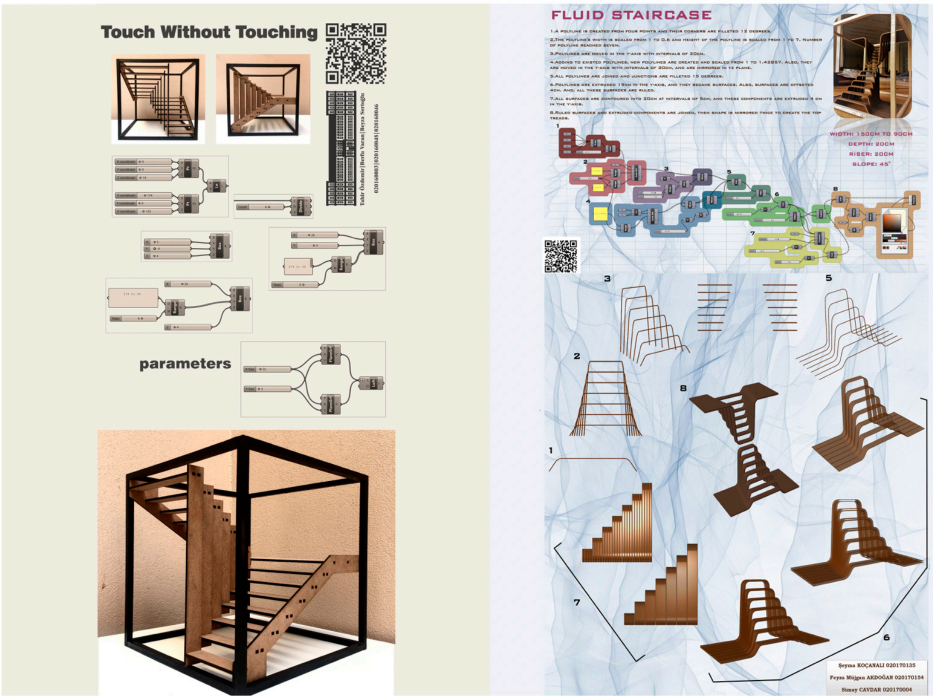

Image 1 - Examples of final project posters

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MODULAR MAKING IN CERAMICS: IMITATION TO IMPROVISATION

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ABSTRACT
Learning by making allows design students to experiment with different materials and provides hands-on learning which seems to lack from a traditional architecture school curriculum. This paper addresses this issue by focusing on the process of an intensive design & build summer workshop, in order to answer the question of how first-year architecture students imitate and improvise ways to design when they meet with new material and a technique for the first time.
The Ceramics is frequently considered being associated with traditional handcrafts yet has a long and rich history in architectural design. Integrating CAD/CAM technologies and the pliable nature of ceramics, which can be formed in a wide range of states (dry clay and wet slip), opens new possibilities in design and production. While there are different production processes, this workshop focused on exploration of the use of press molding and slip-casting.
In this workshop, the intersection of traditional and digital making using improvisational molding techniques is discussed through participating students' strategies of learning to make digital ceramics by imitating forms. This paper investigates how imitation of form as a primary visual reference encouraged students to improvise and ultimately come up with unique methods of production, which helped their projects go beyond to be mere imitations. Despite the limitations of the material, this study suggests aforementioned hybrid approach as a possible way of integrating meticulous ceramic manufacturing techniques into the educational setup.

KEYWORDS
Ceramics, imitation, improvisation, learning by making.

Introduction

Ceramics as a material that is frequently considered being associated with traditional crafts and industrial production yet has a long and rich history in architectural design. 'Casting Geometries' is a two-week-long intensive design-build workshop that introduced first-year design students to different know-how of digital ceramics. The main motivation of the workshop is to understand a production process related to ceramics and create new tools and techniques in order to develop novel procedures by imitating forms and improvising techniques. This paper is a preliminary attempt to suggest a hybrid model of integrating hybrid modes of ceramic making into educational setup.

During the workshop, students taking part experimented with understanding the logic of designing a modular and material system in order to produce a tessellation in real scale with ceramic units. In the beginning of the process, they were introduced with several examples of tessellated surfaces and ceramic techniques, hand-building, press mold, and slip-casting. Having no prior knowledge and know-how on ceramics, the students aim to improvise the technique by observing the examples and imitating the forms. Imitation should be understood as abstracting and deconstructing what you have observed in order to reconstruct it with a creative manner. However, visual analogy is not enough per se to understand complex geometric relations, material performance, and technique. So, imitation also includes learning by doing to realize the observed visual images with the available techniques. Sennett (2008) stated that if one apprehends what he/she is doing, other than pure imitating what he/she has seen, it means that the skill development process has begun.

A technique can be improved and improvised by imitating even the complex forms in order to achieve creative processes and outcomes. The unique engagement with ceramic material as a craft practice enables the exploration of techniques and tools while going beyond the limitations of them. Thus, the dialectic process of crafting oscillates between frustration and satisfaction through trial and error. Experiment is preceded by the understanding the existing precursors such as the renowned modular constructionist designer Erwin Hauer, who developed unique weaving patterns out of several materials such as limestone, composites and concrete (Hauer, 2004). The complexity of these units regarding the geometry and the precision is achieved by integrating analog techniques with CAD/CAM technologies.

The workshop had different objectives on various levels. Integrating CAD/CAM technologies and the pliable nature of ceramics, which can be formed in a wide range of states (dry clay and wet slip), opens new possibilities in design and production by following the early precedents. While there are four different production processes of ceramics such as hand-building, press molding, extruding, slip-casting and 3D printing, we focus on press molding as a semi-industrialized and slip-casting as an industrialized manufacturing technique in this research. While press molding assures a direct engagement with the material, slip-casting satisfies the precision. Both methods support to produce multiple units out of a few molds if they designed properly.

Theoretical Background

According to the Merriam-Webster online dictionary, mimesis is an originally a Greek word, it derives from the verb “mimeisthai” which means “to imitate”. The word has been used in aesthetics or artistic theory, since Plato and Aristotle, to describe an attempt to imitate or reproduce reality. In the pre-modern world, imitation was not an unusual way to learn a new skill, especially in arts and architecture education. Plato argued that all art is mimetic, and it imitates life. Thus, one could teach this technical knowledge of making or the ‘techne’. On the other hand, Aristotle claimed that creativity would emerge from the friction between technical and mimetic learning. Because only then, one would gain a critical view of their work (Kiss, 2017).

According to Downey (2010) and his theory of embodied learning, mimesis comprises the process of observation, imitation, and rehearsal. In line with design education discourse, observing the form to generate mental representations towards understanding the goal is different from simple copying. He argues that it shapes the way people act, especially when they are trying to reach a particular goal (s). The modern way of thinking praises the ‘original’ or the ‘unique’. As Jordan (2011) observes, learning through observation and imitation is important in all higher social animals, but it is humans who have developed this propensity into the primary modality for the acquisition of skills. However, there is still a need for further research to explore the potentials of mimetic learning in design education in terms of making.

Method

Students from architecture, interior design, and industrial design departments who have just completed first-year design education at Istanbul Bilgi University attended to Casting Geometries Summer Workshop in 2017. The workshop is the continuation of Computation-based Basic Design Studio at the same university, which aims to introduce the knowledge of how to integrate making and computational thinking through design basics to newcoming students (Yalinay Cinici, 2013). In this workshop, the participants were given a brief on 'digital ceramic making' and instructed to experiment on ceramic molding and casting using different digital design tools and new fabrication technologies along with the traditional ceramic making and surface treatment methods. The participants are also introduced several examples of tessellations as interior and exterior surfaces produced either with ceramics, limestone or concrete. Then, they were asked to design their own modular components, which would be aggregated in order to create a large-scale architectural surface in coherence with the part-whole relationship of the system. Designing these units, the production process and the connection details required considering the material performance and functionality of ceramics while also keeping in mind the fragile nature of it. The production process of ceramic comprises three phases such as greenware, bisque firing, and glaze firing. Every phase has its limitations, which should be considered and fed into the design process. Additional challenges such as the tolerance and limitations of the physical properties of ceramics, such as multi-piece mold making, and shrinkage and warping during the firing process dealt during the process by integrating craft practice to digital fabrication.

Ceramic Process

Students explored the intersection between digital manufacturing tools and making by hand within the possibilities of ceramics. They designed several variative tessellations of identical components by using two different production techniques. Creating variety of different forms was aimed by students regarding the organization of multiple units rather than having variation of the unit itself, due to the limited time of the organization and lacking prior knowledge.

In this workshop, focusing and exploring potentials of press molding and slip-casting techniques were prioritized. Press molding requires producing the negative part of the unit out of clay or wood. Then, by applying pressure, clay is compressed inside the mold. After drying, the final unit can be moved out easily, if the geometry is tapered. Ceramic slip-casting involves slipping the liquid clay (slip) into a dry plaster mold so that it would extract the excess moisture out of the slip. Afterwards, the slip - the positive part is removed from the negative- the mold carefully. Unlike press molding, mold making in slip-casting is a complex and time-consuming process in terms of understanding the multiple steps with the purpose of achieving precision. Preciseness is needed for both materialization of the digital model and creating multiple copies out of one designed unit. However, digital workflows in ceramics make easier all this process enabling the direct translation between the digital model and physical prototype by using 3D printing.

In the first part of the two-week-long workshop, the participating students were given some basic exercises to get themselves familiarized with the clay material and the casting techniques (slip-casting, press molds… etc.) as well as a few tools of digital fabrication. Later, for the final product of the process, a design brief and several visual references such as Modular Constructionist Erwin Hauer's screens along with other examples of 'digital architectural ceramic making' were shown to the students (Image 1).

For the final project of the workshop, the students were asked to work in groups and come up with their designs for ceramic units and their molds that would eventually produce real scale modular ceramic components, which would be aggregated to create a large-scale architectural surface. Prototyping of modular geometries provides the information on material logic to novice students while enabling to make multiple units out of one designed mold.

In this phase, the participants were observed to imitate the forms they were shown, but since those visual references of architectural modular screens were complex geometries, not made of ceramics, neither were built in a week. Thus, students had to improvise their molding techniques and came up with unique solutions. Eventually, the final design products did not look like their precedents, but those served simply as an inspiration through intensive learning by making process.

Participants who created the modules by hand developed several tools in order to produce multiple units in minimal time. Other students who use slip-casting as a technique concentrated on developing the relationship between the mold and the cast, in other words, the solid and the void. Moreover, the intricate relationship between component and mold leads to rethinking positive and negative spaces, which heavily depend on each other. They try to understand the geometric properties of the module they created in the three-dimensional model in order to manufacture them without damaging the positive part while taking the cast out of the mold. Prototyping of modular geometries provides the information on material logic to novice students while enabling to produce multiple units out of one designed mold.

Case 1:

Students of the first group started with analyzing interwoven tessellations of Designer Erwin Hauer. They prepared a 3D model of one unit, which required to be bend at least two points requiring to achieve connections between two woven layers. After realizing that potential, they first printed their unit and tried to develop mold. They had problems with moving the positive part out of the mold due to the lack of knowledge in the slip-casting technique. Then, they tried another technique which uses the potential of the ceramic material. They cut a 2D mold out of wood plank with a laser cut in order to press the clay into the mold by using a hammer. They put all the units to dry onto the wood profiles in order to create an interwoven pattern by bending the shape in the Z direction. They also opened several holes in that phase as a connection detail. After the bisque firing, the glazing process is done by soaking the units into the powder glaze mixture called slop. All the units are put in the kiln oven for glaze firing (Image 2). At the final step, all the connections between two layers are made by using rope.

Case 2:

As a design principle, students started with two hexagonal sections lofted to each other. Rather than using mere extrusion, they scaled the upper section in order to create voids between the modules after stacking them onto each other. The students first printed the 3D model to ensure precision in the plaster mold. Due to the form of the modules, the two-part mold is designed by using the printed object as a guide for plaster mold. For preparing the first part of the mold, the printed module is laid inside cottle boards. A cut-out wooden piece is put by framing the printed module in order to inhibit the liquid plaster moving to the below. Then, every corner and touching point is insulated. By adding water to plaster powder, the liquid plaster is made and poured into the cottle board. After drying, the cottle boards are dismantled, and the half part of the mold is rotated in order to pour the other half. The steps are repeated for another half of the mold. The dried two-part mold is ready for slip-casting. The ready-made slip is poured into the mold after putting two parts face-by-face by fixing them with elastic bands. After waiting 20 minutes, the excess of the liquid is poured back in order get voids inside of units. The waiting time depends on the temperature and humidity of the environment and dryness of the plaster mold and expected thickness of the perimeter of the module. To multiple the modules, two more molds are prepared. The same bisque firing and glazing steps are followed as the first process (Image 3).

Conclusion

Within the scope of this paper, intersection of traditional and digital making using hand making and digital molding techniques were discussed through participants' projects as a way of integrating very defined ceramic manufacturing techniques into the design process of repetitive units. This workshop suggests an iterative process as an alternative to the linear process to close the gap between design and fabrication by informing the geometry of ceramic components with the limitations and capabilities of designing and having control of production workflow.

The students developed more innovative workflows with the press molding method rather than slip-casting because of the lacking precision in mold making. Especially, in two-part molds, the form should be revised and modified according to the technique. The more cornered modules stick into the mold while more chamfered ones easy to pull out. The complex forms need multiple part molds which should deal with carefully throughout the process. Another limitation of slip-casting is the drying time of the mold parts exceeding the workshop period. When the mold is not cured enough, the liquid clay-slip sticks to the walls of the mold. Although additional modifications are needed for connecting divided parts, the malleable nature of clay allows the modification even after moving the positive part out of the mold.

Even though students were not instructed to imitate exemplary work, images those were presented to them as design precedents at the beginning of the workshop process inspired and encouraged them to imitate the forms. As it was observed by Yildirim et al. in 2012, imitation technique can be an efficient method to use as a time-saver technique to generate the first design idea in early education. Imitation of visual references transformed the process of making into improvisation as the students get familiar with techniques. Creativity emerged in process of improvising the techniques of hand-building, press molding, and slip-casting in terms of digital ceramic making throughout the workshop.

Casting Geometries workshop as an introduction of analog and traditional ceramic making resulted in fruitful outcomes to help students understand design basics such as 3D geometric relationship, solid and void relations and repetition by integration and learning through making. Creating a cyclic design process starting from the visual reference of precedents of moldable complex geometries, then developing novel instruments as a new skill is experienced in this workshop. While integrating several digital and analog manufacturing lanes in one design process, this workshop proved none of these relatively new manufacturing methods are sufficient enough merely on their own. Designers need to hack methods and improvise, cut across different techniques of analog and digital to get richer design outcomes.

IMAGES, CHARTS OR GRAPHICS LEGENDS

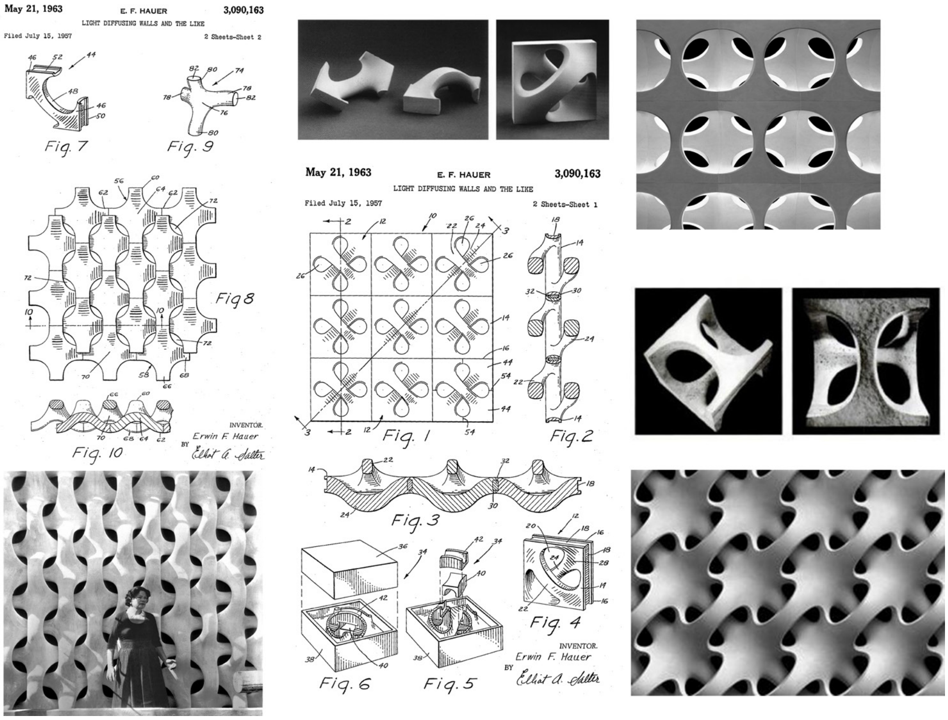

Image 1 - Images and patent drawings of Modular Constructionist Erwin Hauer's porous screen designs were shown to students as visual precedents for complex modular geometries created by mold. *Images showing (from left-right)***,** *Patent documents for Erwin Hauer module Church in Liesing, Vienna, Austria Design (1957); middle column: patent drawings and images for light diffusing wall (1957); some of his other work from his book 'Erwin Hauer: Continua-Architectural Walls and Screens' (2004).*

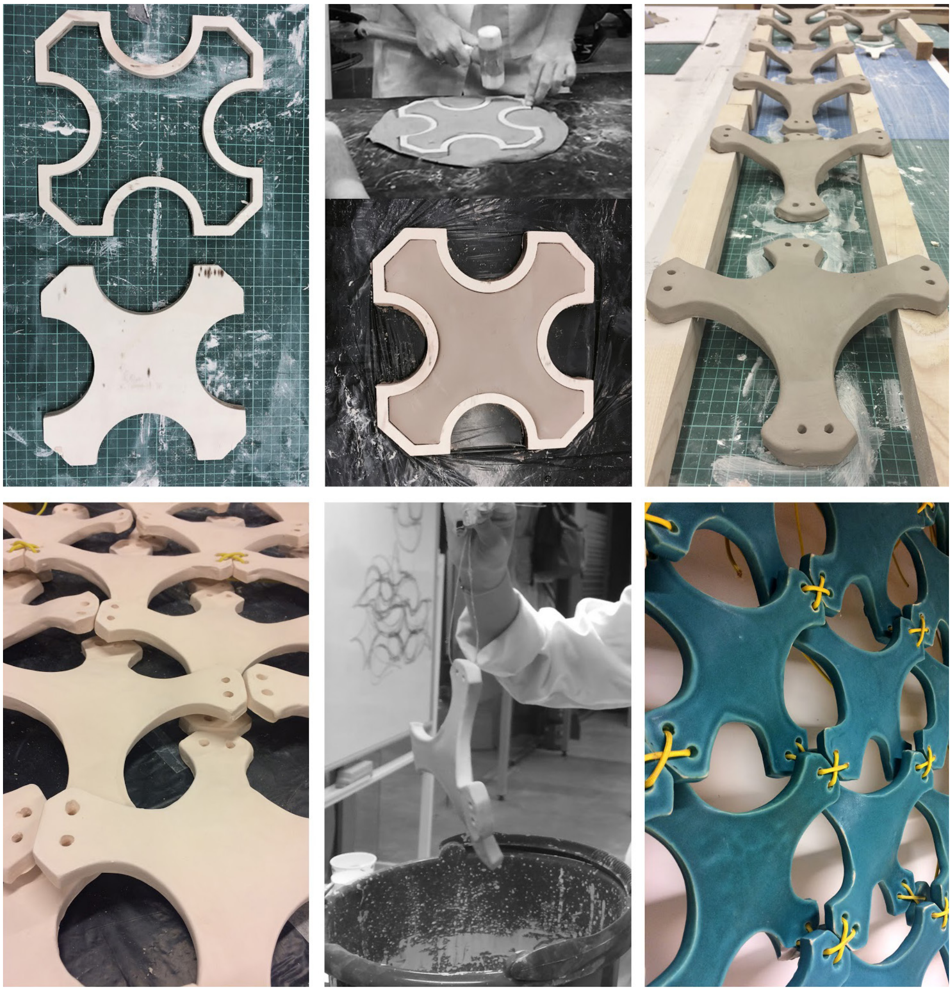

Image 2 - Project "Descendants of Erwin", Students: Arda Yuzkan, Deniz Birkalan, Elif Cansu Kayikci, Gülbüke Susarugur (Photos: Hülya Oral, Canan Erten): *Images showing (from left top to right bottom)***,** *the improvised press molding technique, curing of the units, glazing and the final blue glazed design of the architectural ceramics screen with a new yellow joint detail.*

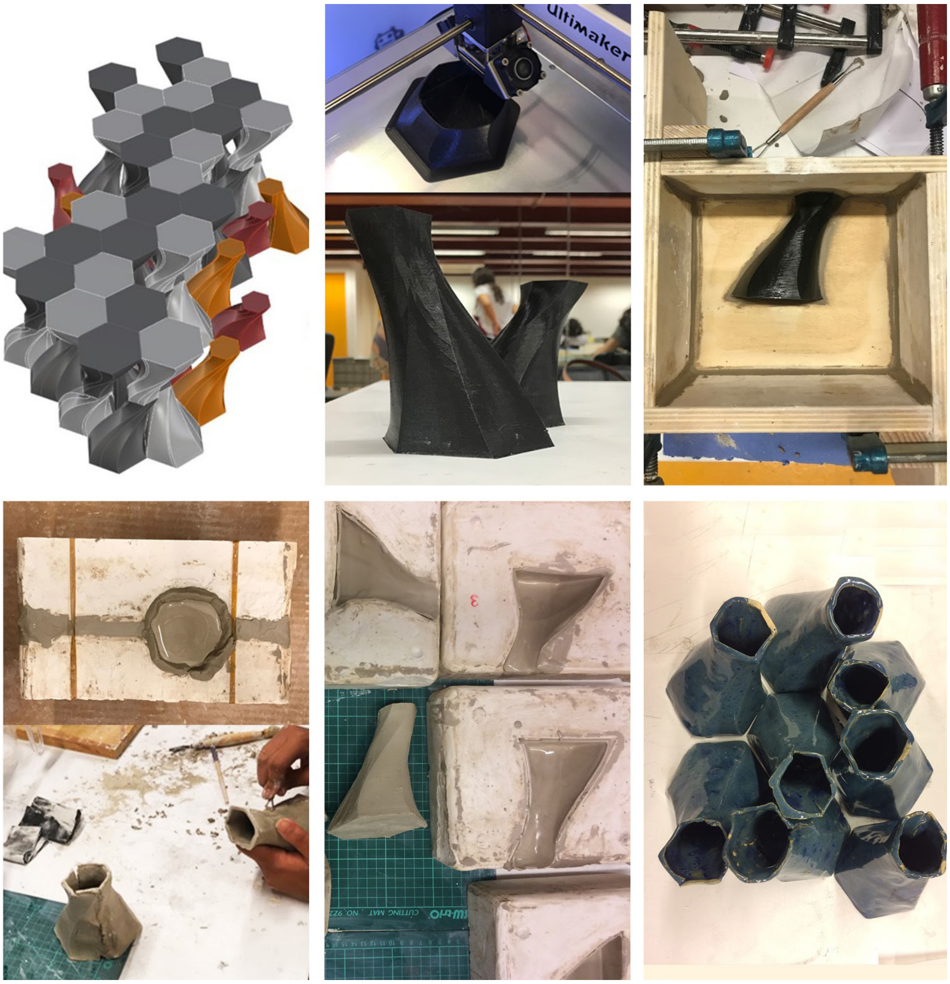

Image 3 - Project Cactus; Students: Derin Gürgün, Ekin Cunbul, Ecem İrem Kılınç, İdil Beliz Saraç, Melda Ayyuce Edikli, Zeynep Aybey: *process images showing the design process (from left top to right bottom): 3D printed prototypes, two-piece plaster mold, slip-casting technique, curing of the units, the final glossy glazed components coming together.*

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