XXI GENERATIVE ART 2018

proceedings of
XXI Generative Art conference

edited by
Celestino Soddu
Enrica Colabella

GENERATIVE ART 2018

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Proceedings

Edited by Celestino Soddu and Enrica Colabella

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The book contains the abstracts of papers, installations, artworks and live performances presented at XXI Generative Art conference in Verona, Italy.

The full texts are in the attached dvd.

In the cover a sequence of sections of generated architectures made by Celestino Soddu Interpreting the Italian tradition

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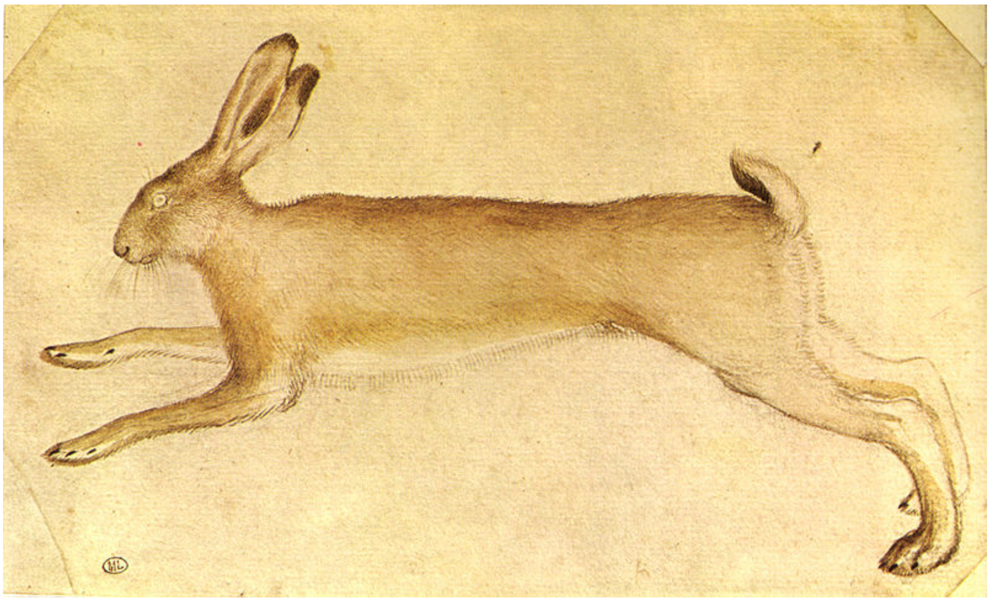
ARTWORKS - INSTALLATIONS

LIVE PERFORMANCES



Drawing by Piasanello, Verona, at Louvre museum

Generative Art Organicity
The similarity between Nature and Generative Art Process

Opening this XXI International Generative Art Conference we would like to thank the Museum of Natural History of Verona and in particular Director Francesca Rossi and the Library Dean Bruna Burato. They welcomed us this year in this wonderful city giving the opportunity of the experience to directly evaluate the similarity between Nature and Art.

Verona is a wonderful city full of Roman and Renaissance artworks and architecture and the unique Italian city of love.

So we can directly compare Generative Art experiences with the evolutionary history of Nature. Our hope is that this unique experience can generate, in all participants, new fields of investigation in their artworks.

A fantastic event gives us a great pleasure: Matteo Peraro e Davide Stupazzoni two workers of Melegatti company that produce the best Pandoro in Verona decided to preserve each day the lievito Madre (mother yeast) that represent the generative tradition of the product quality of their company. They worked each day for free instead of the company was closed for economic management problems. It's a great example of Italian workers for preserving tradition.

The generative formal logic of our peculiar making Art follows the steps of the Natural structure and process. Each generated event is a unique event in multiple variations strongly connected with an idea as genetic code.

The progressive moments of our creative process follow completely the construction and evolution of event species. Observing how, during time evolution, natural species changed preserving their identity and uniqueness, is an essential observation point of view for the generation of artificial species. This in imitation of the natural process of endless representation of the same natural codes.

Following this Nature similarity, we are able to consider two fundamental aspects of the generative process: the organicity and the ability to learn from experience.

Organicity is without any doubt one of the characteristics of generative artworks. From so many centuries human beings created artworks following the harmony of nature, gaining a progressive experience toward complexity.

This similarity between Nature and Art that was missed in the last century is, in our time, re-discovered for gaining a new harmonic configuration performing at the best the new digital technology.

We can identify this generative process as a new organic vision of Nature by creating non-linear systems connecting the whole and all its parts in a fragment of time. Our main reference point is Renaissance where Piero della Francesca, Leonardo da Vinci and Michelangelo connected the complex harmony of Nature in their artworks. More, they have taught us that there is no Art without Science.

The ability to learn from life rises from our direct experience when we become able to connect our vision with reality in a unicum organicity. Even if we have not yet acquired the ability in using machine learning as happens in the most advanced AI systems, we can perform open processes in a generative way. This is totally different from the processes for gaining only contingent forms. The generative process needs an open mind able to reach the complex quality of our times where the question and result are more and more fast. So in Generative Art, Poetry, Music, Architecture, Design and Visual Painting work together in a new creative approach.

Generative Art is not only a technology. It is an approach to complexity able to use digital technologies but not to depend on them. The base of the generative approach is the vision of the future, by imagining a natural progression towards a possible where is not only the contingent result but also the progressive process. Our challenge is to set it in motion and keep it active at our best.

The GA creative process can always be reactivated also in the future, giving more and more surprising and unique results. We can remind to our creative life reviving our creative past. This process is an artificial mirror of our human creativity as artists. We can imagine that in the next century people might generate artworks following our past poetic vision.

Celestino Soddu and Enrica Colabella
Chairs of Generative Art conferences

Verona, 18 of December 2018

Drawing by Pisanello, Verona, at Louvre Museum

Pisanello, St. George and the princess, 1437, St.Anastasia church, Verona

PAPERS



TITLE
DREAM-INSPIRED DYNAMIC GRAPHICS
(Paper)

Topic: Art, Design

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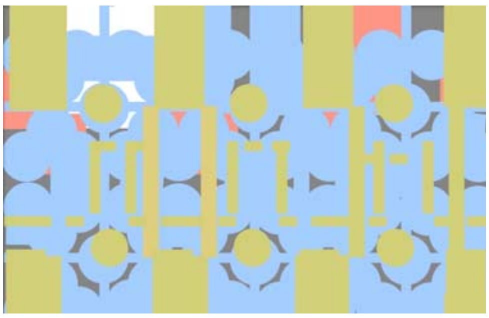
Abstract
Artists have looked for inspiration in dreams for ages. There are multiple examples of dream-inspired literature, paintings, music, or even comic books. Modern art movements like symbolism have often reacted against realism and explored a world of imagination and spirituality. Sigmund Freud's psychoanalysis has had a great impact on culture, as many artists, e.g. surrealists, have started to refer to unconsciousness. Carl Gustav Jung emphasised correlation between dreams and art as he saw them both as expressions of unconscious.
This paper presents a generative tool that makes it possible to create dynamic graphics on the basis of dreams [1]. The idea of dynamic graphics has been introduced in [2] as an attempt to capture the process of visual design, during which a designer adds and removes components, as well as modifies their properties until the required result is obtained. Because each modification is recorded as a film frame, the whole process is finally illustrated by an animation.
According to Gestalt psychology, each component of a dream represents a significant part of the dream owner and brings a message from unconsciousness about their emotions, problems or even possible solutions. Our tool provides a graphical interface that enables the user to illustrate their dream. Dream components (people, animals, places, things, etc.) are represented by symbolic shapes of different colours and can be located anywhere on the canvas. Every scene of a dream is represented by a configuration of components and constitutes a frame of animation. Having visualized their dream that way, a user can watch its action on a film. Automatically generated frames between the user-defined key frames representing scenes are interesting from both aesthetic and psychological point of view. They illustrate the dynamics of a dream, in which objects move, disappear, appear or transform into different things. While such transitions may be difficult to realize during psychological dream work, they can be treated as a dream component and be a valuable subject to analysis and interpretation. The graphics derived from in-between frames help to capture transitions.



The proposed computer program generates images whose irrationality reflects reversed logic of a dream on the basis of real people's experience. The obtained visualisations can be regarded as original pieces of dream-inspired artwork, as inspiration for artist's creativity or as a psychological tool for dream work and introspection.

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Key words: *dynamic graphics, dream-inspired graphics*

Main References:
[1] Natalia Olszewska: *Description of the design process by the example of dynamic graphics*, Master's Thesis, Jagiellonian University, 2018.
[2] Ewa Grabska, Joanna Tarko: *Creative Process of Artworks with the Use of Animation*, Collections of ISSEI [129], 2012.

Dream-Inspired Dynamic Graphics

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Premise

Artists have looked for inspiration in dreams for ages. There are multiple examples of dream-inspired literature, paintings, music, or even comic books. This paper presents a generative tool called Dynamic Images Generator that makes it possible to create dynamic graphics on the basis of dreams. Each component of a dream represents a significant part of the dreamer and brings a message from unconsciousness about their emotions, problems or even possible solutions. Dynamic Images Generator provides a graphical interface that enables the user to illustrate their dream. Dream components (people, animals, places, things, etc.) are represented by symbolic shapes of different colours and can be located anywhere on the canvas. Every scene of a dream is represented by a configuration of components and constitutes a frame of animation. Having visualized their dream that way, a user can watch its action on a film. Automatically generated frames between the user-defined key frames representing scenes are interesting from both aesthetic and psychological point of view. They illustrate the dynamics of a dream, in which objects move, disappear, appear or transform into different things. The proposed computer program generates images whose irrationality reflects reversed logic of a dream on the basis of real people's experience. The obtained visualisations can be regarded as original pieces of dream-inspired artwork, as inspiration for artist's creativity or as a psychological tool for dream work and introspection.

1. Introduction

Artists have looked for inspiration in dreams for ages. There are multiple examples of dream-inspired literature, paintings, music, or even comic books. Modern art movements like symbolism have often reacted against realism and explored a world of imagination and spirituality. Sigmund Freud's psychoanalysis has had a great impact on culture, as many artists, e.g. surrealists, have started to refer to unconsciousness. Carl Gustav Jung emphasised correlation between dreams and art as he saw them both as expressions of unconscious.

This paper presents a generative tool called Dynamic Images Generator that makes it possible to create dynamic graphics on the basis of dreams [1]. The idea of dynamic graphics has been introduced in [2] as an attempt to capture the process of visual design, during which a designer adds and removes components, as well as modifies their properties until the required result is obtained. Because each modification is recorded as a film frame, the whole process is finally illustrated by an animation.

Each component of a dream represents a significant part of the dreamer and brings a message from unconsciousness about their emotions, problems or even possible solutions. Dynamic Images Generator provides a graphical interface that enables the user to illustrate their dream. Dream components (people, animals, places, things, etc.) are represented by symbolic shapes of different colours and can be located anywhere on the canvas. Every scene of a dream is represented by a configuration of components and constitutes a frame of animation. Having visualized their dream that way, a user can watch its action on a film. Automatically generated frames between the user-defined key frames representing scenes are interesting from both aesthetic and psychological point of view. They illustrate the dynamics of a dream, in which objects move, disappear, appear or transform into different things. While such transitions may be difficult to realize during psychological dream work, they can be treated as a dream component and be a valuable subject to analysis and interpretation. The graphics derived from in-between frames help to capture transitions.

The proposed computer program generates images whose irrationality reflects reversed logic of a dream on the basis of real people's experience. The obtained visualisations can be regarded as original pieces of dream-inspired artwork, as inspiration for artist's creativity or as a psychological tool for dream work and introspection.

The paper is organized as follows: In the next section, the different approaches to dream interpretation are presented. The third section introduces the idea of dynamic graphics, while the fourth section describes the Dynamic Images Generator derived from the concepts discussed before. Finally, some conclusion is made in the last section.

2. Dream interpretation

Dreams have always been a subject of interest due to their mysterious nature and unknown purpose. Ancient cultures considered dreams as a way of contact with the world of spirit [3]. It was possible to receive a message from gods in a dream and therefore it was very important to interpret it correctly. In many tribes dreamers talked about their visions with others, especially with exprienced people like tribal elders, priests or shamans, who were capable of understanding the meaning hidden in described symbols. Early dreambooks confirm that symbolic nature of dreams was recognized, as most messages was not taken literally. Dream interpretation had impact on everyday life as well as political decisions, literature and many other aspects of human existence.

During centuries people gradually forgot about the meaning of dreams and lost contact with the spiritual world they had seemed to touch before. However, the twentieth century psychology has brought a new perspective to this issue. Sigmunt Freud, the founder of psychoanalysis, regarded dreams as a source of knowledge about repressed memories and thoughts [4]. According to Freud, dreams inform about contents that are for some reasons buried in the unconsciousness, for example due to trauma or social disapproval. Vague, distorted images occuring in dreams are the effect of so called censorship – a force that protects ego from the unacceptable. Dreams are therefore desires in disguise of various, often fantastic symbols. Psychoanalysis enables to find out their real meaning and solve inner conflicts, that otherwise may result in neurosis or hysteria.

Carl Gustav Jung, the most famous collaborator of Freud and the founder of analytical psychology, found Freud's interpretation of dreams insufficient [5]. According to Jung, symbols present in every psychic manifestation as human thoughts, actions, religion, dreams, art, or even numbers, represent something that is yet unknown and cannot be accessed in another way. Such symbols cannot be invented by any rational thought. They are spontanious and live entities with a power of influencing reality. Although they often refer to collective unconsciousness – a part of unconsciousness that is common for all people in different cultures – their meaning should always be investigated in accordance to individual conditions. Dreams seem more intense than reality because of additional messages hidden in symbols they use and their reference to archetypes, mythic motifs that describe universal human experience and evoke strong emotional response.

Dream interpretation can lead to serious transformation of one's life and support a process of individuation in which the conscious and the unconscious integrate. During the analytical work dreams become more and more meaningful. It is possible to distinguish certain characters often occuring in dreams that represent different parts of psyche. For instance, the figure of the dreamer usually refers to their ego, the conscious and rational part. A wise woman may represent self, the unification of consciousness and unconsciousness in a person, while a coat or a mask can be interpreted as their social face called persona. A female character in man's dream and a male character in woman's dream may represent respectively anima or animus, countersexual complement to the personality.

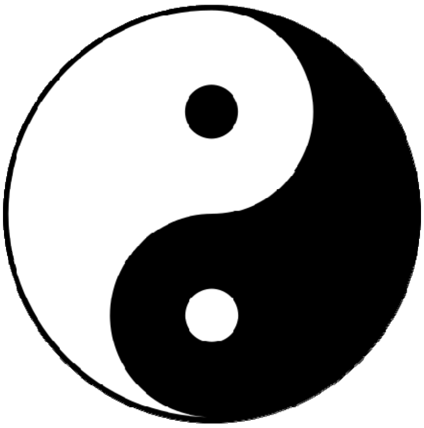


Fig. 1. Yin-yang symbol

The idea of complementarity plays a great role in Jung's approach to psychology and is derived from ancient Chinese philosophy, where two opposite forces, yin and yang, coexist in the universe. Yang, the active, male principle of nature, and the passive, female yin are present in every aspect of reality and cannot exist separately, like day and night, life and death. Fig. 1. presents the Yin-yang symbol reflecting duality of all things in nature. Such unification of the contrary elements is often present in dreams and can be noticed especially in irrational transformations of charactes or places. Jolande Jacobi, Jung's follower, gives an example of a prostitute replaced by a saint in young man's dream [5]. Similar transitions are very characteristic for the language of dreams. The generative tool presented in this paper gives an opportunity to observe them in a form of dynamic graphics, whose concept is discussed in the next section. Understaning the meaning of a dream – its plot, places, characters and transitions between them – gives specific satisfaction and often brings a new quality to the dreamer's life.

3. The idea of dynamic graphics

Contemporary design methods employ computers for automation of tasks that are time-consuming, require complex calculations or high precision which human brain finds unnatural and difficult. Although the main purpose of computer aided design is to significantly increase efficiency and quality of projects, what seems even more interesting is another effect of such approach – the possibility of human-computer interaction which may result in exploration of new creative solutions. Modern design tools assist the designer's creative process in multiple ways.

Generative systems as shape grammars or evolutionary programs of high level of autonomy provide designs that can be used as inspirations. More interactive tools engage in a dialog with the user and participate in the design process by reacting to the proposed ideas and searching for associations.

Another method of supporting creative design, has been proposed in [2] and is used as the basis for generation of dream-inspired dynamic graphics presented in this paper. This approach includes recording of the design actions as an animated film. In each step of the creative process the designer needs to evaluate the configuration of design components – their number, location, size, type, colour, etc., and decide whether the result is satisfactory enough to finsh the project. If not, the process is continued by making corrections and performing the evaluation again, until inducing a positive response. The presented method assumes that each transitional step of the design may be treated as a key frame of an animation. After at least two key frames are obtained, it is possible to generate a film by automatically adding in-between frames in order to gain impression of continuity and fluidity of the motion picture.

The animation gives a new insight into the design process and stimulates the designer's imagination. The generated in-between frames contain completely new, sometimes unexpected designs and therefore can enrich the design space and be treated as full-fledged solutions or as key frames for the next animation. Fig. 2. presents two key frames (Fig. 2.a and Fig. 2.b) defined by two design steps and some of the generated in-between frames (Fig. 2.c and Fig. 2.d). The obtained figures in Fig. 2.c and Fig. 2.d bring a new quality into a set of static pictures explored by a designer and may be used as a source of inspiration for further design.

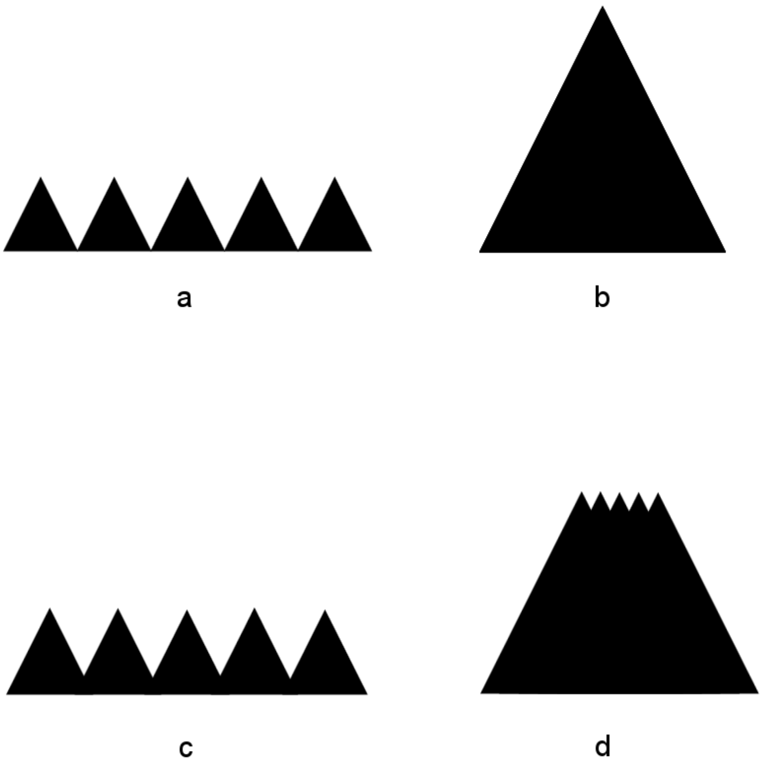


Fig. 2. Example of dynamic graphics illustrating design process

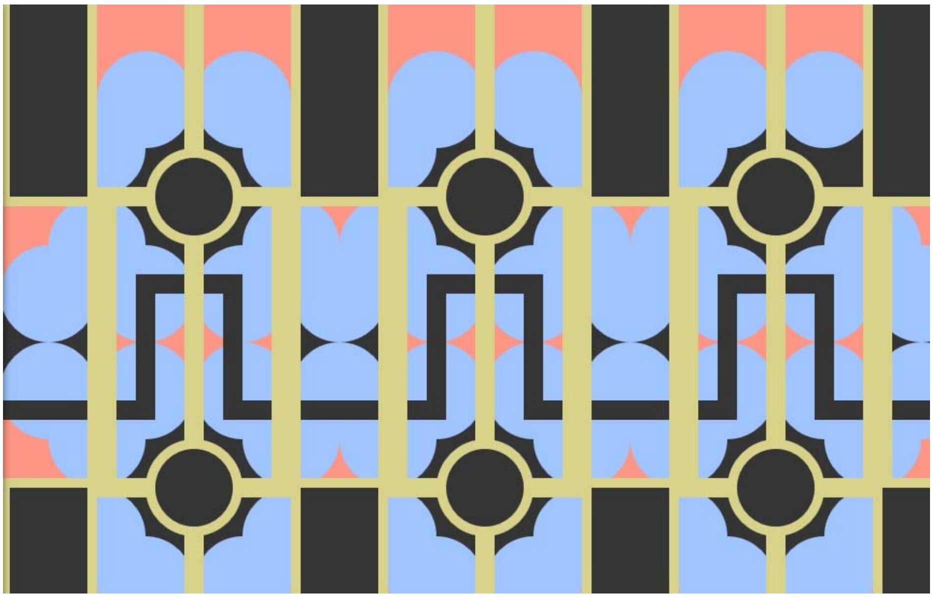


Fig. 3. Key frame (1)

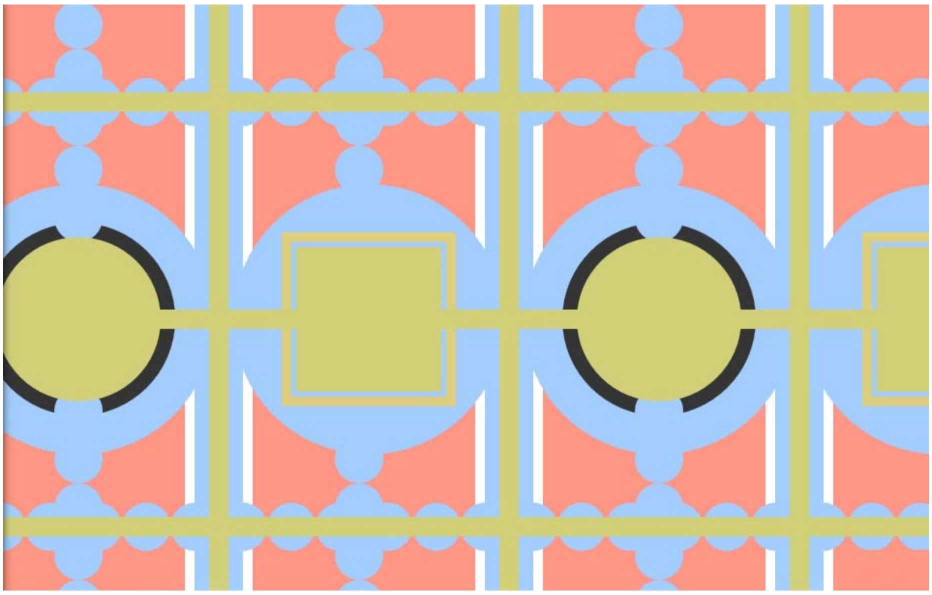


Fig. 4. Key frame (2)

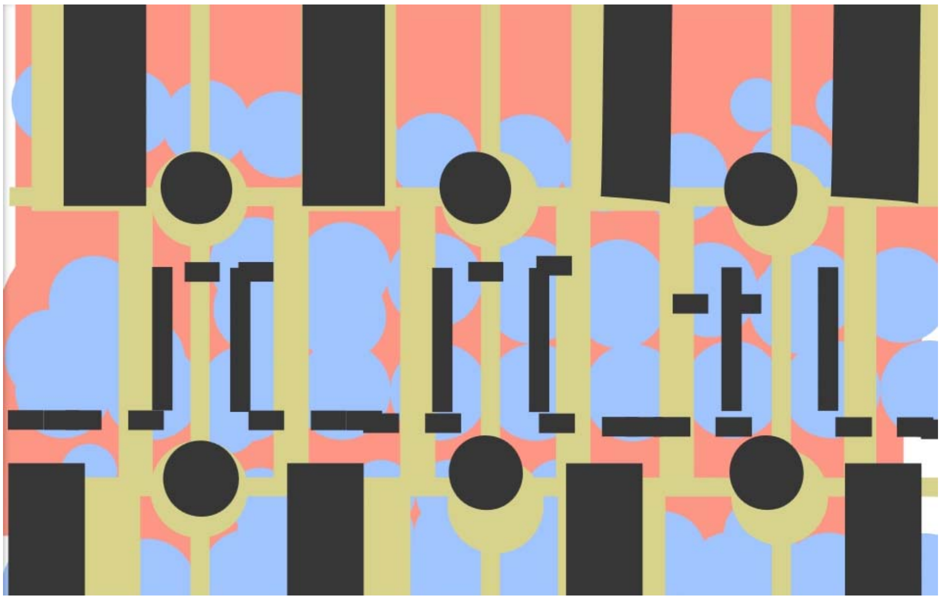
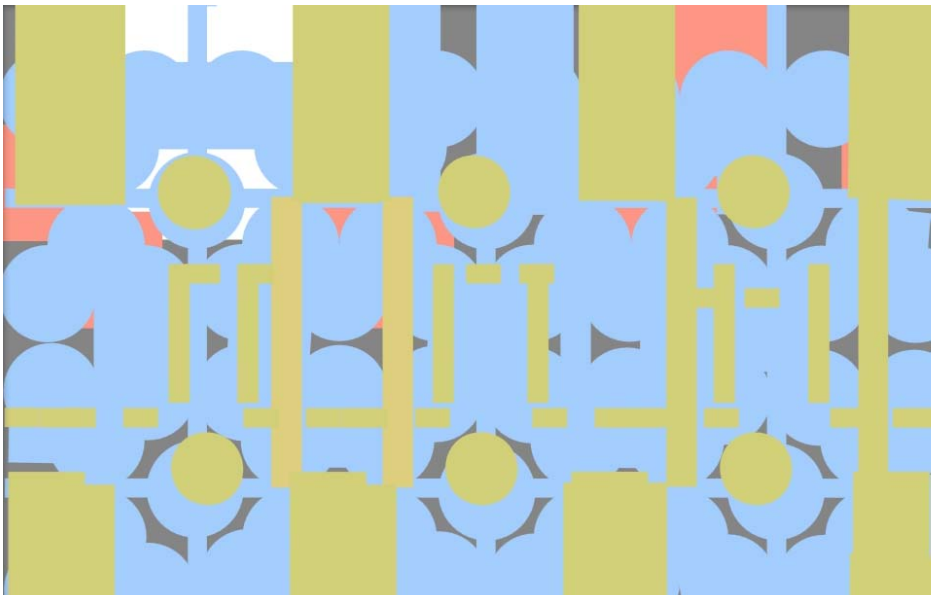


Fig. 5. In-between frame (1)

Another examples of dynamic graphics created by Dynamic Images Genereator are presented in Fig. 5. and Fig. 6. The images are in-between frames of an animation containing two key frames



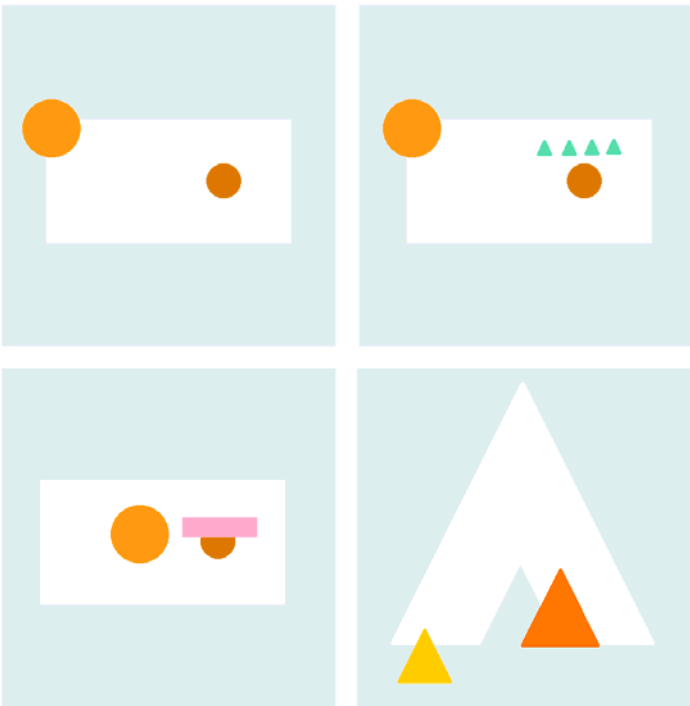
from Fig. 3. and Fig. 4.

Fig. 6. In-between frame (2)

4. Dynamic Images Generator

Although the presented tool – Dynamic Images Generator – is based on a concept of dynamic graphics used to support creative design, it also enables a user to investigate their dreams and generate images that reflect the atmosphere of symbolic visions. Because it is assumed that the user has no experience in drawing or painting, a set of basic components (elementary geometric

shapes like square, reclangle, circle, etc.) is given to represent characters, objects or places occuring in a dream. Although the simplicity of the components may appear insufficient for illustrating complex dream scenes, it has some advantages. A dream scene can be sketched with the use of elementary shapes with little effort from an unexperienced user. People, animals, objects and places from dreams are often vague and difficult to remember in details. Drawing them is challenging even for talented artists. Instead, one can represent dream components by choosing intuitively the most appropiate shape and setting their size and colour to gain required ambience. It is also possible to treat the set of elementary components as an alphabet for freely complex forms. Once a user puts all required elements of a dream scene into the canvas, sets their exact location, colour and size as well as the colour of the backround, the whole configuration is saved as an animation key frame. Analogically, the next scenes of a dream constitute next key frames. When the process of illustrating a dream is completed and all the key frames are stored in the program's memory, the in-between frames are generated in order to obtain fluent transitions between components. The resultant animation enables to observe the dream's story. At any time a user may stop the film in order to capture the current frame and generate an unpredictable image of transient, often uncanny transformation.
As an example, one can consider a dream with the following story: In the beginning, the plot takes place in a shopping centre, where in the hall there is located a glass box with a little boy inside. The boy is a salesperson, but no products to sell are visible. He is acompanied by his boss, an unpleasant middle-aged man that feels scorn for his employee. The boy is making some polite but slightly sarcastic remarks. They contain the truth that is visible in a form of four green sparks surrounding the boy's mouth and head. His speech evokes unexpected rage in the boss, who takes a flat cardboard box and crushes the boy. The next scene takes place in a church, with two middle-aged women in front of an altar. One of them is wearing yellow or orange clothes and is standing a little aside. The other woman, in a light grey dress, is in front, right in the centre of an altar. Suddenly a monk comes and whispers something to the woman in grey. It is information about death of her son, the little boy from the shopping centre. The woman is in despair, but her only



reaction is to genuflect in a place she is standing.
Fig. 7. Dream key-frames

The schematic pictiues presented in Fig. 7. show a sequence of scenes from the dream description.

The white shapes represent the place of action – the rectangle in case of the shopping centre and the triangle in case of the church. On the basis of in-between frames an image from Fig. 8. has been obtained. It can be treated as a synthesis of the scenes above, which is especially visible in a shape representing the place.

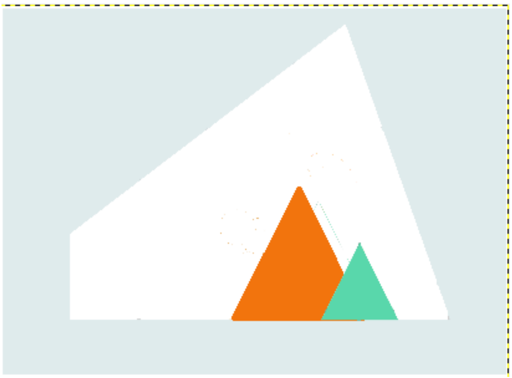


Fig. 8. Dream synthesis image

5. Conclusion

Dreams are an interesting area to explore. The presented Dynamic Images Generator gives an opportunity to illustrate one's dream in a form of animated film. The in-between frames generated automatically for the purpose of animation fluidity enable to capture transitions characteristic for the symbolic language of dreams. This approach is derived from the idea of dynamic graphics that illustrate the creative process in order to inspire the designer. Dynamic Images Generator may be used as a tool for creating inspiring images, but it also performs some therapeutic functions. Users are able to express and observe their dreams, which can help in dream interpretation and introspection. This process may be enriched by modifications of an animation plot and making up alternative solutions.

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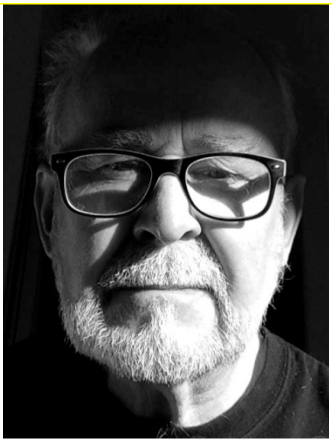

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THE LABOURING MACHINE –THROUGH REPETITION TOWARDS AUTONOMY
Paper and Artworks

Topic: Art

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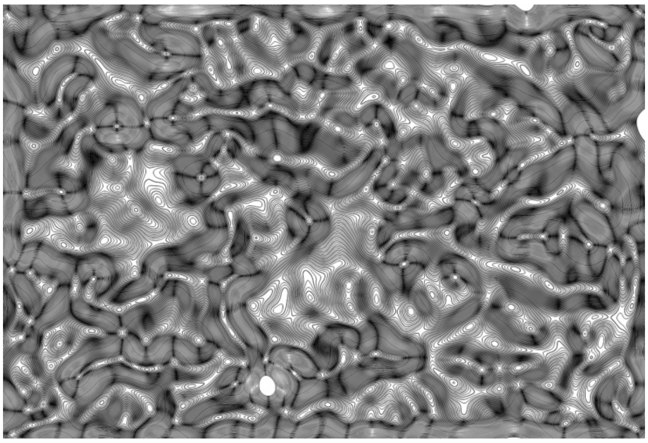
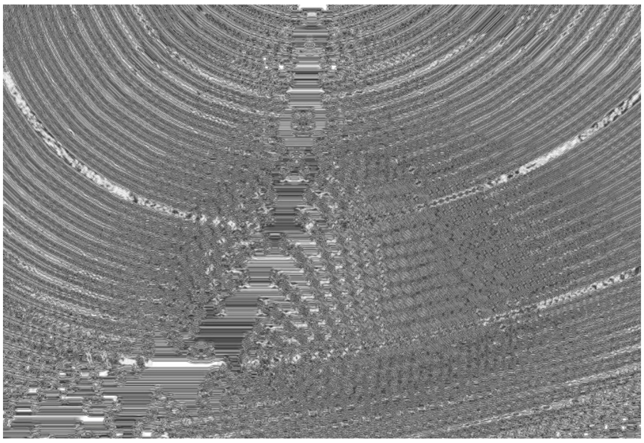
Abstract

Repetitive processes that are at the heart of computing provide a means to generate unintended forms and processes. Although originating in human coding and invention, looping processes left to generate forms and patterns over long periods of time seem to take on life of their own, beyond expectations of the algorithmic results. In this recent work simple actions contained within ubiquitous imaging programs are used to generate new forms through thousands of automated repetitions. The resulting images show, complex structures emerging from the indulgent excesses of the process.

The work is examined in relation to earlier works that used simple human actions repeated over and over again over a period of days and weeks – tracing, scribbling, cutting, erasing, rubbing, and others - to generate large, complex installations that were a visual record of a particular human activity. This new work, and its accompanying theory, imagines a laboring machine, and the idea of a hidden, selfless labour to fancifully suggest an autonomous existence generating unbidden images and structures.





The exhibition of a selection of large printed images show the range and variety of images produced together with details of their processes and elapsed production times. The paper sets out to situate this work within the larger understandings of repetitive process in contemporary art and its use as a aesthetic and poetic device.

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Key words: repetition, labour, art

The Labouring Machine - Through Repetition Towards An Autonomic Uncanny

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Premise

Repetitive processes that are at the heart of computing provide a means to generate unintended forms and processes. Although originating in human coding and invention, looping processes left to generate forms and patterns over long periods of time seem to take on life of their own, beyond expectations of the algorithmic results. In this recent work simple actions contained within ubiquitous imaging programs are used to generate new forms through thousands of automated repetitions. The resulting images show, complex structures emerging from the indulgent excesses of the process. Examined in relation to earlier works that used simple human actions repeated over and over again, the new work imagines a labouring machine, to suggest an autonomous existence generating unbidden images and structures.

The Process of Repetition

Earlier artwork used simple human actions repeated over and over again over a long periods to generate large, complex installations that were a visual record of a laborious, almost obsessive, human physical activity. Transferring that labour to a machine fancifully suggests an autonomous existence generating its own images and structures, as the artist relinquishes control to a machine.

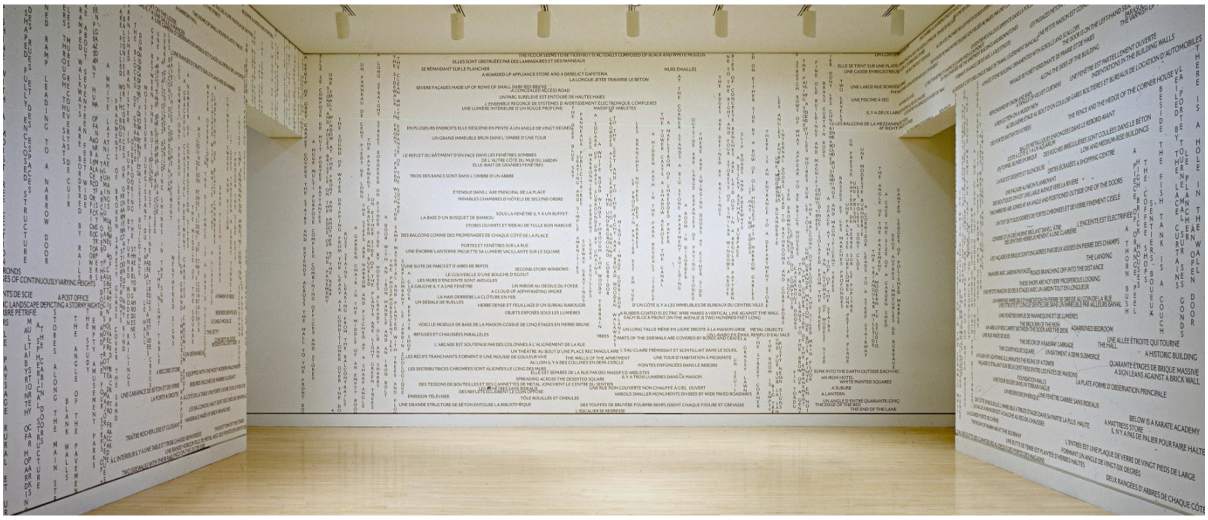

Image 1: City of Lights, Laser cut vinyl, durachrome photographs, © 1997

The work builds on areas in earlier work that explored the unbidden emergence of forms and patterns through prolonged manual and computational processes. This work used analog, hands on, techniques to mix text and image until meaningful phrases or image juxtapositions emerged. In the second half of the 90s computer algorithms were used to generate random textual arrangements. [Image 1] Recent work has referenced paranormal investigations to explore the appearance of organic and human forms in noisy or empty visual and sonic fields, where there should properly be none, and the emergence of lifelike patterns in the visual processes of computers.

Related earlier work comprised hours, days even weeks – gluing, tracing, pasting, cutting, erasing, rubbing, and others - to generate large, complex gallery installations. This early work was deliberately and excessively labour intensive, with room sized, ephemeral, site-specific installations taking up to 1000 hours to install up to 500, 000 elements, and were readable in terms of a clear trace of the labour invested in their production. They contained signs of the process, evidence, of human activity: fingerprints, blood, errors in texts, visible signs of exhaustion in the structure of the work: patterns within the works showed fatigue, loss of concentration, arbitrariness, sloppiness, waning interest, and their opposites: deftness, vigour, care, and so on. They were concerned with building an architecture of signs in which meaning emerged from the actions within the site.

Image 2: Rapture – scattered bodies, printed vinyl, video projections, © 1996

The production/installation process for these works was mentally and physically exhausting. Long days and nights were required to make and complete the works within the periods available for installation. Under such circumstances the process became automatic, unthinking. The placement and configuration of elements was increasingly unconcerned with making meaning, communication or pattern, but simply obsessed with reaching, an end result.

The initial content for these works were established by chance means. Texts for example were culled from various dictionaries and encyclopaedias, printed and cut into individual words, and mixed into a kind of textual soup in large containers. Choosing an element to adhere to a wall was simply a matter of reaching in a drawing out a slip of paper. As such the processes involved in making these installations became increasingly fewer and fewer. A typical process might only be: draw a piece of paper from a bin, paste into an empty space on a wall. Repeat. Again and again. [Image 3]

The meanings that emerged from these works were unclear. That they were handmade was apparent, as was the fact that they took many hours to install. Their initial presence was of labourious installation, of investment, of commitment, coming from the visible, unintended index of that labour. Beyond this recognition, and driven

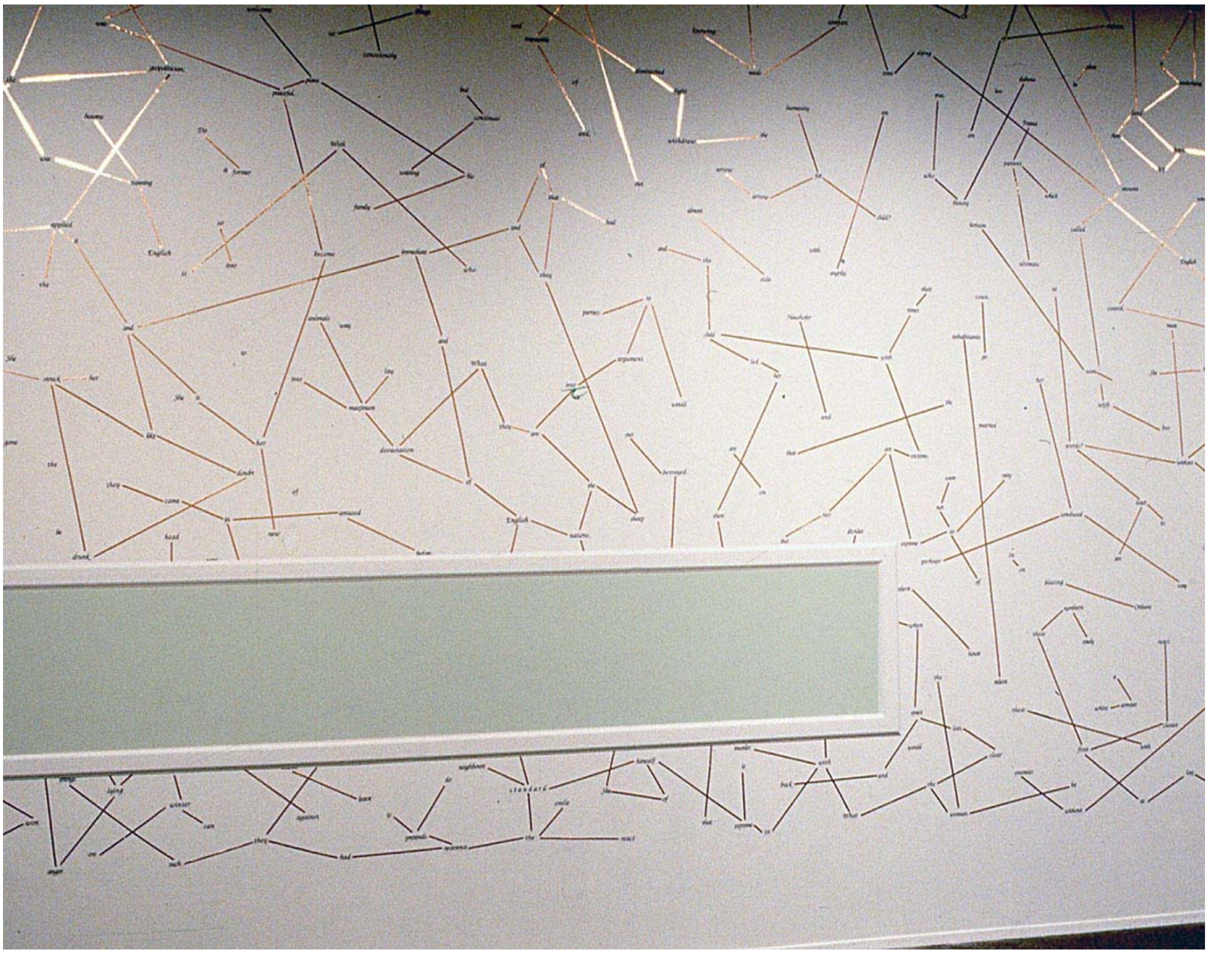

Image 4: mother, Xerox prints, copper tape, paint, wood, © 1990

by seeing recognisable words and images that implied a some sort of narrative, reading the work became an exercise in looking for connections, for meaning that was at best elusive. Often sensible, poetic phrases, or image clusters, would emerge, only to disappear as links became tenuous or untrustworthy, or were subverted by adjacent texts or images. Faced with such resistant meaning, the viewer was obliged to take an entirely interpretative stance to become a producer of meaning rather than a consumer of previously arranged meanings.

These early works presage many later computer works and directly relate to the works discussed here. In both works the smallest of actions repeated many times build a complexity that generates new meanings and new understandings. There are differences. The new works employ a recursive, feedback loop, the state immediately prior to the current state effects changing an imminent future state, that is missing from the earlier activity, the medium for the works is digital rather than material, and the raw material is non narrative, but in both, the works build from simple to complex by the simple reiteration of a process and the accretion of the results of that process, and in the end both rely on a local context of to provide a way to enter the work, beyond mere aesthetic appreciation.

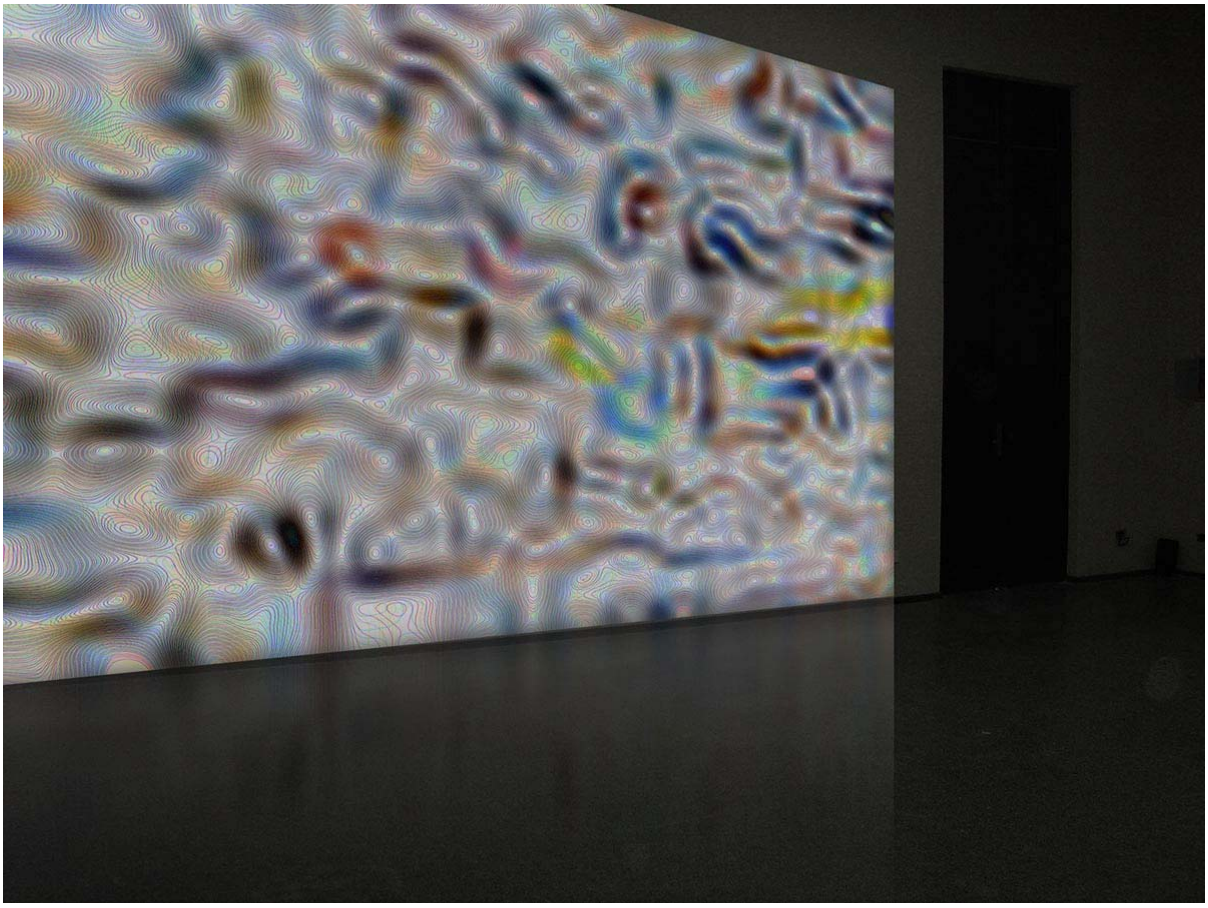

Image 5: Untitled, computer generated projection, © 2018

The images of new work, presented here as prints, are projected on to the surfaces that generate their initial state. [Image 5] A camera takes an initial image of a blank wall and predetermined processes spawn an image that overlays the blank wall with content generated entirely from the location. Quite what these images show is unclear. They are often colourful and complex. They can be more or less aesthetically pleasing. They are final results of a process to generate a particular image in the context of local, site specific, input.

The original image is processed by a repeating loop of instructions culled from everyday imaging programmes. Tracing, finding edges, blurring zooming, cropping and so on. Repeated many thousands of times the process begins to produce images that are increasingly and apparently unrelated to the initial image. The type and length of each process, their places in the algorithm and the total number of reiterations are determined by true random numbers, generated by random.org. The resulting images are highly textured, some reminiscent of topographical maps, some of abstract and op art painting, others of water ripples, stains or shadows. [Image 6]

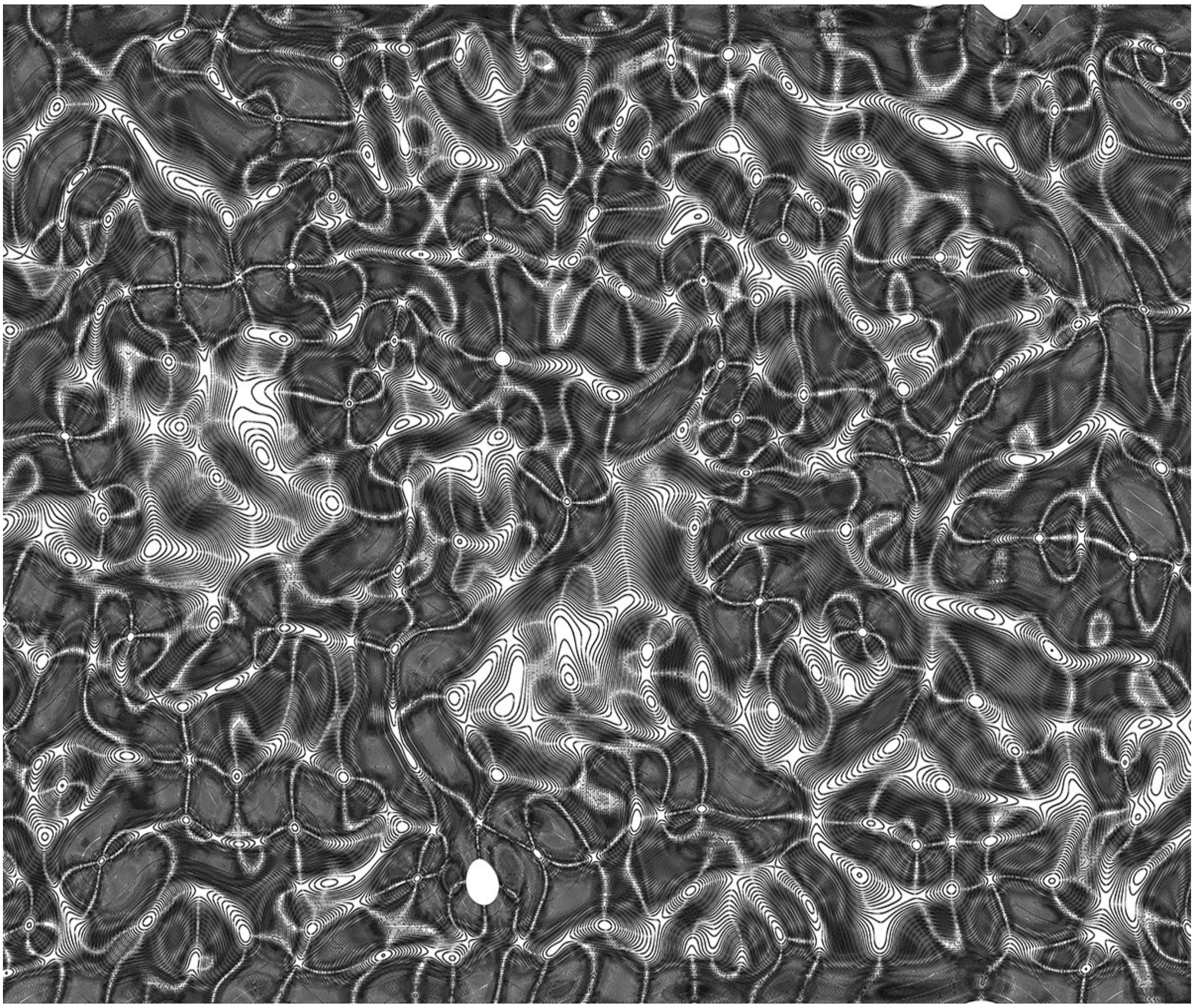

Image 6: Untitled, digital image © 2018

In retrospect, the actions in earlier works seem increasingly like an exact analogue of the actions now employed by computational works presented here. There was a very attenuated set of instructions, the processes were invisible at the time of each iteration (hidden in a closed gallery space), and the results were, to all intents and purposes, even though not unexpected, unforeseen, until revealed by an interpretative viewer.
Amy Gogarty explains:

"The endless hours of searching, selecting, printing, cutting, assembling and eventually disassembling, seem at first pointless, absurd, excessive. …the role of labour is central to the work – The constituent parts have literally passed through the body of labour – Dunning's body – and this deeply personal act has transformed them. The viewer becomes involved in the "labor of language" by entering into the text, passing the shifting signifiers through the mind, and gleaning the scant shreds of shared meaning, the reader/viewer similarly participates in the text." [1]

The Labouring Machine

It is perfectly possible to imagine a machine consuming energy, working tirelessly on some endless calculation. The processes are unseen, the results never seen; the only indication of activity is the warmth of the unit and the consumption of electricity. Something is being undertaken. Pure and autonomous, set into motion by a set of instructions, but creating strings of autonomously discovered numbers. Considering a computational machine in terms of labour, attempts to move our

This machine sits apart, unconnected except for the instructions to engage with and carry out the task. But contemporary thought places the machine as part of a complex interconnected world of objects, rather than objects existing independently from other objects and selves, and its work often appears to mimic the processes of identity formation. While this reimagining of a machine is fanciful, it is useful in a reconsideration of the human/machine relationship in the creation of artworks, as mutually symbiotic.

Parallel with the expanding and developing technologies of communication and representation in scientific research and artistic production, the notion of identity has undergone a transformation. In the past, the notion of self has been directly linked to the physical limits of the body constituting a more or less objective and stable make up. Presently this locative conception of the body has been extended to include all places where electricity can power and spawn communication devices and systems. It is common now to speak of the body as distributed and the mind as extended.

Felix Guattari writes:
…the machine's environment forms part of machinic agencements. The liminal element of the entry into the machinic zone undergoes a kind of smoothing process, of the uniformisation of a material, like steel, which is treated, deterritorialized and made uniform in order to be moulded into machinic shapes. The essence of the machine is linked to procedures, which deterritorialize its elements, functions and relations of alterity. Hence it will be necessary to speak of the ontogeny of the technical machine as that which makes it open itself to the exterior. [2]

Technology has changed how we consider the machine/body relation. Bodies have long been seen as machines, now machines can be seen as bodies. There is a perception that our material selves and machines are becoming increasingly enmeshed in an information age.

Christoph Asendorf writes:

"Unlike the eighteenth century, in which man became a machine, in the nineteenth, the machine is assigned human characteristics … The machine has become a subject, the individual its object …" [3]

Daniel Black continues:

"… while the automata of the Enlightenment had existed in a realm outside everyday life and had possessed no productive capacity, industrial machines operated amongst the human population, working in close relationships with or replacing human workers. For Karl Marx, the industrial machine was an entity that replaced the worker by claiming his tools and wielding them in his place while the mechanised factory was a kind of monstrous organism that absorbed human bodies into itself, 'a productive mechanism whose organs are human beings'. [4]

Anson Rabinbach describes the relationship between the industrial machine and the labouring body: The human body and the industrial machine were both motors that converted energy into mechanical work … From the metaphor of the motor it followed that society might conserve, deploy, and expand the energies of the laboring body: harmonize the movements of the body with those of the industrial." [5]

It is clear we have increasingly complex relationships with machines, and contemporary thought begins to resituate the machine as not only extensions of our bodies but as identities, as selves existing beyond our bodies. Our world has moved towards a hybrid state, composed of biological organism and machine in which it is not always precisely clear "who makes and who is made". The boundary between organism and non-organism, actor and non-actor, self and non-self has been abandoned and our postmodern bodies are artificial constructions of technologies and technological discourses. The body is so inextricably enmeshed with its surroundings and the technologies that support it, that representations of the body become indistinguishable from the mechanisms of its representation. Looked at this way the machine begins to labour with autonomy, with self-purpose, to manage its own processes, to point towards a new unsummoned product from its labours.

As mechanical reproduction has passed into digital reproduction, so new technologies have reshaped the perceiving body. The relationship between the image and the receiving body is now complicated by the processes of a new machine/human interpretative paradigm that extends into all of life.

In 1435, Alberti, in *Della Pittura*, described a surface onto which a projection of a scene could represent 3D reality in two dimensions. The construction of the Albertian grid allowed its users to map an accurate rendering of the world to a two dimensional surface in order to get a view of a scene by observing it through a thin veil, or *velo*. The idea is that we can get a *correct* image of some object seen through such a veil or a window by tracing the outline of the object on the windowpane. However, paradoxically, in the search for a truer representation of the world through the use of a drawing machine to produce more realistic images, artists found out just how distorted the world appears. On one hand the development of perspective allowed the reproduction of increasingly realistic images, but at the same time changed our sense of how pictures are produced. It allowed an observer to understand images not as windows on the world, or as simulation, but as perceptual constructions that are the product of machines and humans.

Context, place, participant

After the initial, decision on my part to initiate the process, the machine does the hard work of repeating a process loop many, many times. They are, without a guiding hand, to all intents and purposes, completely formal, devoid of intentional narrative content, and while exhibiting structure, they present as random images, more or less equal in value and weight, of similar significance and appearance, without apparent obvious meaning.

Images do not exist outside the world in which they are generated. They are connected to memory, to place, to society and its historical, economic, cultural and political moments. Even when obvious meaning is absent or withheld, the interpretative drive is strong. George Wolford at Dartmouth College finds that people find patterns in random sequences, even when they are told that the sequences are random. “There appears to be a module in the left hemisphere of the brain that drives humans to search for patterns and to see causal relationships …even when none exist." [6]

His research partner, Michael Gazzaniga has nicknamed this creative narrative generating part of the brain "the interpreter." [7]

What Wolford and Gazzaniga say is that we are driven to find pattern in randomness, that it is unavoidable, even when we are aware of the drive itself.

N. Katherine Hayles suggests:

The contemporary pressure toward dematerialization, understood as an epistemic shift toward pattern/randomness and away from presence/absence, affects human and textual bodies on two levels at once, as a change in the body (the material substrate) and a change in the message (the codes of representation). [8]

This introduces a new category of subjectivity, an embodied hybrid of human and machine, that privileges pattern, and its opposite, noise, over the material and moves between the material and the immaterial. A new body acknowledges the absent. This body is biologically developed to see pattern and grant it significance in its dynamic mental model of its world. This is why degraded images can be recognized, why patterns can be seen in clouds, or in the noise of a television tuned to a dead channel. And it is why indeterminate images, patterns emerging from noise, can and must be reconfigured as images of things.

The works use this interpretative drive to explore physio-spatial memory, and as means to invoke recent and distant histories or invisible elements, and to create psychologically charged sites, building a narrative linked directly to the site through the perceptions and interpretations of images by a participating audience.

Meaning is always generated through relations between place, context and participant. [9] It is temporary and enduring, dynamic and stable, comprising many psychological, biological and emotional states, and systems of belief, and it is easily and continuously remade. Whether real or imagined meaning is bound to the physio-spatial context even as that context is bound to meaning.

In spite of its apparent randomness, there is a sense that these works embody a system of logic, reinforced by the means by which they are displayed and produced. False leads, blind paths, abound in the interpretation of the images, but what is perceived is that something is actually emerging from the processing that is generated directly from the machine, even when quite what that is remains elusive and uncertain. In this way the images are a visibly direct function of the space suggesting that something is being discovered, that something is being revealed - that something in the material of the space is at play in the generation of the texts.

The feedback loops generating the images recalls the difficulties contained within the Bootstrap Paradox, in which objects can exist even though they have never been created. This time travel paradox describes a situation in which information or an object is sent back in time, it is recovered in the present and becomes the very object/information that was initially brought back in time in the first place. It is this lack of original to generate an image that lays at the heart of the work and a digital uncanny. The forms that emerge represent only the inner workings of a machine system; yet often engender a feeling of an uncanny unbidden presence, the feeling of an otherworldly event.

The Uncanny

One of Sigmund Freud's original senses of the uncanny, that feeling of something appearing to have an inexplicable basis, beyond the ordinary or normal, seeming uncomfortably strange, included the notion of "the unhomely", the experience of strangeness associated with aspects unfamiliar to or out of place in house and family. Freud suggested that there might be aspects of the uncanny that arise from feelings that are usually not allowed to come to consciousness and remain unspeakable. For this project, this suggested that the withheld or concealed might give rise to a sense of the uncanny at the moment that such concealment or withholding is apparent. Moments of recognition of presence rather than absence, pattern rather than randomness, might give rise to feelings that are synonymous with the uncanny. These works leverage the momentary perception that there is something meaningful arising from a place where there should properly be nothing meaningful, as the basis to reconsider the machine as the source of some producer of meaning.

A similar effect, albeit one based in vision, can be seen in Michelangelo Antonioni's film Blow-Up. The main protagonist, Thomas, a photographer takes some pictures of a couple's meeting in Maryon Park, in Greenwich. When developed, the negatives reveal what seems to be evidence of a murder. Subsequent enlargements reveal what might be a body and a gun.

The black and white prints, enlarged until they show only blobs of silver particles are surely unintelligible. And yet they are obstinately open to interpretation. What do the photographs show – an innocent meeting, the scene of a murder, or are they merely an opportunity for one or more pareidolic or apophenic experiences? Cultural and biological compulsions and interpretations drive these random optical marks into patterns that demand to be recognized – and in turn more and more believed. A recursive loop forms – the more believable the images are the more they look like the subject's desires, and in the desiring the more believable they become.

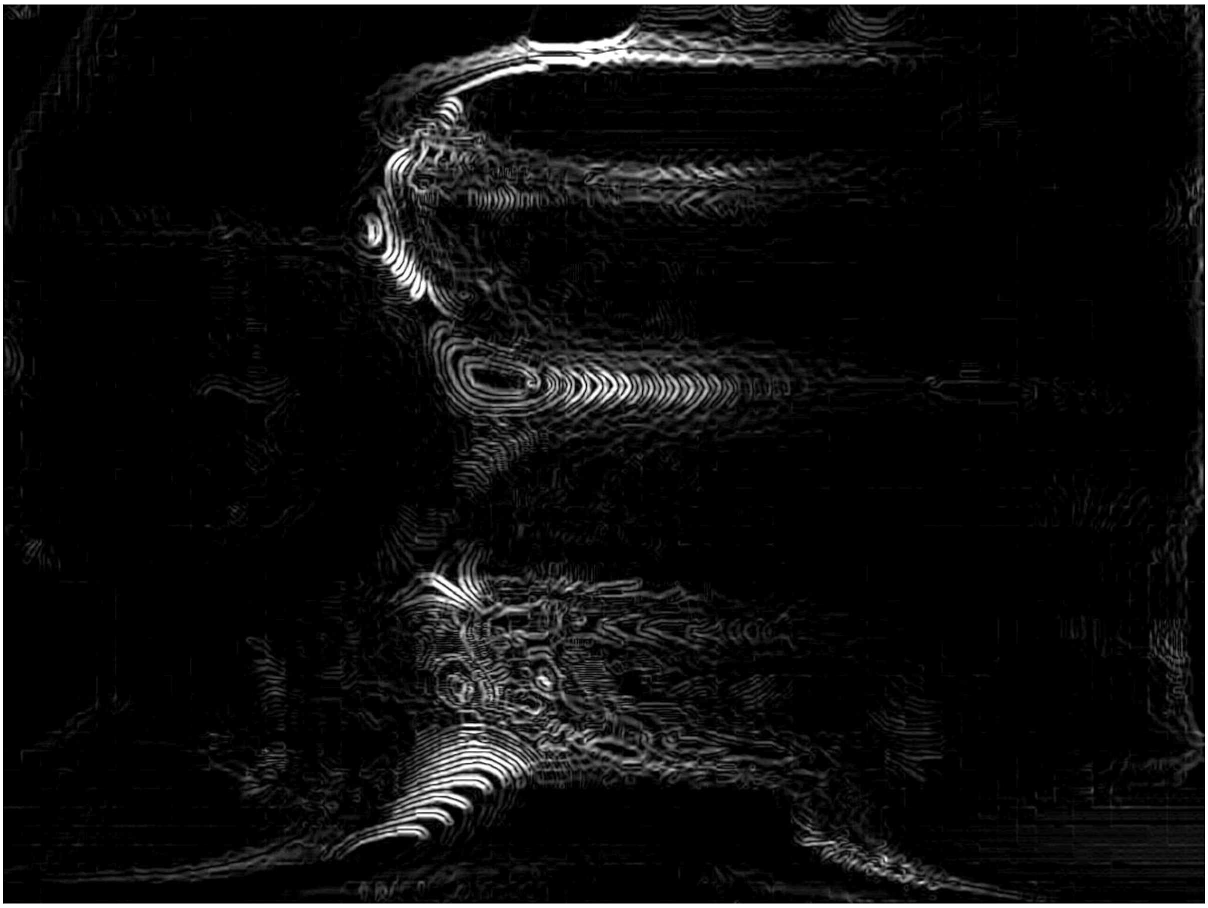

Image 7: Untitled, digital image © 2018

The works seek to use this experience of something made strange, through something hidden being revealed, to complicate a disturbance in the relational field made of the self, its surrounding space, and labouring imaging machines. As a participant sees images emerging from autonomous processes the results are perceived as meaningful and highly structured. Reconfigured through the lens of the uncanny, and the drive to find meaning, the images, like Antonioni's photographs, are remade as product of a symbiotic relationship between human and machine.

An audience is primed to respond in particular ways. Presenting these works in an art context affords a viewer with an experience that is familiar – it is at once an artwork that expects interpretation, it is cinematic, and it is further contextualized through a rational, computing process. Other contexts other locations will elicit different responses, but in all cases the drive to interpret the images will be present.

A machine with any degree of autonomy enables an artist to eschew making aesthetic choices, but one tendency is for the machine to make overly formal and aesthetic images that are devoid of real content other than pattern, form and colour. Framing the work in particular ways, locating the machine as a connected to bodies places, and worlds, recognizes that the machine generates meaningful patterns that can act as emotional and historical triggers. That can like the traces of labour in earlier works acts as indices of past activities to invoke past memories and past emotions.

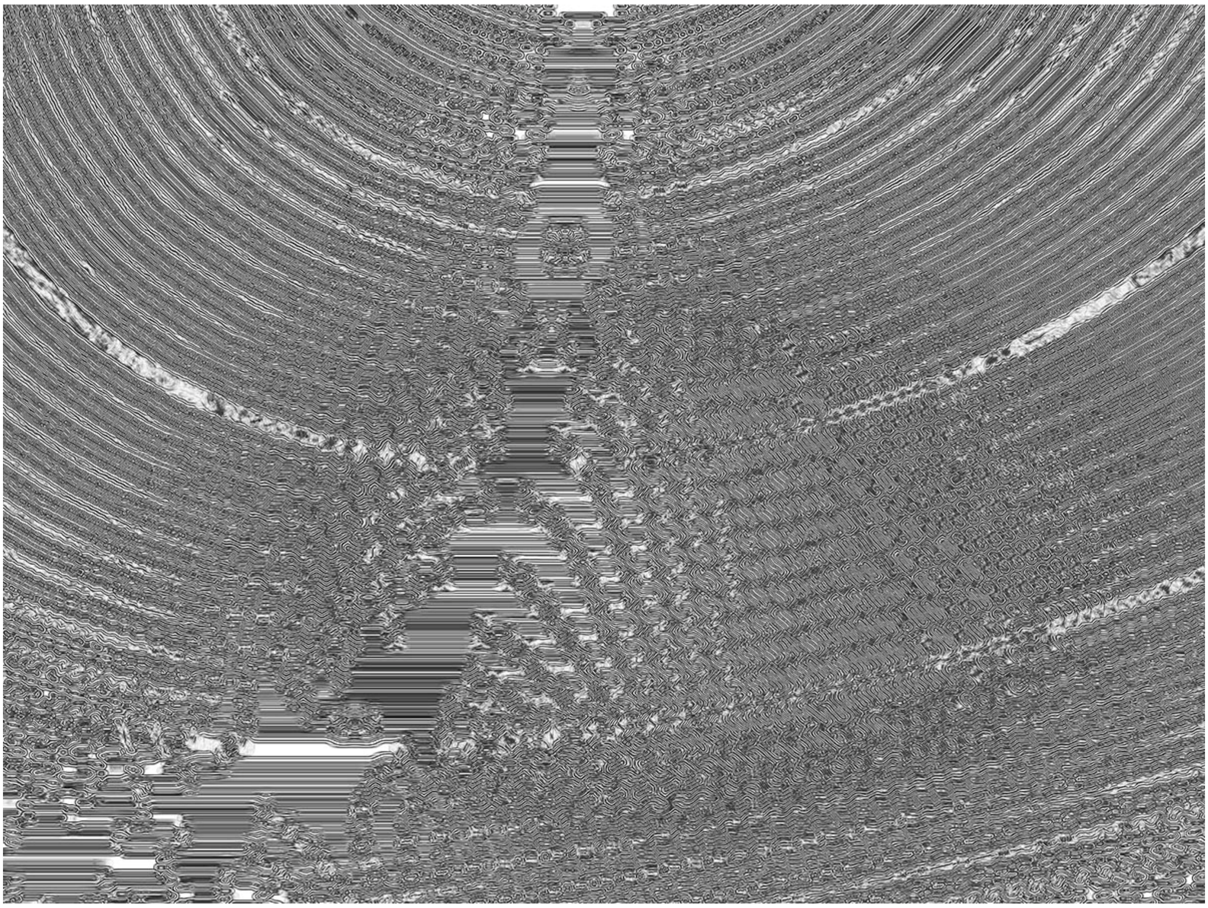

Image 8: Untitled, digital image, © 2018

Orhan Pamuk in remembering the recent passing of his friend Ara Guler the famed photographer of Istanbul writes:

"…the landscapes of the city eventually turn into a kind of index for our emotional life. A street might remind us of the sting of getting fired from a job; the sight of a particular bridge might bring back the loneliness of our youth. A city square might recall the bliss of a love affair; a dark alleyway might be a reminder of our political fears; an old coffeehouse might evoke the memory of our friends who have been jailed. And a sycamore tree might remind how we used to be poor. [10]

New works form the beginnings of a new means to develop installations and visual systems that use the relationship between an observer and an image generating machine to build a picture of the shared autonomy between machine and human. Previous work shows that interpretations of images are constructs that are not uniquely related either to the information that generates them nor the images themselves. They are a complex hybrid of machine, human interpretation, and artistic vision, which promotes a remapping of information beyond any functional value. This powerful drive to fill in the spaces opened up by those parts of an entity that resist their informational links, produces what we might only think of as false positives, but in doing so brings into focus acts of cognition that are inextricably linked to the building of meaning, the understanding of narrative, and, in turn, to the structuring of the body. While earlier work used readable content – texts and representational images - this new work develops processes that use a combination of machine imagining and the apophenic and pareidolic impulses to construct meaning not so easily linked to prescribed index or information. The structures created are a function of the body used to observe them and the machine/human used to produce them. [Image 8]

The works embody the belief that the new technologies have not only altered our traditional understandings of observer and representation, through the development of visual spheres that are now structurally and conceptually different to the mimetic zones of film, television and photography, but also, and much more importantly, through what Virilio describes as: 'the splitting of viewpoint, the sharing of perception of the environment between the animate (the living subject) and the inanimate (the object, the seeing machine). [11]

This shift in consideration opens up the possibility that computational machines are mediums – as opposed to tools, and there are ways to think about the labour of a machine as inextricably linked to our bodies and our selves.

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OPEN WATERS [NORTHWEST PASSAGE AND POLAR SEA]
(Paper)
Topic: Digital Poetics Interactive Installation

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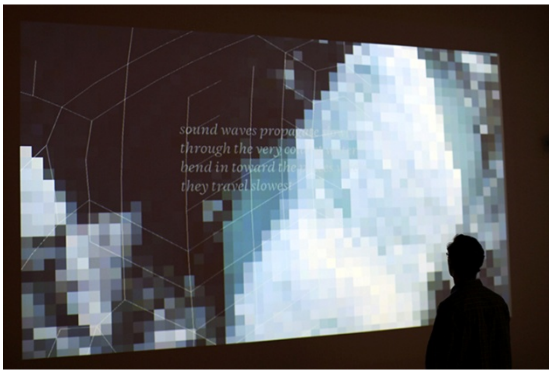

Abstract

Open Waters [Northwest Passage & Polar Sea] is an interdisciplinary, interactive multimedia art work inspired by a five-hundred-year history of expeditions that sought to find the Artic Northwest Passage and Open Polar Sea. The work blends together this rich history with twenty-first century realities of environmental and geopolitical change at the top of the Northern hemisphere.

Through a constellation of interconnected pieces including an interactive book and interactive wall projection, the *Open Waters* exhibit seeks to echo aesthetically the ecological and other change affecting the Arctic cryosphere and to offer creative, analytic lenses through which to understand what is occurring there and how we got to this conjuncture. The installation scrutinizes and reworks a number of discursive and visual genres across disciplines, to expose both how they have represented the Arctic's realities and potentialities and how they have consequentially intervened in their unfolding.

An interactive artist book features a suite of archival poems on Arctic exploration, politics, and ecological change. Across the double-page spread, containing printed poems, appears projected digital generative art consisting of fading poetic text and animated phrases that coalesce and then fade away (or melt). As the viewer/reader turns the pages of this unique, print-digital hybrid book, RFID tags imbedded in each page signal a sensor that in turn signals a computer to "turn" the projected digital page. The interactive back wall of the gallery combine video and audio generative works that, using a Kinect motion sensor, respond to the activity present in the room, evoking the effects of human disruption of the Arctic environment.

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Key words: Generative Art, Interactivity, Digital Poetics

Open Waters [Northwest Passage & Polar Sea]

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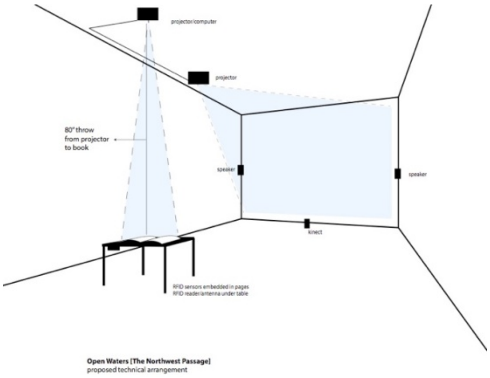

Figure 1 Open Waters Gallery Layout

Open Waters was created for and organized in association with the Brown University Arts Initiative symposium titled *Polar Opposites: Creative Interventions in the Arctic and Antarctica,* April 2018. *Open Waters* transforms the gallery into an ambient environment, produced in large part through generative artworks. Visitor interactions, both intentional and involuntary, with these generative ensembles triggers audio-visual events that shape the gallery space and happen differently each time they occur.

1. Background Collaboration

Open Waters [Northwest Passage & Polar Sea] is the most recent artistic collaboration between the authors, and is part of a series of works focused on the Arctic and Antarctic. A previous collaboration, *Ice Core Modulations: Performative Digital Poetics* was featured at the 2015 Generative Art Conference (among other venues) and included imagery and poetic fragments inspired, generated and controlled via historical Antarctic CO_2 data taken from ice core samples made available from the National Snow and Ice Data Center (NSIDC). These collaborations build on a series of prior works involving several of the authors that have focused on creative approaches to visualizing and sonifying data, generative and interactive audio-visual works involving place and personal narratives, and the synergistic rendering of a creative idea in multiple digital and physical media.

As a collaborative goal, *Open Waters* seeks to create a body of artistic work that is a semantically rich landscape containing simultaneity of disparate yet complementary disciplinary perspectives connected to the historical and evolving conceptions of the Northwest Passage and Open Polar Sea. To create a common source vocabulary for the collaboration, the creation of the work began with conduct in-depth historical research and gathering of archival and audio-visual source material. From this primary matter, poet Judith Goldman wrote a set of poems and poetic text fragments that other collaborators used in their respective media, rendering the phrases typographically, programming their behavior in generated audio-visual projections, and subjecting spoken recording of the phrases to dynamic audio processing.

2. Historical Inspiration, Current Climate Data and Source Material

Our title *Open Waters* is meant to capture multiple, productive contradictions on which our project reflects:

- The historical irony that the Northwest Passage, once so ice-impacted it was thought to be mythical, is now traversable by commercial transport vessels and cruise ships alike
- The longstanding, Western, tragic-Romantic fantasy of a polar paradise and "Open Polar Sea" that was held tenaciously, against all evidence of the frozen, impassable state of the high north
- The contemporary conflict between, on one hand, scientific and indigenous perspectives focused on understanding, assessing, and halting ecological damage and, on the other, forces that see the rapidly melting Arctic as an opportunity for resource extraction, economic growth, and alterations of the parameters of political sovereignty.

Figure 2 Northwest Passage Routes

Figure 3 Gallery Wall Rendering of Northwest Passage Routes

In sixteenth-century Britain, the spatial technology of a Northwest Passage (Figure 2) was central to the inception of globalization and imperialism, while the Arctic, as a region where climate change is amplified and accelerated, is emerging as a focal point of the Anthropocene era. The interconnected pieces of the Open Waters installation (Figure 3) thematically and formally echo, in a number of modes, the process of ecological and other change affecting the Arctic cryosphere.

The gallery's media ecology also reflects the collaborative structure and process of researching and creating *Open Waters*. Our primary sources include archival documents, travel narratives, ship's manifests, personal letters and memoir, contemporary science articles, historical maps, government policy statements, trade journals, newspaper headlines, data sets, recorded environmental sound, and stock and drone video footage. Some of our primary materials have been created, rather than sourced, such as the visual vocabulary of aesthetic ice-forms and the Processing language programs for the digital media. From this primary matter, we have made poems, book components, processed and mixed audio tracks, data visualizations as digital graphics, processed video segments.

3. Poetic Elements and Processes

The twelve poetic texts written for *Open Waters* are original, research-based poems composed by Judith Goldman, through scholarly-aesthetic exploration of the historical archive of works of literacy, documentary, scientific, and political on the Northwest Passage and the Arctic realm. The poems are informed by contemporary scientific literatures on climate change and ice loss in the Arctic; engineering and economic literatures on the feasibility of new routes of transport/shipping; and legal literatures on contemporary questions of sovereignty among nations and indigenous claims.

Major themes of the poems include:

- The long history of extractive capitalism in the polar north, told through the exploits of Martin Frobisher and James Knight,
- Changes in the global ocean current system, due to desalinization through glacial melt,
- New plans around global transport of commodities using various polar routes, Arctic cruise tourism, and the effects of pollution on wildlife,
- The expeditions of John Franklin and the search for his lost expedition,
- Emily Dickinson's abiding interest in polar travel and imagery, and
- Contemporary Arctic geopolitics.

Written specifically for the print-digital hybrid structure of the interactive book (Figure 5), the poems are organized in thematic or topical "vignettes," with each vignette taking up a verso-recto page (double-page) spread, with some of the text appearing in print and some digitally projected. Phrases from the poems appear in the gallery as vinyl printed forms on the walls and are incorporated into the digital projection on the gallery's back wall.

After the poems were written, the collaborators selected textual fragments to feature in their work. Specifically:

- Each two-page spread of the book featured one of the poems and used 'fixed' poetic fragments with typographic layout and formats designed by the visual artist,
- For each spread, 'dynamic' poetic texts were programmed in Processing with generative spawning and behaviour logic as to when and where they would appear and how they would evolve over time, and
- Texts were recorded by the poet and then subjected to sound processing for use in the audio-visual wall projection.

Figure 4 presents an excerpt from the poem "Open Water Fetch".

open water fetch *in the Arctic* sea & swell depend
on open water ***fetch*** air-water-ice interface ocean surface
waves *{sea & swell}* generated by winds blowing over distance ***{fetch}***
waves develop beyond pure wind seas, evolve
into {swells}
long waves resulting
from nonlocal winds
remain tied to available **fetch**

swell waves accumulate *energy*
in the wind sea wave *energy* scales w/***fetch***
{space required to build a swell}
ice can suppress waves distance available for wave
evolution
wave energy scatters

Beaufort Sea: ice-covered in summer: no waves *to measure*
reduction in seasonal ice cover results in larger waves ***waves break***
up sea ice *accelerate*
ice retreat
results in larger
waves break
up sea ice
accelerate
ice retreat results in larger
~ *waves*

Figure 4 Excerpt from "Open Water Fetch" poem

4. Interactive Book of Poetry

The main component of the gallery installation is a large format (65x65cm) hardbound interactive thirty-page artist book featuring a suite of twelve poems. The book is bound with a screw-post binding allowing for flexibility in adding/changing pages for future iterations. The book cover is inlaid with hand-marbled endpapers made from facsimile historical maps of the Northwest Passage. Embedded in each left side page of each double-page spread is an Radio Frequency Identification (RFID) tag that is recognized by a RFID reader positioned within the left side of the table. As the reader turns the page, the tag is recognized by the RFID reader and sends data to the computer (positioned inside the table), which then generates corresponding graphics, and poetic texts that are projected onto the open pages of the book.

The components of the projected information, generated by Processing software, include various sized text phrases, and ice graphical imagery blue triangular clusters, and perspectival line art (***Errore. L'origine riferimento non è stata trovata.***Figure 5). These dynamic visual elements are designed to interact and move around in relation to the fixed text on the page. Different behaviours are assigned to each element; certain text passages are formed from coalescing granular particles before dissolving and fading out. The non-textual imagery evokes qualities of ice, from the translucent blue and surface cracks of frozen lakes to the drifting of icebergs retreating from a glacier.

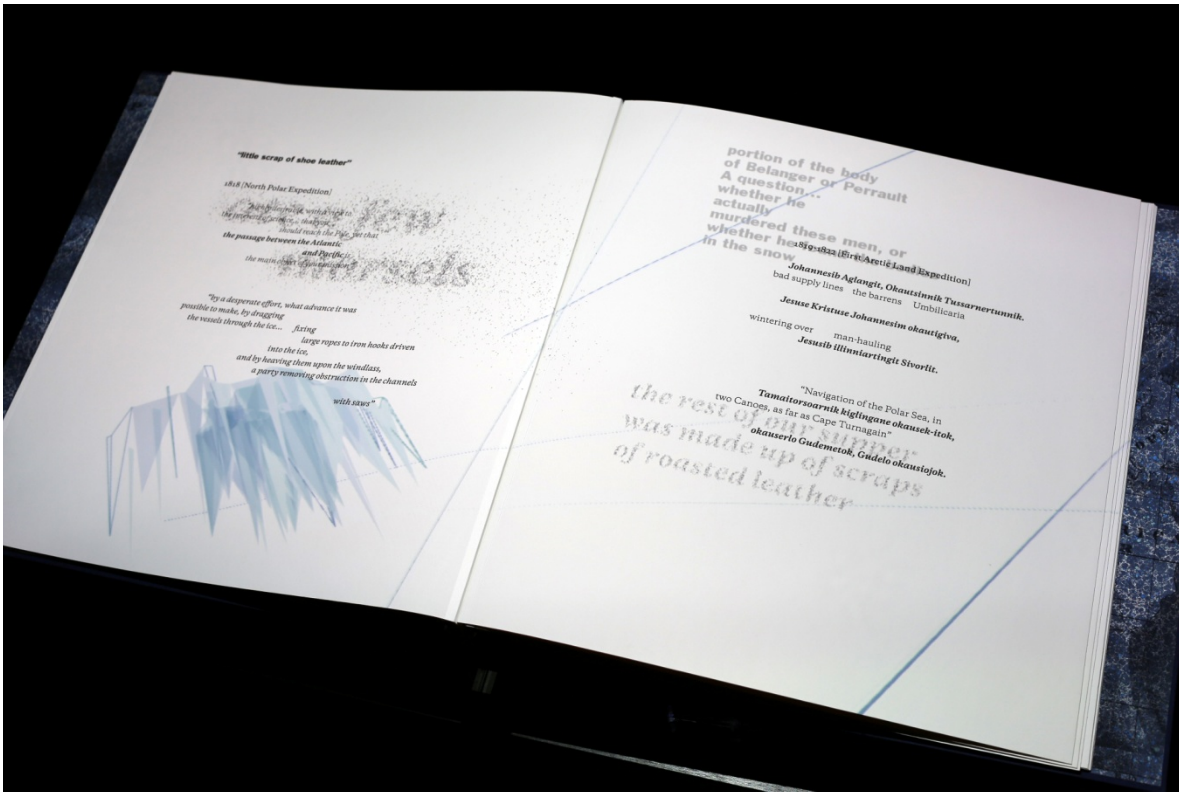

Figure 5 Interactive Book showing fixed printed and dynamic projected elements

Similar to erasure poetry forms, the projected generative typographic elements intentionally obscure and "overprint" the printed text on the page changing the meaning and emphasis of the poem. The projected text and graphics are designed to enter and exit the pages slowly allowing the reader to engage in complex readings. The poetic text and animated granulated phrases slowly appear, coalesce, and then fade away (or melt). Ice cluster forms appear across the pages, briefly obscuring the text. Because the digital text complementing a particular print page changes with every reading, generated by algorithmic selection from materials matched to that page, the book is different each time it is read. By combining physical interfaces with typographical information in a hybrid environment, this piece explores new ways of receiving and reading information.

5. Interactive Visual/Sonic Wall Projection

The interactive back wall of the gallery combines video and audio works that, using a Kinect motion sensor, respond to the activity present in the room, evoking the effects of human disruption of the Arctic environment. The video projection (Figure 6) introduces drone footage segments of Alaskan and Greenland glacial and meltwater, as well as footage from a United States Coast Guard icebreaker. This footage is combined with animated, digital graphic vignettes that combine mesh-structures based on climate data with visual poetic language that is generatively processed/altered through a program whose algorithm is based on ice loss and other data from the National Snow and Ice Data Center.

Figure 6 Back Wall Projection

Movement in the room is detected by a Kinect sensor and granulates the video, amplifies the movements of the mesh-structures (Figure 7.)

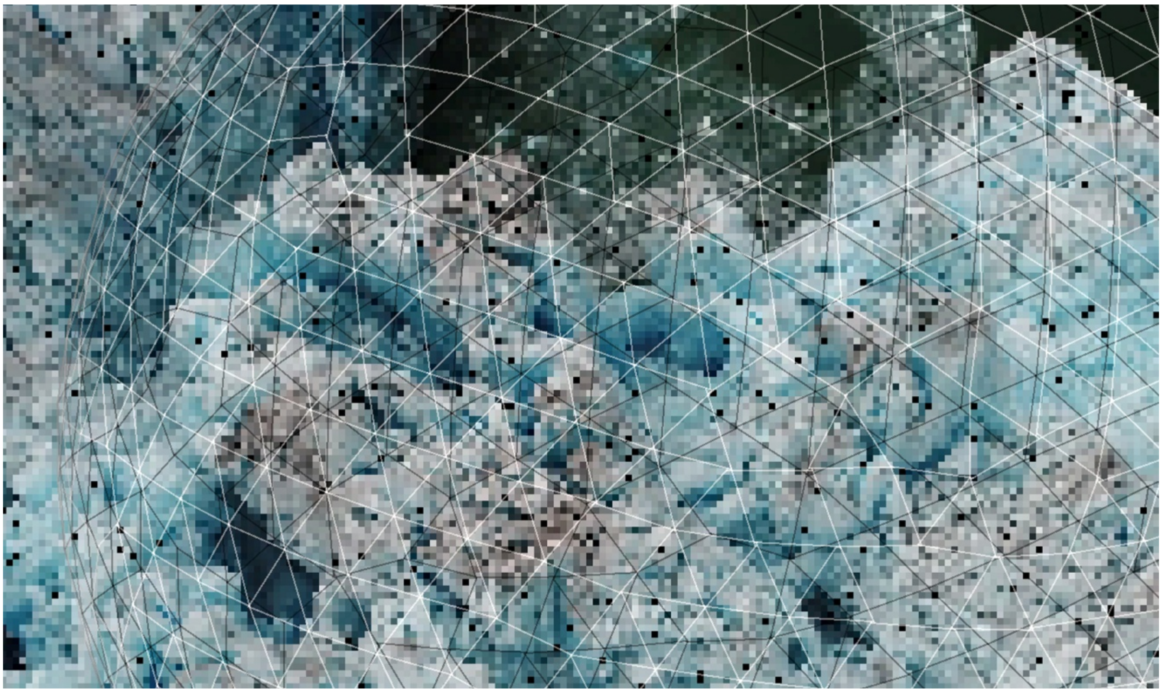

Figure 7 Video Processing based on Kinect Gesture Sensing

The audio embodies a long, multi-layered loop made of processed sonic material from the Arctic landscape (flowing water, glacial calving, whales, sonar, and industrial sonic pollution) and spoken language that includes poetic excerpts and interview responses about Arctic Policy taken from a faculty member of the US Coast Guard Academy. Against this sonic backdrop, audience motion triggers audio events of ice cracking that intensify with increased visitor presence and activity.

The generative behaviours triggered by the Kinect motion sensing are based on an estimation of the number of people in the room and gestural detection of left and right oriented gestures. New visitors and gestures lead to sequences of video granulation (in proportion to the number of people in the room) and activity over short periods of time, returning to a recognizable video background as activity subsides.

6. Summary and Future Directions

The collaborative intent of *Open Waters [Northwest Passage & Polar Sea]* project allowed for interdisciplinary synergy between a creative team spanning poetry, computer science, electronic sound composition, and visual art, expanding the technological and creative means by which the historical information about the arctic could be conveyed and expressed. Our collaborative team plans on an ongoing series of installations that bring art and science together immersively and interactively to educate the public about the Northwest Passage: its status as an important strand in the history of globalization; its potential to reconfigure contemporary networks of global relations; its function as a bellwether of the transformation of Earth systems. We are confirmed to exhibit a version of this work in 2019 at the Burchfield Penny Museum in Buffalo, New York. We plan to travel this research to other exhibition spaces and will transform its components both to continue to explore dimensions of the Northwest Passage/Arctic and to make each installation site- and public-specific.

References

The complete booklet containing all references for this work can be found at:
https://www.conncoll.edu/andrea-wollensak/open-waters-northwest-passage--polar-sea/

Open Waters project links:
https://www.conncoll.edu/andrea-wollensak/open-waters-northwest-passage--polar-sea/

Brown University Arts Initiative Promotional Brochure (page 8)
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Brown University POLAR OPPOSITES: CREATIVE INTERVENTIONS IN THE ARCTIC AND ANTARCTICA (conference and exhibition April 5-6, 2018)
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FLEETING IMPRESSIONS OF THE INDIVIDUAL
(Paper)

Topic: Design

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Abstract
Using as an example the experimental tactile laboratory *Seeing with the Hands, Touching with the Eyes* by Tjaša Bavcon, Katja Burger and Jasmina Ferček of the Oloop design collective, we will look at alternative approaches to learning and working in the field of design. More importantly, we will look at how to avoid getting trapped within the conventional design process, starting instead from nature's perspective; a perspective that—as Maria Blaisse, a Dutch designer and artist, reminds us—is also our own.

The text and the lecture will present the research, which incessantly questions its own results and the results of its experiments in order to transcend the boundaries of the expected. By raising doubt about the established, ordinary notions, it will make us confront the questions about the primary role of design and its purpose. At the same time, our endless exploration will reveal new areas of design potential. By focusing their investigation on perception, emergence, play, learning, action and cooperation, the designers of the Oloop collective sustain the conditions that allow the emergence of a variation of the product or, sometimes, even just a momentary result. The key word here is "variation": every change in this process, however minor, is immediately reflected in the experiment – in the impression of the individual. This is the richness, the emotion that distinguishes their work from conventionally designed products. They set themselves apart by establishing an alternative approach.

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Key words: potentiality, design, experiment, tactile laboratory

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Fleeting Impressions of the Individual

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Premise

Maria Blaisse in collaboration with Oloop Design, the Density of Lessness workshop, from the "Seeing with the Hands, Touching with the Eyes" cycle of participatory events, photo: Tjaša Bavcon

With the three cycles of research/experimental participatory events by Tjaša Bavcon, Katja Burger and Jasmina Ferček of the Oloop Design collective as an example, we will look at alternative approaches to learning and working in the field of design. More importantly, we will look at how to avoid getting trapped within the conventional design process, starting instead from nature's perspective; a perspective that—as Maria Blaisse, a Dutch designer and artist, reminds us—is also our own.

The text presents research that incessantly questions its own results and the results of its experiments in order to transcend the boundaries of the expected. By raising doubt about the established, ordinary notions, it will make us confront the questions about the primary role of design and its purpose. At the same time, our endless exploration will reveal new areas of design potential. By focusing their investigation on perception, emergence, play, learning, action and cooperation, the designers of the Oloop collective sustain the conditions that allow the emergence of a variation of the product or, sometimes, even just a momentary result. The key word here is “variation”: every change in this process, however minor, is immediately reflected in the experiment – in the impression of the individual. This is the richness, the emotion that distinguishes their work from conventionally designed products. They set themselves apart by establishing an alternative approach.

The position of the observer

Broadly speaking, running a workshop involves two sides – the side of those conducting the workshop and the side of those who carry out the workshop activities under the supervision of the former. We challenged ourselves, along with the designers of the Oloop Design collective, to assume the third position – the position of the observer, one who strives to perceive, comprehend and observe the activities of both sides involved in the process. This is a position that workshops usually lack.

Valentina Čabro and Oloop Design, “Textile Body Textile” workshop, from the participatory events titled “Between Inside and Outside”; photo: Tjaša Bavcon

Another challenge was to figure out what I could achieve from this newly conceived position of the observer, this invisible fly on the wall; or rather, how what I observed could be interpreted using the ethnographic method. At the time of this writing, I've already played the role of the observer in three Oloop workshops. The first workshop cycle, titled *Textile Now!* (2016), was followed by an experimental project *Seeing with the Hands, Touching with the Eyes: Tactile Laboratory* (2017) and eventually by this year's participatory event, titled *Between Inside and Outside* (2018).

In anticipation of the first workshop, I wrote down the following question in my notebook: what in particular to observe? I added another question: where should I direct my attention? Should I focus on the participants' answers? On their posture, the energy they invest? Or mostly on the process itself and its results? Eventually I decided to surrender to the workshops' spontaneous flow, turning the observation of the first workshop cycle into a process of *active learning*. In the course of this spontaneous observation, a question arose of how to use unplanned research and experimentation to uncover the latent creativity in all of us, or rather, how to give this creativity the room to express itself and come (back) to life?

I carried on this approach to observation in the subsequent editions. As an observer, I came to the workshops with a blank piece of paper and no questions prepared. In the course of my observations, I was struck by an unexpected question that started to intrigue, even torture me. The questions that were generated also became goggles through which I observed everything that occurred thereafter; this way I was able to verify the validity of the questions while at the same time searching for and examining the multiple variations of the answers.

After the first question, which was how to uncover creativity through spontaneous exploration, the second tactile laboratory evoked in me a fascination with seeking the relationship between the emptiness and tangibility of matter; this came about in the course of researching the understanding of what is essential: the essence itself, or that which gives the essence the potential to exist? The last edition, which explored the space between the inside and the outside, generated a question that represented a sensible superstructure of the previous ones. The focus of the research spurred me to examine the search for ways of balancing the particular with the common, maintaining the equilibrium between the need to establish an individual's voice, while also recognizing, as well as potentially taking into consideration, the broader group they're part of.

In the following text is a selection of thoughts that emerged from the observations at the three workshop cycles. Looking back, it is evident that I inadvertently ended up applying the principles of both observational and perceptual learning. Using the terms introduced by James J. Gibson and Eleanor J. Gibson in the 1955 text "Perceptual learning: differentiation or enrichment?", I found myself alternately answering the following two overarching questions: “(a) In what sense do we learn to perceive? (b) In what sense can we learn by perceiving?”. [1]

The necessity of touch

Bruno Munari wrote in his book *Design as Art* that "copying nature is one thing; understanding it is another." [2] The other side of the same coin is given by Maria Blaisse, who declares that “nature provides all information, but we are occupied with ourselves and we don't realize all information or all solutions are already there." [3] Creativity is similar; children would be described by most as inherently creative, whereas in adults we often perceive this quality as remarkable, as something only possessed by the gifted or the specially trained. The rest must resign themselves to imitation — or stagnation. The first cycle of workshops by Oloop, *Textile Now!* demonstrated the opposite. It showed that the key to unlocking creativity in adults is to let ourselves rediscover it, to allow ourselves to re-establish an (active) relationship with our own creativity. For this to happen, according to John Berger, we need to introduce a key component: touch.

“We only see what we look at. To look is an act of choice. As a result of this act, what we see is brought within our reach – though not necessary within arm’s reach. To touch something is to situate oneself in relation to it.” [4]

Oloop Design, the "Dialogue with the Thread" workshop from the participatory events cycle "Textile Now!", photo: Tjaša Bavcon

It is therefore touch, tactile stimulus, that lets us truly begin an activity, that opens the opportunity to (re)discover our latent creativity. At the workshop titled "Dialogue with the Thread", there was a practical example of pondering this thought that revolved around a particular question involving the participants themselves. The question could be entirely personal in nature, or it could be general; it could be associated with that immediate moment or it could address something that had accompanied the participants for a long time. The only condition was that it had to be a question that the participants could not answer at that moment, and that this inability to answer had to feel significant to them, even to the point of being distressing. It was a question that we could also describe as a conscious or unconscious driving force; something that would make the participants continuously ruminate over it to in order to find an answer.

The merit of this assignment was in the details; at no point during the workshop did the question have to be disclosed to others (whether or not to do so was left to the discretion of the individual). To the contrary – the designers challenged the participants to think about how to manifest the question itself in the form of textile. It was a sudden turn. Only moments before, the participants were faced with their questions, unable to answer them, and now they were asked to perform a seemingly impossible task – in mere minutes, each had to materially express their question through the medium of textile. As soon as they got over the initial surprise at the unusual nature of the task, most of the participants dug into it, thinking about how to express themselves. They accepted the notion that there is no such thing as a wrong way to materialise their question; indeed, most of them ended up spontaneously realising that creativity is already within them. What remained at that point was to sense and touch the textile, thus beginning to form the relationship discussed previously.

To paraphrase Blaisse – just as nature already provides all information, so do we all already *possess* creativity. But in order to discover this creativity, it is not sufficient to merely observe others create — it is necessary to touch, to start establishing a relationship, attempt, make a mistake (assuming there is such a thing as a mistake in the first place), start anew and finally surrender to the process of iteration. A rapport must be established with the material, as Mladen Dolar asserts is the case in the field of art: "you produce the idea with the material, with the matter." [5] This is not a step that can simply be skipped.

By establishing such a rapport, all of us will find discover in ourselves the potential for creativity. By discovering this potential, we clear the path to the next stage of learning – the stage of acquiring new knowledge. The learning stage, in turn, will open the doors that lead to exploration and understanding, and once you have understanding, you acquire the ability to create something from nothing. Moreover, you can start questioning the established notions, blazing your own trail and breaking with tradition. You can start probing the essence.

The essence of the essence

Doubting what is established and examining the essence was more intentionally explored in the second cycle of Oloop's experimental participatory events: *Seeing with the Hands, Touching with the Eyes: Tactile Laboratory*. The workshops focused on the exploration of alternatives to the hegemony of vision (by exploring tactile feel, weight, sound and the motion of textile and other materials) with the intention of enabling the participants to examine their responses to situations they don't often encounter. At the same time, it gave them an opportunity to perceive their ability to look and to see in a completely new way.

Zlatko Đogić and Oloop Design, "The Sound of Textile" workshop, from the participatory events cycle "Seeing with the Hands, Touching with the Eyes";
photo: Leonora Jakovljević

Finnish architect Juhani Pallasmaa would describe the latter as the ability to explore “the very essence of sight itself”. He asserts that “all the senses, including vision, are extensions of the tactile sense; the senses are specialisations of skin tissue, and all sensory experiences are modes of touching and thus related to tactility.” But that at the same time, our “body is truly the navel of [our] world, not in the sense of the viewing point of the central perspective, but as the very locus of reference, memory, imagination and integration.” [6] As the Italian designer Bruno Munari would elaborate – from the moment of our birth we perceive and acquaint ourselves with the world using all our senses; we should therefore dedicate a lot more attention, as well as intentional education, to all of our senses. [7]

An example of such intentional education of and familiarisation with own body in relation to the space we inhabit was the exploration of “spontaneous movement into the material”, mentored by Dominika Kacin. The main purpose of the first phase of the workshop was to expand the sensibility about what defines our feeling of the whole, which Kacin sought to elaborate based on the meaning of a movement through awareness of own body moving in space. Only once the body is free to move do we begin to understand what it means to have enough space, and it is this understanding that enables us to think our space – space that goes beyond the boundary of our skin. Indeed, this newly recognised space can be so much more – much bigger, much denser and much more a part of us than we had initially allowed ourselves to notice and perceive.

This was wonderfully demonstrated in practice during the second phase of the workshop, which Dominika Kacin had named “Seeking the Centre”. Every workshop participant received a piece of textile. Some pieces were soft, others firmer; some thick and smooth, others thinner and rough. The assignment was simple; following the space explored previously, the mentor instructed the participants to continue exploring their own body in space, this time in relationship to the piece of the textile they received. The participants were able to explore textile as an addition to or a part of their own space.

Dominika Kacin and Oloop Design, “Movement into Matter” workshop from the “Seeing with the

Hands, Touching with the Eyes" participatory events cycle; photo: Tjaša Bavcon

After the initial clumsy and timid familiarising steps, most of the participants soon saw the textile become an extension of their bodies, a material manifestation of the space they previously probed with their movements. In mere minutes, numerous forms appeared and then collapsed, crushed under the weight of the material or the body. Open, closed, folded, crumpled – living sculptures of bodies and textile. A palette of potentiality emerged, from the potential of new forms, all the way to new uses, new relationships. The initial experimental exploration of the relationship between the body and the textile soon expanded into an interaction of the body and the textile with the walls, the floor, the corner, the emptiness of space... And in the latter, a collision of two exploring bodies was only a step away. Suddenly, one body became a prisoner in the textile form of another... And then an active collaborator in the construction of yet another body of space and textile. When the bodies freed themselves from the result, we gazed at their creation – gaping before us were two cavities that only a moment previously had been occupied by two bodies. What emerged were two voids that were not actually empty – they were defined by the fleeting impressions of two bodies. In effect, the voids still represented the bodies' space, space that the bodies had expanded and captured in a briefly materialised shell. In other words, the result was a captive emptiness that at the same time remained the bodies of the two individuals – in absence of their physical bodies, the emptiness was inhabited by their impressions.

Dominika Kacin and Oloop Design, "Movement into Matter" workshop from the "Seeing with the Hands, Touching with the Eyes" participatory events cycle;
photo: Tjaša Bavcon

An excellent analogy of the observed phenomenon can be found in Heidegger's reflections on the meaning of things. The German philosopher used a jar as an example; it was based on the question of whether a jar is its bottom and its wall, or if it is better defined by the empty space that they enclose, the space that facilitates scooping and pouring out a liquid. This void thus defines not only the jar itself, but the craft of the craftsman who manufactures the jar. The essence of the jar is the enclosed void that is displaced to allow a liquid (or air itself) to fill the jar. In other words, even though the jar appears to be a tangible clay object, its physical form is only important to the extent that it can be filled with and thereafter hold the potential contents. [8]

It is this latter notion—the possibility of filling and recognising the essence through exploration of sensations—that Oloop members, together with the selected mentors, confronted the participants of the second participatory event cycle with. They empowered them to think about and doubt the self-evident. They gave them the possibility to recognise what was overlooked, touch what was untouched and hear what was missed. They enabled them to perceive all that is essential, that fulfils and defines us, yet often remains outside our field of perception; Maria Blaisse wonderfully summarised the latter at the introductory lecture – the essence is in searching for and exploring the freedom of yet-unnamed forms. This is the privilege that we so rarely allow ourselves to explore, even though this very exploration represents the essence that fulfils us. It fills us with the often overlooked meaning that enables us to change the way we see, hear, feel and move about in the world around us. It facilitates a shift in the attitude to our environment, and by changing our attitude, we also change our future behaviour.

The final thought brings us back to Blaisse and her answer to the question of what defines good design: what defines it is that we carry on, persevere in what we do. This was also the starting point of the third edition of the participatory events – the ability to carry on with this changed perception of self in relationship to the environment.

Equilibrium in Dissonance

In the last participatory events cycle, the aforementioned ability to carry on was applied to the exploration of relationships between the inside and the outside. If in the second edition it seemed that the exploration with bodies and textile opened up an astonishing number of potential ways to further our understanding of how we inhabit environment, the third edition of the workshops ended up examining the need to establish an equilibrium between the particular and the common. The common as the collective – the whole that is established again and again in the entanglement of our particular interests, our newly evoked creative impulse, with the others with whom we've briefly found ourselves inhabiting the same space.

Collaborative creation with Liz Collins and Oloop Design, from the "Between Inside and Outside" participatory events cycle; photo: Tjaša Bavcon

An illustrative example of the latter was a visual arts workshop with the painter Joni Zakonjšek, who announced in the accompanying text that the workshop is intended to guide the participants on the way from the substance to the essence, to "pure sensations", where we end up able to recognize ourselves as individual units in harmony with the broader whole. [3] This workshop also began with the perception of one's own body, first within the immediate circle of the participants, then later in the context of the space which already contained the textile structures created by the previous workshop participants. The introductory part of the workshop involved painting an invisible three-dimensional, spatial canvas with invisible paints and invisible brushes. In this step, the mentor hoped to establish a relationship to ourselves and our potential position in space.

In the second phase the material became tangible in the form of coloured strips of textile. The mentor's instructions were simple: "Find a spot in the part of the space you liked best in the previous assignment, then create something within it using the strip of textile. After a certain time, you will hear a sound, at which point you are to move clockwise, to the space where your neighbour was previously. Continue where your predecessor left off. Add to their work; elaborate on it, if you wish. This way, we will end up constructing a new spatial whole." What the mentor likely did not expect was that one of the participants would fasten the strip to the structure and then keep extending the coloured thread across the entire room. The gallery, a place where every individual was supposed to be able to find their space in relation to the whole and the other participants, thus immediately ended up occupied by a single individual. At the sound that signalled the switching of places, the aforementioned participant merely switched to a differently coloured strip and continued weaving her spatial web. With every minute the space became harder to traverse, forcing the other participants to not only respond to their neighbours' spots, but also to the continuously changing context of the gallery space.


"Aesthetic response" with Joni Zakonjšek and Oloop Design, from the "Between Inside and Outside" participatory events cycle; photo: Tjaša Bavcon

The questions that were coming up during my observations were: has disregard for instructions caused a practical manifestation of the loss of equilibrium between the will of the individual and the community as the whole? If that is indeed the case, how, if at all, is it possible to continue balancing the two? When collaborating, is it more important that we tolerate dissonance, or that we never deviate from striving towards harmony? Does attaining harmony necessarily require subordinating our own expression to the common, pre-arranged symphony? When, in the context of arguing for our own personal interest, *struggling* for our own space, is it undesirable that the individual's voice drowns out the other voices in the environment?

Mladen Dolar would likely identify these questions as referring to “the catch of the universal”. In his book *Bit in njen dvojnik* (*Being and its double*) [9] he writes that the struggle for the universal in philosophy was based on boundaries that exclude. At the same time, what was excluded keeps returning into the very heart of the notion. Something similar happened at these workshops; in building personal space, personal expression, there was continuous re-examination of the relationship to the others and to the space that provided the opportunities. Yet at the same time, as soon as the possibility of personal expression ended up being curtailed, a *struggle* to establish one's own space, to conquer space as such, began. Moreover, a desire arose to transgress the established, seemingly too limiting boundaries. It seemed that the very restriction brought forth the desire to deviate.

This recalls Theodor W. Adorno's thought that in order for declared principles to survive, violation, deviation and dysfunction is necessary. [10] Dolar elaborates: “What appears to be a liberation from the prevailing order is in fact its internal precondition.” [11]

Nothing comparably intense and provocative was observed before the third edition of the workshops. Fact is that various boundaries are continuously being established in everyday life that require all of us to maintain an equilibrium between the internal and the external, between the common and our own particular interests. Yet on the other hand, while—according to Adorno—our opposition seemingly generates dissonance, this is often merely an illusion, the violation merely serving to preserve the prevailing order. We therefore benefit from the apparent satisfaction of the desire to construct our own identity, but at the same time—even as we yell while others whisper—we never truly cut into the common.

The inability of particular expression to prevail took me from thinking about the necessity of seeking balance to the question—how *do* we truly cut into the common? Alan Badiou assists us in thinking this question in his text *Eight Theses on the Universal*. He asserts that a boundary, a dividing line must be identified between the particular and the singular. He writes: “I will call *particular* whatever can be discerned in knowledge by means of descriptive predicates. But I will call *singular* that which, although identifiable as a procedure at work in a situation, is nevertheless subtracted from every predicative description.” [12] According to Badiou we therefore search for something that separates, subtracts itself. Something that, though manifesting within the common, also isolates itself with its sudden appearance. This subtraction leaves a hole in the common, while the singular that subtracts itself transcends the common and becomes a thought demanding a change of some sort. A change "originates in an event", which is "intransitive to the particularity of the situation". [12]

Going back to what I observed at the workshops, I can see that the latter is actually the source of their power. It is the apparent ineffectiveness of particular/individual revolt that illustrates the actual power of the workshops, which, through experimentation, dare to question the process, the established rules and the actualisation of the fleeting nature of the ever-changing results. The authors of the workshops, along with their participants, continuously cultivate doubt and this process also opens up whole new areas of learning and capability for questioning the development of design potential for me—the observer. This gives rise to a withdrawal from the established understanding of how to approach the design process, which is often taken too much for granted.

The end result: perceptual learning

The end result of active observation throughout the three workshops confirms Dolar's thesis that we produce the idea with the material, with the matter. At the same time, it is empirically verified and indisputable that John Berger's observation also holds: "We never look at just one thing: we are always looking at the relation between things and ourselves. Our vision is continually active, continually moving, continually holding things in a circle around itself, constituting what is present to us as we are." [3]

By manipulating the observed, manipulating the matter that was created at the participatory events, a thought was generated that (at least in my case, as the observer) sprouted new knowledge, new learning. In hindsight, what initially seemed to be the neutral position of an observer trying to decode the observed, interpreting and thinking it objectively, actually became a creative process—a creative learning process. That is, a process that I had already spontaneously set out on at the first cycle of workshops. Gibson would probably describe such activity as perceptual development. As "a matter of the correspondence between stimulation and perception", while adding that "the total range of physical stimulation [is] very rich in complex variables and these are theoretically capable of becoming cues and constituting information. This is just where learning comes in."

What turned out to be key to the creative act of learning was exploring the processes that center design and our activities around the recognition of the variability of nature and the acceptance of unexpected and unplanned, of mistakes; and around play, material, material manifestations, the human body, its senses in particular—while constantly establishing (and disturbing) the equilibrium of potential collaboration. All of these are part of an approach that is said by Blaisse to originate "from material and wisdom from nature." [3] With this she is actually alluding to a shift in our understanding, since by talking about the wisdom from nature, we're actually talking about our own nature, and our own wisdom. With this shift, we set up the conditions for a design that escapes the vicious cycle of established processes, and so provide a foundation for alternative approaches—approaches that, using the methods enumerated above, introduce into the reality of reshaping our everyday existence the potential of impossibility and thereby, step by step, transform the existing and the customary. In this, it not only transforms design as an act, but also the perception of our capabilities to redesign.

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TITLE :
USING GRAPH GRAMMARS FOR GENERATIVE PROCESS RECREATING WARSAW'S TRADITIONAL FLOOR TILING
(Paper)

Topic: Design

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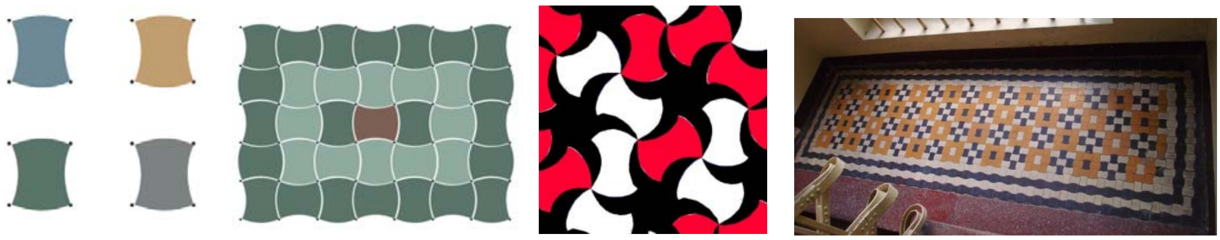
Abstract
The paper presents the advantages of using a graph approach to the design of tile layout patterns.Decorative tilework, known also as tile art has been known since ancient times. It has to be clearly distinguished from mosaic art, which is based on using huge number of, usually small, irregular pieces. In case of tiling the elements used are usualy larger and much more regular. There may be a set number of tiles used in a given project or just one. During the interwar period in Poland (1918-1939) a distinctive type of tiles called "corset" (Polish "gorsecik") became very popular. It has a shape of a curvelinear quadrangle with two convex and two concave edges (Fig 1a). Despite their simple form they allow for the generation of a large number of patterns. Two, three or multi-coloured arrangements of corsets, which form stripes, chessboards, crosses, slices, and also complex designs, frequently occurred on the floors of kitchens, bathrooms, verandas, staircases, in cafes and craft workshops. In Figs1b and 1c two examples of possible designs are depicted and in Fig.1d photograph of a part of tilnig of the staircase in a building at Okrag 3 Street in Warsaw is shown. As the result of war and postwar neglect, and the renovation of old houses, large part of these designs has been either lost or damaged. In recent years there has been a growing interest in saving this part of national culture as well as in adapting it to modern times.



a b c d

Fig.1 a)"Corset" tiles in different colors b) and c) two types of flooring designs, d) staircase in a building,Okrag 3, Warsaw (photo copyright WarszawskiePosadzki).

To make the generation of new designs both easier and more precise we propose to describe the design process with a formal grammar. Using a graph-based representation allows us to express both mutual orientation of corsets and their attributes (like color, material, size, price etc.) and most importantly relations between tiles. Tile layouts in the form of graphs give the opportunity to represent the process of generating them as the derivation process in a graph grammar. By using different initial graphs and by applying various rules of the graph grammar a number of different tiling patterns can be obtained, yet preserving the traditional style of Warsaw's flooring designs.

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Key words: graph structures, floor panelling, traditional tiling patterns

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Using Graph Grammars For Generative Process Recreating Warsaw's Traditional Floor Tiling

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Abstract

This paper deals with using graph-based methods in generating decorative tile layout patterns. Tile layouts are represented in the form of graphs, while the derivation process in graph grammars leads to creation of tile patterns. Graph grammar mechanisms allow us both to recreate Warsaw's traditional floor tilings and ***to*** create new tile patterns on the basis of the previously existing ones. The approach is illustrated by examples of designing tile patterns composed of one or two motifs.

1. Introduction

The paper presents the advantages of using a graph approach to the design of tile layout patterns. Decorative tilework, known also as tile art has been known since ancient times. It has to be clearly distinguished from mosaic art, which is based on using huge number of, usually small, irregular pieces. In case of tiling the elements used are usually larger and much more regular. There may be a set number of tiles used in a given project or just one. During the interwar period in Poland (1918-1939) a distinctive type of tiles called "corset" (Polish "gorsecik") became very popular. It has a shape of a curvelinear quadrangle with two convex and two concave edges (Fig 1a). Despite their simple form they allow for the generation of a large number of patterns. Two, three or multi-coloured arrangements of corsets, which form stripes, chessboards, crosses, slices, and also complicated designs, frequently occurred on the floors of kitchens, bathrooms, verandas, staircases, in cafes and craft workshops. In Figs.1b and 1c two examples of possible designs are depicted and in Fig.1d a photograph of a part of tiling of the staircase in a building at Okrag 3 Street in Warsaw is shown. As the result of war and post-war neglect, and the renovation of old houses, large part of these designs has been either lost or damaged. In recent years there has been a growing interest in saving this part of national culture as well as in adapting it to modern times [1].

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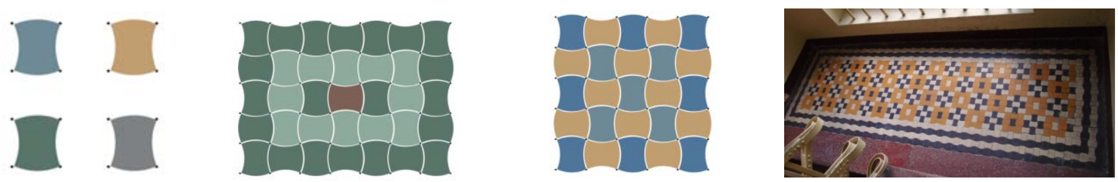

Fig.1 a)"Corset" tiles in different colours b), c) two types of flooring designs, d) Okrag 3, Warsaw (photo copyright WarszawskiePosadzki).

To make the generation of new designs both easier and more precise we propose to describe the design process with a formal grammar. We propose to use a graph-based representation of tilings as it enables us to express both mutual orientation of corsets and their attributes (like colour, material, size, price etc.) and most importantly relations between tiles. Tile layouts in the form of graphs give the opportunity to represent the process of generating them as the derivation process in a graph grammar. By applying various rules of graph grammars a number of different tiling layouts can be obtained, yet preserving the traditional style of Warsaw's flooring designs.

The approach is illustrated by examples of designing tile layouts composed of one or two patterns arranged alternatively or repeating in every second row. The user can define motifs of the size 2x2, 3x3, 4x4, or 5x5 composed of tiles in various colours. The system automatically generates various plane divisions using these motifs.

2. Graph-based representation of designs

In this paper both the tile motifs and the tile patterns are represented by means of labelled and attributed graphs [2]. Graph nodes represent tiles, while edges express their adjacency. Attributes assigned to graph nodes specify the orientation of tiles and their colours.

Example 2.1. A graph shown in Fig.2b represents the structure of a tile pattern composed of 25 tiles shown in Fig.2a. Each node represents one tile and has two attributes ‘orientation’ and ‘colour’ assigned to itself. The value of the attribute ‘orientation’ for every second node of the graph is equal to *horizontal*, and for the others to *vertical*. The value of the attribute colour assigned to the node representing the middle tile is set to *green*, to the other inside tiles it is set to *white*, while for the border tiles it is set to *navy blue*.

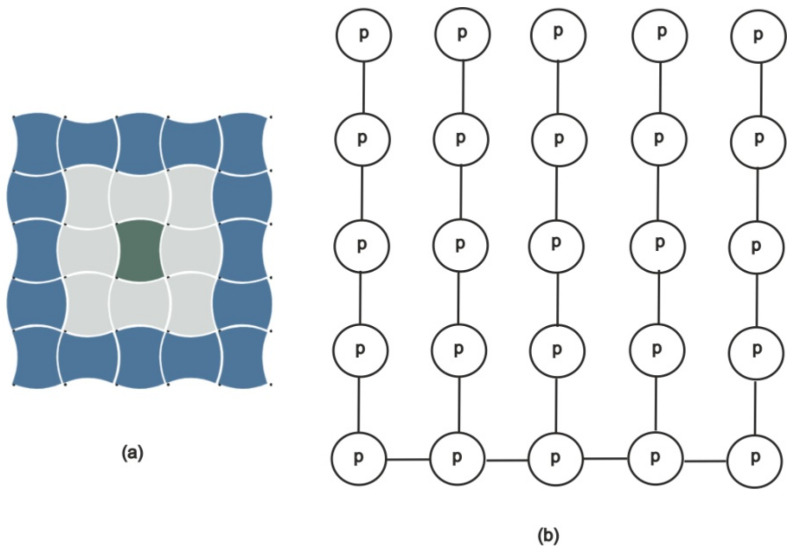

Fig.2 a) A tile motif 5x5 in three different colors b) a graph representing the structure of this pattern

3. Graph grammars for plane divisions

To generate graphs representing structures of tile patterns context-free graph grammars are used. A *context-free graph grammar* consists of a finite set *P* of *productions* of the form $p = (y,r)$, where y is a node with a nonterminal label and r is a graph composed of nodes with terminal and/or nonterminal labels, and an *axiom* named x, which is a node with nonterminal label. The application of the production $p = (y,r)$ to the graph c consists in substituting r for a node v of c, where v is isomorphic with y, and replacing connections of v with connections of r. Graphs representing structures of tile patterns are derived using specified sequences of graph grammar productions.

Example 3.1. The border composed of four tiles of two different colours arranged alternatively in each row is shown in Fig.3a. A graph grammar generating structures of such borders is presented in Fig.3b. The grammar consists of the set of productions $P = \{p_1, p_2, p_3\}$ and the axiom being a node with label S. The connection place of the right-hand side of a production which corresponds to the connection place of the left-hand side is denoted by an arrow.

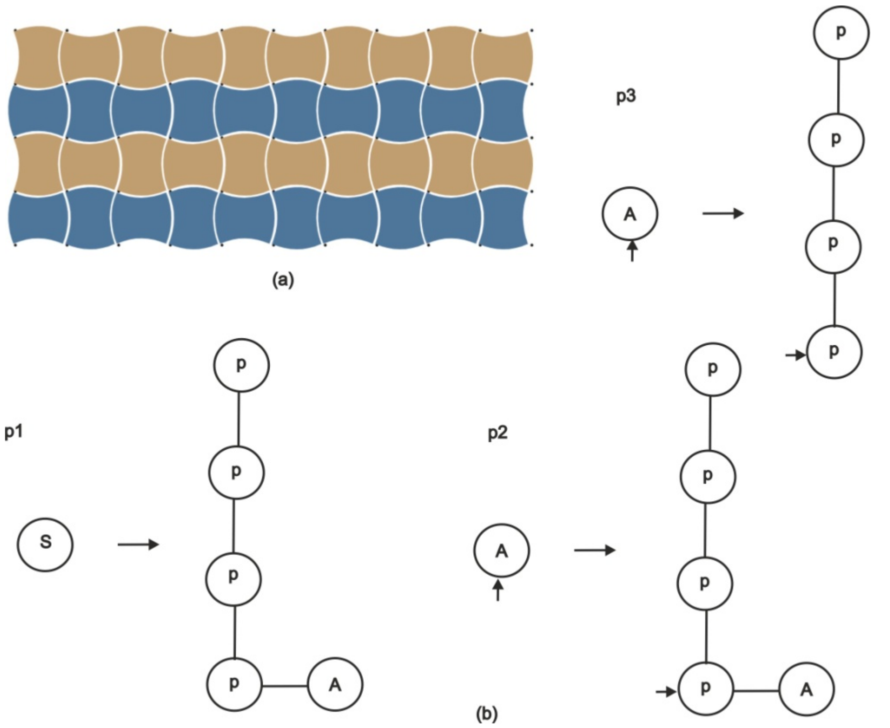

Fig.3 a) A border tile pattern b) a graph grammar generating representing the structure of this pattern

Fig.4 and Fig.5 present the graph grammars used to generate more complex tile patterns. In this case the process of designing starts by selecting the size of tile motifs by the user. It can be 2x2, 3x3, 4x4, or 5x5. In the next step the user defines the colour of tiles for one or two motifs of the chosen size. Then, if only one motif has been defined the rules of the graph grammar in Fig. 4 are applied. If two motifs have been defined both graph grammars are used. The nodes with nonterminal labels *N1* and *N2* are replaced by graphs representing two different patterns or the same one if the only one has been defined.

One motif of the size 5x5 is presented in Fig.1a, while two motifs of the size 3x3 are shown in Fig.6. The grammar from Fig.4 generates graphs representing structures of tile patterns composed of the same tile motif in every second row (see Fig.8c). The grammar from Fig.5 generates graphs representing structures of layouts where tile motifs are arranged alternatively in each row (see Fig.8b).

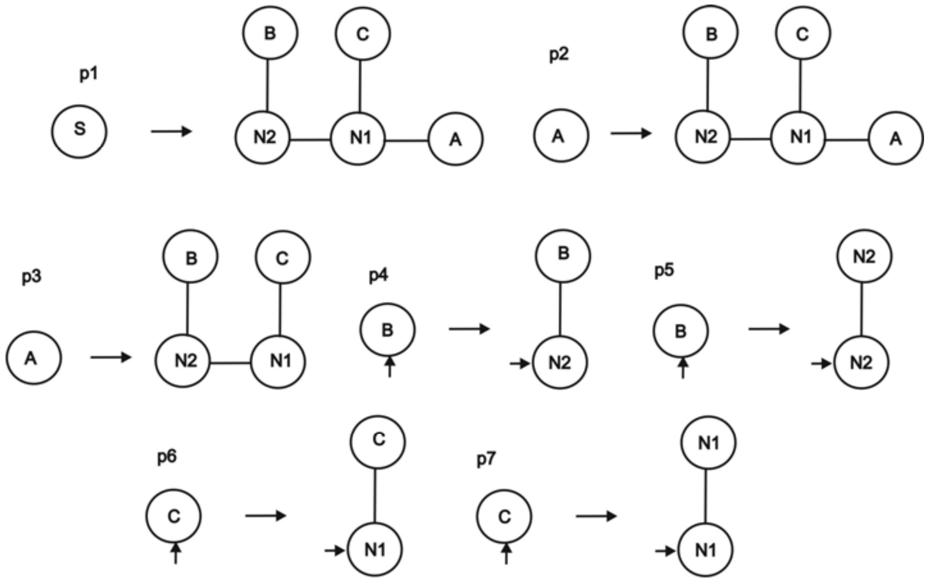

Fig.4 A graph grammar generating structures of patterns composed of the same tile motifs in every second column

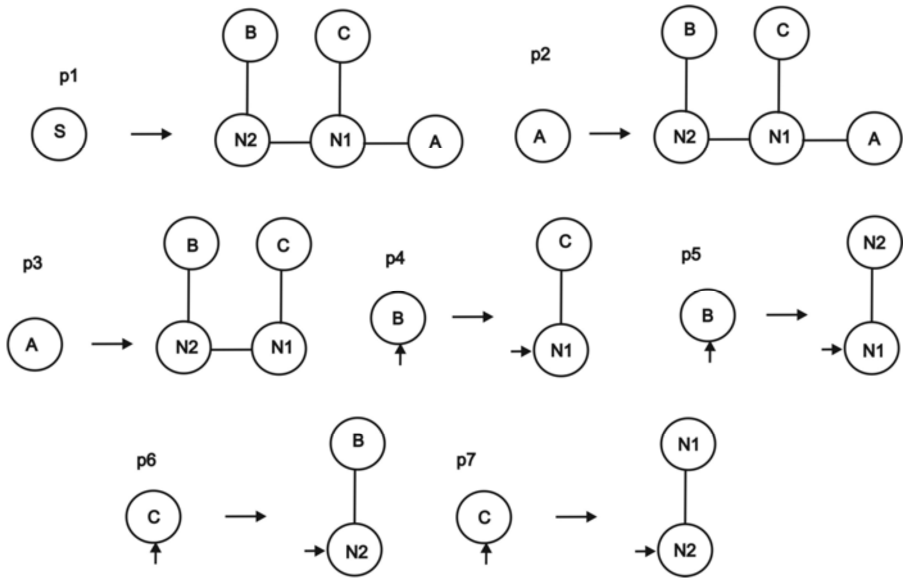

Fig.5 A graph grammar generating structures of patterns with tile motifs arranged alternatively in each row

When a graph representing the structure of a tile layout is created an interpretation of this graph should be specified. The interpretation determines the way in which the tile patterns are transformed in respect to each other. It should be noted that one graph can represent structures of different tile layouts corresponding to various interpretations.

In case of motifs of the sizes 2x2 and 4x4 each motif that should be matched to the motif which is directly under it, can be rotated through 90° or left unchanged. In case of motifs of the sizes 3x3 and 5x5 each motif that should be matched to the motif which is directly under it, has to be rotated through 90°. However it can be rotated as a whole or each tile of the motif can be rotated separately. Therefore if one motif has been defined two different patterns are obtained, and if two motifs have been defined four different patterns are obtained.

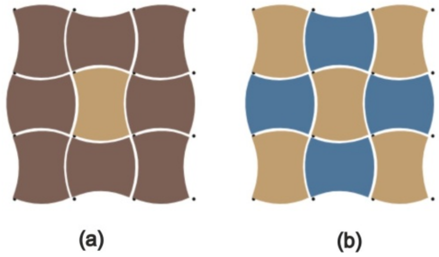

Fig.6 Two tile motifs of the size 3x3

Example 3.2. Tile patterns composed of one motif are shown in Fig.7 and Fig.8a. In patterns in Fig.7a and 7c tile motifs of the size 2x2 and 4x4, respectively, are left unchanged while they are adjusted to the lower motifs. In patterns presented in Fig.7b and 8a every second motif up the row is rotated through 90^{o}. In Fig.8b and 8c two patterns composed of the motifs of the size 3x3 presented in Fig.6 are shown. In both of these patterns every second motif up the row is rotated through 90^{o}, however in Fig.8b motifs are arranged alternatively in each row, while in Fig.8c the same motif occurs in every second vertical row. In Fig.9 another two patterns composed of 3x3 motifs shown near them (Fig.9c) are presented. In the pattern in Fig.9a each tile in every second motif up the row is separately rotated through 90^{o}, while in the pattern in Fig.9b the whole every second motif up the row is rotated through 90^{o}.

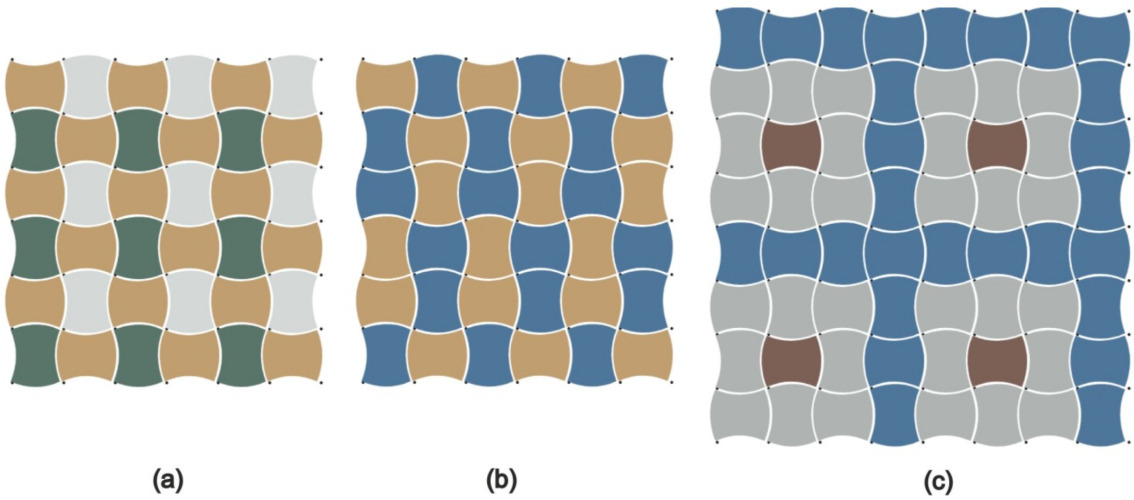

Fig.7 Three tile patterns, each composed of one motif

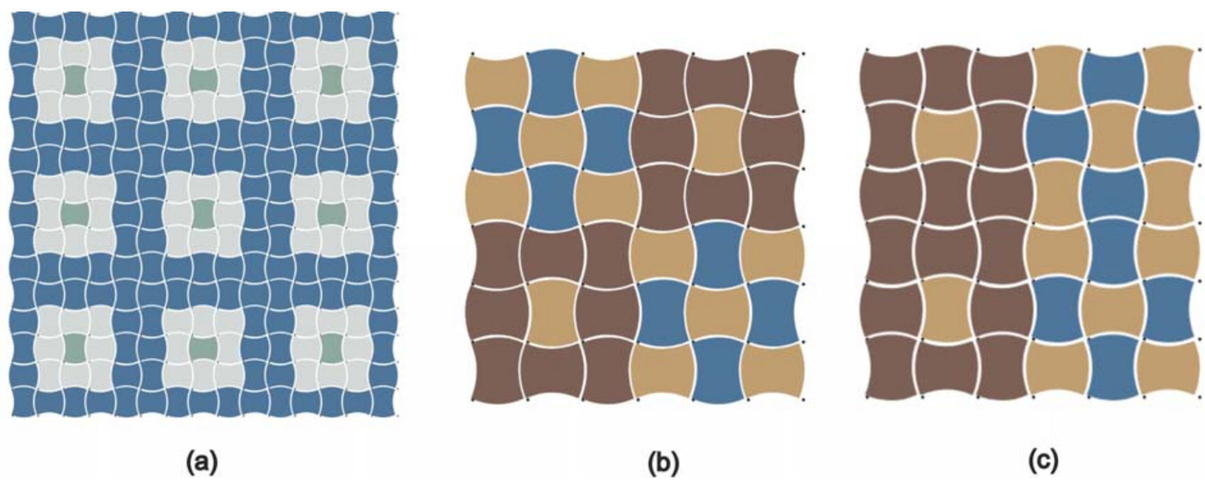

Fig.8 a) A one-motif tile pattern with every second motif up the row rotated through 90^{o}, b) c) two tile patterns composed of motifs from Fig.5, which are arranged alternatively in each row or repeat themselves in every second vertical row

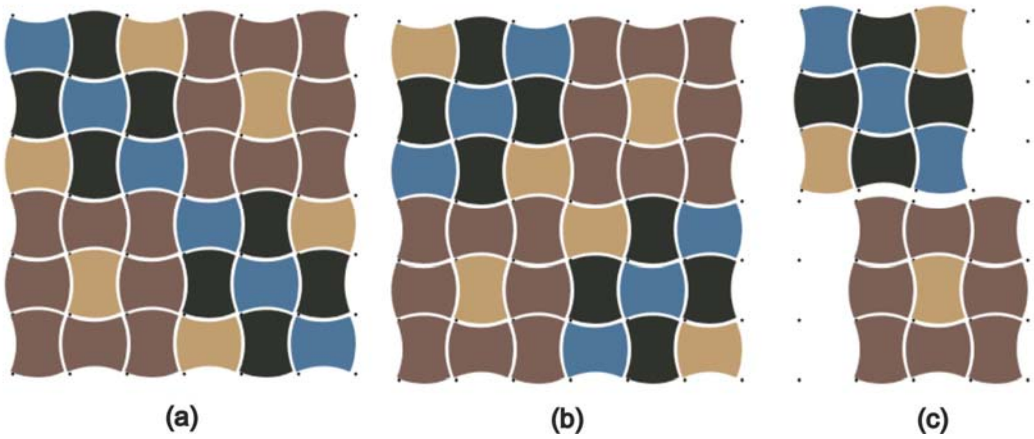

Fig.9 a) A two-motif tile pattern with each tile rotated separately in every second motif up the row, b) a tile pattern with the whole every second motif up the row rotated through 90º, c) two originally defined tile motifs

Plane divisions filled by tile patterns can be based not only on quadrilateral grids but also on triangular grids [3]. The example of filling such a grid by tiles with two different colours is shown in Fig.10. It can be seen that in this case the defined tiles do not fill the whole plane leaving black empty spaces. The emergent black shapes can constitute an inspiration for the designer, who can not only reconstruct the former existing layouts but also create new ones on the basis of the previously existing ones.

Fig.10 A tile pattern with emergent shapes

A big challenge for designing corset tile patterns is a rich range of colours. Thanks to many colours, unusual shapes may be created as motifs. Fig.11 presents the multi-colour corset tile pattern with a floral motif. The basic colour motifs with the palette of colours are shown in Fig.12. The graph grammar generation process of the tile pattern shown in Fig.10 is two-step. In the first step a new pattern consisting of basic motifs is generated. The pattern presented in Fig.12 is a motif for the second step of the generation.

It is worth noticing that a corset grid treated as a layout is a source of inspiration for creating new motifs (see: Fig.14). An example of a corset tile pattern with these motifs is presented in Fig.15.

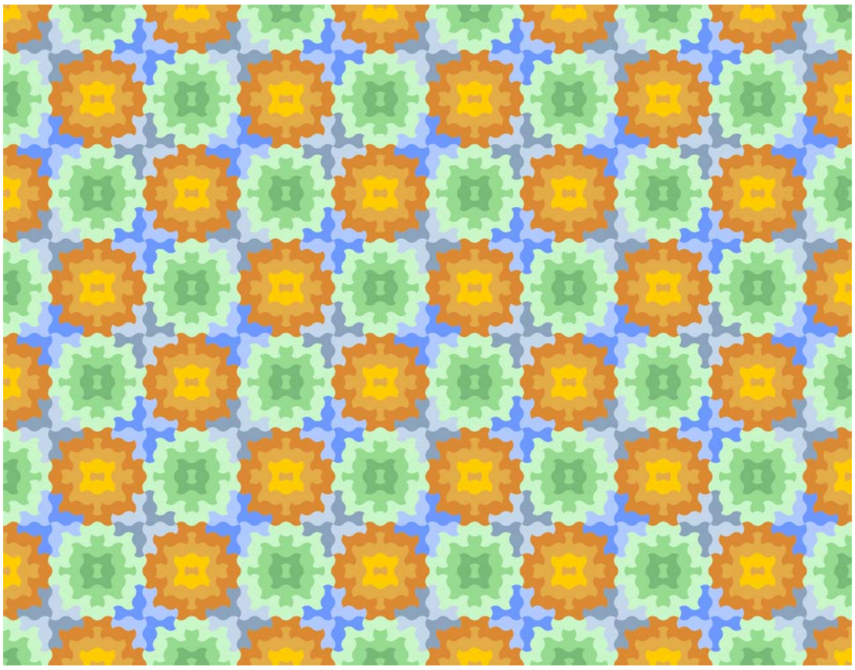

Fig.11 A multi-colour corset tile pattern with a floral motif

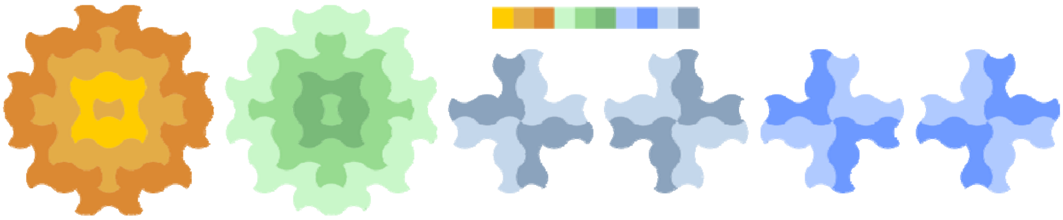

Fig.12 Colour motifs with their pallete of colours

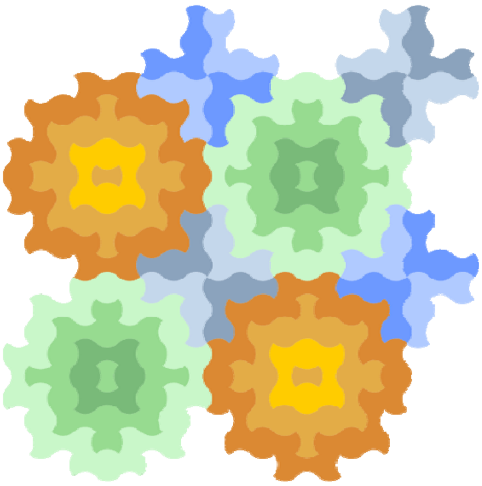

Fig.13 The colour motif for the second step of generation

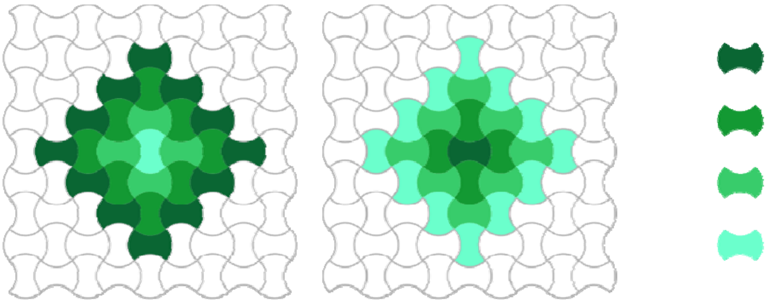

Fig.14 Motifs created on a corset grid

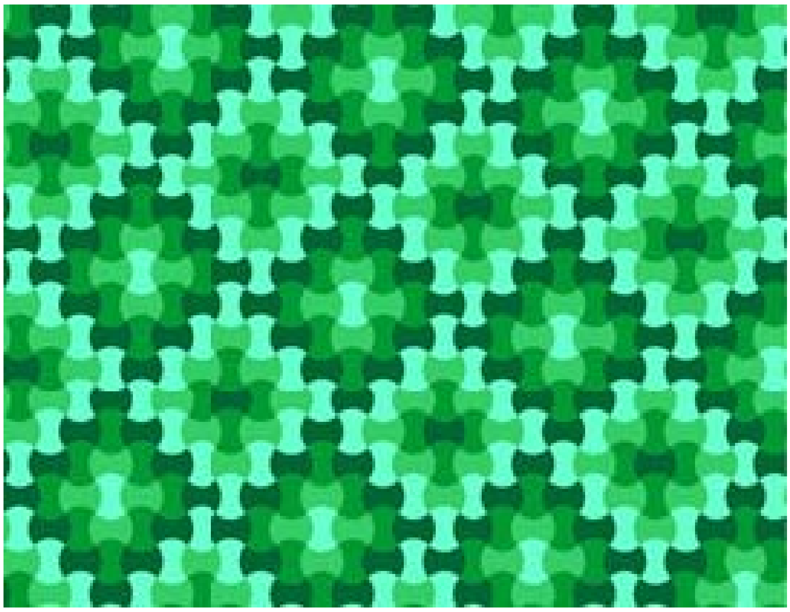

Fig.15 The corset tile pattern with the motifs shown in Fig.14

5. Conclusion

Applying graph-based methods to the design of tile patterns allows us to create a wide range of artefacts. It can be used to assist a designer during the conceptual phase of design. The work presented in this paper can be further developed by proposing a user friendly interface.

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AI ORGANIC COMPLEXITY in GENERATIVE ART (Paper)

Topic: Generative Art theory, Architecture, Design

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Abstract

Generative Art works by creating a process. The executable process as software is the generative artwork. The aim of the process is the executive representation of a peculiar idea, as subjective creative vision defined, at abstract level, with the help of symbolic algorithms.
The results of this processes show the idea through generated multiple scenarios. These variations, all together, tell the idea in its possible and multiple facets.
This type of result is of great personal satisfaction because the designed generative process is a creative engine as a mirror of own human creative approach. It produces an endless sequence of events belonging to the infinite possibilities of performing a same idea/vision.
The generative AI engine that I designed is really very communicative because it is able to focus the idea in its potential future also. In this way, it is possible to represent the idea as an abstract concept that is independent from the various used forms.
Precisely for this reason, the generative process is able to fully communicate the identity and peculiarity of an artist, architect, designer and musician. The possibility to create and, later, recognize the imprinting of the artist is, therefore, one of the most important aspects of the Generative Art and of its results, very closed to AI singularity.
The idea is to imagine a progressive process where the starting point, the past, the pre-existing events will progressively disappear making room for possible new scenarios. This must happen because one of the characteristics of the generative process is the non-linearity. This is essentially due to two factors: the *interpretation*, often tendentious favouring specific points of view, and the *parallel coexistence* of multiple generative processes whose transformation actions are progressively reciprocally contaminated during the processing time, like in a chaotic system (René Thom).
The algorithms that must be developed to manage this process are in the field of Artificial Intelligent systems. The great advantage of the generative approach using artificial intelligence is in abandoning the constructive-deconstructive analysis of the forms. The aim is to structure an abstract approach not based only on the inferential interpretation of the contaminations of the forms but based on the real progressive contaminations of the logics of transformation. This prefigures the essence of a generative algorithm.
Following the AI learning approach, Generative Art pursues the construction of an intelligent and creative system that represents our ideas, our creative possible actions in recognizable way.
Making an artwork that never stops to amaze you, gradually bringing into focus unprecedented aspects of your idea, is undoubtedly the ultimate in creativity. And Generative Art has this undeniable quality.

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Key words: generative design, Verona, Renaissance, Palladio, Baroc

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PREMISE

After 35 years of Generative experiments, and after 21 years of exchanging ideas and discussions at Generative Art conferences, We have to accept that it's difficult to make a unique and final definition of Generative Art. ***As often happens in every approach to scientific discoveries, the generative approach to Art and Science is strongly linked to each subjective mind.*** We can only identify and trace own peculiar way to design, develop and run our subjective generative processes.

But this is not completely true. Following the reason why we are together at the XXI Generative Art conference, there are some questions that it's possible to identify as common:

- Generative ***Art*** is the human ability to design *generative systems*.
- Generative ***Systems*** are tools, software, hardware, robots and machines that manage the designed artificial DNA and produce *events*, all different but belonging to an identifiable artificial species.
- The Generated ***Events***, all different and unique as natural individuals, represent the human vision that was at the basis of each *generative project*.

INTRODUCTION

Generative Art works by creating a process. The generative artwork is the executable process performed as software.

The aim of the process is the executive representation of a peculiar idea. This ***subjective creative vision is defined, at an abstract level, with the help of symbolic algorithms***.

The results of this processes show the idea through generated multiple scenarios. ***These variations, all together, tell the idea in its possible and multiple facets.***

This type of result is of great personal satisfaction because of the designed creative engine is a mirror of own human creative approach. It produces an endless sequence of events belonging to the infinite possibilities of performing the same idea/vision.

More, the generative process, once created as software, can be activated on demand in the future and will automatically produce further variations, unprecedented and sometimes surprising events. Each scenario, in its uniqueness and unpredictability, increases the possible representation of the idea itself.

The generative AI engine, like the one that I designed, is really very communicative because it is able to focus the idea in its potential future also. In this way, ***it is possible to represent the idea as an abstract concept that is independent of the various used shapes***.

Precisely for this reason, the generative process is able to fully communicate the identity and peculiarity of an artist, architect, designer, and musician. ***The possibility to create and, later, recognize the imprinting of the artist*** is, therefore, one of the most important aspects of the Generative Art and of its results, ***very closed to AI singularity***.

Generating an artwork that never stops to amaze you, gradually bringing into focus unprecedented aspects of our idea, is undoubtedly the ultimate in creativity.

Generative Art has this undeniable quality.

FROM THE PAST TO THE FUTURE

As for all creative processes, the ***starting point*** is the pre-existing, the past, the artworks that we choose as a reference, the artworks of our masters, the natural and artificial world that surrounds us and which we are fascinated. In fact, the generative process presupposes the existence of a pre-existing in which it is possible to identify a character, a purpose to be achieved by a vision too.

The generative process uses algorithms. They define how to transform the Past into the Future. It is implemented to make transformations pursuing a peculiar vision, an abstract idea that identifies the character of the results regardless of the possible formalizations. ***Generative Art doesn't repeat the existent but creates the process by interpreting the existent.*** This interpretation tries to find a possible algorithm able to manage some characters that we identified and appreciated in the reference without replicating its forms.

My passion for the Baroc of Borromini was the starting point of one of the generative experiments of mine that I loved most. Precisely because ***the interest in Borromini was not for the shapes he used but for the interpretations of the classical canons that he was able to define*** and structure as load-bearing elements to build his architectures.

Going ahead in this interpretive work of architecture was extremely fruitful. It has been said (The Guardian, Luke Dormehl, Sun 7 Aug 2016, article "Seven ways that AI could be A-OK") that "*the Italian Celestino Soddu have used evolutionary algorithms for taking a stab at what a baroque* *cathedral would look like if it was a living thing allowed to evolve over many generations*", identifying this process as AI process.

I tried to act the same interpretative logic of Borromini referring to my contemporary age.

In the generative process, the idea is not to foreshadow a result but its characters in progress. The vision is to imagine a progressive process where the starting point, the past, ***the pre-existing events will progressively disappear*** making room for possible new scenarios. This must happen also because one of the characteristics of the generative process is the non-linearity.

The generated scenarios contain in themselves the characters identified in the pre-existing but do not contain explicit citations, as identifiable shapes. The generated scenarios do not identify the starting point, which evaporates during the process ***as a catalyst*** in chemical processes, but very subjective interpretations of the past.

NON LINEARITY and GENERATIVE ALGORITHMS

The non-linearity of the generative process is essentially due to ***two factors***: the ***interpretation***, often tendentious and different from moments to moments, favoring specific contingent points of view, and the ***parallel coexistence of multiple generative processes*** whose transforming actions are progressively reciprocally contaminated during the processing time, like in a chaotic system.

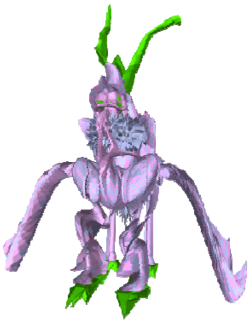
The ***algorithms*** that must be developed to manage this process are in the field of Artificial Intelligent systems. They are based on an inferential data approach. In fact, the data are not analyzed, compared, systematized as happens in other processes but are managed with an act of abduction.

Abduction, quoting *Marco Somalvico*, "*is not so much an inference to the "best" explanation, but rather the generation of explanatory narratives that are driven and constrained by poetic and other conventions, even against the grain of reasoning about the real world*". Following this approach, the main reference is the concept of poetic outlined by *Enrica Colabella* for the generative processes.

The references are interpreted in the light of a particular key, in view of a specific character and quality that is appreciated in an abstract way in the pre-existent. Creating a generative process we like to propose again these qualities amplified according to a subjective contingent point of view. We rediscover these characters as recognizable in the future generated scenarios.

Forms cannot be considered meaningful data but only, following an algorithmic approach, the ***progressive geometric transformations born from subjective interpretation***.

The great advantage of the generative approach using artificial intelligence is in abandoning the constructive-deconstructive analysis of the forms, so appreciated in the last century but that destroyed the relationship between Art and Artist. The aim is to structure an abstract approach not based only on the inferential interpretation of the contaminations of the forms but based on the real progressive ***contaminations of the logics of transformation.*** This means to find again the important role of the author. Rediscovering the human subjectivity of the artist prefigures the essence of a generative algorithm.



SINGULARITY

The advanced idea of AI is identifiable in the progression of uniqueness, in the "singularity" that the system progressively acquires through learning. The AI system becomes more and more unique and unrepeatable because it memorizes the experiences acquired in a variable context. The system makes them its own knowledge through focused interpretive processes that are activated in the light of prefigured objectives.

There are two points that we fully find in Generative Art too: the ***progressive active memory of our learning from experience that increases the identity of a generative work*** and the ***identification of objectives*** to be achieved.

Following the contemporary AI learning approach, ***Generative Art pursues the construction of an intelligent and creative system that represents our ideas, our creative possible actions in a recognizable way***.

Unlike most AI learning systems, which prefers functional and "objective" evaluations of acquired experience, in the generative process feedback and processing of past experience does not happen automatically but occurs through the subjective and progressive interpretation of generated scenarios focused on specific characters that could be not necessarily "functional".

Subjective approach is not in contrast with the advanced AI structure but rather ***increases its progressive uniqueness***. Operating through own critical ability to interpret the generated scenarios and to report these criticisms as an upgrade of the generative algorithms makes the generative structure more unique. Obviously, the generated events will be more recognizable as belonging to the singularity of each generative process. The author identity will be enhanced.

The increasing singularity happens if the algorithm upgrade does not only changes with another one but, adding the new one to a series of "***variation***" ***algorithms,*** this upgrade better describes the many facets of the subjective vision of the author.

We are never the same when we work creatively. Yesterday we were different from today and tomorrow. This non-linearity could be represented in a generative process with multiple possible ways to reach a result.

The adopted logic in different and parallel algorithms are similar but not the same. The differences between these logics tell the progression and variation of our creative identity, together with the variations of our feeling.

Identifying each of these parallel experiences as a logic of a generative process and storing them as a possible alternative of usable algorithms is a small brick in ***the construction of an intelligent and creative system that represents us in a univocal way***.

It is ***the first step towards a myth of the AI, that of the replica of ourselves.*** It is the replication of our creative identity, of our way of working and pursuing a goal, of our ability (Art) to respond, even in an unpredictable way, to questions on how to transform the environment around us. In other words, it is possible to build not another complete self but at least our being architects, artists, musicians. In this way, it's possible to identify the strong relationship between the advanced AI systems and the Generative systems.

FORMS AND TRANSFORMATIONS

The advanced AI Generative systems are possible starting from the consideration coming from a profound difference between working on forms (shapes) and working on transformations (algorithms).

Both forms and transformations can be mathematically represented. But while a form can be constructed through a geometric formula, the transformations are identified through algorithms. This means that the input is any form and the output are the transformed forms. The output acquires a further value, a peculiar character that represents one of the facets of the meaning of the generative idea.

This difference has an undeniable advantage for the generative processes. ***The forms cannot be stratified but the transformations are***. In fact, the forms cannot be added together, they cannot be used in parallel even if they have parametric characters. Once a shape has been chosen, we can also vary it, also randomly, but it remains always a form, even if it is unusual and fascinating. It cannot be a moment of a generative process but only a final static outcome. We can only accept it or replace it. To move forward we need to move to transform acts.

Everything is different for the transformations, and for the algorithms that represent them. We can use one first transformation with a specific objective, insert in the process a second transformation that increases the second character, and so on. ***Identities can be multiple*** and stratified. More, the contamination of parallel generative processes has, in the generated scenarios, ***the simultaneous presence of the characters identified and organized in the algorithms that run in the process***

COMPLEXITY, CHAOTIC SYSTEMS, AND RANDOM

The result of this stratification of different transformation processes has an essential value: complexity. (referring to *Ilya Prigogine*).

The verification is immediate: it is impossible, if it is a real generative process, to manage the reverse process, from the results to the pre-existing event, or even to the structure of the process. The reason is that ***the process is structurally non-linear***.

More, this complexity, storing together different and, maybe, contradictory characters, fits the needs of possible different users (infinite meaning of Friedrich Nietzsche). Each people could find one of the multiple results as "own" result, finding the answer to his subjective need.

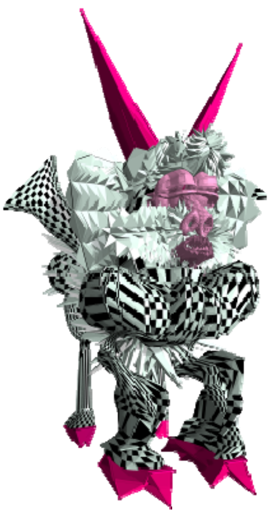
The complexity that is produced through a generative ***process is not reversible*** either because the process was neither analytical nor technological, but based on subjective interpretations, often different from moment to moment.

Moreover, this is also due to the multiplicity of progressive contaminations between parallel processes that, very often, are unpredictable because they are due to the contingency and the uniqueness of the implemented temporal path. ***The system could be called chaotic*** and, following the concept of *René Thom*, some ***singular points of the process could be called catastrophes***. The sudden change of point of view changes the meaning too: the consolidate references and shapes disappear for ***giving space to unexpected events.***

Each generative process is unique because it is susceptible to the contingency of the moment in which it is implemented, as well as any interpretation performed at different times is different even if conceived by the same subject.

The use of contingent parameters related to the time of triggering the process, as I am used to doing in my experiments, is strongly different from the ***use of random*** in the generation of forms. First of all because on one side there are the forms and on the other the transformations. ***Randomness is applied not only to the geometric construction of forms but to simulate the unpredictable temporal contingency of the starting time or of crossing transformation processes. The progressive dynamic of transformations have nothing casual, it's only chaotic***.

This unpredictable contingency translates, in my generative processes, into the possibility of opting for parallel generative paths already identified and organized. This does not detract from the peculiarity of the idea and the characters sought. On the other side, ***the randomness of the forms leads to the homologation, making poorer the creative process because the author identity will disappear.***



ORGANIC HARMONY

Generative experiments and their results show an organic structure. My opinion is that the generated architectures, but also the artworks, design events, and the generated music are organic in the sense that can be attributed to the word organic in reference to Nature. The intrinsic attribute of this organic character is the harmony.

The progressive harmony of the generated structures is, in fact, ***the backbone of the generative process.*** The same harmony that we appreciate in the Renaissance, where the mathematical control was fully used for proportions and relationships between parts.

It does not matter what is the event to be generated: a chair, an architecture, a portrait, a ship, a city and so on. The forms belonging to the reference event are not important. What is really important is ***to gain the harmony that pervades our references and to interpret it mathematically*** in our generative algorithms.

An optimized solution doesn't exist in the structure of generative algorithms. Optimization is out of generative thinking, it's static. What we need to evaluate is how we can generate events that have, in their plurality and diversity, the harmony that we are looking for.

The fundamental aspect of the generative software is to represent a particular idea of organic harmony whatever the occasion: a cathedral, a chair, a portrait of a woman, a palace, a U.F.O., a lamp, a tower, a jewel and so on. My generative software generates a plurality of different events with the same processes of progressive transformation where the idea is a vision of an ***organic system*** and the contingent input is identified and managed by a topological paradigm.

INCIPIT and TOPOLOGY

What is the incipit of the process that leads to these results, different also in the theme and in the generated forms but identifiable in a creative vision?

Surely the basic event to fit the different occasions is ***a topological idea of the relationships between the parts*** that can identify an architecture or any other object. All my generative works have a topological structure, which I call ***paradigm***, referring to *Thomas Kuhn*. This paradigm works by organizing the progressive structure of transformations.

Every object, a lamp, a chair, a woman 3d portrait, and so on, have peculiar topological paradigms but the generative process uses the same generative algorithms.

Giving a particular attention to architectural events, it would seem natural that a cathedral, a tower, a garden, a palace have different topological paradigms. And this is partly true. But the topological structure of an architectural space is based on the external-internal path that we could also identify as a progressive public-private path and on the relationship between central and service spaces. ***The possible paradigms that identify these relationships are quite similar. The difference consists of the characters that we associate with these basic relationships.***

In my architectural work, following the critical approach by *Wittkower*, all architectural paradigms derive from a ***father-paradigm that arises from my interpretation of Palladio***, or rather from his Villa Rotonda.

After that, there is a ***second level paradigm*** fitting the architectural structure. It has as its reference the number 27 pointed by *Francesco Borromini* in his book "Opus Architectonicum" as the number at the base of architecture.

The first paradigm organizes the relationship between public and private, between large spaces and accessory spaces, between central space and service spaces, as it was clearly used in all Palladian villas and in many "organic" architectures.

The second paradigm defines how the generated event will be an architecture and it will follow all the architectural structure, technical and peculiar functions. This secondary topological paradigm, in its variations of the 27 and 21, comes from ***an unexplained statement by Francesco Borromini that I interpreted as the relationship between the 27 elements that make up an architectural unit***: the interior space, the floor, the roof, four beams, four capitals, four pillars, four walls, four pillar bases, four floor edge beams. In total 27. Following the architecture of S. Ivo alla Sapienza, if we act within a triangular grid, I supposed that this paradigm could be transformed into 21. The transformation between the two paradigms takes place, when necessary, even within the generative process through a special algorithm that I designed for fitting this possibility.

They are abstract paradigms that define nothing more than a structure of relations between events that are not yet formalized. They do not even define the overall geometric structure because the ***same topological relationships can be transformed into different geometrical events***. Instead, they define the structure of the generative progressions and the fields of possible interactions and interfaces.

The topological Palladian-paradigm together with the architectural Borrominian-paradigm obviously work in progressive stratifications and have been used in almost all my architectural generations. The peculiarity of every single generation, and the possibility to reach different architectural events, even in their possible use, is given by ***the progressive transformations of this basic structure into geometry events during the generative process***.

For other generated objects the topological paradigm is, obviously, different. Since topological and non-formal paradigms can be easily used to manage the relations between the parties but do not give problems in progressive formalizations because they do not contain forms but topological and harmonic relationships only.

LATEST GENERATIVE EXPERIMENTS

This year the references were to the Peruvian architectural and design tradition, with the occasion of my exhibition in Lima last summer, to the classical and Palladian architecture of Verona, coming here for the 21st GA, to the medieval representations of fantastic animals, designing a species of artificial animals to fit the atmosphere of the Museum of Natural History of Verona that hosts us and, in the meantime, I used the same references not only for architecture but also for the generation of a “new” species of chairs, jewels, rings, necklaces, brooches, bags that I generated and directly made with the 3D printer.

Different occasions but one purpose, my idea of harmonious organic events.

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Organic Complexity and AI in Generative Art

Enchanting Algorithms: How the reception of generative artworks is shaped by the audience's understanding of the experience

Paper

Topic: Art

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Abstract
Since the definition provided by the first Generative Art Conference in 1998 [1], there have been a number of other important attempts to define Generative Art such as those by Galanter (2003) and Boden and Edmonds (2009), or to categorise its different forms and components such as Dorin et al (2012). However, there are perhaps fewer attempts to account for the factors that influence the experience of the audience. This paper considers the particular characteristics of Generative Artworks that may shape their reception, as well as both the artist's and audience's understanding of the experience they offer.

In doing so it will argue that Alfred Gell's [2] conception of 'art as a technology' capable of 'enchanting' its audience, is particularly relevant to the understanding of Generative Artworks. The audience's perception of qualities such as 'technical virtuosity' and 'visual complexity' can be seen as having a particular impact on the reception. The nature of Generative Artworks as processes negotiated between human and machine in the production of unpredictable outcomes lends itself to Gell's description of a seemingly 'magical' technology. Furthermore, this conception may be reinforced by wider contexts outside the artwork.

In considering the audience's experience, it is necessary to examine the contexts brought to the work by the audience. This includes current debates surrounding the invisibility of computational processes [3] and the opacity of code, including neural networks and machine learning algorithms [4].

This paper considers how these elements, both within and outside the artwork itself, influence the reception. It discusses examples that take differing approaches to the audience, including artworks created by the author since 2016 as part of an ongoing practice-based enquiry.

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Key words: Generative Art, Enchantment, Audience, Experience

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Enchanting Algorithms: How the reception of generative artworks is shaped by the audience's understanding of the experience

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Abstract

This paper considers the particular characteristics of Generative Artworks that may shape their reception, as well as both the artist's and audience's understanding of the experience they offer. In doing so it will argue that Alfred Gell's conception of 'art as a technology' capable of 'enchanting' its audience, is particularly relevant to the understanding of Generative Artworks. The audience's perception of qualities such as 'technical virtuosity' and 'visual complexity' can be seen as having a particular impact on the reception.

In considering the audience's experience, it is necessary to examine the contexts brought to the work by the audience. This includes current debates surrounding the invisibility of computational processes and the opacity of code and algorithms. This paper considers how these elements, both within and outside the artwork itself, influence the reception. It discusses these issues in relation to artworks created by the author since 2016 as part of an ongoing practice-based enquiry.

Introduction

Since the definition provided by the first Generative Art Conference in 1998 [1], there have been a number of other important attempts to define Generative Art such as those by Galanter [2] or Boden and Edmonds [3]; or to categorise its different forms and components such as that by Dorin et al [4]. However, there are perhaps fewer attempts to account for how the features and characteristics of Generative Artworks (GAs) may affect their reception. This paper considers the particular characteristics of GAs that may shape their reception, as well as both the artist's and audience's understanding of the experience they offer.

The definition of GAs is often broad and can be extended to include a range of practice both computational and non-computer based, from mosaic patterns to AI systems [2]. However, most definitions note two key defining features: the presence of a system, and a level of autonomy or control passing from the artist to the system. It might be defined as simply "any art process where the artist uses a system … which is set into motion with some degree of autonomy" [2]. Boden and Edmonds also note the autonomy inherent to GAs, arguing the system "takes over at least some of the decision-making". Although crucially they add that the "artist determines the rules" [3]. This begs the question of how autonomous the system or machine is allowed to be and to what extent therefore it is shaped by the artist.

These defining features give rise to other qualities which, while not defining, can be seen as common characteristics or aspirations. Key among these characteristics considered here are complexity and an opacity. Celestino Soddu has noted how GAs produce "events that are unique and complex" [5] adding that these are closely related. For Philip Galanter complexity is not inherent to the GA since they can also be simple and predictable [2]. However, Galanter argues that the work that aspires to an 'effective complexity', by balancing order and chaos, may have the greatest potential [2, 6]. The opacity, I would argue, takes different forms but is related to both complexity and the autonomy of the system. It can be seen in the opacity of the system to the audience who may have a limited understanding of how it has been made or from whom the workings are hidden. It can also be seen as a result of handing a level of control to the system. While the artist may have knowledge of the rules of the system, the results cannot be known in advance and are effectively hidden. It is these characteristics of complexity and also opacity and the hidden or unknown that will be explored here. This paper will focus on computational processes since these present particular issues for opacity and complexity.

To understand the reception of GAs it is necessary to examine the contexts brought to the work by the audience. This includes current debates surrounding the invisibility of computational processes [7, 8] and the opacity of code, including perceptions of algorithms, neural networks and machine learning [9]. All artworks are received in relation to the wider contexts in which they exist, however, this paper examines some of those specific to GAs and which may result from their characteristics.

In understanding the role of complexity and opacity in GAs, Alfred Gell's [10] conception of 'art as a technology' capable of 'enchanting' its audience, is particularly relevant. Gell suggests that the audience's perception of qualities such as 'technical virtuosity' and 'visual complexity' can be seen as having an effect on reception. The nature of GAs as processes negotiated between human and machine in the production of unpredictable outcomes lends itself to Gell's description of a seemingly 'magical' technology capable of enchantment.

Taking Gell as a starting point, this paper examines the characteristics of GAs and the contexts in which they are created and presented. It does not consider all the contexts exhaustively. Instead it reflects on a number of contexts observed while making and presenting an artwork, *Manual_assembly*. This practice based approach, which draws on 'deformance', has the advantage of considering aspects of both production and reception.

Gell and agency

Anthropologist Alfred Gell's in his work 'The Technology of Enchantment and the Enchantment of Technology' [10], and the posthumously published 'Art and Agency' [11], proposed a theory of art which considered the artwork as an 'agent' which can affect its audience. Gell considers the artwork not in aesthetic terms but in its capacity to affect the viewer. For Gell, art is a form of technology which can enchant us, having almost magical properties that lead us to respond to them as though they were living things. He gives the example of the way in which the visual complexity of patterns on the decorative boards of Trobriand canoes were said to be " 'magically' efficacious in demoralizing the opposition" [11]. As well as visual complexity, Gell argues that the perceived 'virtuosity' of the artist can captivate the audience as they struggle to comprehend how the artwork was made. The materials and tools may be understood but the "complexity of the artistic decision making process" defeats the audience [11]. The hidden process, Gell suggests, exerts its own form of agency. In relation to GAs this virtuosity may be attributed in part to the system itself rather that the artist. We may understand the tools and the material, computers and code, but at least part of the 'decision making' is hidden from us.

Gell suggests that all art objects act as agents but this may be particularly true of GAs due to a common intention for them. Rather than a single proposition, they offer a spectrum of possibilities which in turn have an impact, generating new knowledge, understandings or experiences. This is not to imply that there is no single concept or idea underlying the work or that many interpretations of any given work are possible. It merely notes their dynamic nature, where intentions are balanced against the unexpected results with the potential to generate an effect. It has been noted that GAs often traverse disciplines, and can present new possibilities and ways to think about the world [1]. This is not to suggest that it is the sole preserve or purpose of GAs but just to note that a common characteristic is that they have an impact on practices, disciplines and understandings of the world.

Gell's ideas have previously been applied to computational artefacts including Daniel Miller's account of websites as traps, noting the way that they model the creator and the audience [12]. Meanwhile, Adrian Mackenzie has noted the relationship between Gell's description of agency and the 'animating' effects of algorithms whereby complexity invites the attribution of agency [13]. Mackenzie argues that algorithms, like the intricate geometric patterns of Celtic knots or Oriental carpets, posses a "cognitive stickiness" [13]. The complex patterns of knots lock the eye into a constant state of animation and present a "perceptual problem" that cannot be satisfactorily resolved [13]. Mackenzie argues that "[a]lgorithms have similar animating effects on their recipients: they put into question who is moving what" [13].

Here we can see how considering agency leads to a questioning of who is being affected by what and why. As Nicholas Thomas notes, it is not claimed that the art object has an effect "independently of a field of expectations and understandings" [14]. Gell has been criticised for seeing as irrelevant many contexts including its 'aesthetics' and the aura of the artwork by treating it as a form of technology [15]. Rejecting the contexts in which the artwork is made and exists has been widely seen as a considerable flaw in this theory. It has also been pointed out that his theory is itself enchanting in the apparent complexity of its detail [16]. However, as Howard Morphy notes, what is useful is that he shows that the artwork can act as an agent and leads us to consider what the effects might be. Gell deflects attention away from human agency by instead attributing it to the objects themselves [15]. This can be useful in allowing us to attribute at least part of the agency to the artwork itself, distinct from any intentions by the artist. However, this must be balanced by the other "historical and contextual factors" in which they are enmeshed [15].

Manual_assembly

Many of these issues relating to agency, perceived complexity and opacity came to the fore while producing and presenting an artwork called *Manual_assembly*, produced by the author as part of a practice-based investigation. *Manual_assembly* is a relatively simple GA program written using Processing. When running, it changes random values within the Scalable Vector Graphic (SVG) image files of an IKEA instruction manual for a Billy bookcase. This changes the attributes of certain lines, such as their length, curvature, weight, position etc. The SVG is then displayed and in this way a new 'drawing' of an IKEA manual page is displayed every 10 seconds (figure 1), which is approximately how often a Billy bookcase is sold. Subsequent versions altered the work in order to draw out other aspects. This included presenting it as a twitter bot called @Manual_Glitch and a three volume set of books.

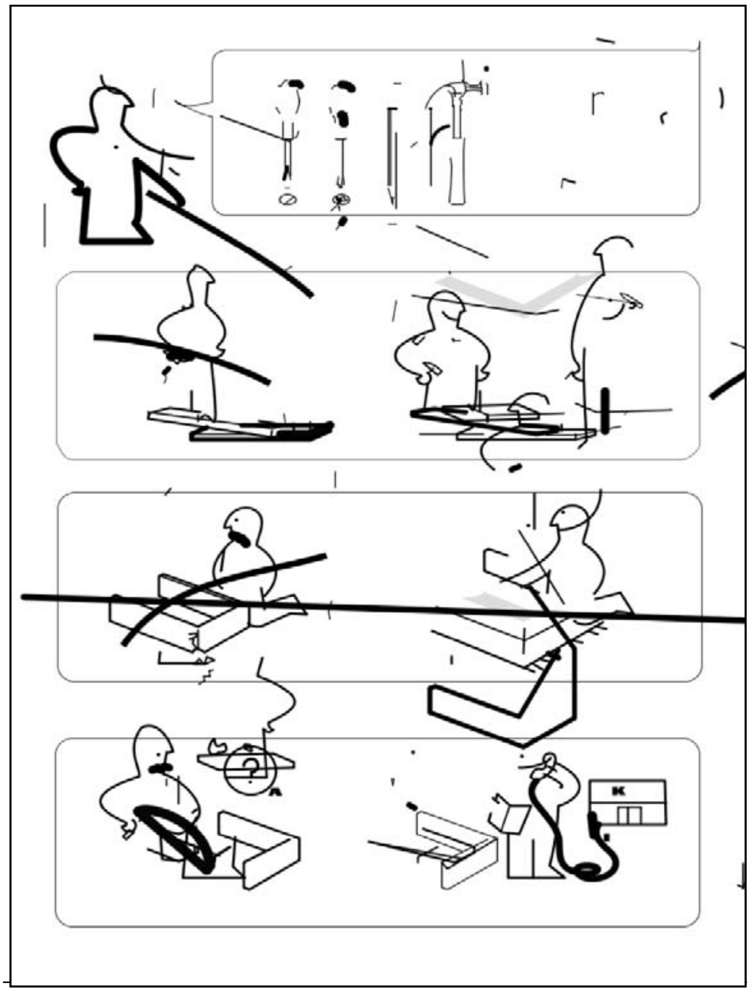

Figure 1. Screen grab of the output of *Manual_assembly*

The approach borrows from 'deformance', put forward by Jerome McGann and Lisa Samuels [17] initially as an approach to the study of written texts, but which has also been applied to other media. Deformance, a portmanteau of deform and performance, involves altering a text, in order to present a new perspective that may reveal new understandings. Each deformance is a 'performance' of the text and aims to draw attention to the "constructedness of a text" and its seams [18], challenging the assumptions about how it was put together. The deformance here works in two ways. The drawings of the IKEA manual are deformed to reveal something of the audience's relationship with the image. However, I also deformed the system, by altering the code itself, in order to try and reveal my relationship and working process.

Complexity and Virtuosity

When considering the complexity of *Manual_assembly* it is important to note that it would score low in terms of effective complexity, consisting of a simple process of randomizing values. Neither can I make any claims to particular technical virtuosity. However, as Galanter and Levy suggest, complexity is "a matter of content, not complicated technique" and involves "large numbers of components interacting in nonlinear ways" [19]. In this way *Manual_assembly* suggests complexity by showing how many components, individual lines and parts of lines, make up the 'whole' image. Ian Bogost notes the dazzling effect that exploded diagrams can have. Rather than being solely informative, we are captivated by the sheer complexity of the system they show and enter the otherwise inaccessible and "murky otherworldliness" [20]. But this complexity requires a careful balancing of order and chaos in relation to the context of the original image.

Manual_assembly uses a random approach to the placement of the lines but this is balanced against the order of the underlying image. The system has been carefully set not to alter the original to a point where it can no longer be recognized and rendered as an SVG image. It has also been set to produce images which are noticeably different to the original and which seem to generate pleasing or fortuitous combinations quite frequently. A great deal of the complexity would seem to be a matter of perception and judgment. Without my knowledge of what the original should look like – clean lines, well placed and spaced so as to give an unambiguous presentation of the drawing as information – it would not be possible to balance the order and chaos. It also requires a very important context brought to the experience by the audience which is an appreciation of the original images, of IKEA and the experience of constructing flat pack furniture. The drawings produced may seem closer to our experiences of flat pack than the original ordered images (figure 2).

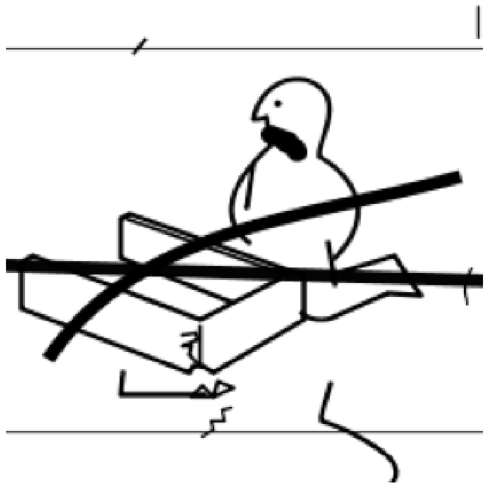

Figure 2. Detail from output of *Manual_assembly*

Anna Munster argues in relation to networks, that complexity is something that can be made perceptible [21]. Recognising a pattern is then a matter of perceiving and recognizing something already seen. This raises questions as to what the role of the human is in, if not determining the outcomes of a GA system, influencing or validating them by perceiving complexity. Similarly, Vilem Flusser in his description of the technical image, highlights the role of the human in selecting and drawing significance from an automatically generated image. It involves “stopping at a situation that human beings have determined to be informative” [22]. This shows an inherent contradiction as the improbable, through its encoding in the system, becomes probable. So “that which was programmed into the apparatus as negative entropy is transformed into entropy” [22]. Here it is the limits of the human that determine the outcome - both artist and audience. Bogost similarly notes the human centric approach, arguing that typically “the idea of computation is inextricably linked to human understanding, experience, and knowledge.” [20]. The human limits are (inevitably) encoded into the work/system as Scott Dexter notes [23]. If not acknowledged this would seem to limit the potential for GAs. What if we can’t see the patterns in the chaos and so engineer them out? This is not to propose a solution but it is important to acknowledge the potential problem.

Aside from the potential for complexity encoded in the system, it became clear that the code exerted an agency simply by being code. When selected for an exhibition of contemporary drawing practice the selectors opted to exhibit *Manual_assembly* as a screen recording rather than a running version of the program (figure 3). This screen recording begins by showing a computer desktop and the code visible in the Processing window as the program is started. It ends when the program is stopped before the video loop starts again. This initially came as surprise but on reflection seeing ‘behind the curtain’ to be made aware of the code has an important role in shaping and framing the audience’s understanding of the images. If seen simply as a series of images made by some unspecified means, it would be far less engaging. When the work was mentioned at a subsequent discussion panel one of the selectors noted it specifically for its use of code as a tool. The agency of the code is such that just seeing it fleetingly can shape the experience. This is in contrast to another version of the work in which the code is completely hidden.

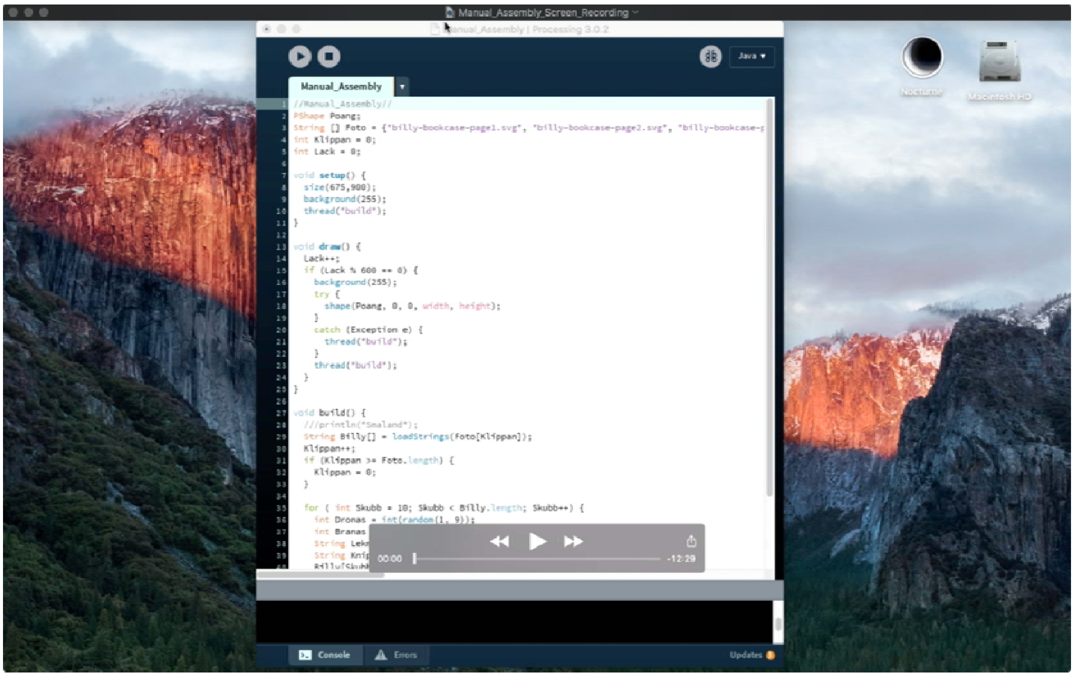

Figure 3. Screen grab of *Manual_assembly* video loop

Manual_assembly was also turned into a twitter bot, @Manual_Glitch (figure 4), which generates new ‘drawings’ daily. Here the code is not visible at all and nor is it presented in a gallery context. Comments from those who liked or followed the bot did not mention code or workings at all and focused instead on the novelty and currency of the images. For example, commenting that more people should know about and share the images produced. It had lost some of its identity as a generative process and artwork. Instead the images produced became the focus as they were enmeshed in a network. Each image, detached from the process, becomes what Rubinstein and Sluis call a “networked object” [24]. The agency of the code and how it was made are gone but it has gained new agency as the emphasis shifts to the “processes of valorization within computational culture” [24]. The system of the GA has intersected with the system of twitter, a situation with the potential for unexpected results that may overcome the human limits/intentions encoded into the system.

Figure 4. Screen grab of @Manual_Glitch twitter bot

Another example of a GA that exists in a similar ‘real world’ context is Shiv Integer by Matthew Plummer-Fernandez in collaboration with Julien Deswaef [25]. Shiv Integer is a bot which remixes objects on 3D model sharing website Thingiverse, creating new model files which are re-uploaded to the site with “word-salad names such as ‘disc on top of an e-juice golf’” [25]. As the creators have noted, the reaction of fellow Thingiverse users is varied from those who simply do not understand the purpose of the generated models dismissing them as pointless, to those actively annoyed by them. While these reactions might have been anticipated, one user’s response was markedly different. The user decided to create back stories for the objects, inventing histories and contexts. This unintended collaboration between the bot and an individual goes beyond the imagined limits of the original bot and has produced a new poetic existence. This seems to hint at the possibilities where GAs are allowed to stray from their original purposes and contexts, breaching the limits of the artist’s understanding.

Opacity of code

Many theorists have noted the opacity of code, algorithms and software including Dourish [26], Bridle [8], Burrell [9] and Campinelli [7]. Jenna Burrell argues the opacity of algorithms poses particular problems for accountability and our ability to question how these processes work and that we might begin to redress these issues by auditing code – involving a careful assessment of what the algorithm does [9]. However, as both Burrell and Dourish note, this is not an easy endeavor since issues of commercial secrecy and also literacy come into play, with the ability to read or understand algorithms a “highly specialized skill” [26].

Another layer of obfuscation comes from slippages around terms. Often code, software and algorithm are used interchangeably. It has been noted that, even within groups of programmers, slippages occur [27]. That there is confusion about the precise meaning of these terms even among experts reflects a wider general lack of understanding. Algorithm in particular has entered common usage to describe almost any system involving a computer, and typically to suggest their ‘black box’ nature. An article recently published in a UK newspaper entitled ‘Franken Algorithms’ claims "[f]ew subjects are more constantly or fervently discussed right now than algorithm" [28]. There is a suggestion in pubic discourses that we should fear algorithms because we, typically, do not understand them.

It has also been said that even artists working with code may not fully understand the algorithms and processes they are using [4]. Alan Dorin et al, while recognising the pedagogical value of imitation and the use of tools such as Processing, are concerned that "these systems operate as 'black boxes' whose internal operations are obscure to the artists and designers using them" [4]. Another deformance of *Manual_assembly* threw into question my own relationship with the code. I changed all of the variable and function names to the names of IKEA products such as 'skubb' and 'trofast'. I also tidied the code removing redundant lines that had been there previously, making changes that have no effect on how it functions. As a result, my very visual relationship with the code was revealed. Lines of redundant code that I had used as reference points were gone. Function names no longer described their function. The importance of the form of the code as shapes on a screen rather than its meaning came to the fore. As Hayles has noted, even "code one writes oneself can also become mysterious when enough time has passed" [29]. Code poetry, 'code work' and obfuscated code show the potential for code as an expressive form and the tension between form and function as has been noted by Geoff Cox among others [30].

What this shows is that literacy is clearly not just an issue for the audience and even makers have limits to their understanding. Seeing the code anew reminded me of the effort and learning process it had taken to construct the code and the satisfaction of making it 'work'. Perhaps this is what we find appealing in the first place in wanting to employ generative systems. The agency asserts itself on us as we make the work negotiating solutions and working to find the limits of our understanding. This is not to suggest that everyone takes the same approach to coding. However, I would argue that we need to recognise the limits of our understanding. It should also be acknowledged that the artist can also be affected by the agency of code.

The Importance of the Hidden

Code and the workings of systems are typically hidden but bringing code to the foreground does not necessarily lead to transparency. Another incarnation of *Manual_assembly* does bring the code to the fore and at the same time becomes almost entirely opaque. In doing so it suggests the importance, even necessity, of hiding the working of the system.

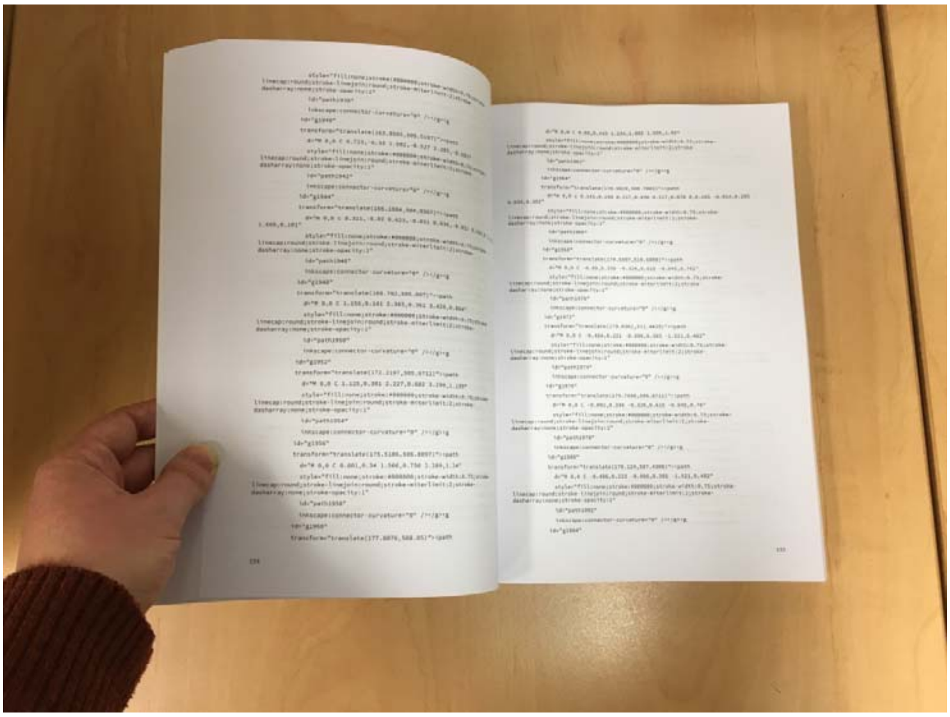

Figure 4. *Manual_assembly* in book form

All of the Processing code and SVG data has been contained in three A4 650 page volumes (figure 4). While the code may be understandable to someone familiar with programming languages, the SVG data, which makes up all but 2 of the pages, is far more impenetrable. Not because the information cannot be read. The markup language of SVGs explains in detail the properties of each line, each angle and point. But the vast quantity of information and the time it would take us to process reveal our human limits. This version shows the opacity of the code precisely by bringing it to the fore. Revealing leads to greater mystification. In addition, without the system – the generative aspect – it is transformed into something else. The vitality has gone and with it the agency seems to have been diminished. That is not to say that it is without agency. The opacity of the code and redundancy of the books as objects, amplifies the differences between human and machine, making them manifest. If I were to execute the code by hand, while the results may look much like the output when the program is run by a computer, it would have a very different character. It will be bound up in the laborious nature of its production and by implication my own will and efforts. This would surely overshadow the images themselves. By revealing all, some of the mystery has gone and the process is all too explainable if not fully accessible. The hidden workings leave a space for imagination.

Boden and Edmonds suggest that for the artist, and the computer scientist, writing algorithmic code gives the " 'feel' of fully controlling the computer", but that this does not necessarily hold true for GAs since they are defined by constraints and rules [3]. And yet as we have seen it is the human that often defines the outcome. There is a contradiction whereby we seemingly want to control our machines and yet also want them to be independent from us. As Steven Connor argues "[o]n the one hand we want to explicate their workings, to work out how they work, thereby demonstrating our priority over them", but on the other hand we want those workings to be "absolute and autonomous of us" [31]. We want to be in control but also expect to be surprised. Dexter argues that have a desire for mystery and for the "yielding of authority" [23]. For Dexter what characterises our relationship with computers is the relationship between the hidden and the revealed. He goes so far as to suggest that we want or need the workings to be hidden from us lest we recognise the limits of the system as our own human limits [23]. Computers are capable of virtually limitless possibilities and yet they are constrained by humans and "[t]he code produced by extremely fallible humans" [23].

GAs offer us the possibility of creating new and unexpected results, but this is only possible if some things are hidden from us. Not only does this prevent us from anticipating the results making the process redundant, but it also leaves room for us to misinterpret the results or even have a misplaced belief in their capabilities. Thomas et al describe algorithms as like a fetish in that they are granted powers to act in the world [27]. Like fetishes, algorithms “enable parties to productively misrecognize what the technology is and does” and this leads to the potential of imagining new possibilities [27].

Our experience of GAs might best be conceptualised as an ‘encounter’ as described by Gillian Beer [32]. Beer describes how cultural encounters do not always guarantee understanding and can sometimes “emphasise what is incommensurate” [32]. Part of the GA will always be hidden and perhaps as we want and need it to be. Attempting to understand our differences is where we can learn the most. The encounter also considers unforeseen and inappropriate audiences who might therefore bring very unanticipated responses and different knowledge [32]. Importantly they also bring “into active play unexamined assumptions” and may allow us to see “unexpressed incentives” [32]. If we consider our interactions with GAs as encounters, then we might highlight the incommensurate and examine the unexpressed and hidden parts. Importantly, these can be encounters not just for the audience but also for the artist.

Conclusion

This paper has set out to show how the reception of GAs is shaped by perceptions of their complexity and their opacity. The opacity is partly the result of literacy but also wider attitudes to computers, code and algorithms which tend to both mystify and also generalise. Complexity is potentially a matter of perception but is no less captivating for it. Much of this stems from our inability to fathom the decision making process behind the system that creates the artwork. There is a negotiation between the control of the artist and the agency or autonomy of the machine, but there is a similar negotiation between the artwork and the audience. To understand the reception it is necessary to recognise that GAs also exists in a network of other contexts, many of which the audience bring to the artwork. Contexts such as where they are encountered shape what we expect from them. These contexts can also change the agency of the artwork, often in ways unanticipated by the artist.

Ultimately the experience is constrained by the limits of our own understanding. The artist is no less susceptible to these contexts and the limit of their own understanding. However, these limits and the hidden character of the GA may be something that we cannot avoid and may even be needed in our relationship with them. The hidden leaves the space for imagination, faith and belief in what they can do, suggesting new possibilities. They allow us to imagine a ‘liveness’ and vitality that makes them captivating and enchanting.

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Watchers – Directionality as Metaphor for Interaction with a Generative Installation
(Paper)

Topic: (Music)

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Abstract
Watchers is an interactive multi-channel audio installation that experiments with different compositional approaches of incorporating the loudspeakers' directionality as central functional and aesthetic element. The directional properties of the custom developed loudspeakers are not only defined by the characteristics of their sound radiation but also integrate a light-based line of sight and orientation sensing mechanism. It is through this latter mechanism that the configuration of the installation affects the algorithmic creation of the musical content. And its also through this mechanism that the musical content is rendered responsive to the visitors' physical manipulation of the installation. The realisation of the installation forms part of a research strand that addresses the issue of rendering the algorithmic principles of a compositional work experienceable not only through its sonic manifestation but also via spatial and tangible representations. These representations can provide affordances for interaction and thereby offer the possibility for visitors to engage through embodied actions with a musical work.

Exhibition of Watchers at the NeMe Arts Centre, Limassol, Cyprus

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Key words: Sound Installation, Algorithmic Music, Interaction

Main References:
[1] Daniel Bisig, "Watchers - An Installative Representation of a Sound Synthesis System", in Proceedings of the 5th Conference on Computation, Communication, Aesthetics & X. Lisboa, Portugal, 2017.

Watchers
Directionality as Metaphor for Interaction with a Generative Installation

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Premise

Watchers is an interactive multi-channel audio installation that experiments with different compositional approaches of incorporating the loudspeakers' directionality as a central functional and aesthetic element. The directional properties of the custom developed loudspeakers are not only defined by the characteristics of their sound radiation but also integrate a light-based line of sight and orientation sensing mechanism. It is through this latter mechanism that the configuration of the installation affects the algorithmic creation of the musical content. And it is also through this mechanism that the musical content is rendered responsive to the visitors' physical manipulation of the installation. The realization of the installation forms part of a research strand that addresses the issue of rendering the algorithmic principles of a compositional work experienceable not only through its sonic manifestation but also via spatial and tangible representations. These representations can provide affordances for interaction and thereby offer the possibility for visitors to engage through embodied actions with a musical work.

1. Introduction

The installation *Watchers* consists of six custom-designed loudspeakers each of which is mounted with a rotational hinge on top of a stand. Visitors can interact with the installation by manually changing the orientation of the loudspeakers. This interaction alters the directionality of the emitted sounds and also affects the generative processes that generate the musical output. Accordingly, the loudspeakers not only serve as acoustic devices but also provide tangible affordances for interaction with the generative musical works.

This publication describes the installation and the musical works that have been specifically created for it. The description includes an overview over the motivation and conceptual background that informed the realization of the installation, a description of the generative sound producing principles of each musical work, an overview of the hard- and software implementation, a description of the exhibition and interaction situation, and a conclusion and outlook for possible future research directions.

Additional information about some aspects of the installation that are only superficially addressed in this paper is available in another publication [1]. This previous publication complements the current publication in that it is more exhaustive in its description of the conceptual background that informed the realization of the installation and also places a stronger focus on a single musical realization. Instead, the current publication focuses on the description and juxtaposition of the different compositional approaches that led to the realization of multiple musical works.

2. Background

The motivation for realising *Watchers* is based on the authors' interest in developing interaction principles that could be particularly suitable for generative sound installations. These developments are guided by the hypothesis that for an audience to creatively engage and interact with generative music, the processes underlying the music need to be exposed on two perceptual levels: Not only through the musical output but also through specific physical affordances for interaction that are clearly correlated with these processes. The authors believe that by establishing a close correspondence between generative principles and affordances for interaction, the audience gains not only an aesthetic appreciation of the musical work but is also encouraged to obtain an intellectual understanding for its underlying formal structure and functioning.

The approach that has been chosen for the realization of *Watchers* is inspired by the field of tangible computing. According to this field, an interface is considered tangible if it establishes a close relationship between physical elements for interaction and the characteristics of the computational system that is being interacted with. The tangible interface elements constitute embodied representations of digital data and at the same time provide the means for their manipulation [2]. It has been shown that tangible interfaces can contribute to the legibility and learnability of a computational system in that the interface's tangible elements leverage the connection of body and cognition and thereby facilitate tangible thinking [3]. Concerning the characteristics of the correspondences between physical and digital objects, Boriana et al. propose a framework that is based on the degree of coherence between physical and digital objects [4]. The strongest form of correlation results from aligning the mutual ontological status of digital and physical objects. This level of alignment is also known as 'full metaphor' [5] or 'natural mapping' [6].

For *Watchers*, two different levels of correspondence have been chosen. On the first level, each loudspeaker corresponds to an individual sound producing unit within the generative system. The loudspeaker not only renders the musical output of that unit audible but also provides the unit with a position within physical space. As a result, the generative system becomes accessible for spatial forms of exploration for instance by approaching a loudspeaker in order to closely listen to the activity of it's corresponding unit in isolation, or by retreating from it in order to perceive the activity of the entire generative system. This correspondence follows the principle of natural mapping. On the second level, the relationship between the relative direction of the loudspeakers and the generative system establishes another correspondence. Whenever the loudspeakers are oriented in such a way that they face towards each other, the corresponding sound generating units increase their level of mutual correlation. Vice versa, when the loudspeakers are facing away from each other, the corresponding sound generating units decrease their level of correlation. This *visibility* among loudspeakers exposes additional aspects of the underlying generative system in a spatial manner. But in addition to this, it also invites tangible and embodied forms of interaction in that visitors can manipulate the generative system through the physical proxies of the loudspeakers, and in that the visitors' bodies through their occluding effects alter the *visibility* among the loudspeakers. This relationship between the *visibility* among loudspeakers and the correlation between sound generating units represents a weaker metaphor of correspondence. By combining the same two types of mapping, the relationship between the tangible properties of the installation and the generative musical processes is made consistent across the different musical works. Moreover, as the second mapping incorporates a weaker metaphor of correspondence, a certain level of flexibility is granted for different compositional approaches.

3. Compositional Approaches

Each of the three authors of this publication has created an individual musical work for the *Watchers* installation. This section describes the different compositional approaches that have been chosen to connect tangible interaction and generative processes.

3.1 Recurrence

This work employs a time-delayed recurrent network as sound generating mechanism (see figure 1). Nodes in such a network exchange signals among each other via directed connections. The signals can be delayed in time as they travel along these connections and some of the connections can even form loops. Such networks are musically interesting for several reasons: the activity of the network can be rendered audible through direct audification [7], they permit the creation of musical structures across a large range of temporal scales, and they exhibit rich and self-organized behaviours. The authors have previously published their findings concerning musical applications of such networks [1, 8, 9].

For this particular musical work, the network consists of six nodes. Each of these nodes possesses a permanent recurrent connection with itself. The connections among different nodes are sparse and their existence changes over time. Each node produces its own unique signal in the form of a sine wave to which it adds all the incoming signals. The summed signal is then passed through a sigmoid wave shaping function which distorts the signal. The slope of the function is automatically adjusted to maintain a stable signal amplitude. The distorted signal propagates across the network connections. These connections process the signal in the following ways: a gain attenuates the signal, a high pass filter removes a DC offset, a low pass filter removes high frequency content that has been introduced by fast changes of the wave shaping function, a delay line delays the signal, and an output gain attenuates the signal before it arrives at the receiving node.

The correspondence between the generative system and the tangible properties of the installation is as follows. The output signal of each node is rendered audible and emitted from the loudspeaker that corresponds to this node. The directionality of the loudspeakers controls the presence and absence of connections in the signal processing network. Whenever loudspeakers are facing each other, a connection between the corresponding nodes is established. The changes in connectivity strongly affect the diversity of signals that propagate through the network. The signals of mutually connected nodes increase in similarity due to the fact that the nodes combine their respective signals and suppress their own sine oscillators. The signals of nodes that are not connected gradually return to their own unique characteristics.

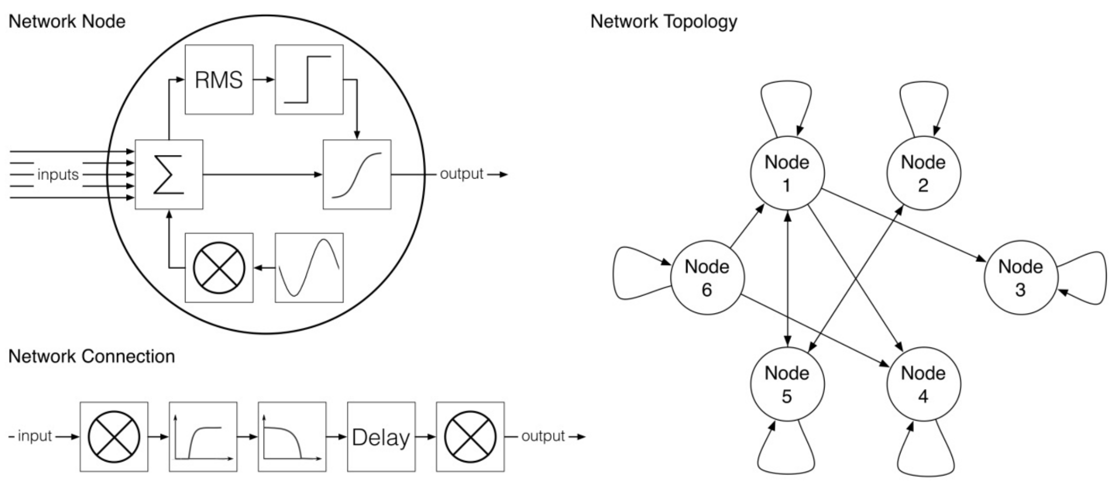

*Fig 1: Schematic depiction of the network employed for the work Recurrence. Shown on the top left are the characteristics of a network node. The symbols are (in clockwise order): signal summation, root mean square of summed signal, threshold function, wave shaping function, wavetable oscillator, gain function. Shown on the bottom left are the characteristics of a network connection. The symbols are (from left to right): input gain, high pass filter, low pass filter, delay line, output gain. Shown on the right side is a possible connectivity in a network of six nodes.*3.2 Synchronization

This work employs Van der Pol oscillators as audio signal generators (see figure 2). The non-linear characteristics of these oscillators gives rise to a sonic output whose spectrum is rich in overtones. The oscillators are inherently stable and therefore do not require external control for stabilization. If certain non-linear oscillators are coupled in a network they can mutually synchronize their frequencies [10]. The frequencies can be identical or related to each other by simple proportions [11]. Synchronization is achieved mathematically by adding to the differential equation describing a single oscillator the state value of another oscillator multiplied by a coupling constant. The size of the coupling constant controls the amount of synchronization that occurs between two oscillators. The larger the difference in the frequencies among the respective oscillators, the higher the coupling value that is required to achieve synchronization.

For this particular musical work, the network consists of twelve Van der Pol oscillators. The output of six oscillators is directly rendered audible. The remaining six oscillators modulate the amplitude of the audible oscillators. The audible and modulating oscillators are organized in pairs in that one modulating oscillator controls the amplitude of one corresponding audible oscillator. All the audible oscillators can potentially be synchronized among each other. The same also applies for all the modulating oscillators.

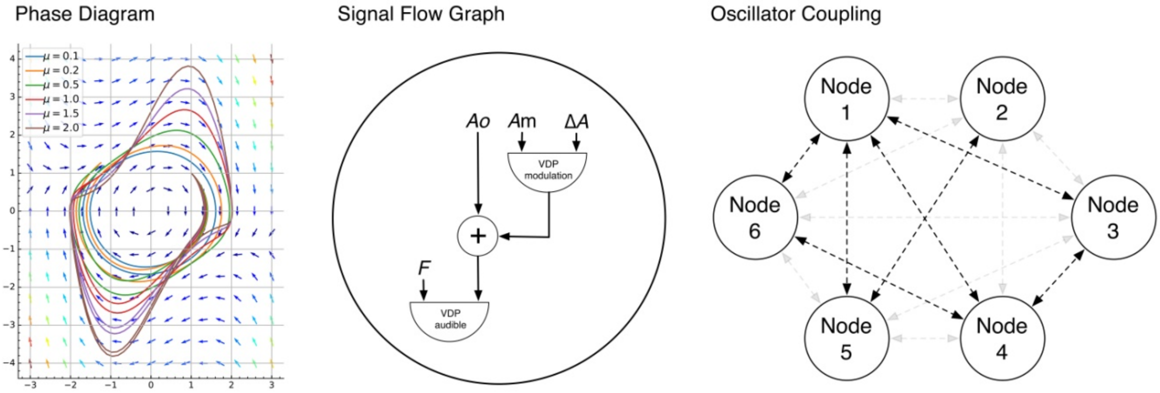

Fig. 2: Schematic depiction of the oscillator architecture employed for the work Synchronization. Shown on left is a phase diagram of a Van der Pol oscillator exhibiting different limit cycles for different values of the μ parameter. Shown in the middle is a node containing the signal graph between a pair of Van der Pol oscillators. The amplitude of an audible oscillator (VDP audible) is controlled (solid arrows) by a second oscillator (VDP modulation). The labels are: reference frequency (F) of the audible oscillator, reference frequency (Am) of the modulating oscillator, width of the amplitude modulation (ΔA), amplitude offset (Ao) to which the output of the modulating oscillator is added. Shown on the right are possible couplings (dashed arrows) among six nodes. They affect either strongly (black) or weakly (grey) the synchronization of the frequencies among the oscillators.

The correspondence between the generative mechanism and the tangible properties of the sound installation is as follows. Each of the audible oscillator emits its sound via a corresponding loudspeaker. The directionality of the loudspeakers controls the value of the coupling constant among the audible and modulating oscillators and also affects their amplitude level.

3.3 Interpolation

This work uses six monophonic synthesizers each of which consists of a resonating filter excited by an impulse generator, an oscillator to modulate the amplitude of the signal, as well as of a white noise generator whose signal is bandpass filtered and mixed to the output signal in varying amounts. The sound quality of these synthesizers can be modified in three ways. First, the attack time of each sound can be changed to lend it a more or less percussive quality. Second, the frequency of the amplitude modulation can be adjusted to control the amount of distortion. Third, the synthesizer's state can be switched to 'inactive' which lowers the volume and adds the bandpass filtered noise to achieve a quieter, noisier and less saturated timbre (see figure 3).

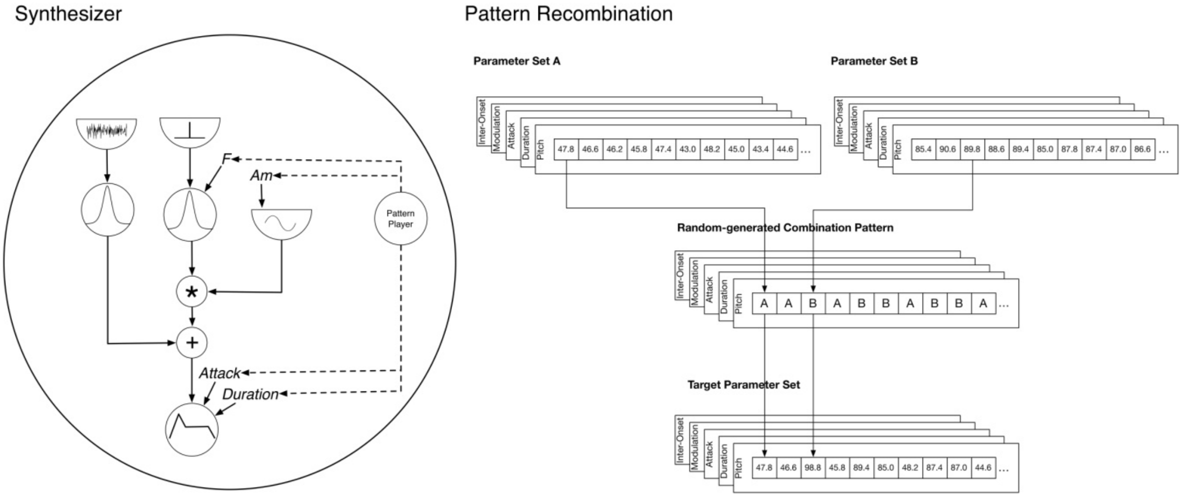

Fig 3: Schematic depiction of the sound generating mechanisms for the work Interpolation. Shown on the left is an instance of the monophonic synthesizer. The symbols are (from left to right and top to bottom): a white noise generator, an impulse generator, two bandpass filters, a low frequency sine oscillator, and an amplitude envelope. The labels are: resonant bandpass frequency (F), amplitude modulation frequency (Am), attack duration (Attack), and amplitude envelope duration (Duration). Show on the right is the pattern recombination mechanism. For each parameter, the two pattern sequences of the two correlated instances A and B are combined into a new target pattern sequence by randomly choosing the values at each sequence position either from pattern A or pattern B.

Each synthesizer is controlled by a generative algorithm named 'pattern player'. This algorithm iterates through a set of five lists all of which contain 15 values. Four of these lists hold the sound synthesis parameters pitch, duration, attack time and amplitude modulation frequency. One list contains the inter-onset intervals, i.e. the times to wait before the next note is played. The pattern player reads these five parameter lists synchronously in a loop to generate a repeating musical pattern of 15 notes. Each loudspeaker's output is individual due to the fact that every pattern player runs through a unique set of lists.

The correspondence between the generative mechanism and the tangible properties of the installation is as follows. When one loudspeaker faces another one, its synthesizer's state is toggled from 'inactive' to 'active'. As a result, the music becomes louder and the noisy sound quality changes to a clean timbre. At the same time, a new set of parameter lists is generated by randomly combining the values of both loudspeaker's parameter lists. This new set of parameters contains half of the original values and half of the other loudspeaker's values. Subsequently, this new set becomes the target for an interpolation process. During this process, the current parameter values are gradually replaced by the values of the target set. As an effect, the musical pattern slowly changes and it becomes audible how the two loudspeakers exchange their musical properties. When a loudspeaker is isolated, its music becomes soft and noisy again. And, after a while, all parameter lists regress to their initial state.

4. Implementation

The hard- and software components that constitute the basic infrastructure of the installation have been custom designed by one of the authors. The software that implements the generative sound producing mechanisms pertinent for each musical work have been developed by each of the three authors individually.

4.1 Hardware

The hardware of the installation consists of a loudspeaker casing that houses a broad band speaker driver, a mono audio amplifier board an infrared light emitter, an infrared light detector, a gyroscope module, and a microcontroller (see figure 4). The infrared emitting and detecting components form the basis for the capability of the loudspeakers to detect and identify each other. The gyroscope module measures the angular acceleration of a loudspeaker. Each loudspeaker is attached to a rotational joint that also houses a slip ring. This joint is mounted on top of a microphone stand. The audio signal, wired communication and power supply pass through the slip ring. Located at the bottom of the loudspeaker stand is a wooden box that contains a Wi-Fi enabled microcontroller and a hum suppression transformer. The Wi-Fi microcontroller serves as interface between the wired communication and a wireless network. A master computer is connected to a Wi-Fi router, an audio interface. The screen is used to show visitors textual information about the currently playing musical work and a visual representation of the *visibility* among the loudspeakers. A schematic representation of this setup is shown in figure 5.

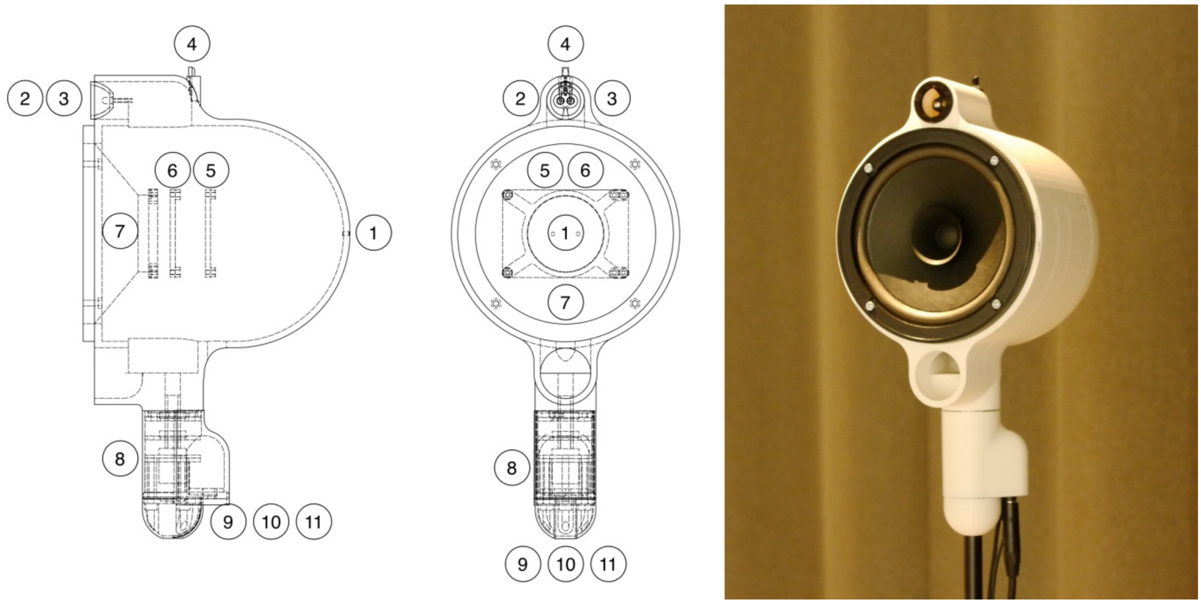

Fig 4: Watchers loudspeaker housing. The schematic depiction indicates several hardware components that have been integrated into the housing. The numbered labels correspond to the following components: 1: status LEDs, 2: white light emitting LED, 3: infrared light emitting LED, 4: infrared light receiver, 5: microcontroller board, 6: audio amplifier board, 7: speaker driver, 8: slip ring, 9: audio connector, 10: I2C connector, 11: power connector.

4.2 Software

A software infrastructure that is required of the installation's basic operation comprises two components: a program that runs on each microcontroller and a program that runs on the master computer. The programs running on the microcontrollers have been programmed in C. These programs control the infrared-based communication among the loudspeakers, the acquisition of the loudspeakers respective identifiers and their transfer via I2C and Wi-Fi to the master computer. The program running on the master computer has been programmed in Processing. It handles the start-up of the installation, the timing of the infrared-based communication, the derivation of the visibility among loudspeakers based on the acquired loudspeaker ids, the communication of this visibility to the currently running musical work, and the switching between different musical works.

The three musical works have been developed in different musical programming environments. The work *Recurrence* has been implemented in the Processing programming environment and makes use of the Beads library. The work *Synchronization* has been implemented using Java within the Max programming environment. The work *Interpolation* has been implemented in the SuperCollider programming environment. All these works communicate with the basic installation software via the Open Sound Control communication protocol.

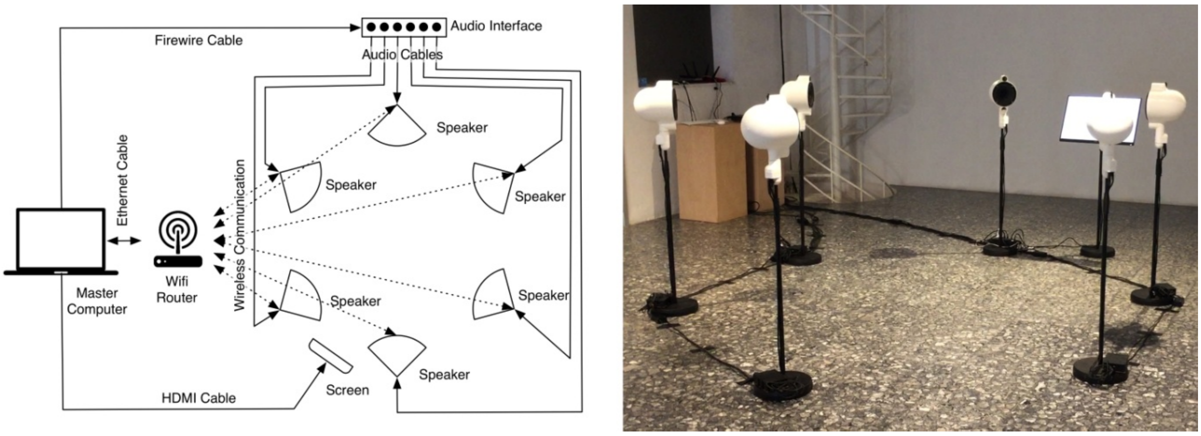

Fig 5: Watchers installation setup. The setup consists of six loudspeakers mounted on microphone stands and arranged in a ring configuration, a screen mounted on a stand, a master computer connected to an audio interface, and a Wi-Fi router.

5. Exhibition

The *Watchers* installation has been shown in 2017 as part of a group exhibition entitled See you hear in the NeMe gallery in Limassol, Cyprus [12]. This exhibition took place in the context of the Sound and Music Computing conference. For this exhibition, the installation consisted of six loudspeakers that were arranged in a circular setup with a diameter of about three meters. The information screen was mounted on a stand and placed outside of this ring setup. A 3D rendering of the exhibition situation is shown on the left side of figure 6. A photograph taken during the opening of the exhibition is shown on the right side of figure 6.

The ring configuration was chosen for two reasons. In this setup, none of the loudspeakers can be oriented in such a way that they see more than two other loudspeakers. As a result, the alignments among the loudspeakers is always partial. The correspondence of the loudspeaker alignment with the sound producing generative processes gives rise to the appearance of multiple musical clusters that differ from each other both spatially and sonically. The sonic changes within each of these small clusters and their correlation with the alignment of the loudspeakers are easier for the visitors to comprehend and control than would be the case for a singular large cluster. Also, this setup permits visitors to interact in two fundamentally different ways with the installation. Visitors can decide to stand either inside or outside of the loudspeaker ring. From an outside position, a visitor is able to carefully align the orientation of individual loudspeakers and then observe from this external listening perspective the resulting changes in the sonic output. This mode of interaction permits a precise exploration of each musical work and fosters an analytic understanding of its generative principles. If, on the other hand, a visitor enters the installation, his or her mode of interaction is much more disruptive with respect to the behaviour of the installation. In this situation, the occluding effects of the visitor's body have a profound effect on the visibility among the loudspeakers. As a result, the spatial aspects of a visitor's movements and the physical extension of his or her body become themselves tangible aspects in the mapping between the installation's physical properties and the sound producing processes. The following subsections describe the relationship between interaction and musical output for each work.

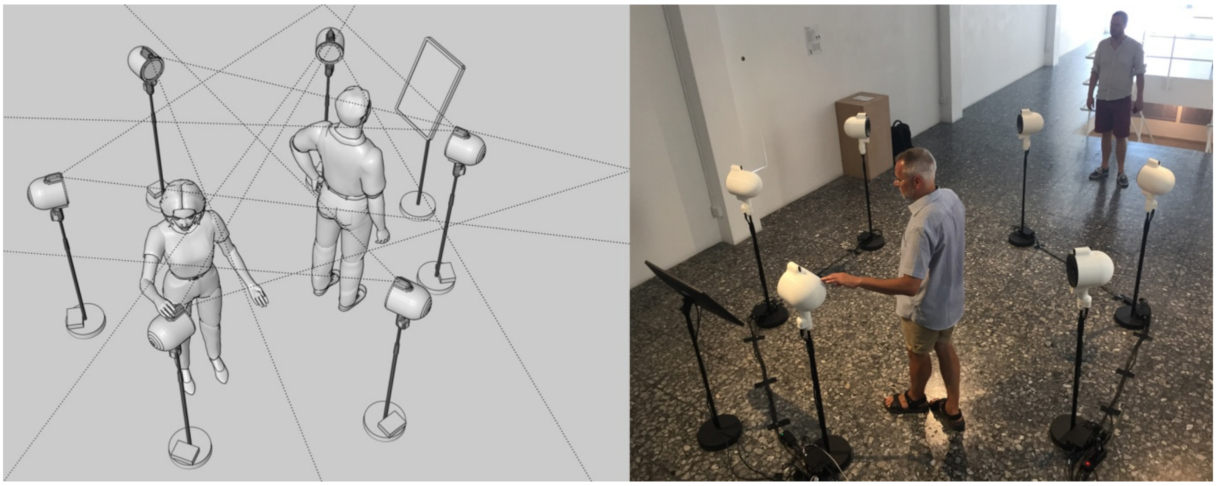

Fig 6: Exhibition situation. Shown on the left side is a 3D rendering of the installation setup including two visitors. The right side shows as photograph of the installation in an exhibition situation. In the rendering, the dashed lines emanating from the loudspeakers indicate visibility cones within which a loudspeaker can perceive other loudspeakers.

5.1 Recurrence

When this work starts, the sound synthesis parameters associated which each node and its own recurrent connection are randomly assigned different values. As a result, each loudspeaker initially exhibits its own unique acoustic signature. This signature helps to highlight the musical consequences of interaction. The acceleration that results from a manual rotation of a loudspeaker is correlated with a change in the delay time of the corresponding node's own recurrent connection. This change triggers a quick, localized and clearly audible perturbation of the loudspeaker's acoustic output. Whenever a change in orientation of a loudspeaker causes it to see other loudspeakers, the resulting establishment of network connections causes the formerly isolated acoustic signal to propagate through the network. As a result, other loudspeakers start to combine their own acoustic signal with that of the propagating signal. This effect is particularly well perceivable when the propagating signals are being affected by the previously described acceleration-based perturbation. And it is also particularly well perceivable when the propagating signal bounces back and forth between nodes via recurrent connections. This eventually leads to a harmonization of the sonic output of all nodes involved. Rotating a loudspeaker into an orientation in which it can no longer see other loudspeakers will cause the output signal of its corresponding node to gradually re-acquire its original sonic characteristics.

5.2 Synchronization

Upon initialization, the frequencies of all Van der Pol oscillators are assigned random values and their coupling constants are set to zero. As long as the oscillators remain in a non-synchronized state, each of them produces a unique acoustic output. When loudspeakers are manually rotated to face each other, the coupling constant of the corresponding oscillators increases rapidly, causing their respective frequencies to quickly settle into a harmonic relationship. This sonic effect is further accentuated by an equally quick increase in the amplitude level of the corresponding oscillators. As a result, synchronized oscillators are sonically clearly distinct from their non-synchronized counterparts and dominate the overall musical result. When loudspeakers are turned away from each other, the coupling constant and the amplitude slowly decreases towards their initial values. Accordingly, the acoustic output of these oscillators gradually fades back and merges with the background of non-harmonic sounds.

5.3 Interpolation

When this work starts, all six loudspeakers emit an individual musical pattern as their parameter lists are in their initial state. The initial parameter lists are designed to make these six musical patterns clearly distinguishable. Their values are each in a narrow range, hence, each loudspeaker plays notes in its own pitch range and in its own rhythm. When two loudspeakers are aligned, they start to influence each other. They randomly exchange some of their parameter values and new musical patterns emerge. When loudspeakers are turned away from each other, they return to their initial pattern. This process, however, takes some time. Thus, if these loudspeakers are aligned soon enough with yet another loudspeaker, they pass on some of their inherited properties. This is particularly perceivable for those parameters that stick out: high pitches, sharp attacks, short durations. By constantly aligning new pairs of loudspeakers, the visitors can control how several musical features spread among the whole installation.

6. Discussion

The following section compares the different compositional approaches. The comparison distinguishes between aspects that are predetermined by the chosen interaction affordances and metaphorical mappings and aspects that have been freely chosen.

The following compositional aspects are predetermined:

- the generative systems are organized in a modular manner. Each module represents an individual sound generating unit whose output is rendered perceivable through a corresponding loudspeaker.
- the visibility among loudspeakers affects the amount of correlation that is established among the generative units.
- the binary state of the loudspeaker’s visibility (loudspeakers are either visible or invisible to each other) is correlated to a binary change in the generative sys-tem (addition or removal of network connections, high or low coupling values, permutation or preservation of musical patterns).

The following compositional aspects are not predetermined are shared by all works:

- all sounds are synthetic rather than pre-recorded.
- the interaction affects the balance between a musical foreground and a musical background as the acoustic outputs of correlated units are more clearly perceivable than those of the uncorrelated units.
- the generative processes cause the musical output of correlated units to become increasingly similar to each other.

The commonality of these non-predetermined aspects is interesting since it is based on voluntary decisions made by the three authors. These existence of these commonalities can shed some light on how strategies derived from tangible computing can inform and inspire compositional ideation. The choice of using synthetic rather than pre-recorded sounds is likely owed to the fact that sound synthesis allows for a precise control of the characteristics of a musical output. This level of precision is a prerequisite for realising a gradual assimilation of the musical output of correlated generative units. The choice to relate the alignment of loudspeakers to an increase in musical correlation is at the same time straight forward and arbitrary. For future compositions, it would be interesting to experiment with the opposite approach of relating loudspeaker alignment to musical differentiation. The acoustic dominance of correlated units which is common to all three musical works leads to a reinforcement of the physical affordance that is already given through spatial alignment. As such, the compositional approaches employ musical strategies that integrate into themselves some of the interaction concepts from tangible computing.

Lastly and most importantly, the differences among the three compositional approaches are to be mentioned. These differences highlight the breadth of creative possibilities that are available to composers even if they adhere to the constraints imposed by specific interaction and mapping principles. The three musical works differ with respect to the following aspects:

- the work *Recurrence* employs a signal processing approach in which the coupling among generative units is achieved by passing audio signals through connections.

- the work *Synchronization* controls the coupling among generative units by changing the parameter values for an oscillator-based sound synthesis.

- the work *Interpolation* exchanges and permutes parameter patterns among generative units as part of its coupling mechanism. These patterns can be likened to musical symbols that operate on note level.

These differences are the result of the application of three fundamentally different compositional strategies. The work *Recurrence* is representative of approaches that directly operate through routing and mixing of audio signals. The work *Synchronization* is representative of musical systems that directly link interaction to changes in sound synthesis parameters. The work *Interpolation* is representative of algorithmic compositional approaches that generate ‘musical scores’ in real time.

7. Conclusion and Outlook

The creation of several generative compositions for the *Watchers* installation illustrates how design principles from tangible computing can serve both as inspiration for coming up with new musical ideas and as means to foster an audience’s understanding and appreciation of the aesthetic and formal aspects of a musical work.

This installation represents one particular example of relating affordances for interaction with the generative aspects of musical works. It is clear, that many other approaches exist that are at least equally valid and promising for the creation of interactive and generative sound installations. But in order start this research into the potential that tangible computing possess for interactive generative music, the authors deemed it useful to focus on a small number of interaction and mapping strategies only. The fact that this research led to the emergence of musical works that are on hand commonly grounded in the interaction scenario provided by the installation and on the other hand represent a wide diversity of compositional approaches lends credence to the usefulness and validity of this approach.

To continue along this research trajectory, the authors plan to develop additional interactive installations as platforms for exploring new compositional approaches for creating generative music. Each of these installations will establish a different type of tangible affordance and mapping metaphor and render them available for the composers to work with. By doing so, the authors hope to contribute to a systematic assessment of the creative and educational potential that tangible computing possesses for the field of generative music.

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ARCHITECTURAL DESIGN SUPPORTED WITH AGENT BASED DESIGN SYSTEMS: CASE OF A PSYCHIATRIC HOSPITAL

(Paper)
Topic: (Architecture)
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Abstract

This paper has been developed within the results of a project developed in the Interscalar Workshop (Systemic Operations), in İstanbul. The theme was Bakirkoy Psychiatric Hospital, and its 90 hectares of urban field and the intimate therapy room for design ideas and interventions. Multilevel investigations took place regarding the site for redevelopment and/or remodeling of the pschiatric healing space. Lately, there has been great move away from the panopticon layout and the oversized, out of sight asylum. The spatial performativities play an integrated role in the supercustomized re-modeling of the patients mind and body.

Classification of privacy between the scale intervals; isolation rooms, patient rooms, daytime living areas in the garden, outpatient clinics, to beyond the hospital complex and its environment in relationship with the city is observed. These spaces contains an increasing degree of public that would introduce dissimilarities, while spatial degrees of security and urgency emerges. Different spaces of qualitative/scalar graduation are meant to be potential areas in thresholds for interaction.

One of the projects developed in the workshop by the author namely, FIELD: Individuals Distribution; was focused on the design of the courtyard within the hospital on human/environment centered scale. The patients' daily routine through space captured by stop-motion is reinterpreted by expansion and contraction. The focus on the courtyard emphasizes the multiple engagement in variying degrees of socialization, the topographic model utilizes interior properties to re-contour the open field condition.

From the data derived from the analysis, agent based design model was developed. To achieve this, rule sets were formed namely: [1] Security (high, medium, low), [2] Sun position (summer,fall, winter, spring between 10 am-3 pm), [3] Circulation (purpose, meandering, stroll), [4] Speed (high, medium, low). Depending on either agents, doctor/nurse (Agent 1), patient (Agent 2); rule sets was used to develop different scenarios. Relationship between Agent1 to Agent2, and between agent to its environment is modelled with various scenarios and an alternative design model is proposed.

The design method was to discover three ecologies focusing on boundaries and interfaces in various scales from the individual to public. Internal and external characteristics of the ecologies were discussed through photographic documentation. Relational modeling techniques and rapid prototyping and manufacturing methods, working environment of the cnc milling and repetitive production was achieved.

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Key words: Agent Based Design, Hospital Architecture, Movement Analysis

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Architectural Design Supported With Agent Based Design Systems: Case Of A Psychiatric Hospital

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Premise

This paper has been developed within the results of a project developed in the Interscalar Workshop (Systemic Operations), in İstanbul. The theme was Bakirkoy Psychiatric Hospital, and its 90 hectares of urban field and the intimate therapy room for design ideas and interventions. Multilevel investigations took place regarding the site for redevelopment and/or remodeling of the pschiatric healing space. Lately, there has been great move away from the panopticon layout and the oversized, out of sight asylum. The spatial performativities play an integrated role in the supercustomized re-modeling of the patients mind and body.
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1. Introduction

In recent years, advances in information and communication technologies provide new possibilities in computer-aided design [1]. The integration of agent-based models using genetic algorithms and artificial intelligence into the design process offers endless possibilities to designers [2,3,4]. Agent-based systems are used in the field of architectural design and building construction and they have also been integrated into large-scale urban planning models. These systems make it easy for designers to solve problems while providing time efficiency.

Agent-based simulation is important in terms of seeing users' behaviors, moves and motion in the facility [5]. Although simulation modeling is a method used by designers to express and develop their ideas; perspective drawings, three-dimensional physical modeling and three-dimensional computer modeling have been used in modeling and simulation of design and manufacturing processes. The rapid advancement in technology opened up new possibilities for more realistic and impressive design simulation capabilities using different, advanced computer techniques.

In this paper's theme, Bakirkoy Psychiatric Hospital is chosen to be focused within Interscalar Workshop. Working in teams, it was asked to respond with a system design in the multiple programatic combinatorics-choosing from a wide scope scales: the current and future site potentials down to the microscale landscape of the therapy space. The aim is to have an amalgamation of projects working in different scales, with prototypes and digital models, feeding in and out from other scales and projects, all working under the similar themes/consraints of the site-program. The site and the program reveal gradiencies of private/common, open/closed, secure/insecure, acute/emergent, specific/generic. Peculiarities like overhead planes every 15 min, dense pine woods of 30 hectares and a byzantium archeological site are undersized by the minute sensibilities of schizophrenia, bipolarities and disorderlies.

1.1 Scope, Aim and Method of the Study

Several problems occur during the post-production utilization process when the design process is completed without taking into account user movements in multi-user environment. The scope of this study will cover user movements in hospitals. To meet user needs, any problem or error that may occur in relation to the configuration of users and hospital settings/environment will be detected and corrected accordingly during the facility design process.

The aim of this study is to investigate the relationship between users and facility design in a virtual environment, under specific conditions, where human users will be represented by intelligent agents through the model we intend to design.

This study provided us with a platform where we have been able to think in multiple levels in order to observe intense systematic processes based on the key concept of interscale. The outline of the study has progressed in a set of guidelines that define the selected and focused ranges of motion by deciphering the concept of interscale as well as the theme of limitations. The theme that has taken its final shape as a result of many interviews with psychiatrists and mental health professionals in the field of psychiatry helped us reveal the security/privacy and interaction/isolation issues. [6]

Following the identification of user characteristics through agent-based modeling, the movement patterns of doctor, nurse and patient groups (selected as facility users) in designated times has been investigated [7]. The aim of this investigation was to design hospitals better equipped to meet patients' needs using the results obtained from situations that change depending on intelligent agents' behaviors representing the facility users; and to effectively detect problems and prevent them before they occur via agent-based pilot testing of the facility [8].

Mental health aims and objectives are as follows: restore the will to live and instil a sense of responsibility; reduce stigma and discrimination that affect thousands of people, families, and society in general; help individuals successfully integrate into and interact with society as well as other urban institutions. It is envisaged to increase the number of clinical services that are designed to address the above-mentioned issues. But, the crucial point here worth noticing is that whether there are any possibilities to transform the divisive/separative mechanisms into various communication interfaces without endangering security. How one can create safe limitations without building a wall or a fence? [6]

This study encourages a new way of thinking capable of bringing up for discussion an "out of chaos into reconciliation" notion in agent-based systems, instead of the notion of fixed limitations which separates these systems from their static values. Thinking through systems and diversities has led to a redefinition of the concept of limitation. Diversity is not a range of different things; it is the fact of knowledge, which models the mechanism, being reduced and aimed at the whole system without requiring static compositions. Each level where differences in scale may conceive interactions at threshold consists of security and urgency specifications. [6]

The busiest times of day in the hospital and the daily schedule and routines of doctors, nurses and patients, chosen as user agents, have been used as determinative factors in developing the model which was designed as part of this research. A user scenario, where each agent represents a human user, has been developed for different time intervals in different situations at various levels of security. Each agent has different travel/traffic patterns that match the prespecified user profiles and their prespecified goals. These patterns have been defined as purposive or goal-directed, meandering and random. Agent-behaviour patterns in different seasons, from 10.00am to 3.00pm have been considered fast, slow and moderate with high, moderate and low security levels.

2. Intelligent Agents and Agent Learning Systems

2.1 Definition of Agent

There are several different definitions for the term "agent". According to Jennings and Wooldridge, agent is a software-based computer system operating without the direct intervention of humans, and having some kind of control over their actions. According to Janca and Gilbert, agents act on the behalf of users translating their requests into operational actions, but they present some limitations [9,10]. Nwana defines agent as referring to a component of software and/or hardware which is capable of acting exactingly in order to accomplish tasks on behalf of its user [11]. A large variety of agents exists including interface agents, simple reflex agents, mobile agents, knowledge-based agents, heterogeneous agents, curious agents, goal-based agents, cognitive agents, learning agents, situated agents.

Agents observe through sensors and acts upon an environment using effectors. The overall goal of Artificial intelligence, which is defined as an area of computer science that aims to analyse natural intelligence and abilities displayed by humans so as to design human-like behavioural patterns, is to design agent programs [10]. Before we design an agent program, we must have a pretty good idea of the possible percepts and actions, what goals or performance measure the agent is supposed to achieve, and what sort of environment it will operate in [12]. Simple reflex agent can be described as follows [10]: A simple reflex agent finds a rule whose condition matches the current situation and does the action associated with the rule. When doing this, it uses the information on how its world evolved and how its actions can affect the world.

The two groups in this study consisted of a group of doctors-nurses (agent 1) and a group of patients (agent 2), interacting with each other. The site chosen for this study, Bakırköy Psychiatric Hospital, also offers multiple interaction opportunities for the study's aims and scope [6].

2.2 Characteristics of Intelligent Agents

Agents have three key characteristics. They are flexible, autonomous and intelligent [10]. But the most important feature of an agent is its autonomy. An agent is able to learn from its experience and use this information in its future actions. In some cases, no learning ability is required. In light of the above, it can be concluded that agents are computer systems capable of flexible and autonomous actions in order to achieve the predesigned goals in environments they are embedded. The most important feature of agents that separates them from other autonomous systems is their "flexibility" in dealing with situations. What we mean by flexibility is, essentially, agent/agents' ability to interact with other agents and humans, and their proactivity since they exhibit goal-oriented behaviour. The emergence of robotics and its efforts for the integration of visual and auditory perceptions into computer systems has resulted in a new approach where artificial intelligence is expected to perceive its environment, act upon it and learn by observing and perceiving its environment [1]. An intelligent agent is a computer system that is capable of taking flexible and autonomous actions in environments it is situated. The flexibility concepts mentioned here involves reflex, and being proactive and social [10].

Since different decisions might be made in environments bearing different characteristics, agents also should be able to act according to circumstances and take decisions that suit the situation. Although goal-oriented actions hold importance in a stable environment; in a dynamic environment, on the other hand, agents' ability to adapt to changes and exhibit behaviours as a reaction to these changes becomes crucial [10].

It is known that agents are defined as programs that can operate independently to reach a specific purpose in complete interaction with other agents and the systems they are embedded in. But, they are also expected to gain the ability to work collaboratively on tasks they are given. While agents can either be stable or dynamic, stable agents mostly work within a fixed-instruction computer.

Each agent has its own environment consisting of other agents and a physical world enabling them to interact with each other, take action together and to produce results by observing its own as well as other agents' situation and the environment they are situated in. An agent is capable of deciding on its own when to change and by whom it will be changed.

Although patients (the second agent group in this study) can act independently under a variety of circumstances, their actions may still be controlled by agent 1 depending on their disease state (behaviours that may endanger security considering they are mental health patients) or disease severity. But agent 1, comprising a group of doctors-nurses, acts independently from agent 2.

2.3 Intelligent Agents and their Environments

Each agent is situated in an environment consisting of other agents and the physical world. It interacts with the physical world in order to be able to act, imports data from the environment it is embedded in and generates an outcome that impact its environment. This interaction is mostly continuous and it never stops. An agent does not possess a full impact on the environment it is situated in yet it can bring a certain impact on its environment [10].

Agent environments contain a certain gradation of interscale privacy, including seclusion room, patient room, common area, inner court, outdoor backyard and polyclinics, and beyond that, the hospital complex itself and its areas of differences that involve the hospital complex's relationship with the physical environment and the city, gradually turning into the gradations of publicness. These scale-related and qualitative areas in gradations differ from each other in terms of security and emergency, while they also mean threshold areas of probability for interaction [6].

2.4 Actors and User Scenarios

In user scenario model that contain actors and use user scenarios, the concepts are used to define the actors, situated outside the system, and to help the system decide what to do (user scenarios) [13]. User scenarios help establish communication between agents, while allowing designers to identify spatial changes or modifications required by the system. Thus, by observing actors' behaviour, we might be able to anticipate the potential users of the system, to explore its functionality as well as attend to any potential or present problems. Accordingly, the scope of the project would be better understood by looking at the relationship between user cases and actors [10].

Remaining in interaction with the system as well as representing everything that requires system-related information exchange, the agents define those that are situated outside the scope of the system [10,13]. User scenarios define everything that is situated within the scope of the system [14]. Each user scenario describes a sequence of events, initiated by actors and illustrating interaction between the actor and the system.

The above-mentioned interaction can be defined with the following function (1):

$$\boxed{i=f(H,K,O)} \qquad (1)$$

I: Basic relationships between the agents' environment and agents' behaviour.

H: Goals (high-level goals associated with inter-agent relationships).

K: Rules (created based on social and cultural factors, each agent must follow these rules when performing tasks).

O: Environment (agents are situated in a built environment containing design elements).

In this study, spaces and times where patients carry out their daily routines have been filmed using stop-motion animation technique to capture space and time frame-by-frame, and an expanded or a compact study of the relationship between the two has been carried out. Efforts have been attempted to implement this relationship in inner court and outdoor areas, both playing a major role in the treatment of patients, as well as to create various levels of socialization in outdoor areas where the playground was chosen as the topography in this study.

Although it is possible to create a wide variety of user scenarios, the following six user scenarios have been devised within the scope of this study:

AGENT 1: User Scenarios for Doctor-Nurse (Figure 1-2)

- Agent 1 - Scenario 1: Closed (Security), Purpose (Circulation), Low (Speed), Autumn time:3.00pm
- Agent 1 - Scenario 2: Semi-closed (Security), Purpose (Circulation), Normal (Speed), Winter time:3.00pm
- Agent 1 - Scenario 3: Open (Security), Purpose (Circulation), High (Speed), Spring time:3.00pm

AGENT 2: User Scenarios for Patient

- Agent 2 - Scenario 1: Closed (Security), Purpose (Circulation), High (Speed), Summer time: 10.00am
- Agent 2 - Scenario 2: Semi-closed (Security), Stroll (Circulation), Normal (Speed), Autumn time: 10.00am
- Agent 2 - Scenario 3: Open (Security), Meandering (Circulation), Low (Speed), Winter time: 10.00am

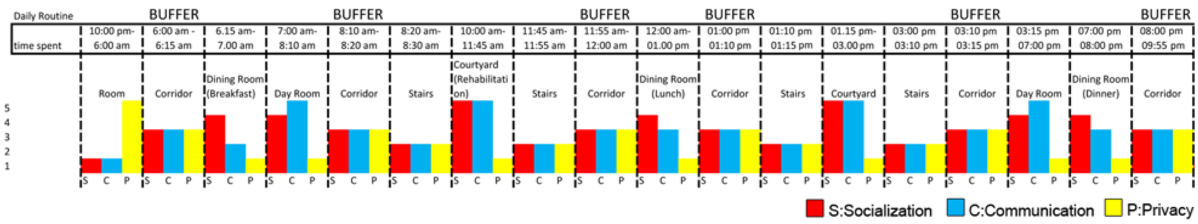

Figure 8. Patient's Daily Routine and Time Schedule

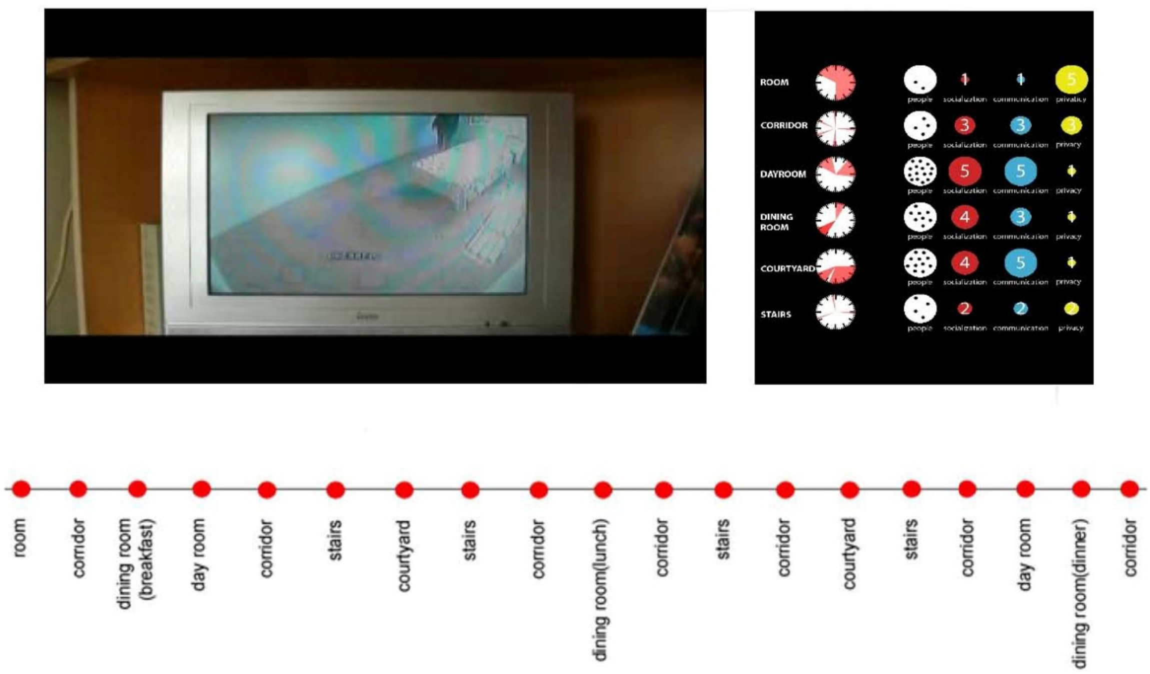

Figure 9. Analysis of the hospital spaces

2.5 System Rules and Limitations

Having aimed at creating a system that can simulate users' behaviours and actions, this study has focused on developing a computer program in order to observe the travelling patterns of the users (doctors, patients and nurses in this case) based on regular behaviours they exhibit within the hospital facility. In this context, rules and limitations governing the agents have been specified (Figure 3).

2.5.1. Rules

Rules concerning the agents are as follows:

- Agents consist of doctors-nurses and patients.
- Each agent represents a user of the hospital facility.
- The site chosen for the study has been split into grids. Each grid represents a cell where agents can travel freely.
- Agents may be male or female.
- Each agent has a specific route defined by the user: purposive/goal-directed, meandering and random
- Agents having specific routes move around the hospital according to their areas of interest (disease, illness, treatment etc.) or other purposes.
- Agents are capable of moving in every direction within the environment they are situated.
- The number of agents is set by the user(s) of the program.
- User age group is not specified.
- Walking pace of agents is determined by the security. Accordingly, the security levels are specified respectively as low, moderate and high.
- Security is also specified according to the topography type.
- Travelling pace of agents is specified by different scenarios, which respectively are fast, moderate and slow. Travelling pace is directly correlated with the scenario type as well. Also, it is not based on any age or gender group. The walking pace (purpose, meandering and random) of agents are automatically selected based on agent group selection.
- Agent behaviour in different seasonal hours and times is selected.
- In addition to walking, it is assumed that agents are performing other actions including sitting and interacting. The inner court, where the socialization occurs, is one of the focal points of the study.

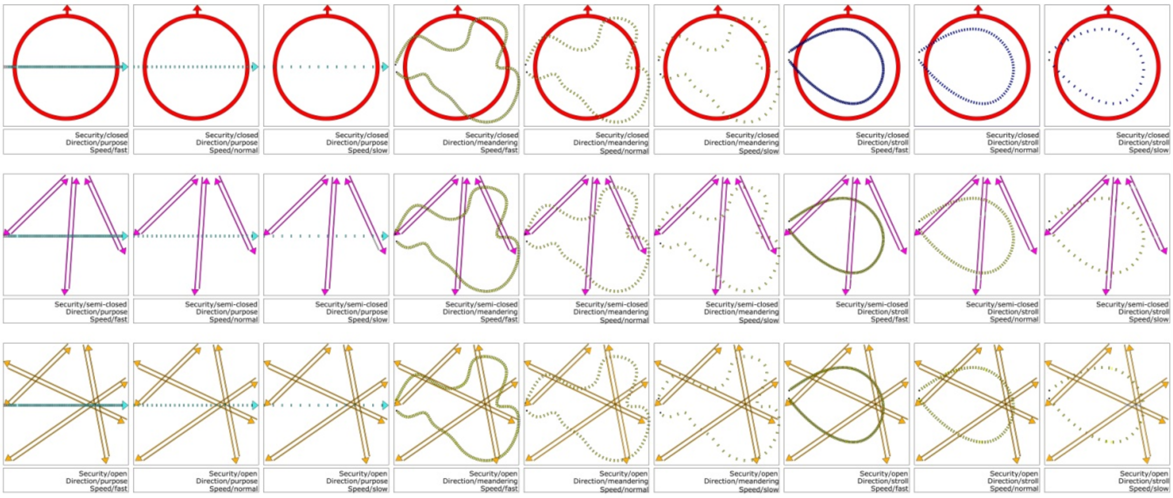

Figure 10. Possible Activity and Interaction Map

2.5.2. Limitations

Limitations concerning the agents are as follows:

- Agent 1's (doctors and nurse) actions depend on the severity of agent 2 (patient)'s illness. That is to say, patients with severe medical conditions must act always depending on agent 1.
- The point of departure of each agent is from the inside out, and the point of arrival is from the outside in.

The hours and times when the hospital facility is being used are represented by time intervals. The time interval we especially focused on in this study is the rehabilitation period spent in the inner court.

3. Conclusions

Agent-based systems used in architectural design field significantly contribute to the decision-making process in the pre-design stage by minimizing or eliminating any potential problems that could happen with the facility. Obstacles, challenges users faced in the use of hospital reveal non-efficacious designs while remaining inadequate to meet end-users' requirements in the post-construction process.

Through the system we developed within the scope of this study, we aimed to investigate the relationship between the users and the way the space was designed, in a virtual environment where each human user is represented by an agent. By selecting two different agent groups where each agent represents human users (doctors, nurses and patients), we have studied the traveling/movement patterns-specified as meandering, purpose and fast -of the agents in different times of the year, designated hours of the day in environments with different levels of security; thus, based on the obtained results, this study has aimed at contributing to the making of better designs with better structured settings for human users (Figure 4-5).

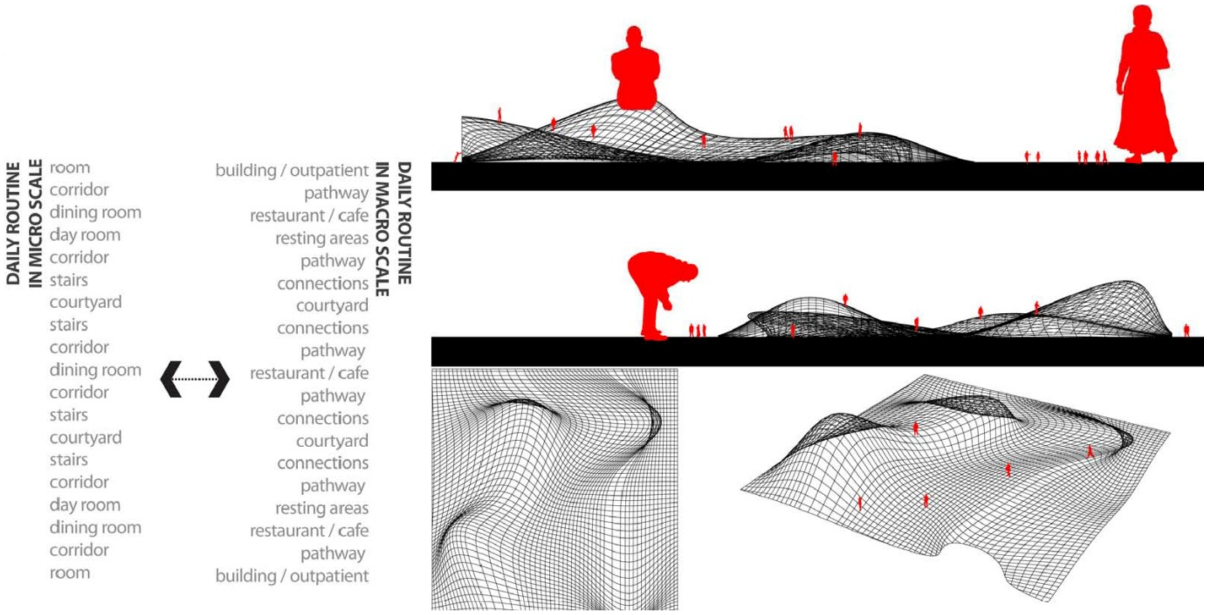

Figure 11. Daily routine in micro and macro scale

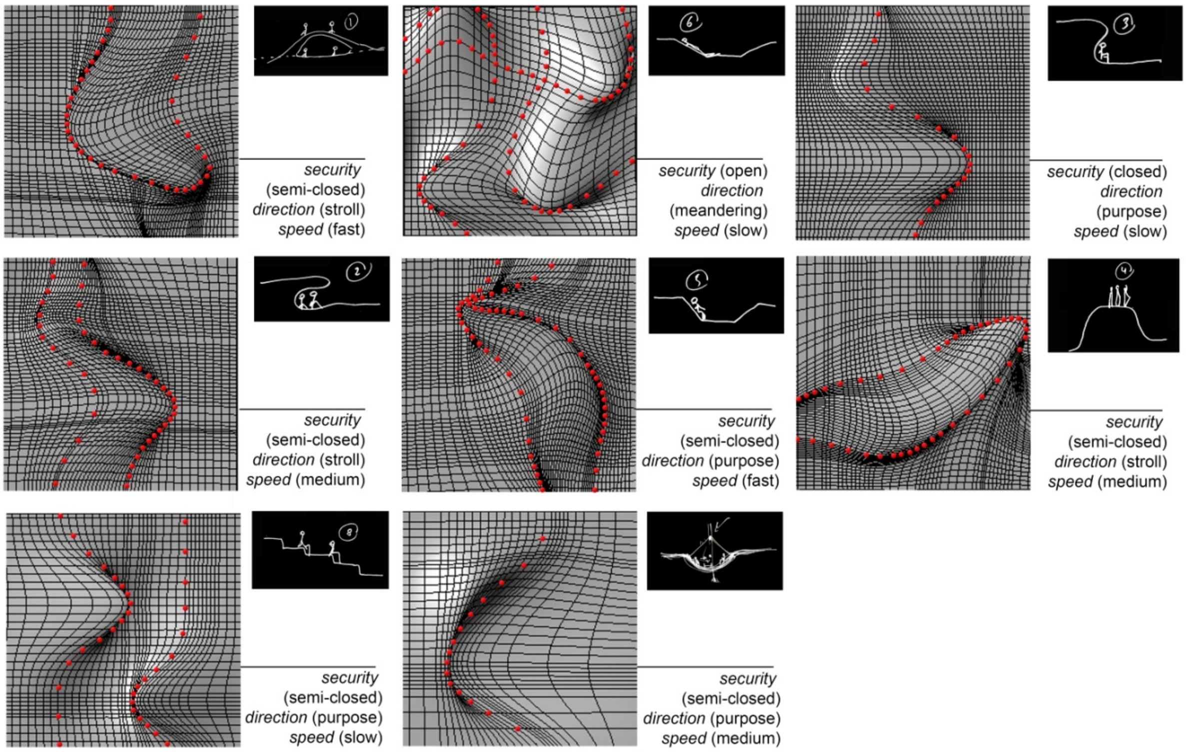

Figure 12. Activity map images

Acknowledgement

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Against the Standards. Generative Architectural Details
(Paper)
Topic: (Architecture, Design.)

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Abstract
The concept of standardization has been one that follows architecture since its modern conception during the Renaissance. It became an imperative with modern architecture and finally a norm in all aspects of design and construction. Standardization guaranties efficiency, performance and avoidance of mistakes. In that sense it is considered "*a blessed concentration of powers (that) can create the universal and generally recognized sense of taste*" as Hermann Muthesius proclaimed during the infamous argument he had with Henry van de Velde (Conrads, 1975).
The encounter of architecture with digital technologies however, initially followed a different route: as the term '*non-standard architecture*' explicitly declares, digital media could release architecture from the standard towards a new, infinitely customizable version of itself that was based on *generative* processes. The introduction of digital fabrication methods in design created initially an even stronger sense of optimism for the architects. However, like all digital processes, digital fabrication incorporate standardization as an inherent element; as much becomes apparent as digital fabrication becomes a common ground in commercial architectural production.
Despite changes in fabrication methods, the general attitude towards the concept of the architectural detail didn't get particularly differentiated. The detail was more often than not understood as an element that comes into play after the design process is concluded. That way of thinking was not inverted after the introduction of digital fabrication in the field of architectural design. On the contrary it continued almost unchanged: The architectural detail remains a secondary part of the whole of the design process.
The standardization inherent in digital fabrication in combination with the inability of the architects to include those new fabrication methods in the design process by restoring the fundamental role of the architectural detail results in the production of highly homogenized outcomes. We need to find an alternative approach to digital fabrication that will allow differentiation in all the levels and scales of design and fabrication. In that context the challenge that the design world has to face is how to find the ways and processes that will transform digital fabrication in a defining part of the design process itself. In order for that to happen we need a change of our point of view towards the concept of the architectural detail: from a secondary element that facilitates some higher scope, towards an architectural assemblage that incorporates the possibility to produce by itself architectural multiplicities and ultimately architectural design. In other words, architectural details must be produced in a generative fashion.
The proposed paper will analyse the theoretical context of the above and at the same time will show, through practical examples of applied research in digital fabrication methods, that in order to avoid the inherent standardization imposed by digital technologies, architecture needs to look towards generative modes and methods of fabrication and detailing.

This research is implemented through IKY scholarships programme and co-financed by the European Union (European Social Fund - ESF) and Greek national funds through the action entitled "Reinforcement of Postdoctoral Researchers", in the framework of the Operational Programme "Human Resources Development Program, Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) 2014 – 2020

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Key words: architecture, digital fabrication, generative detail

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Against the Standards: Generative Architectural Details

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Abstract

The history of architecture throughout the 20th century has been defined to a large extent by the concept of the standard. An outcome of the application of the principles of Modern Architecture, standardization managed to become the norm both because of the social and political conditions that architecture had to deal with in the wake of the two world wars and because of the ideological biases that it incorporated. The standard became an ideal tool for the rationalized version of architecture that dominated the larger part of the last 100 years.

The encounter of architecture with digital technologies however, initially followed a different route: as the term 'non-standard architecture' explicitly declares, digital media could release architecture from the standard towards a new, infinitely customizable version of itself that was based on generative processes. The introduction of digital fabrication methods in design created initially an even stronger sense of optimism for the architects. However, like all digital processes, digital fabrication incorporate standardization as an inherent element; as much becomes apparent as digital fabrication becomes a common ground in commercial architectural production.

Despite changes in fabrication methods, the general attitude towards the concept of the architectural detail didn't get particularly differentiated. The detail was more often than not understood as an element that comes into play after the design process is concluded. That way of thinking was not inverted after the introduction of digital fabrication in the field of architectural design. On the contrary it continued almost unchanged: The architectural detail remains a secondary part of the whole of the design process.

The standardization inherent in digital fabrication in combination with the inability of the architects to include those new fabrication methods in the design process by restoring the fundamental role of the architectural detail results in the production of highly homogenized outcomes. We need to find an alternative approach to digital fabrication that will allow differentiation in all the levels and scales of design and fabrication. In that context the challenge that the design world has to face is how to find the ways and processes that will transform digital fabrication in a defining part of the design process itself. In order for that to happen we need a change of our point of view towards the concept of the architectural detail: from a secondary element that facilitates some higher scope, towards an architectural assemblage that incorporates the possibility to produce by itself architectural multiplicities and ultimately architectural design. In other words, architectural details must be produced in a generative fashion.

The paper analyse the theoretical context of the above and at the same argues that in order to avoid the inherent standardization imposed by digital technologies, architecture needs to look towards generative modes and methods of fabrication and detailing.

The Standard

The concept of standardization has been one that follows architecture since its modern conception during the Renaissance. It became an imperative with modern architecture and finally a norm in all aspects of design and construction. The importance of the standards for modern architecture, along with the opposition to them, is explicitly codified in the famous argument between Hermann Muthesius and Henry van de Velde that took place at the beginning of July of 1914 at the Werkbund conference in Cologne: Muthesius was clear as to his idea of architecture's future and the aim of the Werkbund: "*Both architecture and the whole area of Werkbund activity go toward standardization. Only thanks to standardization these branches can be respected again, like it used to be during the epoques of harmonious development of civilization. Only standardization, as a "blessed" concentration of powers can create the universal and generally recognized sense of taste*"[1].

But while Muthesius was clear as for his commitment towards an industrialized version of architecture, van de Velde was not willing to surrender and emphatically declared that "*[a]s long as there are artists in the Werkbund they will oppose to any suggestion of a norm of standardization. The artist is in his heart of hearts an ardent individualist, a free and spontaneous spirit. He will never voluntarily subject himself to a discipline which impose on him normes and types*"[2]. That juxtaposition between the standards and the individualistic expression of the architect – a juxtaposition between a conception of the architect as an engineer and of the architect as an artist – would follow modern architecture throughout its course.

The Bauhaus for example would begin in 1919 in Weimar as a highly individualistic expression that excluded any form of standardized or industrialized production; but 6 years later, when relocating in Dessau, Walter Gropius had already changed his mind and incorporated the concept of the standards in the new approach of the school. Equally, Le Corbusier expressed both positions: on the one hand the architect as an artist and at the same time the architect as a 'scientist' that applies specific standards to his/her design. The extent of this 'co-existence' of the two approaches goes that far that one could actually argue that it that very juxtaposition between the two ideas of the architect that form the backbone of modern architecture.

But while both approaches remained active during the 20th century, it was clearly the 'architect-engineer' and the design through the establishment of standards that defined the mainstream of architectural production. The opposite position was always present but most of the times as an exception – as if being there just in order to justify through dialectical opposition the other side.

To a large extent, it was the conditions that the societies of the era had to face that defined the outcome of the juxtaposition: the two World Wars and the destruction that they brought gave rise to an urgent need for fast, cheap construction that could answer efficiently to the vast housing issues that arose in the aftermath of both wars. Ultimately, the reasons behind the will to practice architecture and design through standards were 'humanitarian': standardization guaranties efficiency, performance and avoidance of mistakes. Standardization, by making a claim to universality, can ultimately warrant the well-being of those that will occupy and use the produced architecture and will enhance its ability to provide for those that are most in need.

The non-standard

The encounter of architecture with digital technologies however, initially followed a different route: The first experimentations with digital design during the 90s were ultimately categorized under the term 'non-standard architecture' in the 2004 exhibition at the Pompidou Center [3] that tried to provide a common framework for them. The term explicitly declares the belief that digital media could release architecture from the standard towards a new, infinitely customizable version of itself that was based on generative processes. Standardization was no longer understood in that new context as a prerequisite for the well-being of the inhabitants of designed space, but rather as a limitation on its possibilities; as a force of homogeneity. The introduction of digital fabrication methods in architectural design created initially an even stronger sense of optimism for the architects: the possibilities offered by those methods were treated as the vehicle that will carry architecture from the idea of mass production towards that of mass customization, creating in the process a revolution of kinds in the way we understand architectural fabrication and construction. In that context, and since non–standard architectures were largely based on generative processes and techniques, the term 'generative' became almost an antonym for 'standardized'.

However, like all digital processes, digital fabrication – and digital design tools at large – incorporate standardization as an inherent element. The aforementioned standardization becomes more and more apparent as digital fabrication becomes a common ground in commercial architectural production and in projects of larger scale. It is there that it becomes clear that control of fabrication methods is moving away from the architect towards an almost abstract system of the technological protocols that allow the use of those technologies. The digital computer, itself the epitome of modern thinking, is the ultimate application of modern principles; standards being of course one of them. What initially looked like a liberating force that would push architecture towards non-standard paths was revealed to be based on an even harsher and inelastic application of standards. If the standards during modernity could incorporate a certain degree of tolerance, digital standards are rigid and inflexible; they can be either followed completely or not at all. And where 'generative' was initially understood as the opposite to the standard, we can know start to realize that the later might be a prerequisite for the former.

The architectural detail

While all of the above were constantly changing architecture's approach towards the standard, the general attitude towards the concept of the architectural detail didn't get particularly differentiated from older attitudes, despite the vast changes brought forward by digital fabrication and the digital tools in general. Until now the detail was more often than not understood as an element that comes into play after the design process is concluded or, at best, towards its last stages. It could be understood maybe as an afterthought that has to express in a smaller scale the ideas and properties of the general project. As a part of secondary importance (as the term 'detail' itself implies) and at any case, as an element that has to be subordinated to the greater design idea without affecting or changing it much.

The above way of thinking, initiated by modern architecture, was not significantly inverted no matter how many changes were brought in the field of architectural design. On the contrary, and in a quite paradoxical way, it continued almost unchanged: The architectural detail remains a small part of the whole of the design process which is always (according to the dominant conception) much more than a simple sum of its parts. Very much so that in some cases the architect/designer does not even take part in the process of defining the specific fabrication methods of his/her design and opting instead to let someone else take those decisions.

It is characteristic of the above that Greg Lynn, in the 10th anniversary of the 'Folding in Architecture' issue is describing architectural detail as an architect's fetish: "*The term intricacy is intended to move away from this understanding of the architectural detail as an isolated fetishised instance within an otherwise minimal framework. Detail need not be the reduction or concentration of architectural design into a discrete moment. In an intricate network, there are no details per se*"[4]. Greg Lynn here, declares in a way the death of the architectural detail. Ben van Berkel shares a similar attitude towards it: "*It has become essential to define the detail anew. Its classical meaning, as a part of the whole, as articulation, has become obsolete. The idea of ornamentation had long been discarded, but that the notion of articulation has been abandoned too, comes as a shock. And yet the conclusion is unavoidable, seeing that contemporary architecture has severed every link between what takes place inside a building and what can be seen of this from outside. What could possibly be left to articulate in this new architecture...? Neither its structure nor its place in its surroundings says anything about the purpose it serves. There is absolutely nothing substantial left that can be related to articulation of any sort, and when this architecture, despite its radical otherness, is suddenly imbued with 'detail' in the conventional sense the result is monstrous*"[5]. Therefore the concept of the detail for Ben van Berkel, as for Greg Lynn, becomes irrelevant: all three functions facilitated by architectural detail become obsolete: part of the whole, articulation, ornamentation. And while Ben van Berkel is less explicit as to the role of digital technologies and generative processes in the 'becoming obsolete' of the architectural detail, he is in fact subscribing to the same credo with Greg Lynn. Digital technologies and digital fabrication have a large role to play on the extinction of the articulation or the connection, and therefore of the detail.

A new condition

All of the above however, when combined, threaten to create a condition where the architect is left without tools to deal with the complexity of the current situation and is ultimately facing the danger to become himself or herself obsolete. Because on the one hand architects have to deal with the standardization that is inherent in all digital technologies, digital fabrication of course included. On the other hand we are confronted by the inability of the architects to include those new design and fabrication methods in the design process which could have been done – contrary to what Greg Lynn and Ben van Berkel argue – by restoring the fundamental role of the architectural detail: when architects would engage directly with digital fabrication on a one to one level, architectural detailing will inevitable re-emerge as a crucial factor and detail could be themselves be transformed into generators of design. However, the outcome of the combination of those two existing factors – standardization and lack of innovative detailing – is the production of highly homogenized results, along with the downgrading of the role of the architect/designer in the whole process; in this context the architect is rendered almost unnecessary.

Therefore it is crucial in the current condition to re-evaluate the role of the architect and to find an alternative approach to contemporary (digital) fabrication processes that will allow differentiation and creation of innovative fabrication methods in all the levels and scales of design and construction. In that context the challenge that the design world has to face is how to find the ways and processes that will transform fabrication into a defining part of the design process itself. And it has to do so right from the beginning of that process while at the same time giving rise to possibilities for the production of novel fabrication methods. In order for the above to happen we need a change of our point of view towards the concept of the architectural detail: from a secondary element that just facilitates some higher scope, towards an architectural assemblage that incorporates the possibility to produce by itself architectural multiplicities and ultimately architectural design. Details can become, in a rather paradoxical turn, generative.

The architectural detail as an exception

Both the concept of the standard as well as that of the architectural detail were established in the architectural world during the reign of modern architecture. While the seeds where planted earlier, it was during the previous century that the creation of standards became an imperative. At the same time the word 'detail' was hardly used before modern architecture in architectural contexts: "*Detailing is not a word one often finds in premodernist writings on architecture. Words like trim, molding, and ornament were more precise and more useful*". Therefore the two of them – the standards and the detail – were bound to work together: standardized details became more and more prominent for architecture, something that up to a certain extent had to be expected: as materials and architectural parts were becoming standardized, so did the ways to assemble them. The convergence of the two becomes complete as we move towards the present day: today architectural detailing is indeed highly standardized in most ways. Digital libraries and BIM software packages make that even more apparent to the extent that in many cases the architect doesn't even have to think about the detail or the fabrication method: it is already embedded in the software employed.

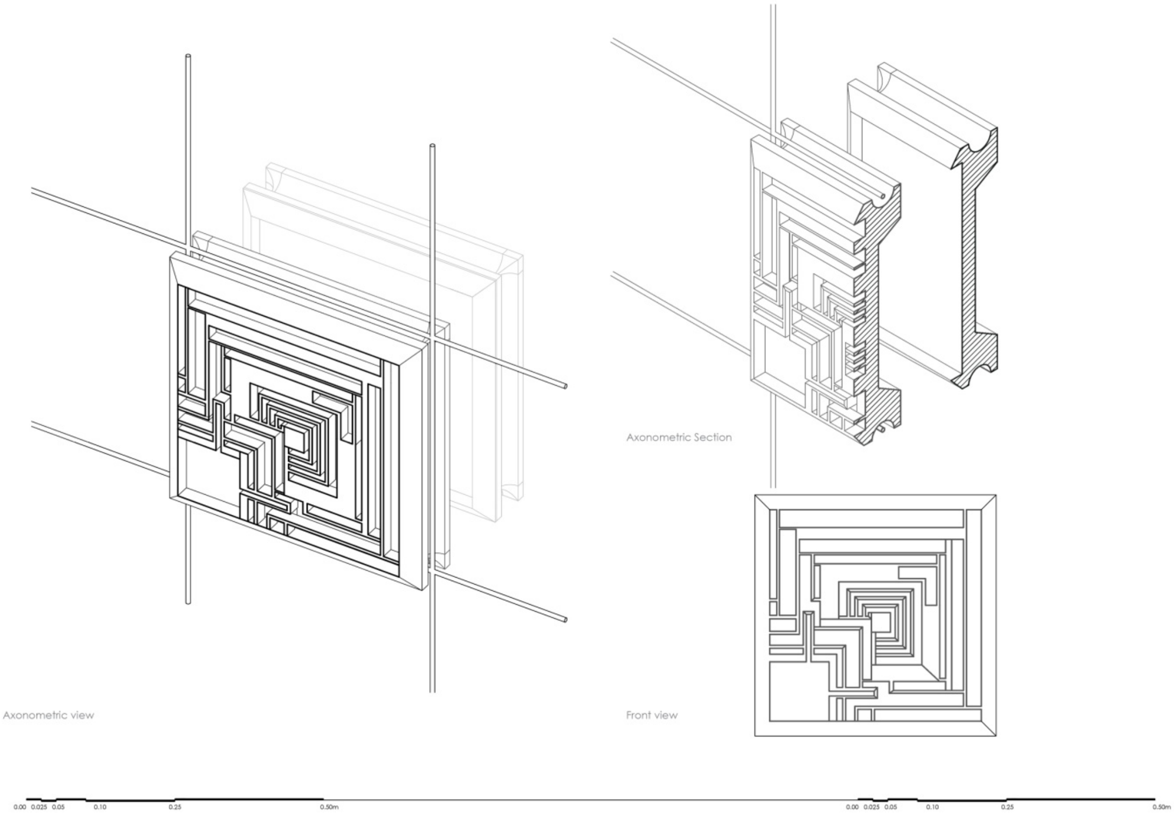

figure 13: Detail of the Ennis House Façade by Frank Lloyd Wright. Fabrication Protocols / The Details of Architecture seminar, spring 2018, post graduate program 'Advanced Design', School of Architecture, Aristotle University of Thessaloniki. Student: Nefeli Papagianni, Instructor: Dimitris Gourdoukis.

And yet, when looking back at the iconic details of modern architecture, they are everything but standard. On the contrary, architectural detail becomes in the hands of architects like Louis Kahn, Frank Lloyd Wright and Ludwig Mies van der Rohe a tool for architectural innovation. In those iconic details the architects invent the assembly of materials – they ways in which they come together – and turn them into a design tool. By designing a detail that goes beyond the standard practice of the time, modern architects were in fact inventing for themselves new ways to design. In many cases those details were iterated and expanded through several projects. The detail was continuously modulated – not necessarily refined but nevertheless altered. The ways in which Mies worked with the corner details of his building is such an example. Beginning most probably with the 860-880 Lake Shore Drive in Chicago (1951) he kept iterating on the same idea and modulating it in projects such as the Commonwealth Promenade Apartments in Chicago (1956) the Seagram Building in New York (1958) the One Charles Center in Baltimore (1963), the 2400 Lakeview in Chicago (1963) and the list could go on and on. Looking back to those details we could argue that while the architect was still solving construction issues he was operating in fact more like an artist or creator than like an engineer. Instead of using standards he was constantly generating new variations on the theme. Detailing in the hands of modern masters was in fact generative.

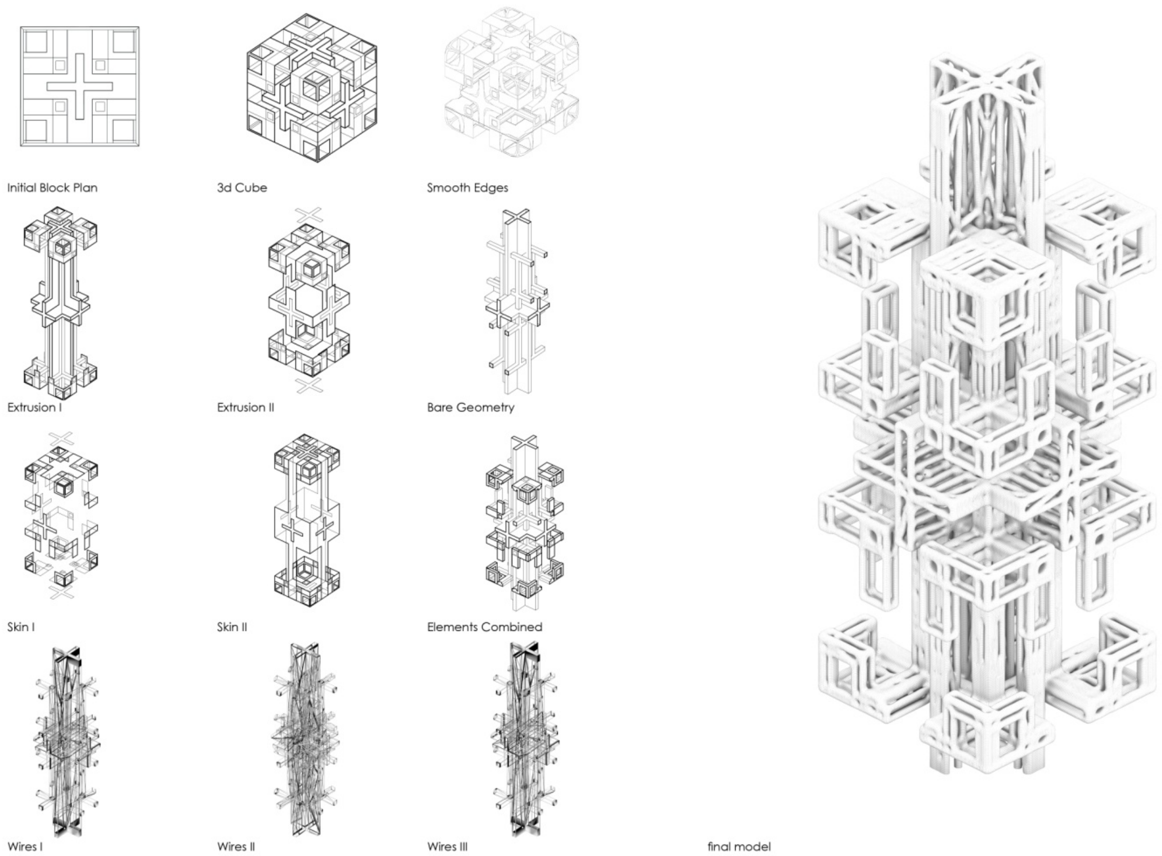

figure 14: Generative Detailing based on the work of Frank Lloyd Wright. Fabrication Protocols / The Details of Architecture seminar, spring 2018, post graduate program 'Advanced Design', School of Architecture, Aristotle University of Thessaloniki. Student: Nefeli Papagianni, Instructor: Dimitris Gourdoukis.

That innovation of the modern masters in terms of detailing – by going against the stream of standardization – can inform architectural detailing today and provide insights into how architects can deal with the extreme standardization brought by digital technologies and how they can overcome it through invention. By revisiting them, categorizing them and understanding how they operate in terms of structure, enclosure, ornament and function one might be able to use the results in order to transcend contemporary processes in design and fabrication. In that way an architect can become an inventor of assemblies instead of the one who chooses between a number of pre-defined possibilities – that last option, the act of selection, soon enough will be an operation that computers will be able to carry out much more efficiently anyway.

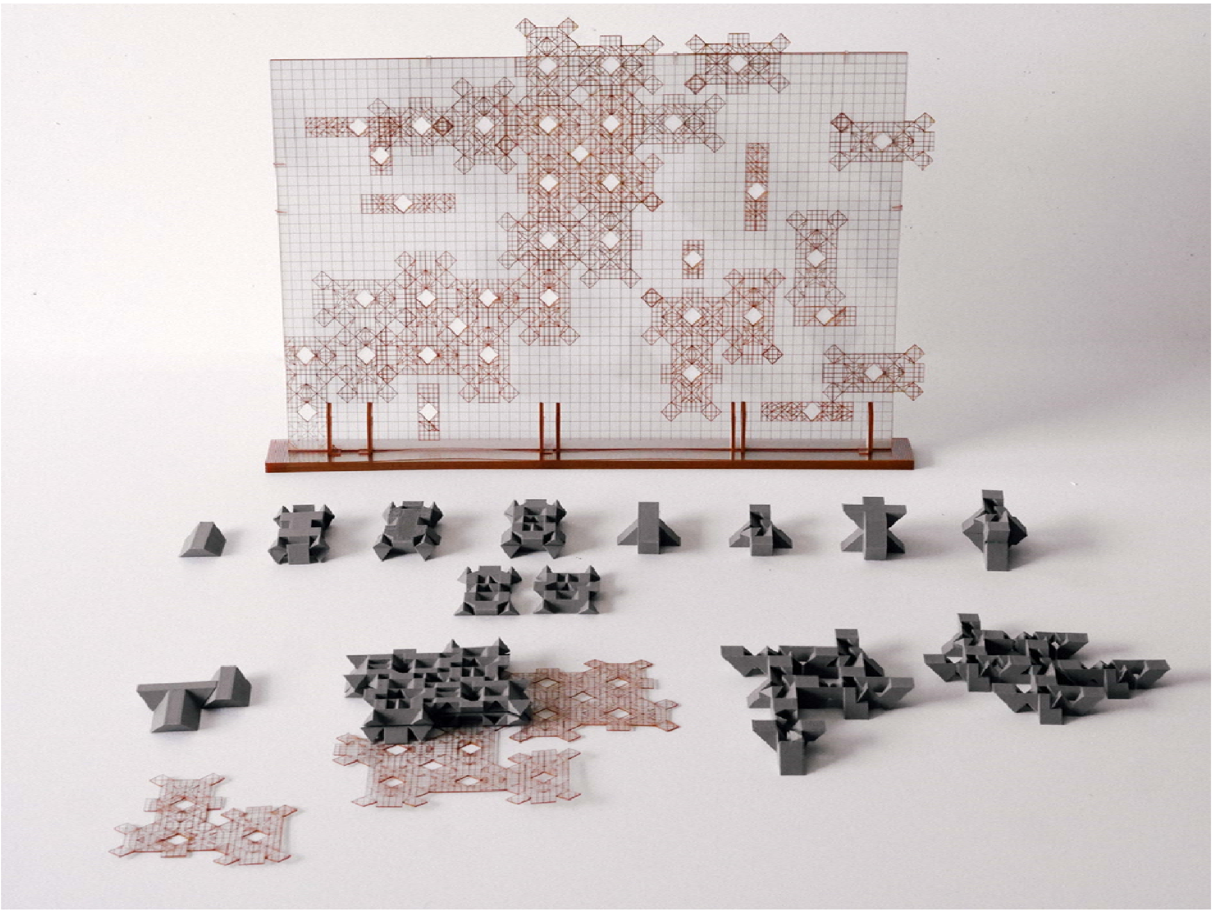

figure 15: Generative Detailing. Fabrication Protocols / The Details of Architecture seminar, spring 2018, post graduate program 'Advanced Design', School of Architecture, Aristotle University of Thessaloniki. Student: Maria Kyrou, Instructor: Dimitris Gourdoukis.

Analog modes of production

A second direction that architecture could follow in order to avoid the inherent standardization imposed by digital technologies, would be to look back to analog modes and methods of fabrication and detailing. Not in order to return to a pre-digital state, but instead in order to graft digital processes with an analog way of thinking that will allow differentiation and multiplicity. In other words, a way of thinking that while employs digital tools understands the continuity of the analog through a constant modulation that can't be reduced to any binary logic and instead is able to introduce true customization in the process. Gothic construction techniques for example might provide very useful insights that can help architects create custom fabrication routines without following the ones imposed by the protocols employed by specific software packages. Traditional construction methods can be equally helpful. It is in the ways of the past that architects need to look in order to move towards the future of architecture. Not in order to reproduce that past, but instead to graft it with the current condition and become able this way to innovate.

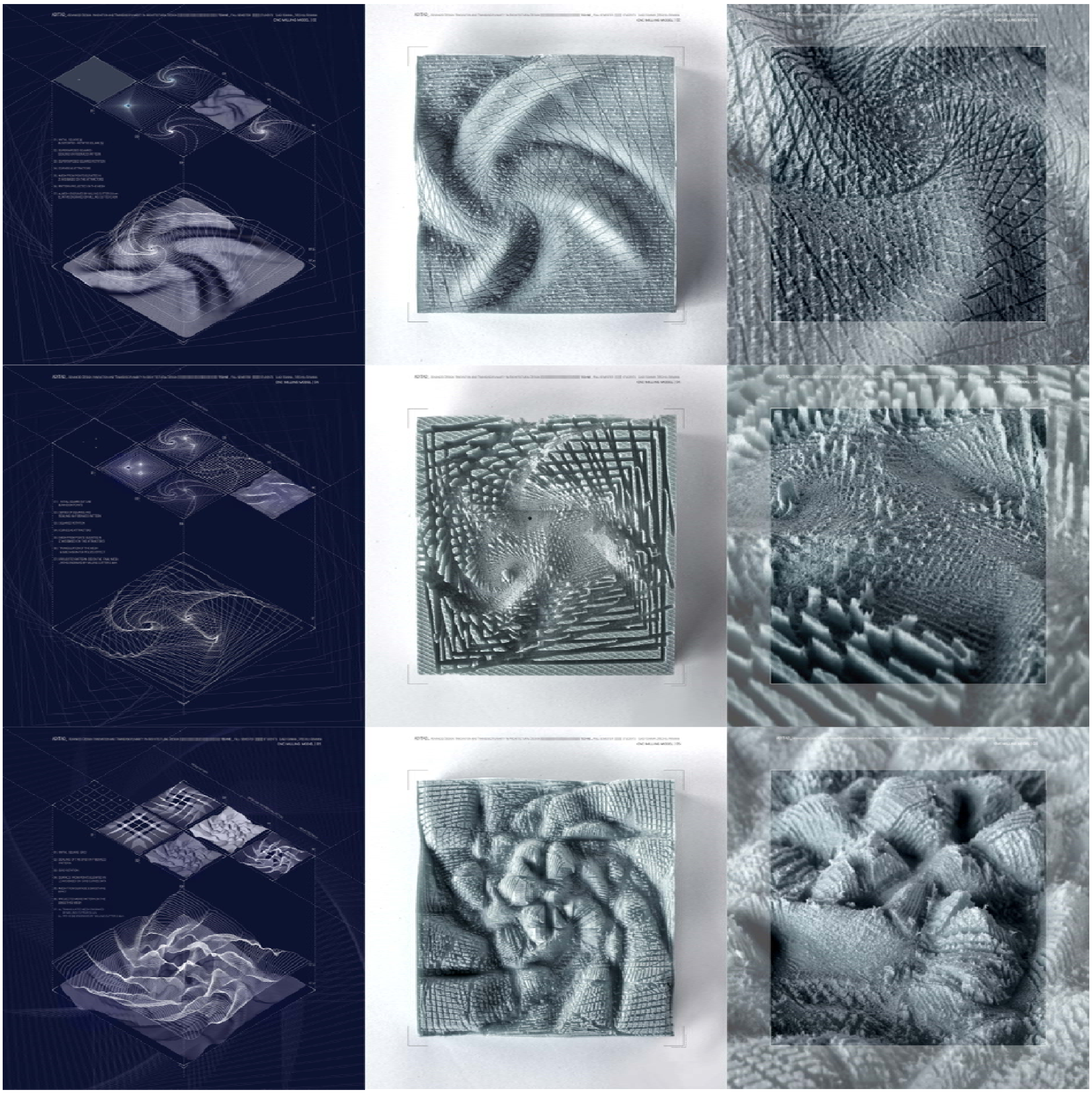

figure 16: 3d milled study model, details and fabrication strategy. Fabrication Protocols / Modulated Surfaces seminar, Fall 2016, post graduate program 'Advanced Design', School of Architecture, Aristotle University of Thessaloniki. Students: G.Illiadi, A.Mexili, Instructor: Dimitris Gourdoukis.

Looking at the two conclusions of the above line of thinking one could easily observe that both appear to go against the fundamental properties of generative thinking and designing. After all, the way of the master architects is counter-generative in the sense that it denies the autonomy of the generative mechanism: it is the architect, the human as author, and its individuality that creates. At the same time looking back at analog techniques is a practice that seems to deny the very nature of generative processes: their digital and algorithmic starting point. The analog, at least if understood as the opposite of the digital, is excluding generative results.

figure 17: 3d milled model and details. Fabrication Protocols / Modulated Surfaces seminar, Fall 2016, post graduate program 'Advanced Design', School of Architecture, Aristotle University of Thessaloniki. Students: A. Arampatzoglou, V. Gaiserlidou, Instructor: Dimitris Gourdoukis.

And yet, if one looks closer might be able to observe that while the above might be true up to a certain extent, it is only when we focus on the technique instead of the intention that they hold their ground. Because both propositions – on the one hand going back to the idea of the architect/author and on the other employing analog processes – in effect champion the main scope of generative processes as they were initially understood: the production of novice, previously unseen design solution that will erase any concept of the standard and will emerge through iterative processes.

To conclude, the ultimate goal of the above direction is to restore architecture as a 'dispositif', if we were to use Michel Foucault's terminology, of the contemporary society. As an autonomous mechanism of production of subjectivity. In other words as a generative mechanism. Only when architecture will reclaim its role as a cultural dispositive it will become able to re-invent its role as an active element of the social and political spectrum and contribute towards a better future. In a certain sense, returning this way to the aims once present behind the concept of standardization, but reframed in a totally different manner. And certainly by becoming generative independently from the nature of the tools that it employs.

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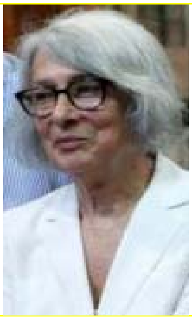

Generative art Meta*Language*

Paper

Topic: *AI language in Generative Art*

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PROLOGO *"Love is not love Which alters when it alteration finds"- Shakespeare, 116 sonnet*

Dancing on a shining generative braid
By flying on your steps, you follow imaginary rhythms/Where time is an ancient man with a crazy hat.
Over the mirror, he waits for you behind the notes, /Suddenly couching for your fear, unexpected.
Take place, baby, in your imaginary site of mind/Immerge your eyes in the shining braid of your heart:
The crazy hat is flatting on the mirror in silence, /Like a virtual hand of a robot wake.
*Meta*Language: is a new power? / Or is it only an ancient *meta*circular dance of ancient times?
Leonardo' *fabulae* teach where you can only find a generative answer/To the eternal question about life and death:
Dancing on a shining braid, imagining /So you become able of putting under your short steps every fear of your time.

C. Soddu *"14 Generative Lamps"* 1998

The discovering aim of this investigation is in trying to outline possible organic structures inside the GA experience of the past, since more than 30 years. Organicity works as a connector by delineating a progressive process looking for also inside the past, in the lighting of the previous scientific results. GA innovation works in art tradition,
This should be the main condition for defining generative *this kind of art.*
Firstly, the choice of the title" GA Meta*Language. This expression identifies two parts that stay together working in autonomous way.*
The main reference is In Douglas R. Hofstadter, that identified possible connections ad continuum *in his book Godel, Esher, Bach.* An Eternal Golden Braid, as a metaphorical escape between minds and machines in the spirit of Lewis Carroll*, published in 1979 .*

Crossing the river *in electric resonance* *The peace of all things is the achieved order".* S. Agostino

Two different systems perform the GA *Meta*Language. The first is not linear and it construers by algorithms open processes The second system delineates a crossing interaction with the first one by a linear system that is time. This process is like *the crossing of a river* that is running toward the sea, connecting its two different sides with all the memory of its own running. In the swimmer crossing time, the running of the double systems generate a **an electric resonance** between the timed crossing and the river flowing with the running swimmer.. This crossing in electric resonance performs a unique result of a perhaps infinite variation of the same generative process.
The best paradigm of the process control is in crossing the river from one side to the other side, by following a past time toward a future with a singular point of view in one direction. This is able to connect the real site into our imaginary vision by performing experience of our idea/ code. This works as a paradigm of control inside our incoming generative experience
The GA artist is alone as a swimmer in the organic sound of nature, preserving in his heart the imaginary vision of his infancy with its sounds, smells and orders. This is the main condition for gaining an art result.

3unfinisheed artworks- 1 Piero della Francesa "Natività-- 2 Leonardo da Vinci, Adorazione dei Magi- 3 Michelangelo La Pietà Bandini

Prolegomeni: Ditirambo; Giulietta e Romeo, *reverted time;* Piero della Francesca, Leonardo, Michelangelo, *unfinished;* G: Leopardi, *Zibaldone;* Pierce, *abduction ;* Mallarmè, *The white page*; Christian Morgenstern, Man Ray, Isgrò*, The song of a mute fish;* J. Swift, *Advice to the grub street verse writers*; Nietche and Whitman*,ending;* Anton Popovič, *Metatext;* Celine ,*Rigodon;* Janis Joplin, *Summertime…*

enrica.colabella@polimi.it

Key words: MetaLanguage, translation, abduction, visionary, organic

Giacomo Leopardi "Zibaldone" www.leopardi.it/zibaldone.ph.

Douglas H.Hofstadter, "Godel, Esher, Bach, un'Eterna Ghirlanda Brillante, ", Adelphi,Milano 1990

Generative Art *Meta*Language

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PROLOGO

"Love is not love Which alters when it alteration finds"- Shakespeare, 116 sonnet
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Take place, baby, in your imaginary site of mind/Immerge your eyes in the shining braid of your heart:
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Leonardo' *fabulae* teach where you can only find a generative answer/To the eternal question about life and death:
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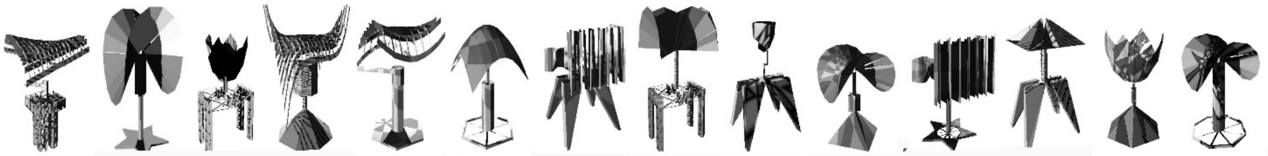

C. Soddu *"14 Generative Lamps"* 1998

GA MetaLanguage is a generative process for gaining a language where the starting point in the preposition meta. This expresses a passage from a time before to a time after as a translation able to cross words toward figurative results. Figurative means that the results are recognizable in our cultural history, where all human artifacts belong.

***Organicity in GA Meta*Language**

The discovering aim of this investigation is in trying to outline possible organic structures inside the GA experience of the past, for more than 30 years. Organicity works as a connector by delineating a progressive process looking for also inside the past, in the lighting of the previous scientific results. GA innovation works in art tradition,
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Two different systems perform the GA *Meta*Language. The first is not linear and it builds by algorithms open processes. The second system delineates a crossing interaction with the first one by a linear system that is time. This process is like the crossing of a river that is running toward the sea, connecting its two different sides with all the memory of its own running. In the swimmer crossing time, the running of the double systems generates an electric resonance between the timed crossing and the river flowing with the running swimmer. This crossing in electric resonance performs a unique result of perhaps infinite variations of the same generative process.

The best paradigm of the process control is in crossing the river from one side to the other side, by following *a past time toward a future with a singular point of view in one direction. This is able to connect the real site* into our imaginary vision by performing experience of our idea/ code. This works as a paradigm of control inside our incoming generative experience. The GA artist is alone as a swimmer in the organic sound of nature, preserving in his heart the imaginary vision of his infancy with its sounds, smells, and orders. This is the main condition for gaining an art result.
.In 1992 Celestino Soddu and I published "The Habitat Morphogenetic Design, artificial codes of the environment" where we delineated all our GA process also in our teaching experiences. My peculiar effort was to choose for every chapter of this book a *prototext* from the words of famous poets, philosophers, artists, as a poetic synthesis of each chapter significance. This for enlarging the contest of each part of the generative theory inside a poetry and prose reference of a past time. For the reason that does not exist generation in the art without references to a past, as in organic life. The generative line is an evolutionary passage from a past toward a future. Following this methodology, I started in experimenting in teaching In 1994 as an *homage* to Leopardi in an Architecture Design course at Politecnico di Milano. The didactic main aim was to generate spaces starting from an abduction process from the Leopardi texts in poetry and in prose too. The abductive action chooses 3 adjectives also in significant contrast as aims of the incoming generative process. Nothing can be generated if we don't fix in advance the characters of our aim. This was the first bridge between the world of poetry and AI processes

Prolegomena:, Dithyramb; Nietzche The Poems by Dyonosous; Celine, Rigodon.
Giulietta e Romeo, a reverted time;
Piero della Francesca, Leonardo, Michelangelo, unfinished artworks
Brunelleschi The Maternal dome, Borromini, The wisdom dome, Gaudì, The Heaven stairs
Poetry in prose - G. Leopardi, Zibaldone Pierce, abduction; Anton Popov, Prototext/Metatext
Mallarmè, The white page; Christian Morgenstern, The song of a mute fish J. Swift, Advice to the grub street verse writer
Nietche - Whitman: Classicism/ Deconstructivism: ending in a avoid silence toward hybrid
Janis Joplin, Jack Kerouac, On the road; Syd Barrett, Flowing the back river
Homage to "The white gloves", Singing by hands

In this investigation about MetaLanguage I performed 7 braids at 3 voices finishing with an homage to a visual sound. My process had the main aim in generating resonances between similar voices from an interpreted past toward sounds of future.

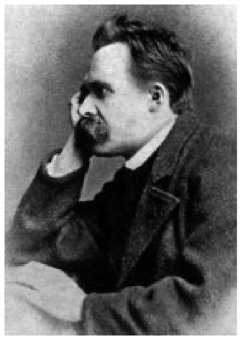
1 First braid at 3 voices Dithyramb, Nietzsche, The Dionysus Dithyrambs, Celine, Rigodon

1. 1 Dithyramb

The term διθύραμβος is of unknown origin, appears for the first time in Archilochus, which indicates it like that "song to Dionysus" that is performed under the inspiration of the wine. Initially, a group of people intoned it headed by a corifeo, or exarchōn, chorus magister. It was a choral poetic composition, where poetry, music, and dance work together and all three indispensable in equal measure. The collective dance, dramatic and rapid, performed a circle by dancers crowned

with braids; the exarchōn represented the same Dionysus, while the corals accompanied him with lamentations and songs of joy. The dithyramb has an important conceptual importance as a "form-generator " that generates, what will be the tragedy and the comedy.

1. 2 Nietzsche- The Dionysus Dithyrambs



“,,,, Only the one who changes stays in touch with me...”   After song

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Nietzsche published in 1889, the Dionysus Dithyrambs as an expression of his rich and multifaceted personality: This is his last work soon before his so terrible madness. His poems are rooted in classical poetry (from Pindaro to Goethe and contribute to laying the foundations of the next from Dadaism to Hermetism. Because Nietzsche, in verse as in philosophical speculation, is always ancient and contemporary: his word of the twentieth-century philosopher has the best full force of the oracle. This work is one of the most problematic of Nietzsche: what place does it occupy within its immense production? What relationship can be established between speculation and the poetic word? What value should be attributed to these verses, written by the German philosopher in his full maturity but a step from the abyss of madness? To these questions, we can discover an answer inside Nietzsche poems, as in all human poetry. In this investigation, an answer is in his great ability to perform an organic line between natural events and mental processes. This knowledge strongly gains together his passion for harmony and beauty in the human tradition with a visionary description of the incoming future. As an oracle...

1-3 Celine; Rigodon

“People dance Rigodon on a two times motif, on a site, without going either ahead or back, neither from the side."

The genesis of poetry in prose, as a precious lace

“*Words are wonderful until they leave the dream”*

Rigodon is the name of an ancient dance, perhaps of Provençal origin whose uncertain etymology can be traced, according to Jean-Jacques Rousseau, to the inventor Rigaud. The most common form is in any case rigaudon; Céline decided to adopt it as a metaphor for his escape into Germany "in full vivisection". The dancers move one step forward, one step backward, but at the end of the movement they do not move from the same point

This is a masterpiece of the invention in literature as a metalanguage between prose and poetry. Where the impulse of a monocentric writing reveals an orality transposed inside the scripture. In every part of this sounds book we find locutions to passages, interjections that break up and disarticulate the phrase, proliferating words in freedom and periods dismembered in fragmented sounds-noises. There is an interpretation of this fluid sounds in words as a *protofuturism* generation that defines Céline is a *"metafuturist* who knows it if unconscious as in certain types of futuristic sound: *"**bruio !, vlang !, piutt !, bang !, brrrrrr !, tac! tac! tock! ...*** *"* About this hypothesis of a *protofuturist* representation: in Celine, the noises are not those of the exaltation of war and the fight emphasis of Futurists. "*Noises are not intoned"* here. On the contrary, the word breaking and shattering itself emits sounds of fear and of pain. What concerns Celine is to leave his last will where his testimony of the journey with his wife and his cat through the places of war destruction can emit shattered sounds of meanings *but also redundant of a deep unique love for the art of writing.* So he reached the highest form of poetry through the word's fragmentation as of a child's voice remind in learning.

2- Second braid: Romeo e Giulietta, a popular voice in a reverted time

The original tale is one of the most truthful and touching among the few that have stirred the heart of the world for ages, or that in Shakespeare's trans-figuration of it his fancy and his youthful fire had a much larger share than philosophy or his imagination. Reality over classes' fantasy. The popular voice expressions on the walls of Juliet home in Verona are a collective graffiti of an emphatic phenomenon ***in a reverted time***. These expressions are full of the romantic dreams of writers in deep resonance *with the terrible pain of the protagonist tragedy protagonists These drawings perform a unicum in a collective metalanguage*.

3. Third braid of 3 unfinished artworks- ***Piero della Francesca***; Natività - ***Leonardo da Vinci***, *Adorazione dei Magi*, 1471 – ***Michelangelo***; *La Pietà Bandini*, 1547-1555,

3 – 1 Piero della Francesca, "Nativita" London National Gallery

"*non vi sia dentro se non quello che è appena necessario, semplice lecto, semplice studio, semplici figure, ogni cosa renda odore di povertade"*
"there is nothing inside but what is scarcely necessary, simple bed, simple study, simple figures, everything makes the smell of poverty "
This is the last artworks before his death. Piero places Jesus in a blue cover, alone on the ground inside wild plants, adored by St. Mary. This is a humanistic acting. A humble sparrow represents a silent sound, on the roof of the hut This painting is unfinished in many fragments. In the eyes of the two people ahead on the right, on the eyes of Angels that are closed, On this Arcadia habitat the effort of the donkey that crosses the sky is completely an exception inside the paintings of that time. This shout could identify the quote of the apocalypse where the animal tried desperately to ask God for mercy, Here the Arcadia song seems almost a suffering, expressed also by the lack of strings on the guitars. Piero was becoming blind. These unfinished fragments express all his pain in leaving the painting world, to which he dedicated all his life with devotion. A song full of almost silent fragments. The last song of an old blind great artist. The father of Generative Art

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3 -2 Leonardo da Vinci, Adorazione dei Magi, 1471, Galleria degli Uffizi

Vasari said about; "There is no fixed point" Each people has a singular point of view and a unique direction. These run in singular way toward the head of St. Mary. This unfinished painting made in Milan in Leonardo fist years of experience in art is strongly innovative for the total new way of representation singularity in an organic vision.An unfinisched artwork of a youg man that was runnig out of Milano with Luca Pacioli with the all Piero knowledge







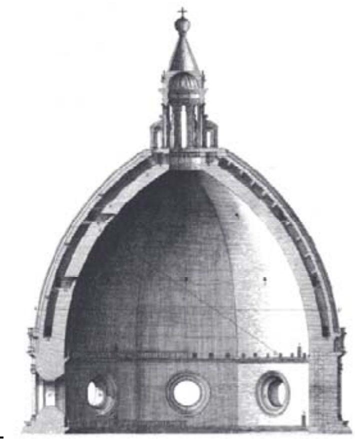
3.3 Michelangelo; La Pietà Bandini, 1547-1555, Firenze Museo dell'Opera del Duomo

Michelangelo worked to this very important sculpture in the last years of his life, after the death of his loved friend Vittoria Colonna. After a long working time he changed idea about the group organization of their singular parts and he should like to change the Jesus legs. But the structure crashed and he broke a part of the marble, leading to hit the marble group with great anger, leaving signs of ruin, still visible today.

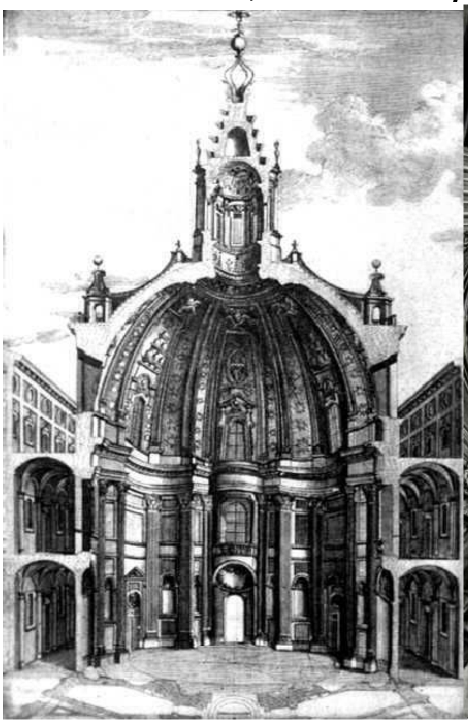
Anguished and fearing his imminent death Michelangelo instills in this work a strong dramatic accent in the characters that surround Christ, as a mirror of his death. Jesus is shown standing lifeless on the Virgin, supported also by Nicodemus on the top and on the left by Mary Magdalen The group of characters forms a pyramid, and the body of Jesus, carved in an *oblique* position,
All the protagonists are connected to each other, and it seems that throughout the scene there is *a balanced rhythm*, which starts from the left and goes to the right. Among the various details, it is necessary to consider the left hand of Jesus placed towards the outside, which indicates *the physical abandonment* to death.
According to some critics, Nicodemus represents a self-portrait of Michelangelo Buonarroti.

4 - Forth braid on the main characters of 3 <u>Organic Domes:</u> Brunelleschi; The Maternal dome - Borromini, the wisdom dome, <u>Gaudì</u>, The Heaven stairs walking

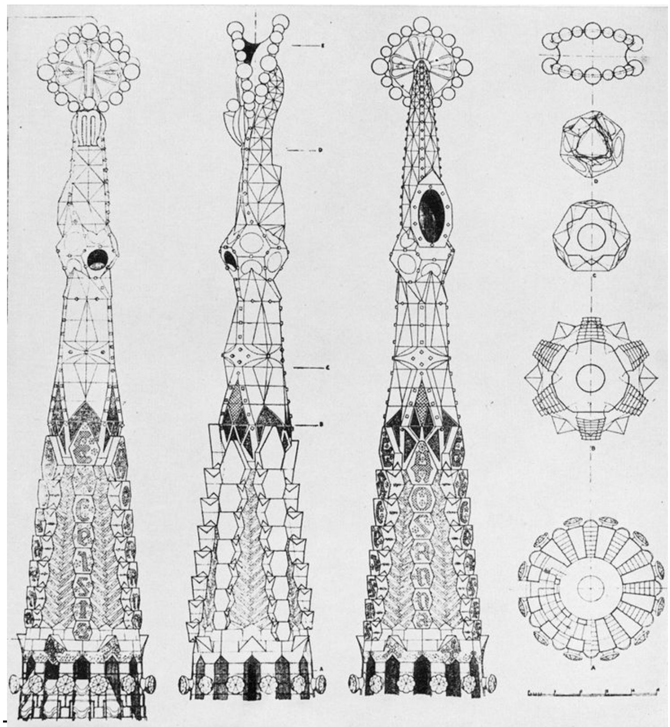
<u>4 – 1 Brunelleschi. Il Manto della Misericordia . The Maternal dome</u>



4 - 2 Borromini, S. Ivo alla Sapienza, the wisdom dome



4 – 3 Gaudì La Sagrada Familia The stairs for Heaven



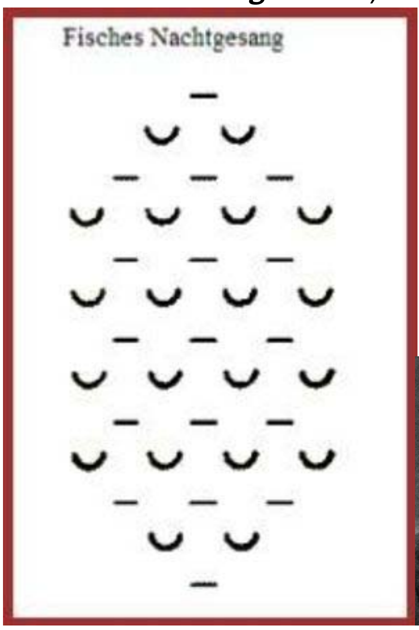
5. Fifth braid on the silence expressions: Mallarmè, *The white page;* ***Christian Morgenstern,*** *The song of a mute fish;* ***J. Swift***, *Advice to the grub street verse writers*.

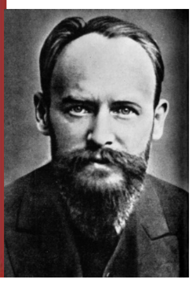
5-1 Mallarmè; The white page

Mallarmè in a portrait by Edouard Manet

As a central figure in Parisian literary circles for much of his life, Stéphane Mallarmé was influenced first of all by Baudelaire and in turn, influenced other poets. During his lifetime, poetry was evolving from the regular forms and clearly expressed emotions of Romantic verse to the fluid and often more obscure forms that would produce modern free. However, another image intrudes that had not appeared in Baudelaire's work, ***the empty whiteness*** of the page. This image entirely represents his fear of being unable to write, to soil the white page. This fear might lead him to flee, even if his departure at the end of the poem is associated with the disaster of a shipwreck verse and the prose poem. He was a vision of the evolution of poetry toward its death declaration in the Adorno words after the horror of Second World War.

5.2 Christian Morgenstern, *The song of a mute fish*

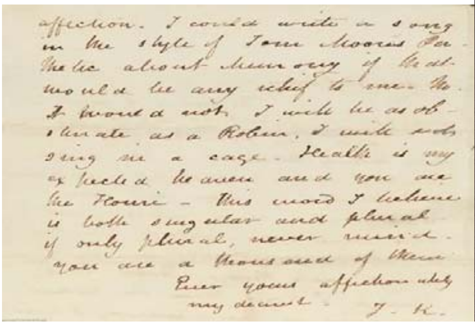




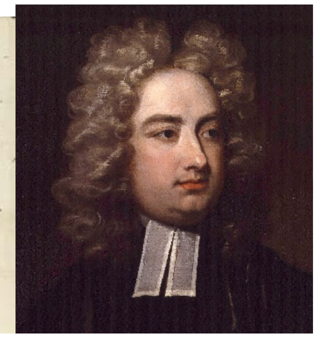
In Italy, for Christian Morgensternl as a poet, the barrier was constituted by the extreme difficulty of translating his poems. Among the poets who published their poems collections at the beginning of the last century, Morgenstern remained one of the most popular, often sent to memory, used in the fanny and desecrating conversations, sometimes able to make even children laugh. Therefore, no sublime difficulties: but the humble and yet tremendous difficulties *of those who make a toy in language, and break it up, disarticulate it, overturn it, mask it and unmask it to the infinite.* What can be very enjoyable in the original, but that becomes a despairing puzzle when ***those verbal prowess you want to transport them in another language.*** The translator's paradise is the poetry in which Morgenstern offers ***pure nonsense sounds*** (but of beautiful or gory sound) that on the opposite page can be reproduced without changing a letter, like the composition titled *The great Lalulà*; or the one that stops at the mere graphic visibility, like the sequence of ***dashes and semi-circles*** that constitutes the nocturnal song of the fish. well known as ***"The song of a mute fish "***This work became a great reference point for artists, from Man Ray, Isgrò and for many visual poets.

5.3 J. Swift, Advice to the grub street verse writers

The art of writings, poems, letters and tales for job on the street is very ancient. The translation in written words from a talking voice is a great act of lovely friendship, but also it may gain only a money aim.



affection. I could write a song in the style of Tom Moore's [illegible] the [illegible] about memory of [illegible] would be any relief to me. [illegible] I would not. I will be as obstinate as a Robin, I will not sing in a cage. Health is my expected heaven and you are the Houri – this word I believe is both singular and plural – if only plural, never mind. You are a thousand of them. Ever yours affectionately my dearest J. K.



; .....And when he sets to write,
No letter with an envelope
Could give him more delight.... ....
...Sell them to Curll for fifty pound,
And swear they are your own.

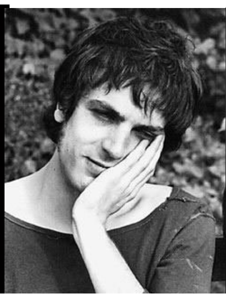
<u>6- Sixth braid on ending by 2 voices more one voiceover: Whitman; Nietche: Shelley</u>s

"We are unfashioned creatures, but half made up, if one wiser, better, dearer than ourselves — such a friend ought to be — do not lend his aid to perfectionate our weak and faulty natures." (*Frankenstein*, 1818)

Life and death appeared to me ideal bounds, which I should first break through, and poor a torrent of light into our dark world

Nothing is so pain full to human mind as a great and sudden change

7- Seventh braid of 3 voices in singular electric resonance: Janis Joplin; Syd Barrett; Jack Kerouac, On the road ;


j***7. 1 Janis Joplin Summertime***

anis Joplin wonderful voice sing following a *reverted time* where words run toward chaotic sounds for searching for their ancestral significance.as a neolalism in a deconstructive way. All in a deep use of drugs.

7 . 2 Syd Barrett

A music researcher of new sound using LSD

“I think it's good if a song has more than one meaning. Maybe that kind of song can reach far more people.

“I am treading the backward path. Mostly, I just waste my time.

7- 3 Jack Kerouac

“[...]the only people for me are the mad ones, the ones who are mad to live, mad to talk, mad to be saved, desirous of everything at the same time, the ones who never yawn or say a commonplace thing, but burn, burn, burn like fabulous yellow roman candles exploding like spiders across the stars and in the middle you see the blue centerlight pop and everybody goes “Awww!”

8 Ending in whiteness: the chorus of white hands: music without voice

Enthusiasm generates invisible bridges

Whites gloves stand up following the rhythm of the orchestra pl*ayi*ng an especial melody.Music against diversity. Music against disability of mute children. White gloves that rise to the rhythm of an orchestra and play a special melody, that of expression. It starts from Venezuela and the story of Josè Antonio Abreu and his "System", the experience of the White Hands choir. An experimental course that has been active in Italy since 2010, specifically in the Testaccio Popular Music School in RomeThe experience of “Le Mani bianche” rises from.

"The White Hands” is a vital project that creates a lot of interest from scholars, therapists, journalists, many people want to know this therapy that is an artistic activity of the highest level as Abreu claims in saying 'we do not give poor people a poor art'



The experiment is inspired by a project born in Venezuela 30 years ago thanks to Abreu, first in the form of an orchestra that brought together children who grew up in social problems. Shortly thereafter Educacion Especial was born to include disabled and deaf children. Thanks to the experience of Johnny Gomez and Naybeth Garcia, founders of the first version of the Manos Blancas choir, he grew up as a project designed to translate the song transcriptions into sign language

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Ferhan KIZILTEPE

A BRIEF ESSAY ON SEMANTİCAL ANALYSIS OF SPACE TIME AND SPEED IN DRAWING AND PAINTING
(Paper)

Topic: The Semantical Analysis of some Drawing and Painting that are Chosen for Architecture, Interior Architecture, Industrial Design Education

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Abstract

One of the most important applications of the designing process is the visualization of every phase of the design. This allows the designer to be more precisely manage the differences between mental and visual work from the beginning of the design process to the end of the designing process. Besides the classical methods such as drawing, and printing, photography, animation, digital design, digital drawing/visualisation programs to android drawing applications, one of the common features of advanced technologies is the visualisation quality of the idea. The criteria that construct this quality includes the technological possibilities as well as the designer's ability to express the idea of generativity. This ability of the designer is more related to the ability "vision" and "visualisation.

This paper contains drawing and painting analysis which is one of the subjects that are taught within the scope of Visual Perception course of Anadolu University, Faculty of Architecture and Design. In this regard, a semantic analysis is conducted on how the concepts of space, time, and speed are expressed as line and colour values. The works of art chosen for these analyses were selected from Cubism, Futurism, Dadaism and Surreal movements, and artworks have been tried to be analysed comparatively.

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Key words: Design, Visualization, *Design Drawing* Visual Sensing, Space, Time, Speed, Generativity, Futurism, Cubism, Daddaism, Surrealism

A Brief Essay on Semantical Analysis of Space Time and Speed in Drawing and Painting

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Abstract

One of the most important applications of the designing process is the visualization of every phase of the design. This allows the designer to be more precisely manage the differences between mental and visual work from the beginning of the design process to the end of the designing process. Besides the classical methods such as drawing, and printing, photography, animation, digital design, digital drawing/visualisation programs to android drawing applications, one of the common features of advanced technologies is the visualisation quality of the idea. The criteria that construct this quality includes the technological possibilities as well as the designer's ability to express the idea of generativity. This ability of the designer is more related to the ability "vision" and "visualisation.

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1. Sight, Interpretation, Visualization[1]

Today's world, in which we exist, and which we can maintain the continuity of our species, has evolved through the struggles of our ancestors for thousands of years. In general, this struggle was given against the earth we live on and the nature of the living things outside us. So much so that we continue to evolve in this world, where human beings with the needs and desires are shaped. The most important element that enables this process is the people who can see the world as they live in and convert them into an idea-design. Hence, it is an important competency to be able to see.

Vision is an action that can be performed physically with the sight organ. The image obtained by this action is interpreted in our minds. The meaning is realised through the five senses, the data we have acquired about the world outside our body (the family we are born in, the social environment in which we are, all our experiences, the education we have received, the information we receive from our culture, and the source we have obtained), in our minds according to our body-mind capacity. Therefore, the act of interpretation is individual. In this case, abstracting can be explained as visualisation of the concretisation of abstract thought using various techniques (language, writing, music, architecture, design, knowledge production, scientific research, etc.). In these circumstances, it will not be wrong to call the result obtained by visualisation in a very general sense, abstract or concrete image.

The concretisation of the ideas we developed to meet the material and spiritual needs and demands of the people was carried out one by one until the second half of the 18thcentury (especially the last quarter). For those periods, we will call designers and producers, they were either called artists or craftsmen. The products were valuable in terms of their uniqueness, durability in time and accessibility to the people of certain classes. The most important factor in the formation of this difference was the different approaches of the artist or craftsman/master's way of seeing and understanding the problem and providing the solution. For instance, one of the reasons why the architect who designed the dome of Florence Cathedral was F.Brunelleschi or the painting of the Cosimo de Medici[2] in S.Botticelli was shown to have different approaches to design within the periods of Brunellischi and Botticelli. Due to these differences, Brunelleschi and Botticelli's works have taken their place in the history of European art and architecture as a result of their meaning and thus their value had increased.

Until 1781, science and the technical developments that we have experienced created the infrastructure necessary for the invention of the steam engine of James Watt, the Scottish engineer. With the use of steam engines, the concept of production and consumption began to change rapidly. In general, mechanisation, the development of production processes, the accumulation of capital has led to the beginning of the period we call the Industrial Revolution. In the nineteenth century, it continued its development by evolving with the introduction of electric energy and machinery using petroleum and natural gas. The production of the unique products by artist or craftsman/master has been replaced by the mass production, which had brought the necessity to design the product. Due to this development, a new professional group called "designer" has started to be formed. If we take the example given above from the art of painting, in the nineteenth century, as well as the development of moving images/cinema in addition to the use of cameras, technical images were obtained and allowed to be reproduced as desired. In this way, the portrait painting that was originally ordered to Botticelli was replaced with photography that could be reproduced as desired.

At the end of the eighteenth century, the economic changes that become major and the social changes followed it with in all aspects continued in the late 19th–early 20thcentury. These developments in mathematics and science accelerated the development of existing ones as they paved the way for new technologies. Thanks to these developments, people have been able to use the new technologies at every stage of their lives[3].

The developments we have expressed with very general outlines above, along with many innovations towards the middle of the 20thcentury continued with the development of information about the universe, electronic technologies, and computers. While the 20th century was called with the adjectives such as the age of space, communication age, speed and the age of information technologies, the revolutionary digital developments that entered human life after the second half of the century led to the definition of the 21stcentury as the first digital age. In addition to the production of information and technology, virtual reality began to take an active place in people's social life practices. The virtual space-time has begun to take place in the space-time, which was previously defined as "real".

It is not only the definition of reality that changes. Within this paper, it is necessary to redefine the basic concepts of the field of design such as artwork, design, production, reproduction, vision/concretisation, image, new discourse, and myth. One solution to this necessity came from German literary critic and thinker W.Benjamin in the first half of the 20thcentury. In his 1935 paper "The Work of Art in the Age of Mechanical Reproduction"[4], Benjamin while introducing a new definition to the basic concepts of art, artist, artwork, reproduction and design, on the other hand explaining the changing design patterns and design/art markets[1]. This process naturally affected the artist/designer's decisions in the process of creation, as well as the meaning of the form language/image of the physical or non-physical function of the resulting work.

In his book "Art and The Committed Eye-The Cultural Functions of Imagery"(1996), R.Leppert gives a strong support to our understanding of the changes I have mentioned above, with his remarkable refined analysis of the social and cultural uses of images in European art history-especially art of painting-which he dealt with on the basis of European culture[2]. One of the best examples of these changes from the 20thcentury can be found in R.Barthes's book called "*Mythologies*(1957)", in which he gives semantical explanations. In particular, the essay was written of Citroën DS model car, called "The New Citroën". In this essay, Barthes makes a semantical analysis of Citroën's new model of DS's design, by giving a striking example of the new discourse of the age. In the same issue, Barthes's book called *Empire of Signs*(1970) makes noteworthy semantic analyses of Japanese culture, unlike European culture[3].

2. Designer, Creativity, Generativity

It is thought that some recent developments and evolution processes of the recent history, which are outlined in a limited number of selected studies above, constitute a general framework for examining today's world in terms of art/design.

As stated in note 3, the world's population registered in 1900 was 1.650million while the world population reached 7.324million in 2015 according to the same source. There is now a global, regional and global market. Hence, the needs, questions, demands have multiplied by the number of people who design, produce and consume.

According to the "Digital in 2018" survey made by the companies We Are Social and Hootsuite, the number of internet users in the world is over four billion[4]. It says that at least four billion people are at their fingertips all over the world. When people use spaces and objects in the time of the real world, it is clearly seen in the social life that the digital world begins to use spaces and objects in the concept of time. One of the best examples of this is the story of filmmaker Cronenberg in the film "eXistenZ(1999)". The story tells a group of people who begin to experience the time of the digital world from the real world through the console game that creates a kind of simulation.[5] One of the main themes that Cronenberg questioned is the fact that new biological designs can be made. It is also important to note that science continues to seek answers to questions in real and digital space. Artificial solutions developed in all areas where people need to evolve (in response the problems created by artificial solutions), instead of artificial, the production of similar to the biological one, the speed of the work like robotics, artificial intelligence continues to increase. In 2006, Prof.M.Sarıkaya and Prof.C.Tamerler collaborated in a study with a method called artificial evolution, they discovered producing gold in the laboratory, which the alchemists had been chasing for about 2500 years[5]. In 2014, Prof.B.Koç and his team were able to print the aortic vein tissue[6] with the 3D printer for the first time in the world, or the oil painting portrait work made by an artificial intelligence found a buyer of $432.000 at an auction organized by New York Charities[7].

In today's world, which we have discussed above, the designer must be able to exist in real-digital space-time. One of the important providers of this is that it can create a unique design language by developing a different approach to design with a good understanding of the world of the day and the interpretations it will bring. This process also leads to the emergence of productivity in creativity. The best examples that will be easy to follow are the plastic arts.

3. The Different Images of Space, Time and Speed

Since there are key phrases, I would like to start in this section with two quotations:

"…But it may be said that geometry is to the plastic arts what grammar is to the art of writing.", G.Apollinaire[8] and " Our remarks until now about visual perception have concerned its content alone, the two dimensional 'seen' and the three dimensional 'known' visual images." from D.H.Kahnweiler[9].

Among the works of C.Monet there are a series of paintings in which a façade of a building is depicted. The cathedral that Monet made more than thirty paintings of west façade between 1892-93 is the Rouen Cathedral which is a beautiful example of the French gothic movement; the cathedral is located in Rouen, the capital of the Normandy region of France. The artist painted more than thirty paintings of the cathedral's west façade by looking at the same point for a year. Each painting in the Rouen series is a different view of Rouen Cathedral. As an impressionist painter, Monet portrays the cathedral which he sees under the light created by the changing seasons, as he saw himself. The differences in the artist's view have allowed him to depict the space-time and the velocity in which the cathedral is located, within the boundaries of each painting. One flows slowly with the lust of heat, the other runs at the speed of the cold. One is standing as close as you can when you extend your hand and the other is a few meters lower. (Kandinsky's "Concerning of Spiritual in Art" published in 1911, is notable for its concepts of colour, sound and space[10]). In the series of Monet, every piece of painting depicts a different appearance of the Rouen Cathedral. Monet used his brush and colour palette as a way of embodying what he saw in the way he wanted. Differences in concretisation are included in the approach of a painter to the art of painting. Therefore, the charge of the painter will radically change everything.

3.1 P.Picasso(1881-1973), Cubist

R.Leppert identifies the image created in the field of art as the main tool for manoeuvring time and space, while at the same time pointing out that the image is a diagnosis, prediction and confirmation mechanism[11]. Picasso and his works are a good example of this recognition.

The main tool for Picasso's transition from description to abstraction in his paintings is the geometry and mostly the classical perspective approach that comes with it. As I mentioned before, we see more clearly when we comprehend more than what we actually see. When we look at a branch and its leaves seen behind a building in a photo frame, we see the whole building and the branch and tree (if our minds can complete the image of tree and branches from) seen from behind as a whole. Therefore, it would not be wrong to say that our physical view may be of a higher dimension than 3D. Hence, 2D objects can be fully visualised on a 2D plane (canvas), while 3D and above objects are visualised in 2D creates the necessity of changing geometry and perspective. This process can be easily followed in the classical art of painting developed by P.Cézanne by adhering to the definitions of perspective, form, light and dimension. For example, while in "Man Smoking a Pipe" painting, one can see the top of the man's shoulders and a small section of his back, in the painting "Mont Sainte-Victoire 1902-04", he partially stretched the topography and reduced the slopes of natural details. In the article "Note of Painting" J.Metzinger refers to this situation as "Cézanne showed us forms living in the reality of light, Picasso brings us a material account of their real life in the mind"[12].

The document of G.Barque published in 1917 is a kind of specification of Cubism[13]. The ground rules mentioned here can be followed in the style of Picasso. The forms of the live and lifeless objects are deconstructed and recomposed in an unusual way in line with Picasso's point of view.

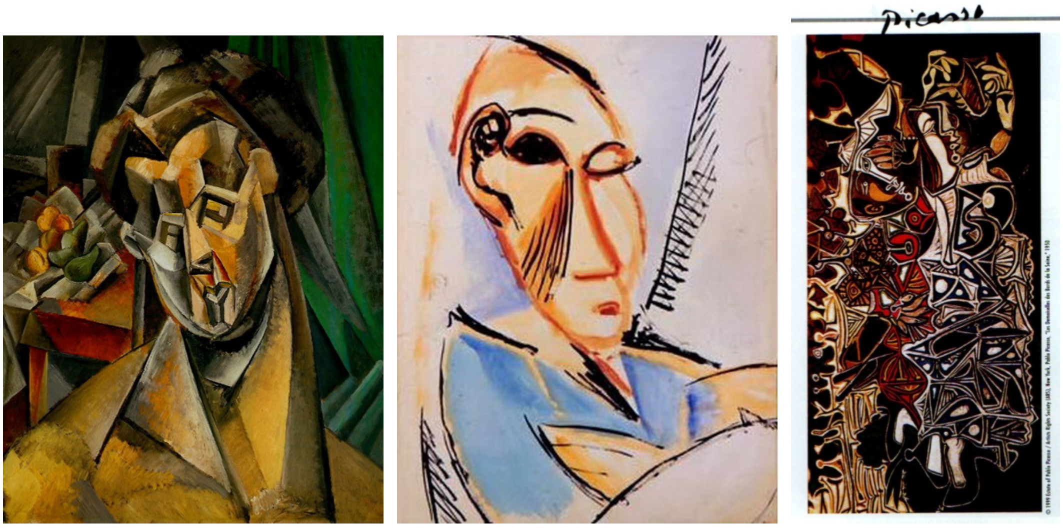
The colour stains composed of polygons are located on the canvas by combining rough-and-tumble with thick dashes. The deepness is not read itself easily just like the perspective and light. Although J.Riviére insert those among the mistakes of Cubism, the aforementioned situation goes beyond the general acceptances and requires to be treated with a new point of view[14]. Picasso changed the geometry. Now the geometry in question is the Non-Euclidean[6] geometry, not the Euclidean one. The shift in the geometry changes the space-time and accordingly the speed of the image.

While the rapidly advancing developments in the field of mathematics in 19th and 20th century revealed new geometries, B.Riemann's Riemann Geometry, E.Noether's Symmetry Theory in which she correlated symmetry and conservation law, or the developments improved by Minkowski, H.A.Lorentz and M.Planck, and especially H.Poincaré's Poincaré Conjecture[7] cosmology played a vital role in the development of quantum physics. Since then the fourth dimension theory ensured that many theories in the fabric of space-time and in similar topics could be developed. The most important output of that period was A. Einstein's[8] works on the photoelectric effect, the Brownian motion, the special relativity and matter-energy equivalence. Those works in particular, the progresses were revolutionary for the science world. The subjects like the higher dimensions, the fourth dimension, the curved space-time contrary to Newton's model, subatomic particles are the subjects drawn considerable interests of the people in their importance. Thus, for a sensitive artist it is unlikely to be isolated from those developments. In an interview done with the painter, he says the art is concerned with the form initially and the form arose lives its own life. According to him, while the geometry meets the temporary needs, he doesn't concern with the speed and the subjects like trigonometry, mathematics, physics, and therefore the people correlating the art with those don't understand the cubism[15].

From left to right: Portrait of Ambroise Vollard, Naked Woman Sitting, Woman with a Fan[22].

When it is considered the vision is something upon 3D (In the design training, 3D is usually interpreted upon the Plato solids. However, those bodies could be broadly defined as Euclidean geometry elements. But the geometry of the dimension we would define as 3D includes the non-Euclidean geometries as well. So, the expression of upon is used.) it wouldn't be wrong to say the image on the canvas –arose in artist's works because of painting what she/he sees– would remain in a place between 2D and 3D (the structure arose as a result of any material added to a plane as the thickness of the paint or the collage style would come up the 2D in all cases). If it's considered the space called 4D involves the 3D, in this case we can say it entirely involves/enfolds the world which a person perceived out of her/his body. If so, when looking at higher dimension objects (if we can perceive), we make out that we can be entirely in the image. In general for Cubism and in particular for the art of Picasso it's said that, the artist reduced the 3D he saw to 2D by extraordinarily visualizing some angles of the objects which the eye cannot see. Whereas, because of the reasons we mentioned briefly above, the images produced by Picasso could be also interpreted as the projections of the higher dimension and the related space-time speed in 2D. Herein, Arthur Miller's work entitled *Einstein, Picasso: Space, Time and the Beauty That Causes Havoc* in which he comparatively analyzed and interpreted Einstein and Picasso is a remarkable study[16].

An important outcome of digital image technologies is to acquire the images of scientific developments and imagined designs. By this means, visualizing the stages of an idea recorded during the realization period facilitates to process the mentioned idea in every aspect. The visual reality technology, both an interactive game and the 3D movie screenings shows to the player/moviegoer how the space-time they perceived surrounds them with a different concretization method. In the movie called Interstellar (Director: C. Nolan, 2014), when the hero came behind the bookshelf, the geometry used for visualizing the space-time-speed perception changed behind the bookshelf in respect to the in front of it and its encompassment the hero is the non-Euclidean geometry. Especially the fractal geometry elements were intensely used. Similarly, in the fantastic science fiction movie called Dr. Strange (Director: Scott Derrickson, 2016) in which the space-time-speed fiction rapidly changes at the scenes, while the space-time-speed was changed by using different geometries, the reality of metamorphosis is raised at some scenes. The visualization of rapid shifts between fractal, elliptic, hyperbolic, topologic, Euclidean geometries is quite successful in this movie.



From left to right: Woman with Pears, Head of Medical Student, Les Demoiselles au Borrd de la Seine[23].

In brief, the projection of the perception of higher dimensions (thus of the space-time-speed) on the 2D are the images expanding limitlessly to the four directions on the well-defined plane like a canvas, always being in the direction which the viewer looks, returning all the looks to right and left, up and down, in and out with a look in a portrait viewed. Besides, the alignment of the objects in the extraordinary ways and locations, namely, their setup changes the mood of the viewer at a pace. The swing of the rhythm built on the balance (symmetry) of the paint is effective. The speed is slightly felt in that order which could be clearly followed in the works of Picasso (although the discrepancy of the material, pen, paper, etc. which the painter used in his drawings changes the perception of the image, in principle the space-time-speed is perceived similarly). His paintings are like the image of a moment in a different space-time, or...

3.2 U.Boccioni(1882-1916), Futurist

While the speed takes part in the back rows in Cubism, it's almost the main generator in Futurism.

Savaşı That anarchist spirited movement blessing the war accepts the speed as a new value of beauty as mentioned in its manifest written by F.T.Marinetti[17]. The dynamism rapidly coming and the crystallized view are the important elements of the paintings[18]. The movement in his paintings are the important elements enabling the speed. So, the elaboration, the profundity and the perspective of the action enabling the movement is an important technical detail enabling the perception of the speed. The photo dynamism is a technique allowing that to the futurists. By transposing the images of the movement details acquired by that technique to other materials, the futurists materialized the speed with the main elements of the composition. The forms which compose the details reveal the movement by stratifying. The use of polygons, especially acute angled triangles are projected according to the direction and/or the focus of the speed. The geometric structures of the crystals and the scattering of light are the important parts of the composition complementarily.


From left to right: Horizontal Woman, Simultaneous Visions[24].

In a race car travels accelerating, the image outside the car rapidly changes. The figures composing the objects linearize by becoming kind of triangles through the reverse direction of the speed. That completely changes the geometry of the image of outer world in an airplane moving with a speed of 3.000 km/h. As if the airplane travels in a different space-time surrounding it. The vectors, the values of direction and length and a good geometry enable the visualization of that kind of space-time-speed on a canvas. In Boccioni's paintings, while the elements were located according to the order he wished to show, the first prominent thing is the Euclidean vector perception. In some paintings, the geometry of those stains elongated afterwards and transformed to the stains slightly elliptic and/or bearing the lines of the hyperbolic geometry (As the vector space is the subset of the topological space, it is possible to follow the traces of the topological geometry). That turn enables the looks of the viewing person are encompassed by the speed. Therefore, in the paintings of Boccioni in which substantially Euclidean and some non-Euclidean geometries were used, the speed was an image which didn't change the physical structure of the object and as if perceived the formation of a high-speed car with the place it enabled (The sculpture entitled "*Unique Forms of Continuity in Space"* made by the artist in 1913 should be discussed in this context). A similar speed perception is seen in the painting entitled "*Nude Descending a Staircase No:2"* by M.Duchamp in which he illustrated the details and the speed of a movement with its beginning and end. The space-time composed by the speed with the movement here is different from the perceived in the paintings of Picasso.


From left to right: The Charge of the Lancers, Nu Descendant L'escalier No.2- Duchamp[25].

3.3 S.Dali(1907-1989), Surrealist

...Or it is very fast.

It is seen that the psychoanalysis theory of Freud and the dialect of Hegel took an important part in the surrealism definition revealed by A.Breton in two manifests and an article written in 1924, 1925 and 1929 [19]. There, in general he expresses the dreams and hallucinations of the person are the superior reality according to the reality of the world outside her/him. The image of the objects in the real world completely differs in the superior reality. It is out of the ordinary. That definition of image is clarified with the definition of formless by G.Bataille[20]. And Dali adds to the definition of the surrealist image that it's the mental process of the paranoia. According to him while that image discredits the real world, it is far away the limitless, non-hierarchical and classical representation mechanisms[21].

The space-time-speed taking part in the centre of dream, hallucination and paranoia concepts which create themselves in a mental process in general, differs from what it is perceived in the outer world. For example, although the dreams seen in the rapid eye movement sleep last for one minute at most, the dreams remembered may contain the events last for hours or days. Herein, based on the relativity theory of Einstein, it could be said that the time passes slow because of the dream speed. So, the geometry used in visualization of the projections of the forms on a plane existing in the real world and included in the scenarios built in the mind, in the speed of thinking would change. To express the image of the space which becomes fluid with slowing down of the time with the lines of the non-Euclidean and especially the topological geometry, simplifies the transfer of the main point to the viewer. Therefore, the speed in the paintings of Dali entitled "*Melting Watch*" and "*Spider of the Evening*" are so high, the time slows down and the space flows correspondingly. The familiar forms transform to a flexible structure. The image of the clock, the cello and the cellist elongates like a rubber. And the speed dissolved Gala to her molecules in "*Galatea of the Spheres*". Likewise the speed visualised in the fight scene of Agent Smith with Neo, the hero of Matrix movies (Directors:Larry and Andy Wachowski, The Matrix, The Matrix Reloaded, The Matrix Revolutions) which have a scenario passing in the virtual reality. That speed is equivalent to the digital signal speed. As if Neo and Agent Smith are dancing with slow movements under the pouring rain. While watching the raindrops flow down, we see that Neo opens a large crater during his rise slowly and coast down.

From left to right: Melting Watch, Spider of the Evening,Galatea of the Spheres[26].

If we return to the first sentence of this part as the last sentence of this part, the space-time which Picasso illustrated in his works like "*Les Demoiselles des Bords de la Seine*" resembles the one Dali illustrated. Both artists illustrated the world they perceived/built in their minds with the speed-space-time of those worlds by using the elements of non-Euclidean, especially topological geometry.

4. Conclusion

Through the three names selected from the plastic arts, the different forms of approaches to design and the images expressing different space-time-speed revealed by the use of different geometries in concretisation of those are aforementioned. While those differences created a tremendous impression in their period, they caused important changes in the flow of art. However, with its premises, contemporaries and consecutives, there are more in three different points of view, in the creativeness and in the space-time-speed showed by the produced worlds. M.C.Escher's Poincaré disk model composed of fishes, topological picture gallery; or the stratified fluid networks take part in the digital space-time on the pictures of J.Pollock, can be mentioned. We can talk about three layers in the painting of Istanbul, which is seen by D.Erbil. In general, the first layer of His Istanbul paintings refers to miniature art on the Euclidean plane. The second layer is a layer in which multiple perspectives can easily be traced referring to fractal geometry (as a decimal size between 2D and 3D). Finally, with the 3D layer as the third layer, the artist combines 3 different space-time-speed sensations on the same painting. A similar example of this layered structure by Erbil is seen in a series of photographs by M.Germen. Or A.Ebüzziya Siesbye's ceramic pots that are resist Newton's principle of gravity. So these bowls are the dynamic bowls that are rising and expanding while the mud bodies rotate rapidly, on a small base.

From left to right: Istanbul 2005 D.Erbil, Morphosis Istanbul-Zincirlikuyu2013 M.Germen, Untitled 2003 A.Ebüzziya Siesbye [27].

In brief, developing science and digital technologies play an important role in better understanding the world we live in and the universe in which we live. This process changes humans perceptions, thoughts, ways of exist and needs. Therefore, in today's evolving world, the designer/artist has to become aware of science and technological developments. In this way, the designer/ artist can interpret the data acquired by his senses with his cognitive sensitivity and put forward a different perspective. This is an important factor for a designer / artist to be creative and generative.

5. Notes

1.The concepts of vision, interpretation, and visualization are broad concepts. These are very generally defined to be appropriate to the paper content.

2.”Portrait of a Man with the Medal of Cosimo de Medici the Elder”-S.Botticelli,(1474-1475).Wikipedia.

3. The individual and social changes that emerged as a result of scientific and technical developments took place at a dizzying speed. In 1900, the population of the world was approximately 1.650 million while the European population was 408 million (according to the data in the Wikipedia article). Developments in the field of health (such as, X-ray, presence of blood groups, blood transfusion, penicillin, etc.) while prolonging the life expectancy, reducing the new-born deaths. Public transportation increased the mobility of people while increasing life speed and shortening the distances. Easy access to food. The telegram, the phone’s discovery. Women’s rights. The use of steel instead of tensile iron. Widespread education. Cinema, radio, video recorders. Sending the first photo by electric telegraph. The first intercontinental phone call. Atlantic extreme sea voyages. Warplanes, battleships, submarines. The first works of modern literature by Joyce, Woolf, Beckett, Proust, Kafka. Bugatti’s racing and navigation car manufacturing factories. I. Ducan and modern dance. Garment production. Fashion. Coco Chanel. The start of astrophotography. The first colourful feature movie. And so on. There are many people who have contributed to various different disciplines to make our world the way it is today.

4. The aforementioned article is included in Walter Benjamin’s *Das Passagenwert*, which he started in 1927 but could not complete due to his death. (Istanbul: YKY, Author Biographies, Walter Benjamin item.)

5. Although there are many works to be considered as early as the works of Cronenberg in the art of cinema, the movie called *The Purple Rose of Cairo* (1985) by the American filmmaker Woody Allen (1935-) should be remembered here. In this movie, Allen has taken the film’s main characters from the curtain to the real world.

6.Euclidean Geometry. Non-Euclidean; Hyperbolic Geometry,Elliptic Geometry, Topological Geometry, Fractal Geometry and so on.

7.The books *"La Science et l'Hypothèse"*-1902 (http://henripoincarepapers.univ-lorraine.fr/chp/hp-pdf/hp1917sh.pdf, 10.11.2018) and "La Valeur de la science"- 1908

(http://henripoincarepapers.univ-lorraine.fr/chp/hp-pdf/hp1919vs.pdf, 10.11.2018) written by H. Poincaré are the first sources to look at.

8.“Über Einen die Erzeugung und Verwandlung des Lichtes betreffenden heuristischen Gesichtspunkt” (1905), “Über die von der molekularkinetichen Theorie der Wärme geoforderte Bewegung von ruhenden Flüssigkeiten suspendierten Teilchen” (1905), "Zur Elektrodynamik bewegter Körper" (1905), “Ist die Trägheit eines Körpers von seinem Energieinhalt abhängig?” (1905), “Über die vom Relativitätsprinzip geforderte Trägheit der Energie.” (1907), “Über das Relativitätsprinzip und die aus demselben gezogenen Folgerungen.” (1907), “Prinzipielles zur allgemeinen Relativitätstheorie.” (1912), “Grundlagen der allgemeinen Relativitätstheorie.” (1916), These articles of Einstein are prioritized sources.

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GENERIC IMAGES (INDEX, GENERATE, LEARN): AN HETEROMATIC ENVIRONMENT?
Paper

Topic: Art, Generative aesthetics, Software, Education

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Abstract

In the 1960s and 1970s, scientific and technological progress heralded a new industrial era and a new cultural model. Fordism gave way to information society; and post-war modernism to dematerialized post-modern art [1]. The New Tendencies movement which emerged in Zagreb seized upon this rapid development by conducting *Computer and Visual Research,* offering its project of making concealed processes visible in the hope to give everyone the opportunity to negotiate this future world.

In a society that is now composed with algorithms, dubbed by the promise of a computational intelligence, we must ask ourselves what place is reserved for the construction of the subject (in the words of the epistemologist Jean Piaget). Algorithmic art presents itself as a ground to investigate in terms of education because it is an art that must be verbalized. The hypothesis here is that this investigation should enable an increased reflection on aesthetic values and artistic practice, which we find in the theories of pioneering computer artist Frieder Nake [2]. Following theoretical investigations in generative aesthetics, we will then present a creative approach.

“Generic images” is a software creative project based on a workshop opened to transmission in algorithmic art. The procedural drawing software that is presented here serves as an experiment for creating a graphical and generative content from a participatory process. Through an experience such as the one proposed how do individuals, algorithms and artistic language interact? Can we talk about a “heteromatic” environment [3]? Can we transpose artistic practice in an algorithm or in a software? In retrospect, is a generative image an image that has learned art?

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Key words: algorithms, early algorithmic art, participatory art, generative aesthetics, drawing, language, education

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Generic Images (index, generate, learn): A Heteromatic Environment?

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Abstract

In the 1960s and 1970s, scientific and technological progress heralded a new industrial era and a new cultural model. Fordism gave way to information society; and post-war modernism to dematerialized post-modern art [1]. The New Tendencies movement which emerged in Zagreb seized upon this rapid development by conducting Computer and Visual Research, offering the possibility of making concealed processes visible in the hope of giving everyone the opportunity to negotiate this future world.

In a society that is now composed with algorithms, dubbed by the promise of a computational intelligence, it is worth asking which place we reserve for the construction of the subject (in the words of the epistemologist Jean Piaget). Art, which is conceived with algorithms and in particular the digital image, is investigated in the context of education. The fact that algorithmic art must be verbalized and formalized would foster an increased reflection on the artistic practice itself. We find these thoughts in the practice of pioneering computer artist Frieder Nake [2]. Following theoretical investigations in generative aesthetics, we will then present a creative implementation.

Generic Images is a creative software project based on an open workshop for algorithmic practice in the context of art education. The procedural drawing software that is presented here serves as an experiment for creating graphical and generative content from a participatory process. Through an experience such as the one proposed how do individuals, algorithms and artistic language interact? Can we talk about a "heteromatic" environment [3]? Can we transpose artistic practice to an algorithm or a software? In retrospect, is a generative image an image that has learned art?

Generic Images website
https://tabouret-studio.github.io/Images-Generiques

Introduction

In a society that is now composed with algorithms, coupled with the promise of a computational intelligence, it is worth asking which place we reserve for the construction of the subject (in the words of the epistemologist Jean Piaget). Art, which is conceived with algorithms and in particular the digital image, is investigated in the context of education. The fact that algorithmic art must be verbalized and formalized would foster an increased reflection on the artistic practice itself.

Generic Images is a creative software project based on an open workshop for art education in the context of algorithmic practice. The procedural drawing software that is presented here serves as an experiment for creating a graphical and generative content from a participatory process. Through an experience such as the one proposed how do individuals, algorithms and artistic language interact? How to structure a cognitive space, which weaves these relations? Can we transpose artistic practice to an algorithm or a software? In retrospect, is a generative image an image that has learned art?

One of the working hypotheses proposed here is that in order to produce an environment specific to artistic development and teaching of generative aesthetics; it is necessary to think of an environment that is both human, software and hardware, and to structure it in three parts: 1° an index of visual elements drawn by hand or generated by algorithmic procedures, 2° "generation" of new arrangements and the transformation of these arrangements from a given repertoire, 3 ° learning through verbalization and the determination of a syntax of visual operations, in between natural and formal language. Strongly inspired on one hand by the sources that have been produced by the New Tendencies movement, and on the other hand by the approach of Software Studies, Generic Images software, which centralizes the efforts of intellectual and collective development is then offered both as a collective work and an interface to foster an increased interaction between individuals, algorithms and artistic language. In this context, we intend to question the critical framework of the relation between art and program by the means of a survey conducted with the pupils from a high school. Through this paper, we will defend that it is the experience of different groups with a software - from its conception to its use, and the visual and generative production chain understood in its globality, that engender a model for thinking about an artistic and heteromatic environment. Not only does this environment function as a system of interaction between human agents and automated agents, but moreover, it is a critical step towards questioning human activity in the era of automation of cognitive work. We will then argue about the possibility of formulating artistic environments that could be both generative, critical and heteromatic (#1).

1. New Tendencies: Computers and Visual Research

In the 1960s and 1970s, scientific and technological progress heralded a new industrial era and a new cultural model. Fordism gave way to information society; and post-war modernism to dematerialized post-modern art [1]. If a large majority of the intellectual and artistic community rejected the technological efforts of the time, the “New Tendencies” movement, which emerged in Zagreb seized the burgeoning computer science to project a future free from alienation and oppression. The Zagreb movement is singular for a variety of reasons. Geographically, Yugoslavia is one of the non-aligned states, which entered modernity late, but with the strength of cultural renewal. Many European research groups met on this artistic platform: GRAV (France), Zero Group (Germany), Group N and T (Italy), Equipo 57 (Spain). It is a truly international movement. Other aspects further underline the exceptional character of NT: reformation of the notion of artistic genius, reformation of art through research, public viewed as user or co-producer, art-science articulation, social-cybernetic synthesis...

Computers and Visual Research symposium, Zagreb, 1698.

During the summer of 1968, the NT movement organized the colloquium and exhibition “Computer and Visual Research”, which together with the Cybernetic Serendipity exhibition in London, would become the first international manifestation of computer art. Artists such as Marc Adrian, Charles Csuri, Frieder Nake, Herman de Vries, Hiroshi Kawano, and Zdeněk Sýkora - presented in the exhibition, have in common the intuition or the desire to recast visual and artistic language through the creation of algorithms. Logical instructions are then used by the artists to produce a new image regime. Umberto Eco who participates in the movement develops the concept of "open work". The images are then thought by these artists as instances, which from a given repertoire of signs and a finite number of instructions, generate an infinitely variable space.

The symposium of 3rd and 4th of August 1968, which brings together researchers, artists, architects, mathematicians and engineers, presents a mathematical, ethical, technological and social approach to research in art. The theory of information aesthetics is defended by Abraham A. Moles who will open the first conference of symposium [4]. In producing algorithmic art and visual research by and with the computer the NT movement aims to make visible hidden processes. In doing so they attempt to give everyone the opportunity to negotiate a future society in which the computer would play a central role. As Armin Medosch points out in a book dedicated to the historical analysis of the movement: "The growing availability of software in general and software for artists in particular introduced a substantial problem into the discourse of art.” We cannot avoid evoking the decentring of the author. Indeed, what becomes of the artist’s work, if a program produces an aesthetic form in its place? How to perceive the work if it is embodied in a software?

2. The machine of Moles: Cybernetic and social art

Two diagrams by Abraham A. Moles from Cybernetics and the Work of Art (1965): “III. Amplifier of intelligence or complexity of an algorithm: 1° Artist’s imagination, 2° Idea, 3° Field of possibilities, 4° Algorithm, 5° Integration, 6° Program, 7° Machine, 8° Repertoire of encoded signs, 9° Filter, 10° A priori, 11° Reject, 12° Translation, 13°Consumption ” and “V. Synthesis : 1° Translation, 2° Machine language, 3° Analysis, 4° Temporal laws, 5° Rapid analysis, 6°Messages in machine language, 7° Stores of forms, 8° Iteration, 9° Retranslation, 10° Consumption”.

New Tendencies movement focused on Abraham A. Moles and his theories mostly between 1965 and 1968. His cybernetic posture and his interest in objectifying aesthetic judgment appealed to the Yugoslav movement. His idea of automating art production rebounds to the connections already established by the movement with industrial processes and materials. As Medosch reports via the minutes of a symposium held during the 3rd Zagreb exhibition, by 1965 NT already wanted to extend the notion of art to visual research. The computer's arrival was to provide the means to formalize this search. On the occasion of the 1968 colloquium, Abraham A. Moles announces a revolution of "automation, artificial thinking, and symbiosis with machines". He then asserts that "information is the third fundamental element alongside matter and energy" [25]. Unreservedly, Moles relies on the unification of sciences through cybernetics, in order to deploy his vision of society and culture. Moles direction in thinking directly echoes the theories of Norbert Weiner on communication between man, machine and animal. Medosch points out that according to Moles, "Automation (...) should allow each person at home to enjoy unique artworks designed by the cybernetic creative machinery of human and machine components."

Convinced in his ability to describe mathematically the measure of originality [5], Moles then seeks to statistically reconstruct human perception and aesthetics in his cybernetic model. It is clear that his proposal to orient art towards a cyborg practice raises many problems, particularly that of a computer fetishization. Moreover, even if his theories conclusively lead to a statistic of the image and to a logic of quantification or categorization of its constituents (as signs and supersigns), it is legitimate to ask how and in which way an automatically generated image, could inherit the human, social, material and environmental factors from which it is derived from. Finally, the idea of Moles's cyborg artwork separates the work from its critical reception, which would represent a major contradiction with the positioning of art throughout the twentieth century [6].

3. The drawing in Generative Aesthetics

3.1 Max Bense, for a generative aesthetic

Max Bense is also a theorist who inspired the second phase of the NT movement. Bense is a key player in the emergence of information aesthetics in the 1960s. Like Moles, Bense assumes that it is possible to objectify the aesthetic measure of a certain object. To arrive at this measure, quantities of order and complexity are put in relation to one another, all based on the measurement of information as proposed in the theories of Claude E. Shannon. Even if "Moles was one of the first who predicted machines would soon generate aesthetic objects based on automatic decision making" [2], it was Bense who first proposed the term "generative aesthetics". He conceives with the mathematician Georg Nees - then his PhD student, the world's first computer art exhibition. The exhibition took place in the study gallery of the University of Stuttgart in February 1965.

In a text titled Projects of generative aesthetics [7], edited for the occasion, Bense introduces his concept as follows:

> Generative aesthetics therefore implies a combination of all operations, rules and theorems which can be used deliberately to produce aesthetic states (both distributions and configurations) when applied to a set of material elements. (...) It helps to formulate the principles of a grammatical schema–realizations of an aesthetic structure.

As Frieder Nake points out in a text titled "Information Aesthetics: A heroic experiment":

> The interpretation that we traditionally expect from an aesthetics gets changed into construction. The effort to rigorously define measures in order to evaluate certain characteristics of the work (of art), in the case of the model of Information Aesthetics is shifted to the opposite effort of algorithmically generating such works. Scientific and engineering methods break into the realm of the humanities – a provocation!

In complicity with Georg Nees, Frieder Nake will also continue Max Bense's project. He is foremost a mathematician and will have access to one of the first computers of the University of Stuttgart. He then takes advantage of this situation by programming algorithms to explore aesthetic propositions, hence becoming a pioneering artist of algorithmic art. Thus, Bense's ideas quickly take shape in the production of works (of drawings), which attract the attention of the art realm in Germany and internationally.

Through what will be called the Stuttgart School [8], computer art would eventually surpass the vision of computer as a tool. Thinkers and artists could focus on the computer so as to incorporate the rules and formulas of art [9]. Bense proposed the term "art as a model for art" [10].

3.2 Frieder Nake, from hand to head

Frieder Nake, Hommage à Paul Klee, software: COMPART ER56,
hardware: ZUSE-Graphomat Z64, 40x40 cm, 1965.

Through generative aesthetics, and more particularly with respect to drawing, the work of the artist shifts. According to Nake, moving from the immediacy of the gesture of the hand to the conception of an algorithm transforms the artist into "the mediating specifier of conditions a machine has to obey when it generates a physical line" [11]. As he put it, his part has become "drawing by brain" instead of "drawing by hand". Furthermore, Nake argues that this shift from material to semiotics implies that the artist has removed himself from the immediacy of the material and gained a "higher level of semioticity". In reality, it is not so much a matter of thinking and drawing a line, a single line. It is rather the intellectual gesture of anticipating the drawing of any line. In this way, Nake envisions that creativity then has much more to do with "semiotic situations and processes than material situations and processes".

However, this statement should be nuanced. Indeed, the assertion does not really take into account the material situation with which computer art could develop especially around 1965. The nascent computer equipment that comes to furnish the laboratories of the time is an essential technological environment that should be detailed. We thus plan to problematize the apparent antagonism between a fundamentally semiotic art and the material and industrial reality in which it was constituted.

3.3 The Stuttgart school, technical environment

A computer and a drawing machine in Stuttgart in 1965.

On the occasion of a 2013 CAPC conference in Bordeaux [12], Frieder Nake accompanied his personal account with two photographs of the machines with which he developed his first artistic works in 1963. He is a student in mathematics at the University of Stuttgart and works part-time in the computer center. The first image shows a control console that allows operating standard computer Elektrik Lorenz ER56 at the center. The second presents the plotter with which Nake debuted, a Zuse Graphomat Z64 machine. Before receiving the plotter, the professor in charge of the department asks the young mathematician if he would program the software - which did not exist then, and which would allow the machine to draw. Frieder Nake tells us that it had not yet occurred to him that a computer could draw. “How to draw when your instrument is not made to draw? " he asks us. It is a constitutive moment in his thinking; Nake takes up the challenge and gets to work [13]. He then develops at the extremely low level of the ER56 machine language an overall program to develop simple geometric shapes that could be realized automatically.

Through his writings on the "Computers and Visual Research" period of the New Tendencies movement, Armin Medosch continues the description of this material environment: “The Graphomat could be filled with four different colors made of Indian ink of varying consistencies, some drying up too quickly, others forming drops.” Added to this was that “although the drawing table was described as fully automated by the manufacturer, it actually had to be watched all the time" [14].

What Medosch suggests in his analysis is that, beyond a concept, one should actually look at this emerging artistic form as the result of an entire assembly of human and machine. In addition to embodying a new figure of mathematician-artist who confronts abstract concepts with the production of relevant images, “she or he struggles with the physicality of complex machines that produce unexpected results precisely due to their properties as machines, as real things producing heat, making noises, breaking paper tape, spilling Indian ink [1]. The competence was not only to be able to conceive an algorithm, but also to build an assembly of hardware, software and people to produce something that could be shown as art. One could ask then if it would be possible to give a different perspective to algorithmic thinking when considering the importance of such heteromatic embodiements. Can the technical and material conditions we have described here inspire a particular physical environment conducive to the reflection of generative aesthetics?

3.4 The algorithmic image as a transmissible form

In the field of drawing, approaching the image by the algorithm leads us to verbalize and formalize what is visible. This transposition of the visible into the language and into the universe of calculated procedures enhances the possibility to discuss gestures and a practice. Analyzing a generative artwork is attempting to retrieve an algorithm induced before a precise analysis of the visual work in question [15]. From the point of view of the analysis of early computer art, the 2012 ReCode project by the American Matthew Epler retains our attention. The project embodies an effort in translating images back into programming language. Here is what he writes on his own website:

> The ReCode Project is a community-driven effort to preserve computer art by translating it into a modern programming language (Processing). … The focus of the ReCode Project is three-fold:

1. Bring historic works of computer art back into the public eye.
2. Make it accessible and useable.
3. Save the code. (Epler, 2013)

However we can see today that the work on the platform is discontinued. On the German side, Frieder Nake, adds a remarkable critical analysis of the relationship between code and aesthetic form. He also proposes a "re-coding" approach. But unlike Epler, his discourse on the re-coding of existing works focuses more on the effort of interpreting than of translating them. At the center of his teaching of algorithmic art, Nake offers the experience of algorithmic thinking, a concept that should be elsewhere examined.
If the activity of coding or recoding a work constitutes a rich perspective in the field of aesthetic production or that of artistic education, how to approach a work with an inexperienced public in the realm of computer programming? Can algorithmic language operate intuitively in the field of drawing? Moreover, how to incorporate in this type of artistic education that, which goes beyond the computational framework: the relationships which cross a group of individuals in the process of learning, or the verbalization of their experience in a relationship with the machine? The project Generic Images is an attempt to provide some answers to these questions.

4. Generic Images

4.1 From "generic" to generative

> The work is a software. It is a software that learns. It also has a cogito. It has no voice, but it thinks by drawing. It is a graphic machine. From the visual memory that founds it, it presents graphics of individuals engaged with algorithms and who live in a world that is transformed with technology. The software returns us an image. Sufficiently different from our world so that we can look at it differently and close enough so that we can live in it. Without fatigue, the drawings evolve, they multiply, they vary, they transform and they generate new figures according to learning procedures. The drawings offer generic representations, but these representations become singular at each step while the program progresses over time.
>
> Extract from a presentation note of the Generic Images project, 2017.

Generic Images is a creative software project based on an open workshop for algorithmic practice in the context of art education. The procedural drawing software that is presented here serves as an experiment for creating graphical and generative content from a participatory process. The software and the drawing process are both created during different stages of the workshop.

In this work, we want to reflect generative aesthetics and the vision of computer as "universal image generator" [16]. A notion of the generic in art is also developed. A notion that the poet and artist Franck Leibovici describes as follows: "the characteristic of a generic is to serve as a template for receiving other questions. it is therefore left to future users to adapt this generic to their particular problem "[17]. Thus the generic term in our case has a double meaning, that of a structure capable of being modified according to situations of use on one hand and on the other that of a generative dynamic which delimits a visual repertoire and explores at the same time a space of possibilities.

This project was set in different phases. The first phase involved the design and development of the Generic Images software (**./i**), which responds to a scenario of generative images capable of representing relationships between individuals and digital interfaces. The second phase involved a high school class, offering them a workshop with sessions on hand drawing, algorithms, manipulation of generative procedures, and materialization of these new drawings by a pen plotter. The third phase is the maintenance and documentation of the software. The project resulted in an exhibition, with the results from the workshop as well as an installation that includes elements from different phases of the project.

4.2 Diagram

Gaëtan Robillard, Generic Images, diagram, 2017.

Schema, diagram, sketch, piece of penciled tablecloth... Are they not the place of a common language in which thought is spatialised and displayed ? Isn't it happening like the instantaneous mediation of a stroke, whether it is about giving a visual form to a theoretical system or thinking about an artistic device [18]?

If the diagram is the matrix drawing of a situation of experience (David Zerbib, 2018), the figure presented above, which is elaborated prior to the project enabled the organization of thought. The following three parts are connected:

1. Index: graphic shapes, hand drawings, or transformations of these drawings. The index can be related to the notion of repertoire found in generative aesthetics.

2. Generate: new visual propositions from the distribution of elements from the index. Most of these spatial operations use random calculation. The generativity of the software is similar to the distribution of probabilities in the field of generative aesthetics.

3. To learn: a language allowing to describe algorithmic operations (instruction, assembly, loop ...), but also - saving visual results.

The notion of learning intersects here at least two things. Integrated as a function in the software - even symbolically, it problematizes the translation of an artistic gesture into a formal language - an algorithmic one or a program. The question that arises then is: what does formal and natural language have in common ? On another note, the notion of learning confronts machine learning methods often present in our contemporary technological world (genetic algorithms, deep learning, artificial intelligence, ...). As the epistemologist Giuseppe Longo points out, if in mathematics some researchers are worried about the way in which artificial intelligence technology comes to hide the most fundamental aspects of scientific theories [19], we in this project, initiated a critique on the relation of art to this same technology. We will now look at how artistic intuition and algorithmic writing work together.

4.3 Software

Principle

The software ***./i*** was designed and developed with the help of a team of engineering students from the IMAC(3#) program at University of Paris-Est Marne-la-Vallée. It is embedded in a pedagogical program of tutored projects within the curriculum. The Generic Images project was therefore a teamwork with several steps such as open workshops during which other students, teachers, artists and outsiders - were invited. This open work process emphasizes a participative principle involving users whose feedback validates the outcome of the algorithms. From the research point of view, succession of human choices dictates the design of the software, which makes the software a machine to produce knowledge [20]. As Eglantine Schmitt points out in a 2016 article, "if the functioning of a program enjoys a certain autonomy, its conception and its implementation consist of a succession of moments of choice in a space of possibilities that leaves the capacity of human action at the heart of the process ". It is precisely this space of possibilities that we have striven to produce.

Collective experiments with ***./i*** *in the situation of a class, Paris, 2018.*

Elements of language and visual elements

In order to establish an interaction between a large audience and the creation of algorithmic or generative visual procedures, we wanted to allow everyone to develop elementary semantic assemblies. Regarding the functions, the terms used are extracted from a lexical field of transformations or spatial distributions: translate, rotate, chain, scatter, ladder... For each of these terms, we have developed an algorithm that acts on a set of visual elements from a chosen vector drawing. In some cases and particularly effectively, algorithms such as "rotating" and "translating" use a random calculation that quantifies the transformation or distribution of elements from the drawing. On the other hand, we have chosen to categorize two distinct visual elements: shapes and paths. The shapes are given by a sequence of Béziers points connected to each other, and capable of forming any figure. The shape can be open or closed and the number of points is unlimited. The paths are the smallest visual element included in a vector drawing: a pair of dots delimiting a single segment that can be curved or not. Thus one determines two sets, that of the transformations / distributions, and that of the visual elements which can be targeted by these transformations (shapes or paths). The user is then offered to combine two elements so as to link the two sets, for example: "reordering the forms". By convention we chose to name this combination an instruction. The user can then compose several instructions and thus define an assembly.

Two indexing functions make it possible to produce two different tables from "shapes" and "paths" contained in one drawing. Thanks to these analysis functions, we can visually list the components from any drawing in vector format. These components are understood as elements in a repertory.

We are aware of a digital infrastructure that is global. Therefore we aimed for connectivity: an export function is integrated in the software. It allows the user to save a vector image from the assembly operations at any point in the loop. This export saves a file in SVG format which can be reintegrated into the general file index of the software.

We do not confuse ***./i*** with a programming environment. We preferred to propose a method of continuity from hand drawings to generative transformation and to distribution of signs that constitute them. The interface is light and offers a list of moderate number of possible actions.

4.4 "What drawings & what future for the code?" (#2)

Series of posters, part of the final presentation of the workshop with a high school class, Lycée Colbert Paris, 2018.

How to transmit algorithmic art? Is a generative image an image to which a gesture has been transmitted? The project aimed to move drawing gestures in a software environment in order to question the role of the algorithms in artistic creation. During our experiments, we addressed high school students. At first, we offered them a drawing session. Students would draw their neighbors at the table; then they would move in space and draw again by observing each other. We then listed together a specific vocabulary that could describe the drawings they had produced. We focused on developing an ability to name specific plastic components. To put a drawing into words - and to voice an artistic gesture with these words, necessarily induces a passage between an instruction and the interpretation of this instruction. But comparing an instruction, which passes from one individual to another with one which passes to a machine is indeed necessary for discovering the field of algorithmic art. Inspired by Charles Sanders Pierce's theory of signs, Frieder Nake stresses that human beings interpret in the greatest diversity all that is presented to them, while the machine can interpret (calculate) a sign in only one and unique way. Therefore natural language and its implication became a large part of our work in class. After verbalizing various drawings and visual characters, we vectorized the hand drawings, and we created instructions and assemblies with the software ***./i***. We would then modify the directory of drawings and the indexes of lines (shapes or paths).

Visual materials produced through various workshops were collected. Thus the image directory, which constitutes the memory of the program increases in size. The first images represent human figures, learning situations, human-machine relationships. Gradually the images evolve into a registry of structures (grids, point clouds, chains, ...). The pedagogical project, which is made of several stages (draw, index, code, generate, draw, show) allows everyone to see the entirety of a creative process, with its know-how, its fortune and its accidents. This process was ongoing until the final presentation of the completed work.

4.5 A plotter in the work environment

In order to echo the technical and material specifics of the genesis of algorithmic art, we have integrated into our work environment and software deployment a light pen plotter of the type Makeblock XY-Plotter Robot Kit V2.0. Once the form and path elements were indexed and redistributed generatively by the users, we suggested that they choose the results that pleased them the most, so that we could have the images drawn with black pen on paper. We argue that it is the experience of moving from the hand gesture to an algorithmic expression that promotes an intuitive understanding of the computer as a "Universal Image Generator". The experience is completed when drawing materializes anew. We defend that when compared to the computer screen, the plotter enriches the construction of artistic sense. The triangulation between intuitive gesture, generative algorithm and mechanical realization then supposes such an environment of creation and transmission as a global chain. In our case, these three parts are indissociable from each other. We come forward with this model because it enhances awareness in the field of generative aesthetics.

Generic Images, workshop views, 2018.

4.6 Questions to students

In such an educational environment, how is the relationship between art and program perceived? What happens to artistic creation and the image if a program deals with the random distribution of visual elements? These questions are embedded in the discussion around the generative aesthetics of the 60s and 70s. The reception of computer generated aesthetics is still often accompanied by a debate on the place of the artist. We also wished to introduce this debate to the students of the class. We asked twelve of them the three following questions:

1. Do you think a program can do art for you?

2. What would be the conditions for this?

3. What would you ask it to do?

In the absence of a complete analysis of the given answers, we can still note three types of recurrent responses. The first type refers to the notion of freedom. The reasoning is then: the program follows instructions, it is not free and so it cannot do art. The condition for a program to be able to create would then be that it has a free will. The second type of response summons the intention as a priori to the creation of an artistic form. Finally, the third type of response is between nature and tools: the technological tool is an intermediary that separates us from a type of artistic production called "natural". It is interesting to note that some answers bring out the term artificial intelligence. Other answers could also be mentioned here. But above all, we want to retain their great diversity. Overall, the questions allowed the students to become aware of the place of the human and his relation to the machine through a process of artistic creation.

4.7 Conclusion on the experiment

The Generic Images project has evolved in various stages of the work and in a variety of organizational modes. It is a project that has been supported by educational institutes such as University of Paris-Est Marne-la-Vallée and Colbert Lycée in Paris. Its first outcomes were presented at the “36hours of research in art, in Paris” [23]. Ultimately the core of the project is based on the development of the software ***./i*** that we have thought as a succession of moments of human choice concerted in a space of possibilities. Generic Images takes the form of a C ++ / OpenGL application that must be compiled for use. Currently, the installation only works on UNIX systems (MacOS, Linux, etc.), which is an important restriction when considering experimenting in new contexts. We retain that the interface we propose allows a relatively intuitive handling and no specific programming knowledge is required for interacting with this computer environment. The counterpart is that the algorithm is only perceived in a symbolic way. Moreover, we defend a global approach that certainly considers software as an artistic agent in an algorithmic environment. But this global approach must also consider spatial, material and human environment in which the software takes place. The graphic and semantic chain from hand to algorithmic thinking is at the center of our project. The posture is also to consider the software as an open structure that is as much a potential place for artistic production as of visual research.

We have seen that the proposed system leads to questions on the relationship between manual and intellectual gesture, but also between thought and algorithmic calculation. We believe that today the wakening to the importance of such questions is necessary and that it goes beyond the framework of artistic education. The heteromation analyzed by Hamid Ekbia and Bonnie Nardi in 2017, which divides the work between humans and machines by means of algorithms, poses an economic, social and political problem. Just as artificial intelligence can be perceived as an "epistemological revolution" [24], the importance of illuminating relationships between human cognition and machine calculation must be considered. Focusing on the artistic creation to reflect the social activity of an era also allows a critical experience in a complex maze of individuals and algorithms.

From the point of view of visual creation, many new sets of drawings were produced. Succeeding, the Generic Images project has been transposed into a new program and installation project titled Logical Drawings.

5. Logical Drawings

Gaëtan Robillard, Logical Drawings (detail), plexiglass with laser engraving,
5” LCD screens, raspberry computers with program, coloured paper, 2018.

Among the questions we raised, we wondered about the possibility of teaching a drawing to a program. If it is obvious to digitize an image, what is it to conceive a generative program that would explore a given element of representation? What about gesture and writing? Moreover the artistic challenge in a program of generative images does not rest only on the software domain. To apprehend forms and produce meaning, it is necessary to conceive the material space in which the program takes place. That's why we'll talk about the installation. How can one perceive the variation of the drawing? How to perceive the generativity and calculation of the program? How to propose a critical articulation between cognition and machine learning?

Logical Drawings, various visual outputs, 2018.

The work Logical Drawings conceived by Gaëtan Robillard attempts to pursue these questions both in terms of writing a new generative program and by designing a space that integrates and displays the program. Responses the high school students gave to the questionnaire mentioned above offer a discursive counterpoint to the presentation of the dynamic images. The installation is variable in size. Plexiglass holders that carry screen and microcomputer systems can be shown suspended in the middle of an exhibition space, or hung on the wall. Colorful backgrounds are used to differentiate each of the programs, which adapt according to a repertoire of predetermined drawings. The colors are consciously chosen referring to edutainment aesthetic. The programs are differentiated according to a nomenclature M1, M2, M3, M4, ... For each of them, a series of parameters are varied such as the definition of the subdivision of a line into segments, or the minimum distance between two points so that a line is actually drawn on the screen.

The program adopts a logic inspired by genetic algorithms: from an initial situation and through a process of crossing and mutating values, we explore a space of possibilities. A set of vector drawing files make up the base directory. The program selects a file and draws a line by following coordinate points (X, Y) extracted from the lines recorded in this file. With each new iteration, a crossing function randomly exchanges coordinates between the set of points established, either between X1 and X2, or Y1 and Y2, or between X and Y. A second function - of mutation, modifies the value X or Y by adding a positive or negative value fixed at the beginning. After a certain time, the drawing is saved and the original file is replaced. Finally, a next file is called and the program draws and then executes again the two functions described above. So on and so forth. The number of source files is infinite. After having drawn and modified the elements of the last file of the list, the program returns to the first file. Thus all the files are progressively modified by the program. According to a preset time cycle, the program randomly chooses a file that has been successively modified over time and replaces it with the original source file.

As a whole, the installation presents us with a multitude of drawings that change over time. The initial drawings describe situations of transmission. As an environment, it proposes a transaction of meaning between program, image and language. The verbal responses of the students in formation counterpoint the programmed image. The divergent opinions represented by these texts sometime oppose to the logic of the program. We hope that this juxtaposition forms the critical character of the installation which enhances public awareness on learning and creating in the "heteromatic" society.

Conclusion

Through this article, we sought to question the creation of generative and critical environments in relation to the educational context.

To this end we proposed an incursion into the genesis of algorithmic art not only to derive a theory of generative image but also to understand the social and reformist vision present in the New

Tendencies movement. Abraham A. Moles and Max Bense contemporaries of each other, and both involved in information theory have in common the discussion of an objective aesthetic measure which relates order and complexity. But their proposals also differ. Max Bense, who is interested in poetry and exhibits works in the university, offers a constructive approach. The generative aesthetics that emerges in Stuttgart is thought to produce aesthetic statements from rules and theorems calculated in a program. Through Bense's manifesto the scientific method possibly breaks into the humanities. Mathematicians and artists like Frieder Nake develop an algorithmic and visual production that responds to this vision of “art as a model for art.” According to him, thinking a form drawn by the algorithm moves the artist's attention from the manual gesture to a conceptual gesture. In doing so the artist is extricated from the material immediacy of the work and gains a higher level of semioticity. However, this shift towards semiotics does not reflect the material reality in which this thought emerges. Mainframe computers were not designed to produce aesthetic forms. In 1963, the University of Stuttgart receives one of the first plotters. Frieder Nake, as a young mathematician who is asked to program a pilot, then considers the computer as a drawing machine. It is in this scientific and technical environment that he begins his artistic career. One should not be mistaken about the seemingly automatic character of such an environment. We learn in Medosch's analysis that far from working alone, the plotter then requires constant monitoring. Its physicality must be understood as the assembly of hardware, software and people in which the practice of algorithmic art is forged. Besides characterization of this historic environment, we studied a current tendency in the analysis of the pioneering works created using a program, called the “re-coding”. We then asked ourselves the question of whether the mastery of a programming language was essential for transmitting these artistic forms. In order to answer this question we looked at the practical implementation of transmission of algorithmic art: the project Generic Images.

The Generic Images project is a software creation project that explores different dimensions of generative aesthetics. We presented and defended the way the software has been designed, placing human capacity for action at the heart of the process. We also wanted to stand back from an existing model for the transmission of art and algorithmic thought. We believe that it is necessary to form a triangular relation between intuitive gesture, generative algorithm and material realization. This model then requires a certain creation and transmission environment. It is seen as a global chain where each part must be linked to the other two through an experience. To try to characterize this experience, we must focus on the notions of gesture, verbalization, instruction, assemblage and looping. As we have seen, the attempt to create art with algorithms generates a debate. This debate which is also related to the developments in artificial intelligence is not new. It has therefore been necessary to open a critical space within this project. On the other hand, the concept of "heteromation", which we have discussed, gives a new perspective on the labor society that now consists of algorithms. We then proposed that the project Generic Images becomes part of an expanded reflection on the relationships between image, human cognition and computability.

Finally, we presented Gaëtan Robillard's installation Dessins Logiques, which stems from the thoughts initiated by the Generic Images project. The installation is a generative environment and carries an edutainmental tone. It distributes signs repertories ranging from speech, generative image to space. It is not only about offering a programming experience with the help of a partially genetic algorithm - which explores a space by mutation and crossover without being selective, but also about producing discursiveness on this same space. Thus we want to introduce a disruption between creation and automated learning.

If we come back to the constructivism of Jean Piaget and his contemporary reading by the philosopher Patrice Maniglier, we can assert that learning is a true construction of oneself (the very structures of functioning of the mind). Maniglier informs us that such integration of change in a structure reflects on the connectionist models of neural networks[22].

In his text "Calculating Cultures" dated 2007, the philosopher confronts the symbolic approach of generativism with connectionism while seeking a filiation in structuralism. Beyond comparing which model would be most capable of variation, the philosopher proposes an archeology of artificial intelligence and returns to semiology: "a science which studies the life of the signs within social life "(Saussure, 1972). One can wonder how in a future stage of research we could echo such an archeological approach by addressing it from the point of view of creation and transmission.

Notes

(#1) The term "Heteromatic" is derived from "Heteromation", a concept defined by Ekbia and Nadi as a shift from technologies of automation that disallow human intervention to technologies that call for heterogeneous actors (humans and algorithms). Ekbia and Nadi point out that in the context of artificial intelligence and the asymetric relation between firms and workers, heteromated systems alter social relations by fashioning humans as computational components. This raises remarkable social, economic and ethical questions. Heteromated systems include video games, social media, certain crowdsourced applications, system of microwork such as Mechanical Turk, personal health records, devices that require intermediation for some users (such as cell phones)...

(#2) Translated from the French title that was given to the workshop with high school students of Lycée Colbert - Paris : "Quel dess(e)ins pour le code?".

(#3) Image Multimedia Audiovisuel Communication – Engineer training dedicated to art and science field. IMAC is a part of ESIPE in University Paris-Est Marne-la-Vallée

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TITLE
Multimodal Architecture of the Ode to Christus Hypercubus

Topic: Music

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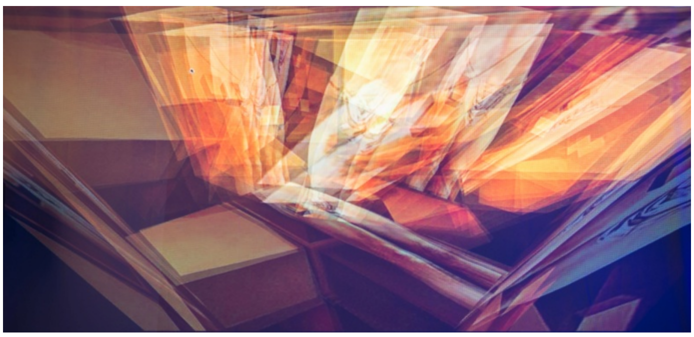
Abstract
The article introduces a creative process aided by computer involving music, images, and poetry. The Ode to Salvador Dalí's Christus Hypercubus reported here is a multimodal performance fulfills the sound space with alliterations of sacred music. It consists of images and music that interacts with live musicians and a virtual choir in real time. A diffused acoustic field generated with fragments of sacred music invites the audience to rediscover and recreate meanings for the Catalan's masterpiece. The computer system orchestrates 16 compositions in miniatures called "stanzas of the Ode". The poem "Caminho da Espera" written by the author provides lyrics for excerpts from three sacred works: "Ave Maris Stella" by Perotin (1200-1225), European composer who is believed to be French, "Benedictus" by Portuguese composer Frei Manuel Cardoso (1566-1650) and "Sepulto Domino" by the Brazilian composer Father José Maurício Nunes Garcia (1767-1830). The Ode reconstructs the Medieval Organum as a metaphor of an imaginary echo that still has persisted in the walls of Cathedrals. A constant musical drone accentuates resonances in which memory is expanded into fragmented chants that still linger on the walls and in the arches. The article also elucidates how the development of an interactive real-time animation using seven cropped fragments of Dali's Christus. The idea is to simulate fourth-dimensional hypercubus using the audio signal to produce 3D transformations. The program extracts pitch and intensity from the audio signal and animates the four cubes in real-time iteratively. Therefore images are generated along the sounds in real time see the visual result in the images below. Finally, using interactive techniques derived from computer-aided real-time composition the Ode attempts to explore human cognition and understand how creativity operates in a multimodal environment. Multimodal generative installations can be seen as a way to create a unified experience where sound, image, and audience are merged in space and evolve coherently in time; to explore both implicit and explicit cues in their individual and collective interaction; to boost interaction with audio-visuals generated during the man-machine interaction, as discussed in [1]. A video synopsis of the Ode can be found in: https://youtu.be/Ks3X8OTZkMs



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Key words: multimodal, Salvador Dali, Music, Visual Arts

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Multimodal Architecture of the Ode to Christus Hypercubus

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Abstract

The article discusses the creative process of a multimodal performance titled as an Ode to Salvador Dalí's Christus Hypercubus. It is a composition and performance aided by computer involving music, poetry, and images. The performance of the Ode intends to immerse the audience in an imaginary Cathedral and invite them to rediscover and recreate meanings for the Catalan's masterpiece. The article introduces theoretical viewpoints, elucidates the compositional process and finally describes how the computer system controls the performance in real time.

1. Introduction

The creative process described here is anchored on an interdisciplinary research in Art and Science that was already introduced in previous articles [1][2]. They discussed how multimodal generative installations could be seen as a laboratory to develop computer systems for aiding generative composition and to control multimodal performances. Another starting point was to imagine a multimodal architecture inspired by a sound metaphor associated with the reverberating architecture of Cathedrals. Imaginary walls were built with sound and images to invite the audience to immerse in time and space and construct new meanings for the Salvador Dali's masterpiece Crucifixion (Corpus Hypercubus) (1954) with their own senses.

The theoretical perspective presented here starts upon Salvador Dalí's Mystical Manifesto (1951) [3] followed by a decade-long interaction between Dalí and the mathematician Tomas Banchoff [4]. The compositional and performance environment combines algorithmic techniques such as Markov chains [5], granular processing of pre-recorded and live sounds [6] and an application of an ambisonics diffusion system to simulate a Cathedral reverberant environment in real time [7]. The first section discusses the integration of viewpoints and the conception of the multimodal architecture. Next section elucidates the composition process that is based on collages of sacred music and images, and the third section describes the computer-aided performance environment.

2. Integration of View Points

The composition described here was inspired by Dalí's masterpiece starting upon two observations: what would it be like to represent in music the sensation of observing such a transcend painting? What would it be like to integrate visual and sonic languages in a multimodal performance in order to recreate the dialogue between Art and Science that Dali developed throughout his artistic career? To combine these motives in a single artwork, I decided to include many musical voices. I have applied collage techniques to recreate the atmosphere of sacred music in line with generative stochastic processes to generate an electroacoustic part and an interactive animation.

2.1 Dali's Mystical Manifesto

Dalí wrote the Mystical Manifesto [3] in 1951, but only in 1954, his mystical concept was fully realized. That new artwork followed also a path of interaction with concepts from modern Science. He painted the fourth dimension using a Tesseract or Hypercube anchored in an unfolded four-dimensional cube in Crucifixion (Corpus Hypercubus), lately named as Christus Hypercubus (see figure 1). Salvador Dalí dialogued with Theoretical Physics concepts for many years and some of his remarkable paints were guided by 20th-century theories. He expressed a dialogue with the Theory of Relativity in his paint "La persistència de la memòria" (1931), in Dali's words:

> [...] ever since the theory of relativity substituted the substratum of the universe for the ether, thus dethroning and reducing time to its relative role, which Heraclitus already assigned it when he said that "time is a child", and Dalí too when he painted his famous "soft watches" ([3] pg. 365).

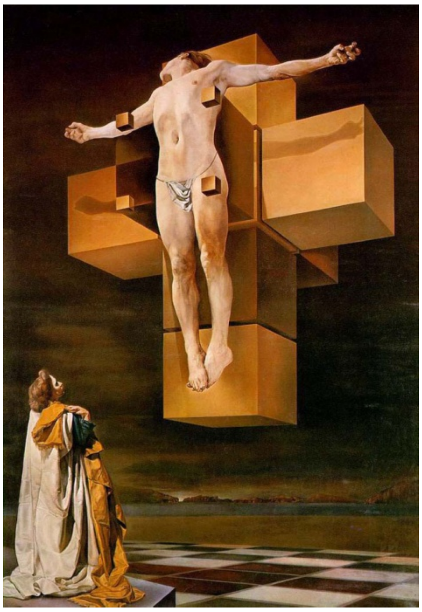


Figure 1: Dali's Crucifixion (Corpus Hypercubus) (1954).

Although until his death in 1989, Dalí had explored concepts from Theoretical Physics, it could also be understood as the result of years of interaction with the mathematician Thomas Banchoff of Brown University. Recently, in 2014 Banchoff revealed their collaboration and Dalí's connection with 20th-century theories such us Relativity and the fourth dimension [4]:

> Dalí painted the masterpiece, "Corpus Hypercubus" [...] It is rated as one of his most popular and recognizable paintings, right after the Melted Clocks. While the deformed clocks are often considered statements about space-time, "The Crucifixion", as it was originally called, makes a statement about four-dimensional space and soon it became known by its geometric name ([4] pg. 2).

Given Dali's point of view when painted the Hypercubus Christus, my intention was to recreate Dali's statement about four-dimensional space and his dialogue with concepts from Theoretical Physics in a multimodal performance. The creative process aimed to represent all these elements and, therefore, I opted for a creative metaphor in which an imaginary sound navigates the walls of a Cathedral. That sound generates also a digital painting in real time obtained through the application of geometric transformations on eight cropped fragments of the Dali's Christus. The resulting new animated images are projected during the performance such as stained glasses of the imaginary Cathedral (vide figures 4, 5, 6).

2.2 Multimodal Architecture

This article presents also a research on implementation of computational resources for controlling immersive digital processes and to develop computer systems for aiding generative composition and multimodal performances. This study aims to create a unified experience where the performers and the audience are immersed in space while the performance evolves coherent in time [1][2].

The application of multi-modal sensing and effector systems can boost interaction and assist the understanding of the data flow generated during man-machine interplay [8]. We argued that new interactive music technology could function as a laboratory to evaluate man-machine interplay behavior [1]. Ada: intelligent space (2002) is also a good example of an installation where visitors had interacted with generative multimodal information performing a soundscape composition based on synthetic emotions [9].

Integrating these previous studies, the architecture of the Ode attempts to explore human cognition and understand how creativity operates in a multimodal performance. Although in the creative process of the Ode there are composition techniques derived from probability and stochastic process that are described in the next section.

3. Composition of the Ode

Starting upon the multimodal architecture, my intention was to recreate the sensation of a Cathedral in which ancient chants were still reverberating in the walls. Thus, the compositional process recreated a sound environment in which excerpts of ancient music are performed to the listeners. I have decided to work with collages and I rewrote small stretches of sacred music and after integrated them with lyrics of two poems of mine. However, even that the small passages are previously written, the order and the moment they are played during the performed is indeterminate. To concatenate the sequence of the excerpts and indicate when to perform them, I have developed a computer program to integrate the performance and generate video animation in real time (see section 4).

3.1 Collage of Music and Text

The poem "Caminho da Espera" (Path of Waiting) (see Table 1) provided most of the lyrics for excerpts extracted from three sacred works: "Ave Maris Stella" by Perotin (1200-1225), European composer who is believed to be French, "Benedictus" by the Portuguese composer Frei Manuel Cardoso (1566-1650) and "Sepulto Domino" by the Brazilian composer Father José Maurício Nunes Garcia (1767-1830). The excerpts were fragmented to build melodic and harmonic collages and later to assign new lyrics. Each small composition, with duration around one minute, were denominated "Stanzas of the Ode" and were sixteen in total (see figures 2, 3).

All sixteen stanzas were adjusted around Liturgical Modes. Subsequently, the computer integration in real time produces a multimodal polyphony by superposing fragments with the different Modes. Further, the application of Markov Chain [5] to concatenate the stanzas results in a continuum of sound layers that are processed by Granular Synthesis [6].

With these sound processing applied in real time, an electroacoustic part accentuates resonances to resemble that chants are still lingered on the walls and in the arches of the Cathedral. The stanzas are recombined and superimposed in real time using the granular synthesis technique and each new performance produces unique sound textures. They are used in the composition to reconstruct the Medieval Organum that is a kind of vocal polyphony composed by preexisting liturgical chant [10].

Caminho da Espera

somente o vazio sobre mim da mesma maneira quando percorri distâncias para te encontrar. somente estou lá na saída e já transito da entrada para ela. somente com o espaço sobre mim é que posso cruzá- lo. somente aqui é que nunca estou mas sempre lá.	only the emptiness over me the same way as when I travelled distances to meet you. only here by the exit I am and already transit from the entrance to it. only with the space over me can I cross it. only here where I never am but always there. .	somente ao longo do caminho deixa-me próximo e distante a tua espera. somente há espaços quando sinto que neles habito. somente agora entendi que sempre estavas lá. somente sei do teu olhar sempre olhas para mim são há como fugir da tua presença.	only along the way leaves me close and distant waiting for you. only there are spaces when I feel that in them you reside. only now do I understand that you always had been there. only do I know from your gaze that always looks at me there is no way to escape from your presence.

Table 1: The poem "Caminho da Espera" (Path of Waiting) provided most of the lyrics for excerpts extracted from the three sacred works.

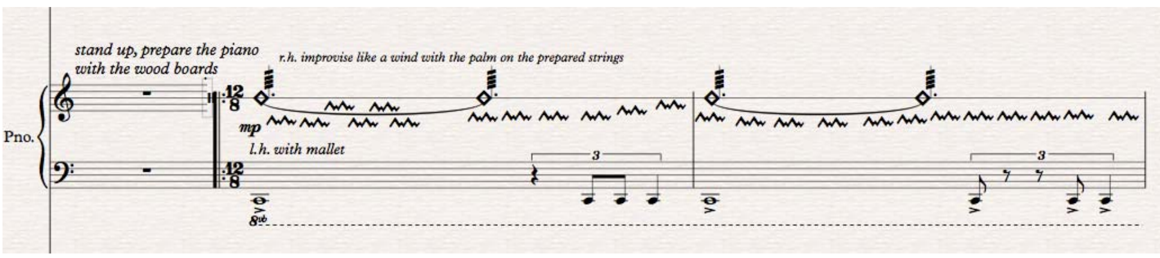


Figure 2: Musical excerpt of the piano part of the Ode.

Figure 3: Excerpts of the voice part of the XIV stanza of the Ode.

3.2 Animated Visual Collages

The Ode integrates images and sounds, the process for generating visual collages is briefly described here. Using the Pure Data GEM library [11], an interactive real-time animation was developed using cropped fragments of Dali's Christus. I have developed a computer-assisted generative method based on the extraction of spectral information from the audio to control the visual collages of the piece.

Geometric transformations produce complex textures that are obtained by the iterative superimposition and dilatation of two pair of connected cubes displayed in the graphics interface. The idea is to manipulate fourth-dimensional hypercubus resemble stained glasses of the imaginary Cathedral. Using the Pure Data primitive *fiddle~,* the pitch is extracted from the audio as MIDI note values [0 … 128] and sound intensity [0…100]. Therefore, the computer program detects and extracts these two audio features and iteratively transforms the pairs of connected cubes.

Every time the computer detects a new note, a new image from a set of the eight-cropped fragments, is assigned. The translation and dilatation produced by the sound interaction reproduce new images generating complex visual variations in the graphic projection. The next images (figures 4, 5, 6) present three different moments of the animated visual collages. The images were produced with photos taken by Nato Manzolli using a long exposure in order to extend the persistence of time in the views of the animated collage.

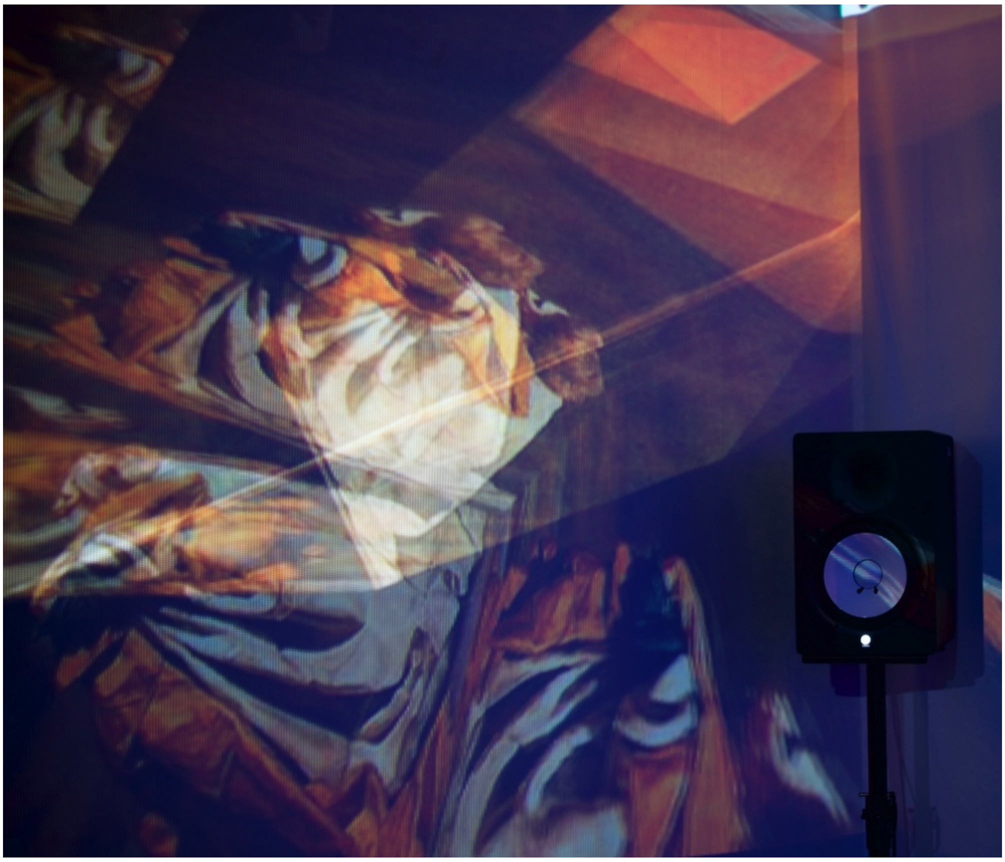


Figure 4: Photo of the animated collage generated during the performance of the Ode.

Figure 5: Photo of the animated collage generated during the performance of the Ode.

Figure 6: Photo of the animated collage generated during the performance of the Ode.

4. Performance within an Imaginary Cathedral

A program was developed to concatenate and granulate the sixteen stanzas, and control sound diffusion in real time (see performance diagram in figure 7). To order the sequence of the stanzas and indicate when to perform each one, a Markov chain procedure [5] was applied to control their sequence and a negative exponential distribution [12] to control the time between two consecutive stanzas. The performers choose freely to perform or not a stanza indicated by the computer, the number of repetitions is given in the score and every stanza ends with a fermata. The indeterminacy to start the next stanza follows four rules, indicated to the interpreters:

I – perform a stanza only once;
II - the greater the number of reiterations, the greater the silence to start next stanza;
III – do not perform two consecutive stanzas with maximum reiteration;
IV - start the next stanza after listening to the silence.

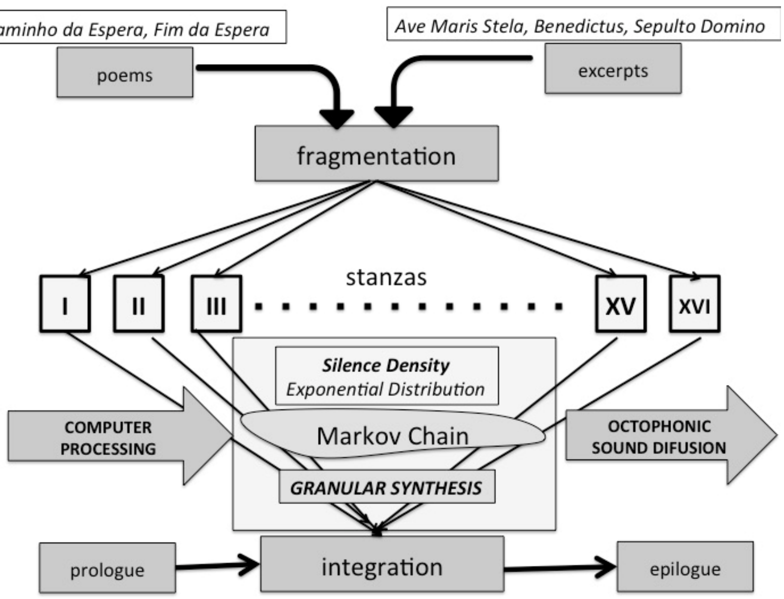


Figure 7: Diagram of the Ode performance. The poem and music excerpts (above), the integration of the stanzas using the Exponential Distribution and Markov Chain (below).

A notion of four-dimensional sound space was built with an electroacoustic diffusion system controlled by the computer (see figure 8). A set of speakers is distributed throughout the installation inviting the listener to immerse into multiple sound layers or dimensions. A "hypercubic sound space" is conceived within the quadriphonic or octophonic sound diffusion controlled by an ambisonics system [7].

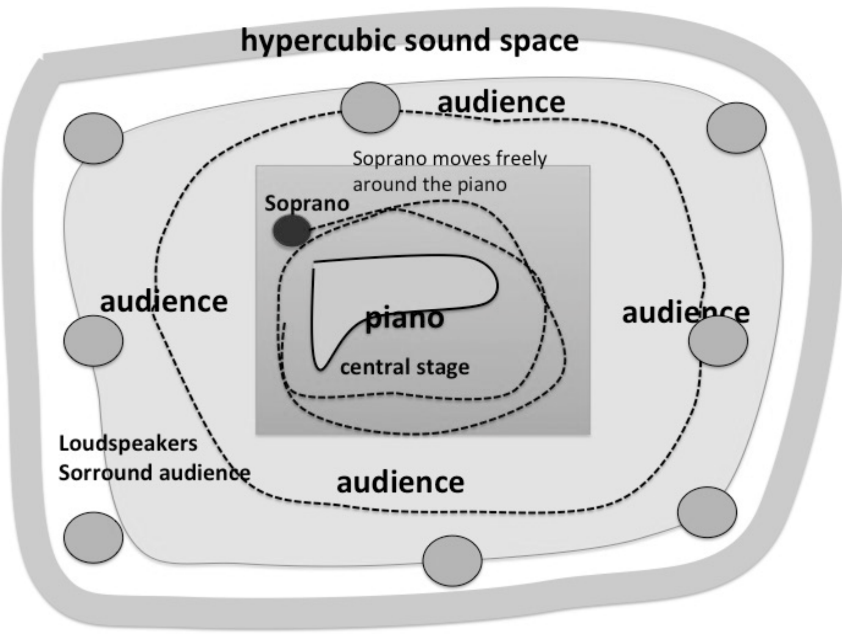
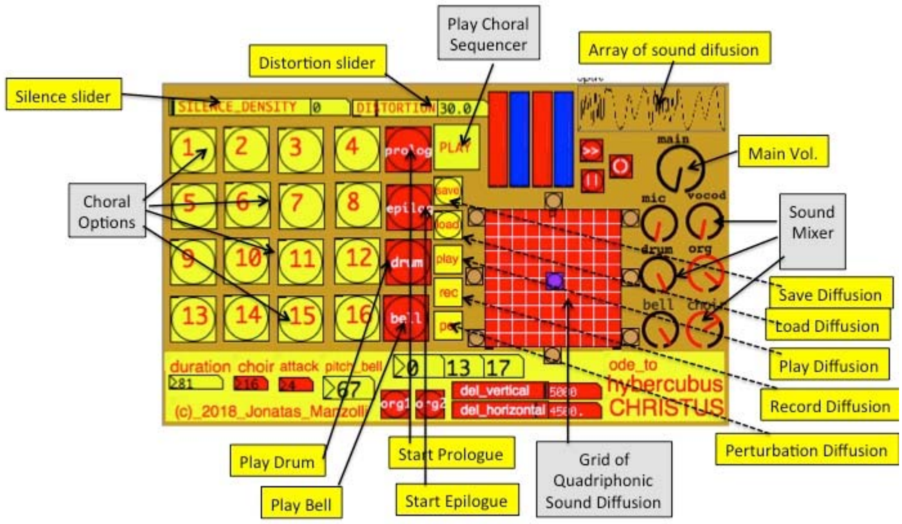


Figure 8: Diagram of the hypercubic sound space with the electroacoustic diffusion surrounding the public.

In order to integrate all composition aspects in real time, a computer program was developed in Pure Data [11]. Figure 9 shows the GUI and highlights the main control parameters: 1) the slider "silence" [0...100] controls the average of waiting time and it is adjusted during rehearsal. At zero level, the sound stream is quite not interrupted while at the 100 level, the flow of sounds becomes very rarefied.



Diffusion: sonic path in a quadriphonic diffusion systems

Figure 9: GUI of the main program implemented in Pure Data. The sliders for the values of silence density, for distortion, the diffusion Grid and buttons for triggering the sixteen stanzas are showed.

The use of the computer-assisted performance provides a wide field for performing the Ode. Those possibilities vary from a performance in a concert hall with musicians interacting only in the acoustic domain until a multimodal assembly in which stanzas are integrated by performers and the audience.

Figure 10: A photo of a performance of the Ode in an electronic studio where it is possible to visualize the man-machine interaction and the real-time animation generated by the computer.

5. Conclusion

The research developed around the composition of the Ode is anchored in a series of artworks described as interactive narratives and supported by digital music instruments, virtual soundscapes and synthetic visualization [1, 2, 8]. It is a study on how virtual spaces, augmented with interactive soundscapes, digitally generated sounds and animations, and interactive video contribute to the understanding of creativity.

The architecture of Ode to Christus Hypercubus integrates music, poetry, and video in a multimodal performance that refers to an imaginary Cathedral. The use of collages from excerpts of sacred music and fragments of the Dalí's Christus produces an environment for the audience to build new relationships with the Catalan's masterpiece. The computational control during the performance allows all the elements of the work to be reconnected and that each performance of the piece is unique.

The multimodal architecture promotes an audio-visual dialogue between performers as well as performers and audience through real-time visualization of events and the sound projection. By developing a computer-based technology for audio-visual interaction and support for storage, analysing and controlling multimodal data, the composition of the Ode advances tools for the performance of contemporary music and interactive installations. The Ode to Christus Hypercubus integrates sound resonances and images to reflect how new knowledge is created through the Art and Science dialogue. The result is a new artwork where the audience is invited to explore multimodal dimensions resignifying their own aesthetic experience.

ACKNOWLEDGMENT

I thank the first ArteFacTo International Conference for the invitation to premiere the Ode to Christus Hypercubus and Marcos Mucheroni for the inspiration to create the piece. The world premiere of the Ode was only possible thanks to high-stand interpreters from the University of Aveiro, Portugal: the pianist Helena Marino, the Soprano Ana Beatriz Maia, the conductor Aoife Hiney and the Vozes Nuas Choir. Nato Manzolli created a photo essay for the article. The Brazilian Research Council (CNPq) supports Jônatas Manzolli, fellowship (305065/2014-9).

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Title ***Infinite Virtual Stoa***

Topic: ***Art***

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Abstract. Stoicism is a philosophy that considers the object of life to be *ataraxia* (αταραξία), a state of psychological stability which is undisturbed by exposure to phenomena and circumstances that lie outside one's control. Such circumstances may include ill health, poverty, natural disasters, corrupt social orders, unpopularity, and unrequited love, and may cause loss of composure and mental balance through feelings of pain, humiliation, insufficiency, envy or greed. Stoicism is a coherent system of powerful ideas about how to pursue a life of equanimity in the face of adversity which has inspired philosophy and psychology to this day. The founders of Cognitive Behavioural Therapy have cited Stoicism as their main inspiration. Stoicism flourished in ancient Athens and Rome at a time when ancient democracy was dying and people experienced loss of control over their lives under authoritarian and imperial regimes. In an age of serious global economic, environmental and psychological uncertainty and crisis, stoicism has still pressing and valuable lessons to teach us about calm, composure, stability and emotional resilience.

Stoicism owes its name to Stoa Poikile ('painted porch' in Greek), a colonnaded building in the Athenian agora where Zeno of Citium founded his school in the 4th century BCE. Inspired by this, we develop an 'Infinite Virtual Stoa' to host an expandable online repository of resources about Stoicism. Our repository exists in the space defined by the Stoa, which is a colonnaded building in the form of the ancient, and sacred to many cultures, geometrical pattern known as 'the flower of life'. The building is composed of multiple evenly-spaced, overlapping circles arranged in a flower-like pattern with six-fold symmetry that is potentially expandable to infinity. Our Stoa is immersed in water, with pools regularly forming in the space between the colonnaded walks that delineate the space, and becomes an art gallery-library for the creative exhibition of online stoic resources: quotes, stories, books, paintings and videos. Here, one can create areas of study devoted to great stoic philosophers, like Epictetus, Seneca and Marcus Aurelius, or thematic areas where stoic ideas are explained with quotes, text, animations and videos. Specific ideas or themes can be presented in a creative fashion to the viewer as multimedia illuminated sculptures using Timaeus, a digital art studio for the creation of such 3D media sculptures which was developed at the University of Hull inspired by the homonymous Platonic dialogue.

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Key words: Timaeus, Virtual Sculpture, Stoicism

Infinite Virtual Stoa

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1. Introduction

Stoicism is a philosophy that considers the object of life to be ataraxia (αταραξία), a state of psychological stability which is undisturbed by exposure to phenomena and circumstances that lie outside one's control. Such circumstances may include ill health, poverty, natural disasters, corrupt social orders and unrequited love, and may cause loss of composure and mental balance through feelings of pain, humiliation, insufficiency, envy or greed. Stoicism is a coherent system of powerful ideas about how to pursue a life of equanimity in the face of adversity which has nurtured philosophy and psychology to this day. The founders of Cognitive Behavioural Therapy have cited Stoicism as their main inspiration [1]. Stoicism flourished in ancient Athens and Rome at a time when ancient democracy was dying and people experienced loss of control over their lives under authoritarian and imperial regimes. In an age of serious global economic, environmental and psychological uncertainty and crisis, Stoicism has still pressing and valuable lessons to teach us about calm, composure, resilience and emotional stability.

Stoicism owes its name to Stoa Poikile ('painted porch' in Greek), a colonnaded building in the Athenian agora where Zeno of Citium founded his school in the 4th century BCE. In this project we develop an 'Infinite Virtual Stoa' to host an expandable online repository of resources about Stoicism. Our repository exists in the space defined by the Stoa, which is a colonnaded building that takes the form of the ancient, and sacred to many cultures, geometrical motif known as 'the flower of life'. The building is composed of multiple evenly-spaced, overlapping circles arranged in a flower-like pattern with six-fold symmetry that is potentially expandable to infinity. Our Stoa is immersed in water, with pools regularly forming in the space between the colonnaded walks that delineate the space and becomes an art gallery-library for the exhibition of online stoic resources: quotes, stories, books, paintings and videos.

Aerial view of the infinite Stoa

Stoicism explored patterns of psychological fallacy on one hand, and patterns of thought and behaviour for the pursuit of ataraxia on the other. Our Stoa is built on a geometrical pattern that is expandable to infinity. Thus the concept of pattern is central to this paper. Firstly, we focus on patterns as they occurs in Mathematics, Science, the Arts and the mind. Then we discuss patterns within Stoicism and the design of the infinite Stoa. Finally, we highlight the long term goals of this project and its further evolution.

2. Téchnē and 'Arthematics'

We start from a vision where Mathematics, Geometry, and Computer Science may be embraced in a sense of the unified arts and technology suggested by the ancient meaning of the Greek word téchnē (τέχνη) [2]. Stefanie Mandelbaum interestingly coins 'Arthematics' as a crossing field between the Arts and Mathematics [3]. This goes also in line with another neologism, that of 'Artification' [4], which gives name and meaning to the fusion of the artistic and the - apparently - non-artistic, that then sublimates to a new Art. In this context, we are specifically interested in the dynamics between Artification of Games and Gamification of Arts.

2.1 Mathematics, patterns and the Arts

The appearance of perspective in Renaissance painting is intimately related to the influence of 'the science of sight' [5] and the mathematical notion of infinity. It is an example of mathematical thinking that proved to be instrumental in the making of artistic masterpieces. This advance in the Arts was driven by the Renaissance artists' brave geometrical thinking including the contemplation of insightful but counterintuitive ideas, such as equating the existence of parallel lines that do end up meeting [6].

Deeper in history, humanity has left us with an ancient panoply of beautiful patterns still exposed in old walls, windows, floors and ceilings, or visible in other kinds of artefacts - such as ceramics - of antique cultures like the Assyrian, Greek, Roman, Byzantine, Iranian and Arabic [7]. This heritage has inspired artists through times. Technically, the motifs and regularities can be classified by periods and styles or even in more systematic ways and they too have an intimate connection with mathematical knowledge. These ancient arrangements are still present in contemporary works of the decorative arts of ornament and in prints. Yet their influence is not limited to those fields of creativity. Escher, for instance, has used them - and has also developed his own ideas over them - in his engravings and drawings introducing the visual senses into new heights of thinking geometrically.

Perhaps the harmonies of symmetry, isometry and geometry are desirable and explain that the order present in the universe is also present in cultural artefacts such as Art, Music, and Architecture [8]. Such thoughts led Ackerman to state that 'the modern argument of form versus structure is as meaningless as the mediaeval argument of *ars* versus *scientia*, for it likewise disrupts a partnership which can function only in happy union' [9].

In Music, as in the visual Arts, Geometry and Techne also coexist. In musical composition, geometric transformations and symmetry are known to have played a role in the works of Bach and of Bela Bartok [10]. There are also known composition symmetries such as the 'Friezes patterns' [10] and tonal and rhythmic patterns, such as dissonance, two-voice vs. coloration, and ostinato patterns [11]. These are resourceful tools for the composer because patterns in music can also be derived from one into another by variation [12].

2.2 Historic technologies in the service to the Arts

The history of the synthesis of Mathematics and the Arts is also exemplified by several engineering artefacts such as the tools that have helped artists to achieve extraordinary paintings and sculptures. From the chisel to calligraphy pens, the compasses and the proportional dividers, to more complex tools for achieving a correct perspective in painting, such as the perspective machine depicted in Leonardo's 'Draftsman drawing an armillary sphere' [13] or the pantograph, a linkage device invented in 1630 by Christoph Scheiner that makes it possible to draw a scaled copy of a smaller depiction [14]. The automation that nowadays is the focus of interest of the Generative Art is also rooted in history, from the legendary Antikythera mechanism to the pervasive echoes of the music of the automatic carillons of Mafra [15] and the writing, drawing and musical automata of Jaquet-Droz [16].

3. Patterns and Computer Science

Patterns are also prevalent in Computer Science, and that indeed is the case in the fields of pattern recognition and machine learning [17]. Pattern recognition searches for regularities in data and deals with their automatic classification [17]. In Computer Science, a pattern is an abstraction of an object that can be understood as a class described by certain attributes and that can be searched for in the data [18]. Patterns can usually be recognized statistically or syntactically [18]. It is, for instance, possible to run pattern matching algorithms in a musical piece to study its 'motifs and their variants' [12].

3.1 Repetition, tilings and tessellations in Computer Graphics

Going back to the works of Leonardo da Vinci and the Renaissance, it is remarkable to see that his description of dealing with perspective essentially matches the contemporary approach for rendering a 3D scene to a computer screen. Long before the Renaissance, the Romans had also used small tiles – tesserae - to build mosaics that could fill the plane with depictions. This regular tiling of the plane or even space is hence called Tessellation. Still today, the 'tessellation stage' is one of the steps of current graphics 3D rendering pipelines. Other kinds of regularities are also thought fundamental in Computer Graphics. The symmetrical divisions of the plane and of higher dimensions are crucial for rendering pictures, movies and geometries as they can be reduced to structural repetitions of bidimensional pixels and three-dimensional voxels.

3.2 Pattern generation

Efforts are also directed towards understanding pattern formation and to 'describe universal classes of pattern' in a 'precise formalism which serves as the conceptual basis for synthesizing and analysing patterns' [19].

3.3 Proceduralism, and digital games

Proceduralism in the realm of digital games allows the automatic creation of infinite and randomised worlds. These can be populated with procedural models and game objects, geometries, textures, levels, AI behaviours, and with impact on the dynamics of narratives, story, and in music generation where, for instance, musical piece sections are repeated according to dynamic patterns [20]. Dynamic music can be parametrised by variations of tonality, rhythm, harmony, 'andamento', pitch, and themes and can have an impact both in immersion and inclusively play with the narrative and player interaction, as in the use of the 'leitmotiv' in dynamic game music [21].

4. Patterns and the mind

There are two noticeable connections between the realm of patterns and the human mind. The first is that the mind has the tendency to be attuned and attracted to regularity as in symmetric patterns, in which it finds beauty [22] [23]. The second is that patterns have an influence in processes and flows within the human mind. For instance, temporal patterns have the power to induce an 'inner clock' that influences the perception of music [24]. One recognises and remembers different birds by the melodies they sing. Studies in psychology have also investigated intrinsic and extrinsic structures of stimuli and their relationship with discrimination, classification, judgement of similarity [25] and, particularly in music, in long-term memorisation of melodies [26]. Additionally, the repetition of static images and sculptures are also interpreted as 'visual rhythm, or an impression of coherence and movement' [27]. The 'same measure' of patterns is also mentioned in some mental pathologies, as it is the case of the obsession with symmetry in Obsessive Compulsive Disorders [22].

5. Stoic patterns

Stoicism is an ancient philosophy that encompasses logic, physics and ethics in a comprehensive philosophical system from which much can still be learned about tranquillity, resilience, mental balance as well as tolerance and openness in society. Stoic philosophers used the analogy of a 'garden' to describe their system [28]. In this analogy, philosophy is seen as a garden that it is fenced by logic protecting it from erroneous reasoning often motivated by imperfections in human nature. Within the garden, physics is the soil where we cultivate our understanding of the world including that of our human nature. The fertile soil of physics in turn yields the fruits of philosophy which for Stoicism is the 'ethics', or living a 'good life' characterised by serenity and justice that can be experienced individually and collectively.

Stoics have made contributions in many areas of intellectual enquiry. Chrysippus, for example, is known to have founded propositional logic, an early form of the formal reasoning system employed in contemporary analytical philosophy and Computer Science [29]. However, one of their most significant and lasting contributions is in the area of psychology. Stoicism is indeed the first systematic attempt to understand patterns of fallacious reasoning that cause disturbances in human psychology and behaviour; and stoics proposed remedies which still inspire modern cognitive therapy [1]. For the purposes of this paper, and its discussion of patterns, we focus on three areas of human behaviour where stoics identified dysfunctionalities caused by fallacious thinking and where they proposed interesting remedies: anxiety, agitation and tribalism.

5.1 Anxiety

Many of us tend to live in constant anxious anticipation of stressful events, e.g. fearing loss of status, wealth, health, or reputation. According to the stoics such anxieties are largely caused by mental confusion and inability to consider a basic dichotomy between those things that we can control and those that we cannot. Status, wealth, and health are largely defined by external events which can be random and outside one's control. Realising this can lead to a fundamental shift in how one then responds to unfortunate events. It is not the event itself that matters - argue the stoics - but our responses to it, and these can be adjusted. Once one understands, for example, that a job promotion is not entirely in one's control, but depends on circumstances and personalities of others, then failure to obtain the promotion becomes less personal and hurtful and therefore one can be less anxious about the outcome and rather focus on the effort. Stoics instead propose that life should prioritise the pursuit of four cardinal virtues: wisdom, courage, justice and temperance, and all these are entirely in our control. A good life is defined as acting with wisdom, be courageous and doing the right thing, treating others justly and responding to events with moderation. Status, wealth, health and reputation, on the other hand, are simply defined as 'preferred indifferents' i.e. things that may be nice to have but one should easily part with [30]. Stoics developed some excellent advice around this theme. Epictetus, one of the eminent stoics, for example, advised us to think of our loved ones not as possessions but as borrowed from the universe [31]. When the time comes to return them, we should not be devastated but be grateful for the time we had with them as we would be grateful when we have returned a good book lent by a friend.

3.2 Agitation and anger

Stoicism attributes agitation and anger to overt optimism and unrealistic expectations. In his Enchiridion, Epictetus gives a lucid illustration of this using the example of a citizen visiting the Roman baths for cleansing, relaxation and recuperation.

"If you are going to bathe, picture to yourself the things which usually happen in the bath: some people splash the water, some push, some use abusive language, and others steal. Thus, you will more safely go about this action if you say to yourself, "I will now go bathe, and keep my own mind in a state conformable to nature. For thus, if any hindrance arises in bathing, you will have it ready to say, 'It was not only to bathe that I desired, but to keep my mind in a state conformable to nature; and I will not keep it if I am bothered at things that happen' " [32].

For the stoics 'nature' in the above effectively means 'reason' (logos), because nature is both logical in its regularities and has gifted humanity with the capacity to reason. Epictetus makes a very apt point: overt optimism disappoints and agitates. Indeed, many of us regularly get upset about traffic jams and aggressive drivers as if we lived in a world where these things were extinct. We use computers for online banking but hope never to suffer malware, and when we do we get angry. However, Stoics had a very clear view of anger as temporary suspension of mental faculties. In his famous essay, Seneca described anger as temporary madness [33]. The stoic message is that unrealistic expectations lead to disappointment, agitation and anger. Thus, it is preferable to be realistic, and when we encounter potential triggers of anger, create mental space between external events and our responses to allow reasoning and calm reflection to take place.

3.3 Tribalism

Tribalism assumes that a strong cultural or ethnic identity, often based on proximity or kindship, separates one member of a group from the members of another group. Various forms of tribalism, including nationalism, have historically exploited false and simplistic conceptions of history which glorify the tribe or the nation, and exclude other groups.

The stoics developed an antithesis to tribalism based on a cosmopolitan view of human nature and society. According to the cosmopolitan view, we are social animals who participate not in one but many groups which are increasingly larger. In each of those groups we may assume different roles which, if performed well, lead to collective benefit. The word cosmopolitan derives from the Greek κοσμοπολίτης meaning being 'citizen of the world'. Hierocles, an eminent Stoic, developed a brilliant illustration of the concept by placing the individual in the centre of a series of expanding circles of concern: the smallest circle is the individual itself, next comes the close family, the extended family, the city, the neighbouring cities, the country, and finally the larger circle is humanity. Our task - stated Hierocles - is to compress those circles so as to bring humanity closer to the core of our concerns [34]. Cosmopolitanism thus becomes the idea that all humans belong to one community based on our shared nature and capacity for logic and morality.

6. The infinite Stoa

Stoicism has lasted millennia and still carries valuable lessons for humanity. There are contemporary communities of practising stoics, hence there is no reason to believe that stoicism will cease to exist and develop in the future. To facilitate this, we propose an infinite virtual Stoa that will enable hosting an expandable online repository of resources about Stoicism. The internet is already potentially infinite, but we propose to create a more interesting virtual space that offers artistic possibilities and sensibilities for the presentation and exploration of stoic ideas. Thus, we configure our gallery as a virtual colonnaded Stoa that is reminiscent of the original Stoa Poikile. Our Stoa has no boundaries, being allowed to grow *ad infinitum*. Below we explain how this is achieved.

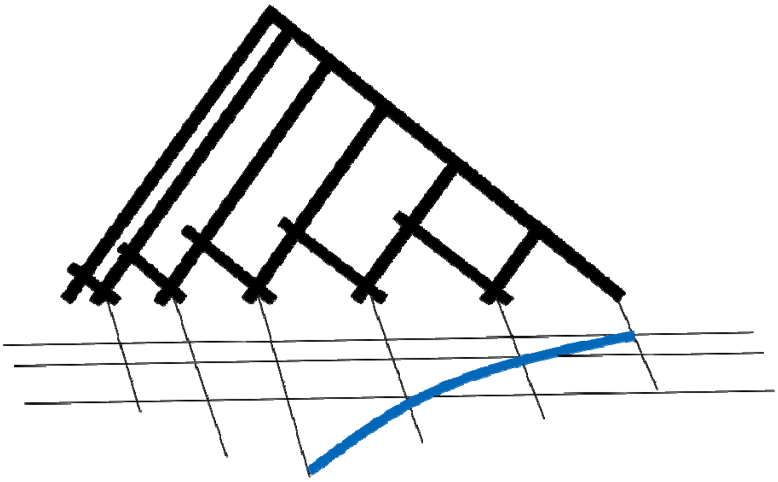
6.1 The geometry of the circle

Computationally, an infinite virtual Stoa can be built procedurally. This requires some form of structural arrangement that can be repeated in the Stoa's architecture. We could have created a linear Stoa but have chosen a more interesting motif of seven overlapping circles known as the 'flower of life'. This arrangement has the particularity that by the connection of all points another pattern can be found, one that combines the projections of all platonic solids, known as the 'Metatron Cube', that is a figure that shows 'perfect proportions and relations between its geometric components' [35]. This hidden pattern is also known since antiquity and archaeologists account finding it in the architecture of a defensive structure of the Copper Age in the Iberian Peninsula [35].

6.2 Pantographs and Splines

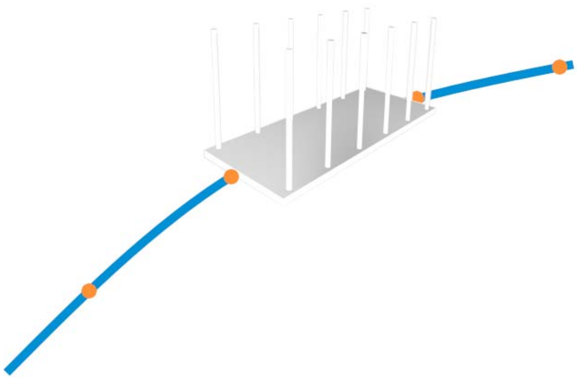
The prominent technical device necessary for building the pattern is the spline, a computational resource with roots in the ancient art of making tools [36], specifically the pantographs that have been conceived and used for drawing elliptical arches in the 17^{th} century [37].

In the 1950s, automotive design required novel ways for the representation of volumes' and shapes' which led to the invention of computational splines [38]. The invention of splines moved from the elliptic pantograph to defining curves algorithmically, an innovation that also moved on from defining the arch inside a sectioned 2D rectangle, to a 3D parallelepiped [38].



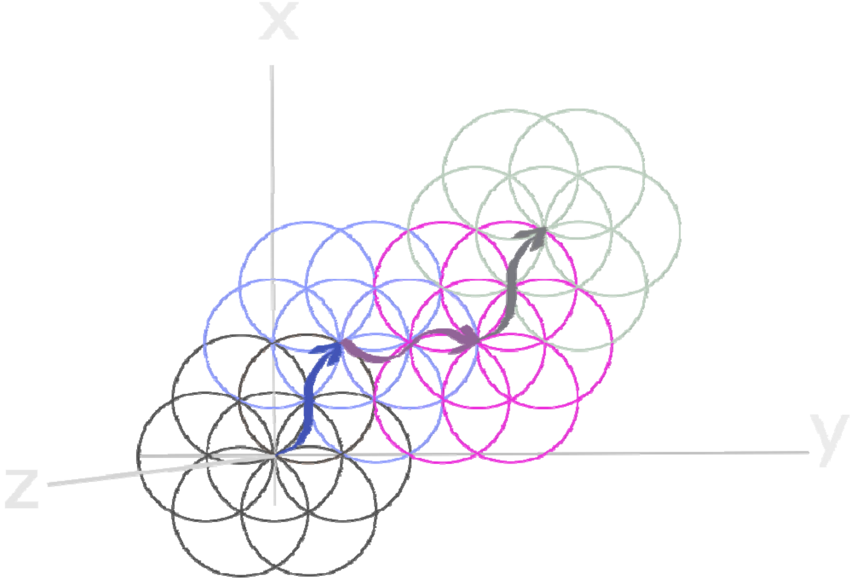
Drawing ellipses before algorithms, with a pantograph (diagram based on [38]*)*

Splines are nowadays present in all kinds of drawing and modelling software, and also present in digital game engines, along with multitudinous other technical advances in the service to the Arts, that mostly have all had their roots in historical engineering. Among the contemporary applications, splines can, for instance, be used for extracting the geometrical features on digitally reconstructed parametric model representations of objects [39].



The Stoa's modelled section is reproduced along a spline

By resourcing to splines, it is possible to section them equally and populate their parts with 3D models. In the Stoa, the spline sections are associated with a reduced 3D model of a small motif of a segment of a Stoa, that can be repeated, and then sections are harmoniously collated. Every spline instantiates a circle of the flowered pattern and infinity is achieved by making the rendering of the Stoa dependent on the player's navigational directions. The circles also have anchor points that can work as the origins for further splines/circles. So, by being generated on the fly, in conformity with the navigation of the viewer, the Stoa becomes virtually infinite in any direction of browsing. The result is that moving towards the horizon creates new space. This is a characteristic of what is known in game development as 'procedural world generation'. Whilst, by navigating, the world is created instantly, it is also possible to recreate previous paths towards where the audio-visual sculptures have been situated.



Process of the splines being generated during navigation, viewed from above

6.3 A procedural art gallery for viewing artworks

Navigating the Stoa resembles walking on an infinite unbounded labyrinth. Along the continuous paths, the player can find the audio-visual sculptures that can be designed with the resources provided by TIMAEUS. TIMAEUS is a virtual art studio, which has been inspired by Plato's homonymous work, especially in its narrative about the Platonic realm of geometrical thinking. The sculptures contain audios, films, pictures and texts that are continuously being displayed and that can be visited from inside by the wanderer. An example sculpture inspired by Hierocles' circles of concern is shown below.

Hierocles-themed sculpture viewed from the Stoa

The sculpture viewed from the inside

7. Conclusion and future

The world seems to be full of recurring patterns that repeat themselves in completely different areas. The branching of the trees is similar to that of veins, the delta of rivers, the wrinkles of a palm and cracks in dry soil. In this paper we discussed the concept of pattern as it occurs in Mathematics, Science, the Arts, the mind, and the philosophy of stoicism. Stoicism is a philosophy that explored patterns of psychological fallacy on one hand, and patterns of thought and behaviour for the pursuit of ataraxia on the other.

Building on the themes of patterns and Stoicism, we designed an infinite virtual Stoa using a classical geometrical pattern that is expandable to infinity. The Stoa could be used to host and present in an artistic manner an infinitude of past and future resources about Stoicism. It can potentially host areas of study devoted to great philosophers, like Epictetus, Seneca and Marcus Aurelius, or thematic areas where stoic ideas are explained with quotes, text, animations and videos. Specific ideas or themes can be presented in a creative fashion to the viewer as multimedia illuminated sculptures using TIMAEUS. The gallery is designed to be accessible online.

Finally, this Stoa can be seen as a serious game for education and learning or a development towards Gamification of the Arts, a topic that we will further explore in the future.

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Form Exploration with Optimized Three-Dimensional Printed Architecture
(Paper)

Topic: Architecture

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Abstract
There is a fundamental relationship between architecture, structure and construction technology. Besides ideology change, the main reason behind the change in architectural form is new structural analysis tools, new material discovery or the invention of new construction methods. Additive manufacturing techniques will change the construction methods of the future making it faster and more cost-effective. New modeling and analysis technologies such as voxels, will enable unprecedented forms and structure optimization beyond what is currently possible.

On one hand, designers' creativity has depicted truly remarkable novel forms despite the technical limitations of the current Additive Manufacturing technology to produce such forms or to achieve usable multi-story buildings. On the other hand, the cost-effectiveness and speed of production of the technology have been a reason to produce three-dimensionally printed architecture that is a replica of what could have been produced with conventional or mass production methods, using same productions techniques and reinforcing the building material the same conventional way, which defies the purpose.

This paper explores the architectural form opportunities with currently available materials and AM techniques without resorting to conventional constructions methods or forms. The research explores possibilities of form achieved with a widely used material such as ordinary concrete, a material that is limited in its ability to create horizontal floor slabs which prohibits the making of multi-story buildings. The research is composed of three stages:

First, generating a form using the voxel technique, where two-dimensional images are used to generate three-dimensional geometry.

Second, the resulting geometry is structurally analyzed against typical loading conditions, with the use of ordinary concrete, a material that can be used to 3D print the depicted structure.

Third, the resulting structural analysis is optimized for minimum use of material, resulting in an unexpected architectural form.

The resulting forms are used as building blocks for hypothetical architectural structures.
The main objective is to achieve a usable multiple floor buildings possibilities with structurally optimized three-dimensionally printed forms.

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Keywords: Architecture, Additive Manufacturing, Structural Optimization

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Form Exploration with Optimized Three-Dimensional Printed Architecture

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Abstract

There is a fundamental relationship between architecture, structure and construction technology. Besides ideology change, the main reason the architectural form change is due to better structural analysis tools, material discovery or invention and advancement in construction methods. Additive manufacturing techniques will change the construction methods of the future making it cost-effective and achieving faster delivery. New modeling and analysis technologies such as using voxels, will enable unprecedented forms and form optimization beyond what is currently possible.

Despite the technical limitations of the Additive Manufacturing technology to produce usable multi-story buildings, designers' creativity depicted remarkable but unattainable forms. On the other hand, the cost-effectiveness and speed of production of the technology produced three-dimensionally printed architecture that is a copy of what would be produced with conventional or mass production methods.

This paper explores the architectural form opportunities with current materials and AM techniques. The research explores possibilities of form achieved with a widely used material such as concrete, without reinforcement, a factor that limits the ability to create horizontal floor slabs and prohibits the making of multi-story buildings

1. Introduction

Architecture form is a function of the structure system, and as architects, we are always interested in novel architectural forms which are usually a product of new structural systems or analysis capabilities. As the modern movement based its form shift on the advancement of structural steel and reinforced concrete, today's additive manufacturing technologies and advanced structural analysis tools would again reshape the architecture form.

"… the particularities of structural form can be closely related to spatial functions and to conceptions of space. We can thus interpret structure as being part of an integrated design approach in which we cannot completely explain, understand, or appreciate structural form without recognizing its strong co-dependence on the particular character and use of the architectural space. It is of importance to note, however, that any gross deviation from what can be considered to be a reasonable concern for mechanical requirements should not be the result of random, uninformed, or thoughtless design, but rather of carefully considered ideas related to other design imperatives" [14]

Additive manufacturing is a technology that is transforming the industry including the AEC industry. The technology promises a novel way of producing buildings that are economical and fast. With the new technique of depositing layers of material to construct three-dimensional forms, comes new form possibilities that were prohibitively expensive with the traditional building methods based on modular repetition and mass-produced parts.

Since the industrial revolution, mass production was the process with which manufacturers were able to significantly reduce the price of production, making product cost very competitive to consumers. The 20th-century development was marked mainly by the mass production market. Architecture like everything else has benefited from this trend which availed parts that contributed to the construction industry; such as construction equipment and assembly lines of doors and windows.

However, this did not change the form of the produced architecture. The building technology that shaped the form in the turn of the 20th century did not change, in an interruptive way, the main lines of the architecture form. [5]

Possibilities are endless if the gap between the technology and the structural properties of the used materials can be closed (Figure 1).

With the introduction of computer modeling, the limits for creative forms has been elevated significantly, allowing previously “difficult to draw” forms to be economically realized, albeit within the boundaries of conventional construction methods. The introduction of additive manufacturing has stretched the limits even further with the promise of achieving complex shapes not possible with conventional methods.

Figure 1. 3D printed buildings for Mars (www.marscitydesign.com).

Despite the promising traits, the structural limitations of the current processes and materials might impose certain form restrictions on the resulting architecture. Unlike the imagery that is depicted as 3D printed buildings, the current structural limitations give an entirely different form typology.

One significant restriction that has to be overcome is the tension force which requires reinforcement in concrete. Without a practical way to add reinforcement to any building material with properties suitable for 3D printing such as concrete, it is difficult to imagine some specific shapes especially horizontal flat slabs covering large spans.

Many research projects have addressed similar issues, and partially resolving the problem in some ways. In their research project “The smart takes from the Strong,” [10] managed to fabricate a concrete slab that can have the adequate load-bearing capacity. Their approach explored the synergy between the geometric flexibility of 3D printing sand formworks and the structural capacity of concrete. It allowed the production of composite components with properties superior to either individual material [10]. The result of this project indicates possibilities for achieving a horizontal slab that can be used as another floor slab, but without addressing the vertical support.

Other projects, such as VULCAN [7], utilized materials other than concrete, in this case, it was plastic, to realize full scale three dimensional printed usable spaces, yet sacrificing the possibility of having a usable horizontal surface as a first floor.

Since there are many economic benefits in using AM technology, it is possible to get some form insights of what can be achieved with current limitations. This research is exploring the form possibilities when utilizing non-reinforced concrete as a material to build vertical support and provide horizontal surface above providing a usable space within and potential of adding a second floor.

Utilizing the analysis capabilities of Autodesk project Monolith, an optimized form of 3D printable structures were produced as an exploration of form possibilities.

2. Background

2.1. Autodesk Monolith as an experimental platform

According to the software website, Monolith is a voxel-based modeling engine for multi-material 3D Printing. Besides its ability to generate form using geometry description and preset functions it also can create form that is derived from image blend and sweep, enabling a novel way to generate forms that adhere to different set of rules than currently possible, such as having a particular shape cross-section at certain height and a different one at another enabling a sort of a loft operation with an unprecedented level of control and detail.

It also enables "Topology Optimization," which the maker defines it as: "… a form-finding solution which uses static analysis to determine the optimal distribution of material within a volume based on a loading/support condition. It is a process which seeks to find the optimal load path for a particular loading condition and boundary volume. By defining the constraints of the system, the optimization process will attempt to numerically optimize the distribution of material so that it meets the prescribed performance targets." As mentioned on the software web page at monolith.zone

While doing this, the process alters the form of the support element, resulting in new visually unexpected forms.

If the original form is proven architecturally to support the required load and be aesthetically appealing according to our historical standards for aesthetics in architecture, the deformation resulting from the optimization process will challenge that.

In reality, the optimization process produces unexpected results. Few questions arise;

- Should we accept the optimization process aesthetic results?
- Can we control the process to generate what we would consider aesthetically appealing?

And another more profound question;

- What will it look like?

- How will it affect the usability of the generated space?

2.2. The current state of the technology

Lately, the possibility of utilizing the AM technology to produce full-scale architecture has been tested. Up till now, few full-scale examples were demonstrated. In May 2016, the city of Dubai launched the world's first "functional" 3D printed office building of 250 square meters (Figure 2).

A structure of a single floor with all amenities printed in 17 days, and "assembled" on site in two days. The goal of the project, as mentioned by officials, is to push the envelope on technological development, innovation, and creativity. The machine responsible for printing out the office building is a massive warehouse size printer that stands at about 6 meters tall, 40 meters long and 13 meters wide. The resultant building form, despite being slightly unconventional, still respect the traditional building shapes of vertical walls and horizontal slabs.[5]

In January 2015, another firm in China produced a 5-story residential house and the world's first 3D printed villa (Figure 3). The villa measures 1,100 square meters and comes complete with internal and external decorations.

Figure 2. Dubai first 3D printed office building.

Figure 3. 3D printed villa in China (3ders.org)

Other successful full-scale projects have utilized different production techniques such as VULCAN, the world's largest 3D-printed architectural pavilion (Figure 4) [7]

But the project that most lends its form aesthetics to actual optimization process while maintaining a functional role would be the "The bridge" project (Figure 5), which began by the Joris Laarman Studio and Petr Novikov and Saša Jokić from the Institute for Advanced Architecture of Catalonia (IAAC) to be placed across the Oudezijds Achterburgwal canal proposed for Amsterdam.

Figure 4. VULCAN, the world's largest 3D-printed architectural pavilion by Lei Yu et al.

Figure 5. The bridge project, by Joris Laarman Studio, proposed for Amsterdam.

3. The experiment:

To explore form, an investigation with a small structure of dimensions 4*4*4 meters was conducted. The scale of the structure qualifies it to be a room module, either a standalone or part of a larger building. Some difficulties, discussed later, prohibited larger scale tests.

3.1. Choosing building material:

The reason to select concrete:

The structural properties of concrete are well known and well-studied. Concrete has high strength in compression and more importantly has no useful tensile strength. Concrete is also the only primary structural material commonly manufactured on site; it has no form of its own. The suitability for injection through a nozzle while in the liquid state makes concrete a viable material to demonstrate the technology. Large format full-scale 3D printed architecture examples have used concrete, albeit no disclosed details about the mix. It would be safe to assume that concrete can be adapted successfully to be three-dimensionally printed.

However, without reinforcement, and due to the binding moment, it would be technically challenging to achieve horizontal elements out of concrete.

This experiment assumed the following structural properties for analysis:

Young's Modulus of Elasticity = 40 Gpa

Poisson Ration = 0.15

Density = 2400 Kg/m3

The loading conditions of the two test were identical using 10000 KN on the horizontal part of the form, and constraining the four lower corners of the structure in x, y, and z.

3.2. Exploring the analytical results of the software

Starting with a proven form that can create an enclosure with compression stresses only, a cross-vault was tested in the analysis module of the software. The form was created using the “image sweep” function (Figure 6).

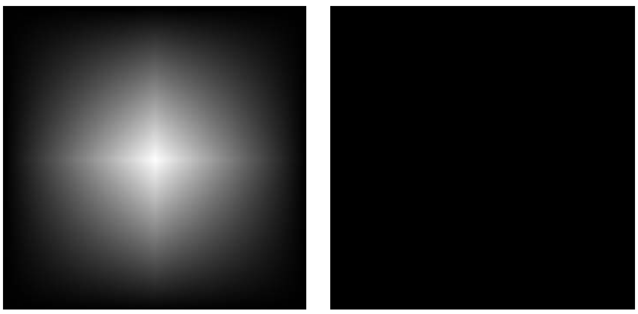

Figure 6. Base and top images used to generate the starting geometry.

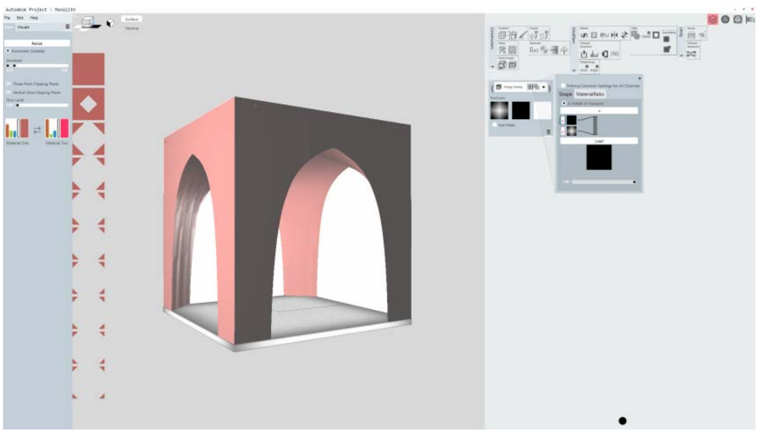

Figure 7. The generated form of a cross vault before optimization.

Then, a generic loading test situation that is very close to a cross vault was also tested using the optimization module of the software. The two approached produced forms that are close to each other.

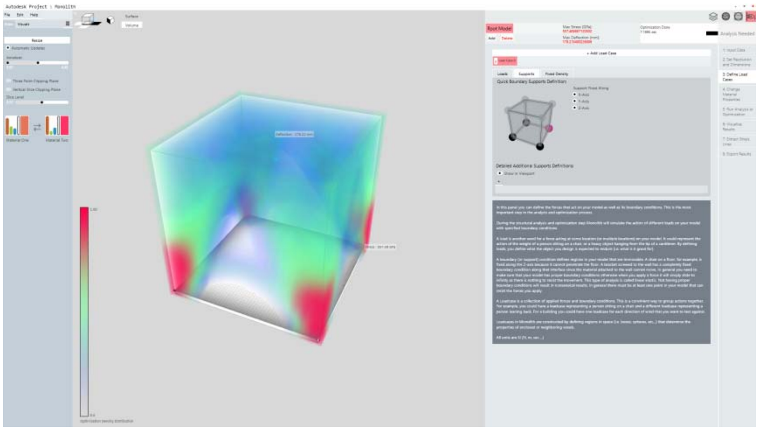

Figure 8. Loading and support generic test would also produce a cross vault.

3.3. Applying variations.

Different variations of the images that when swept creates the geometry were tried. The conditions of the tests were to have a form that includes:

- a possible usable internal space
- openings that can act as windows and doors
- a top horizontal level that can act as a second floor, or at least
- provide small span ranges that can be crossed by with other materials such as wood board without the significant need for extra support.

3.4. The results

Case # one:

Continuous optimization of the cross vault geometry created a four-legged structure that optimized as per the use of the construction material yet preserving the internal enclosure of usable space as well as a horizontal roof (Figure 10).

The architectural visualization of the resulting form (Figure 11) is depicting a multi-story structure with different variations of the scale of the unit.

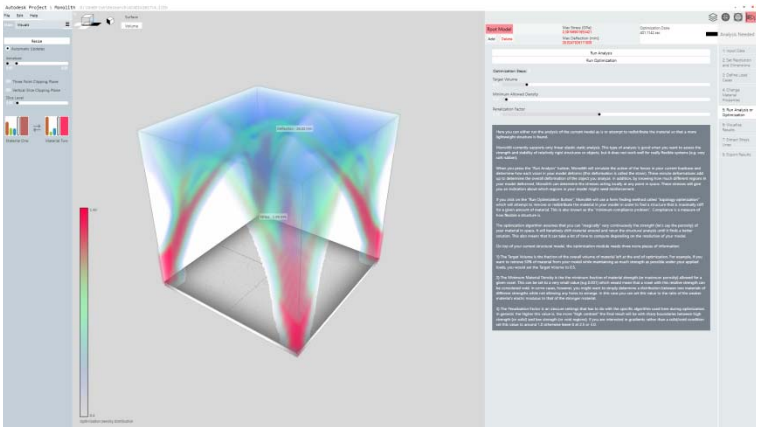

Figure 9. Loading and support generic test would also produce a cross vault.

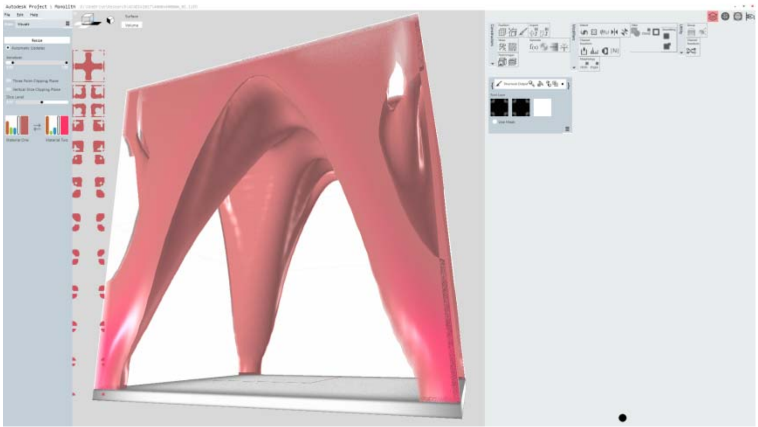

Figure 10. Loading and support generic test would also produce a cross vault.

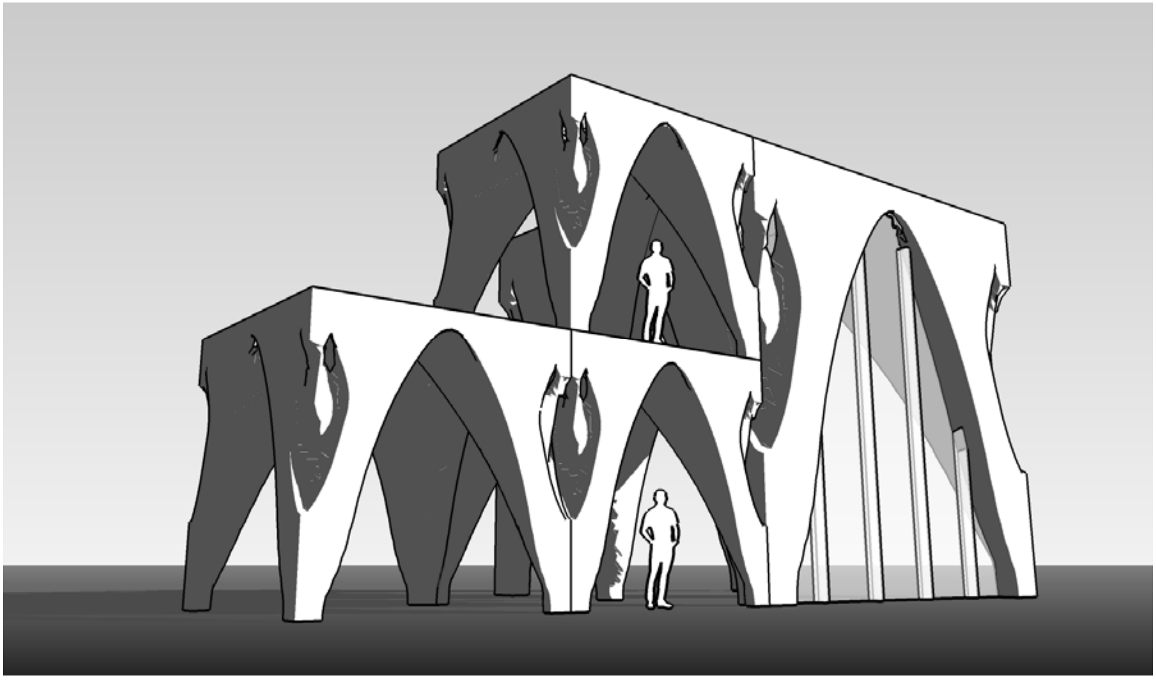

Figure 11. Loading and support generic test would also produce a cross vault.

Case # two:

The creating images (Figure 12)

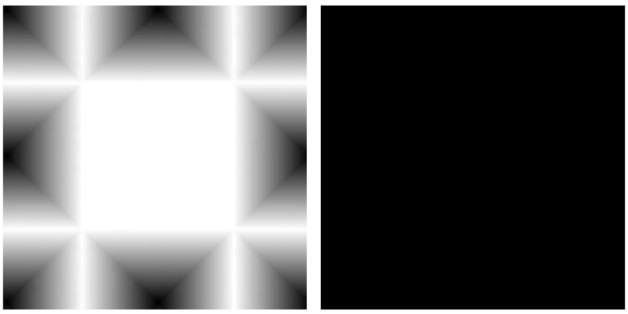

Figure 12. The images swept to produce the 3D structure in case two.

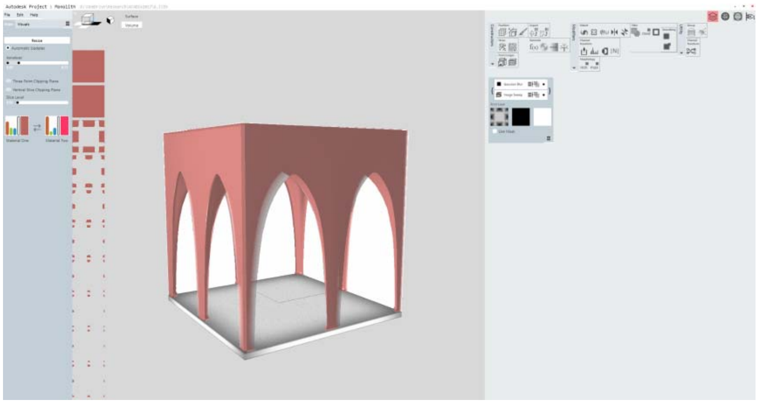

Figure 13. The resulting structure of the swept images for case two before optimization.

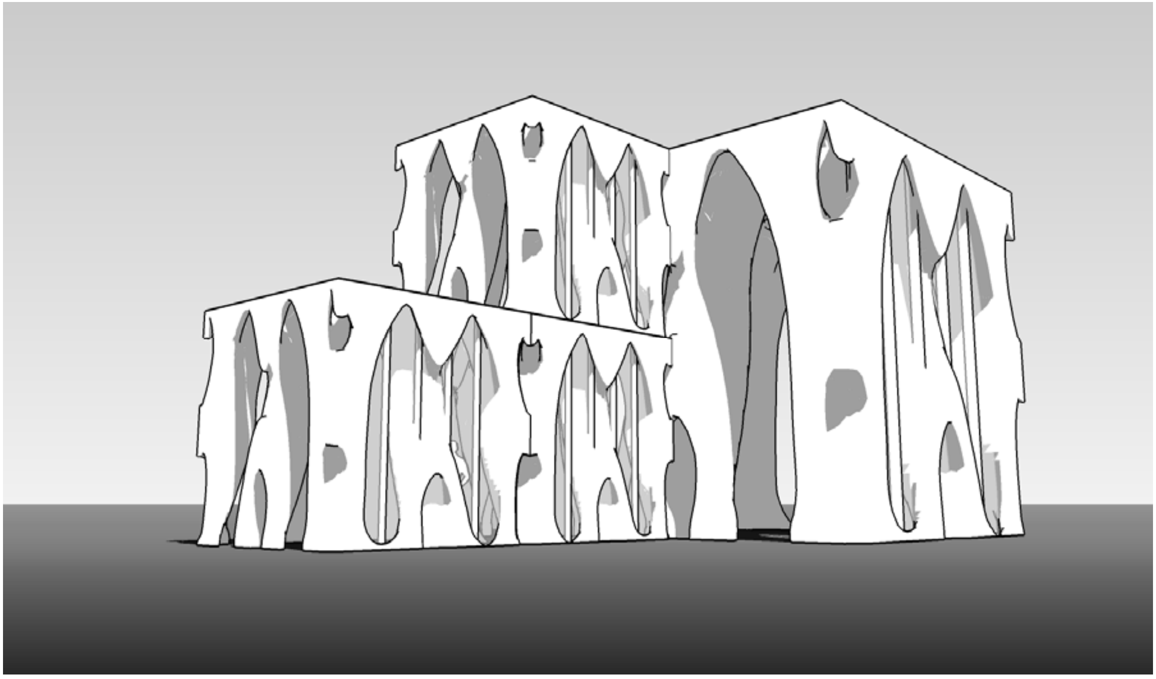

Figure 14. Architectural visualization of the resulting optimized structure of case two.

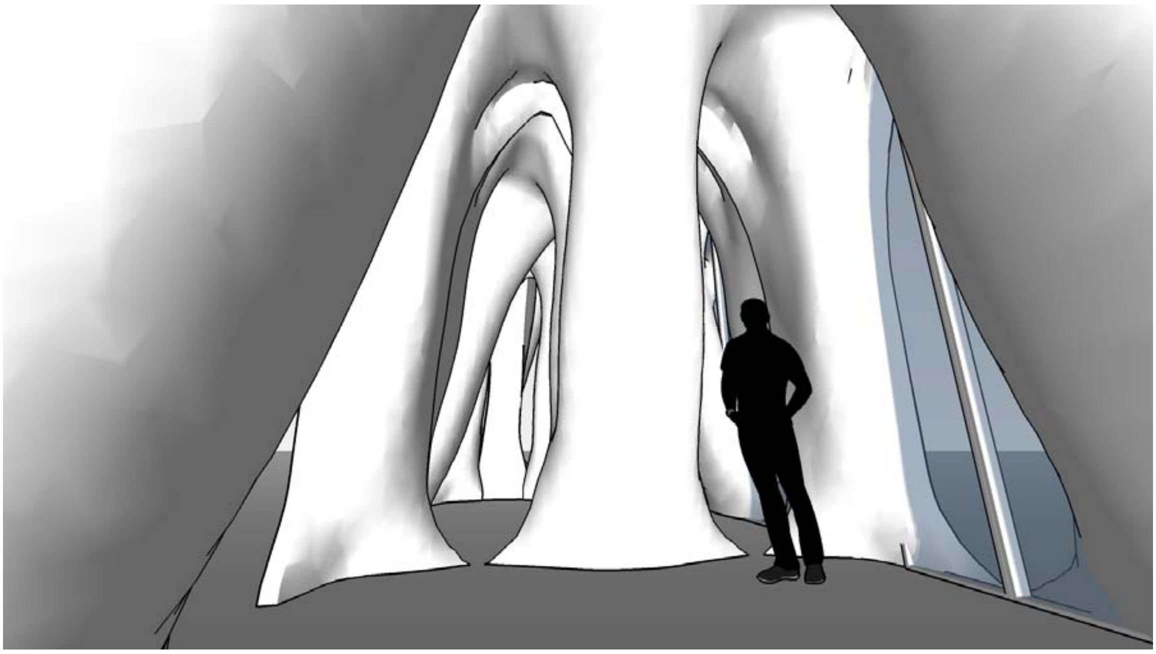

Figure 15. Interior visualization of the resulting optimized structure of case two.

More variations: in this variation, a completely solid top was replaced by a different possibility that would create a structure with spans that can be crossed by other materials such as wood boards, or stone slabs.

Case # three:

The creating images (Figure 16)

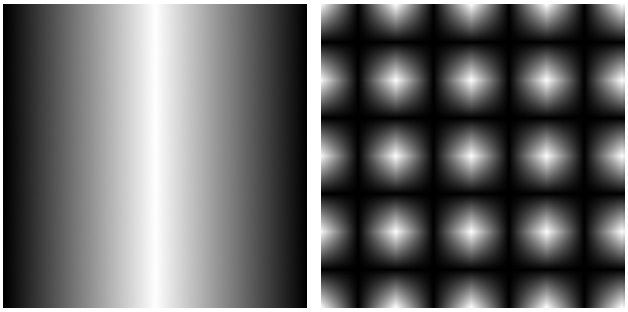

Figure 16. Architectural visualization of the resulting optimized structure

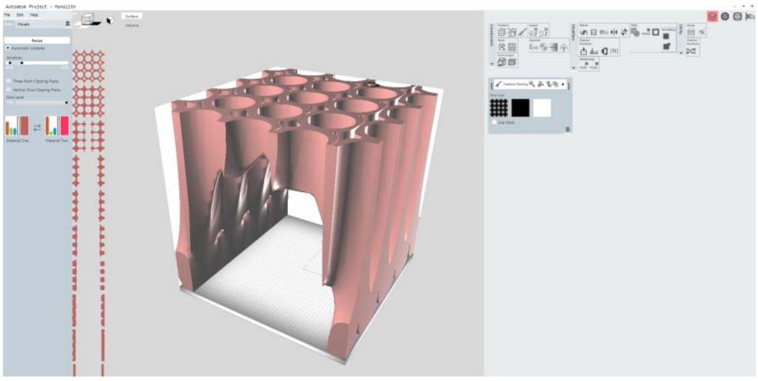

Figure 17. The form resulting of images used for case three.

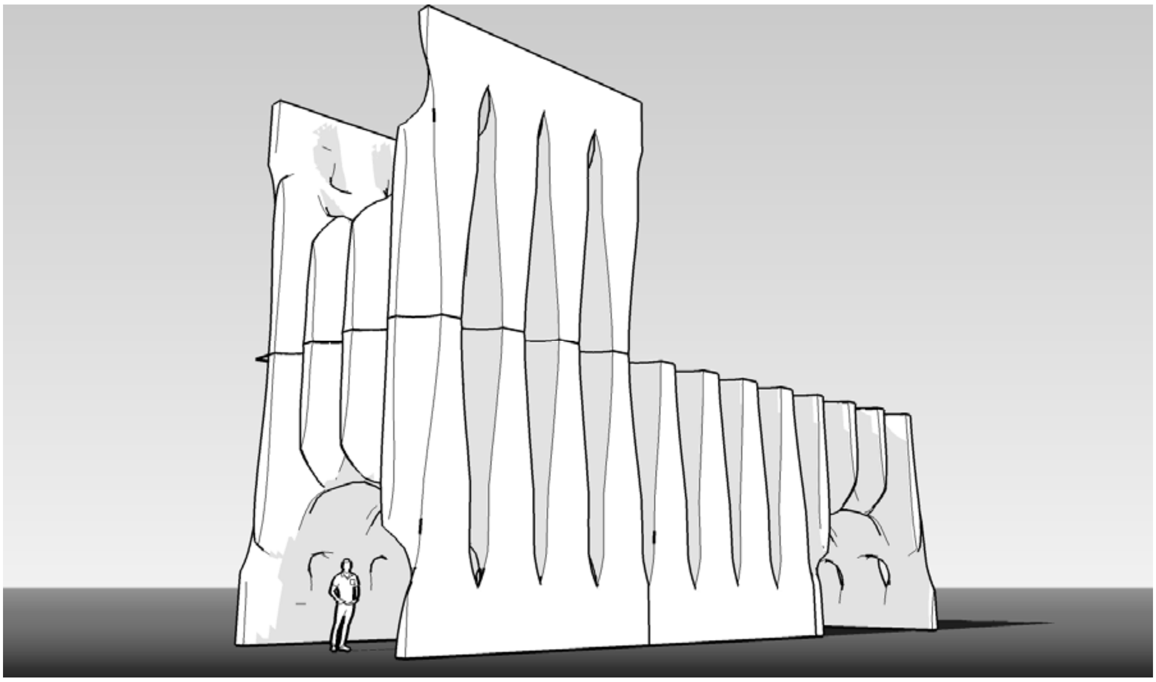

Figure 18. Architectural visualization of the resulting optimized structure of case three.

4. Discussion:

Producing traditional looking buildings with the AM technology would be one dimension of utilizing it. The real potential would be to produce a new form following the new rules of production. Since the optimization process of the structure cannot predict the resulting form, this opens an excellent opportunity for a novel form vocabulary never used before.

The approach generates some dilemmas though, are we seeking 3D printing for productivity or novelty?

The other concern is about the approach to form, should we envision complex form that cannot be achieved by conventional manufacturing techniques, then develop methods to achieve it? Or envision a form that follows the physical boundaries and the structural properties and limitations of material and technique, and explore its possibilities?

This research sought the latter approach, trying to imagine what is possible first.

Many difficulties were faced due to the novelty of the test tools. The rough interface of the program and the unexpected behavior along with scarce documentation made the testing difficult. Issues with the resolution and proper scaling, as well as computing power required to run the analysis and the optimization of parts, also added to the difficulties.

5. Conclusions

There are potentials in utilizing the AM technology in construction; from speed of construction to economy, it is crucial to capitalize on such technology and benefit from it. The resulting form should be guided according to the designer intentions. However, it should also follow the physical limits of the used material.

Form exploration with new analysis tools opens a new horizon for architecture.

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TITLE

Decadent Digital Art growing into Architecture for Virtual Reality + Artistic Interpretations. Artworks: slideshow of JPGs from projector.

Topic: Art and Architecture for Virtual Reality.

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Abstract
I have been working on my digital artworks since 2010. I started to visualize my dreams, stories through photos, hand drawings, collages from paper. Later I used computer 2D and 3D programs. I created 3d models, rendered them and made collages again. I wanted to enter those 3D virtual spaces, be immersed in the digital world. Because I could only print 2D final digital images or present a computer slide show of digital images as a result.
With the possibilities of the technology of virtual reality is now possible to inhabit virtual space. Since 2015 I have been a PhD student at Czech Technical University in Prague. I figured out that in virtual reality you can cross the boundary between art and architecture. The border of what is the virtual art object, what is the virtual statue, what is architecture for virtual reality no longer exist.
I have spent 3 months in Barcelona on visiting research at ETSAB/UPC. I developed a case study architecture for virtual reality. I was interpreting Casa Milá of Antoni Gaudí and the urban plan of Ildefons Cerdà. I was able to design virtual spaces in 3D, but I was not able to transform it into virtual reality with VR equipment yet. That will be my next step.
I deleted functions and activities that are not happening in VR. I formulated a new manifest for architecture in VR:
1. Architecture in VR can float in space, can exist without gravity.
2. Architecture in VR can have no bearing structure or structure that has not connected parts.
3. Architecture in VR can change shapes and moves.
4. Architecture in VR can exist without project documentation.
5. Architecture in VR can be made without many pieces.
6. Architecture in VR architecture can disappear.
I would love to show my experiments during the Generative Art 2018 conference in Verona. It would be the JPGs slideshow.

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Key words: digital art, architecture, virtual reality, virtual environments.

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[2] Manuel Kretzer, "*Alive: Advancement in Adaptive Architecture*", Birkhauser, Basel, 2014

Decadent Digital Art Growing into Architecture for Virtual Reality. Presenting Paper and Artworks for GA2018

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Abstract.

This paper is about the development of my digital art into Architecture for Virtual Reality. I was educated as an architect, after graduation I worked a for few years in architectural offices in London and Los Angeles. In 2009 I got back to the Czech Republic and I worked for Universal Production Partners, UPP as a matte painter and I was creating digital backgrounds for films. I worked with Photoshop a lot and I learned how to create 2D collages very well. Then in 2010, I started to create my own art, in fact, I did collages from magazines with hand sketches. I drew on top of them. One day I used the computer to work on my collages digitally. In 6 months, I was thinking how to use 3D programs to create environments, renderings and how to express stories, emotions that I had in mind. Digital collages from renderings of 3D models were my step two. Every day I did at least one digital collage. I was learning by doing. I was experimenting with digital models and textures with hand sketches. Sometimes I even designed fantasy spaces, fantasy architecture, fantasy concepts. Since 2015, I have been a student at Czech Technical University in Prague, Faculty of Architecture. My topic of the thesis was the Theory of Smart Structures. But step by step I decided to deal more with virtual reality. I wanted to design environment, the architecture for virtual reality. Because I hope that in the future, we as humans will inhabit virtual space and work, relax and have fun online in VR platforms. Even now you can see people concentrated on the screen of their cell phone or tablet when they are in the city.

1. Digital Art.

Beatriz Colomina [1] in 2017 during her lecture in Prague asked the question, what will happen to the cities when people will no longer pay attention to the existing reality? My question is what will happen in virtual space if people will be inhabiting that virtual space? Should this space be designed by architects?

Vincent Guallart [2] writes about the meaning of the word ***digital***: "New Technologies make it possible to transform data flow to the point of creating authentic landscapes. Spaces with or ***without gravity***. The paradigms and the physical laws of the real world are not necessarily applicable to the virtual world. But this virtual world could be a clone of a real world or ***generate infinite possible spaces***, like a world with infinite times and therefore infinite possible, parallel histories. Quasi-real spaces. An acoustic space: a music room. A fractal trajectory. A mountain of infinite dimensions. A cloudy dawn: a city. ***Settings for virtual meetings and real use***. Spaces and computer programs accessible from an ***intermediate space that can lead to a virtual world full of real content***."

Fig.1 Digital Art, renders: Dear Emotion, 2010.

In my artwork occurred the topic of the virtual environment, virtual architecture, also interpretations of the virtual universe, space with no gravity, space with emotions. I was trying to figure out how to enter those digital spaces. In fact, when you can ***immerse yourself*** with the digital virtual space you are already in-between disciplines of digital art and closer to Architecture for Virtual Reality.

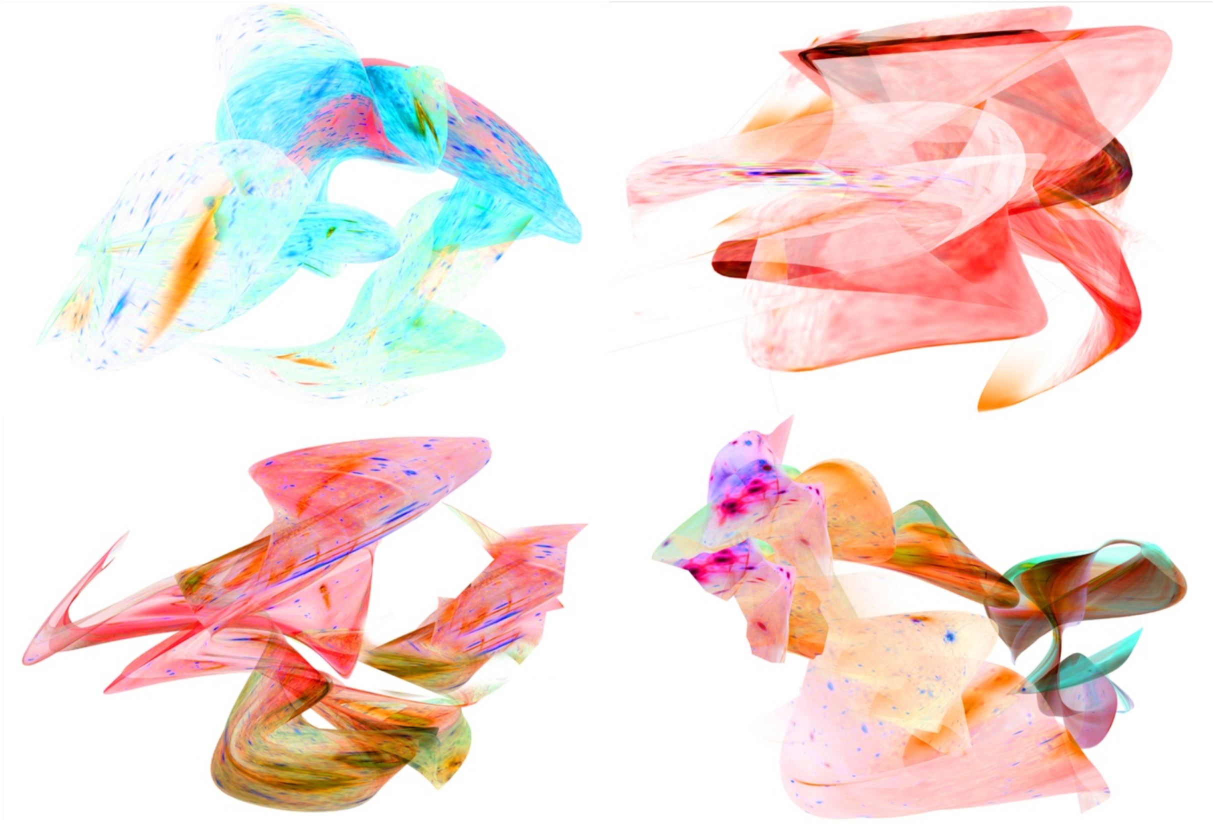

Fig.2 Digital Art, renders: My Private Universe, 2011.

Word ***virtual*** by Marcos Novak [2] means: “The virtual-as-construct enabled by the technologies of cyberspace or neurobiology is not to be confused with the virtual-as-ideal that exists as a hermeneutical figure, relativized and beyond all scrutiny. Just as the recognition of the embodied mind renders absolute the Cartesian mind-body division, the virtual-as-construct enacts an embodied that is engaged in the world as we are constructing it, in all its problematic but rich specificity. The virtual-as-ideal, on the other hand, stops short of engaging the underlying matrix of physics and materiality that makes both mind and cyberspace possible; the virtual-as-ideal limits itself to making isolated conventional forms in conventional space, dressing them in rhetorical conceit and leaving the world unchanged. The virtual-as-construct includes the virtual-as-ideal, for rhetoric, has its place in human affairs too, so the issue is not one of exclusion or dichotomy, but rather one of the considerations of the critical concerns of the visual-as-ideal in the production of artefacts within the virtual-as-construct. While the virtual-as-ideal operates by ‘troping’ and interpretation to enact power-plays of membership and exclusion, ***the virtual-as-construct encompasses a variety of existing, emerging, and still-to-be invented forms of expression, including liquid architectures, trans architectures, hypersurface architectures, and other as-yet-unnamed alien hybrids of bodyspace and cyberspace.”***

Fig.3 Digital Art, renders: Virtual Fashion Show Atlantida, 2013.

My invention is ***Architecture for Virtual Reality***. I think it will be a new discipline for architects, artists and designers who would design and create environment and spaces for virtual reality, because of the recent fast development of virtual reality and it's devices like VR glasses and headsets for VR.

Before I got to the topic of Interpretation of Architecture into Architecture for Virtual Reality, I had the topic Smart Structures in 2015 at the Czech Technical University in Prague, Faculty of Architecture. I was interpreting imaginary structures by 3D models from Rhinoceros, these models were my fantasies, creative designs that were inspired by real Smart Structures by Philip Beesley [4] or Manuel Kretzer [3]. From these 3D structures, I did renders, from renders I did 2D collages. But virtual reality works with 3D models only.

In my opinion architects, artists and designers should collaborate on creating the environment and architecture for virtual reality together with VR Specialists. I think that the exchange of knowledge between architect, artist and designer and between IT and VR specialist would really help both sides and they could create regular discipline Architecture for Virtual Reality. Just like when new media film emerged about a hundred years ago, there was no discipline called film architect. But with the new development of film as a media architect in that field was needed.

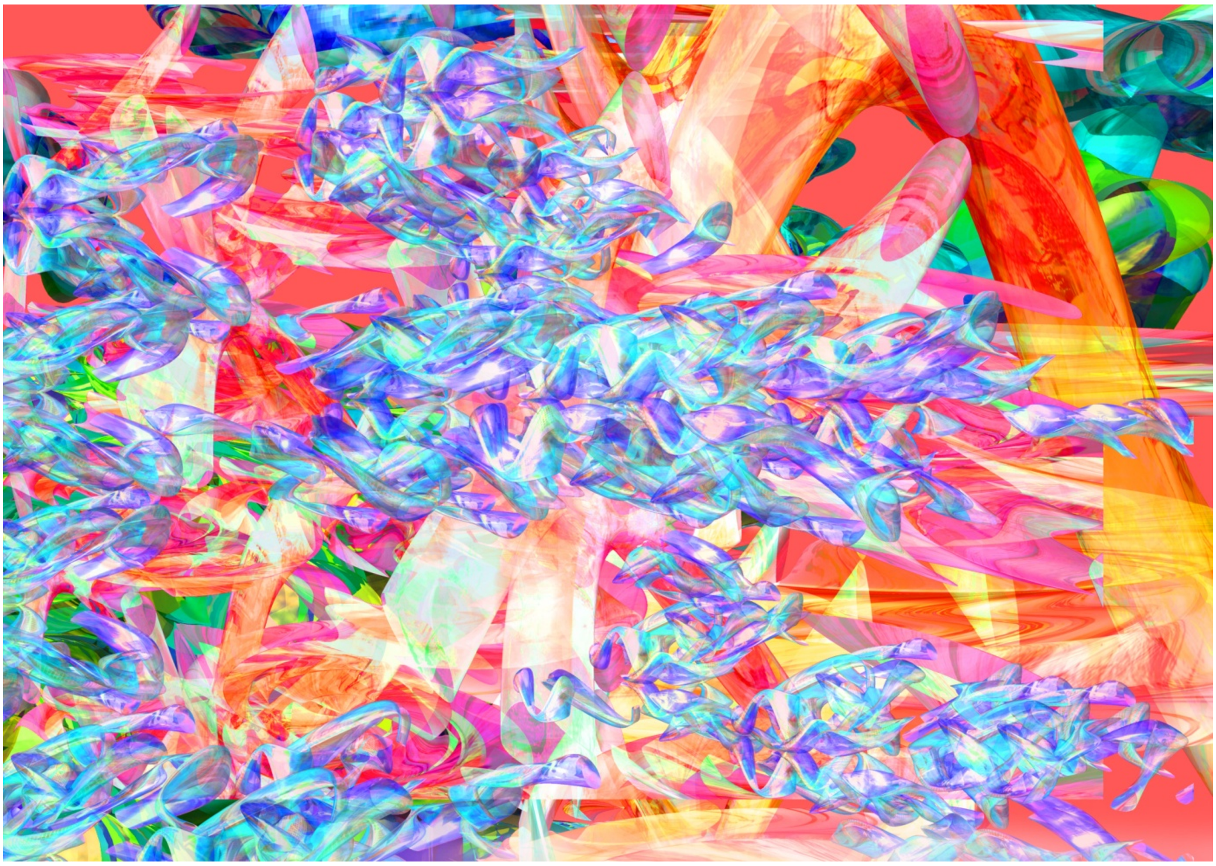

Fig.4 Digital Art, renders: Compositional Archontextures-Smart Structures, 2015.

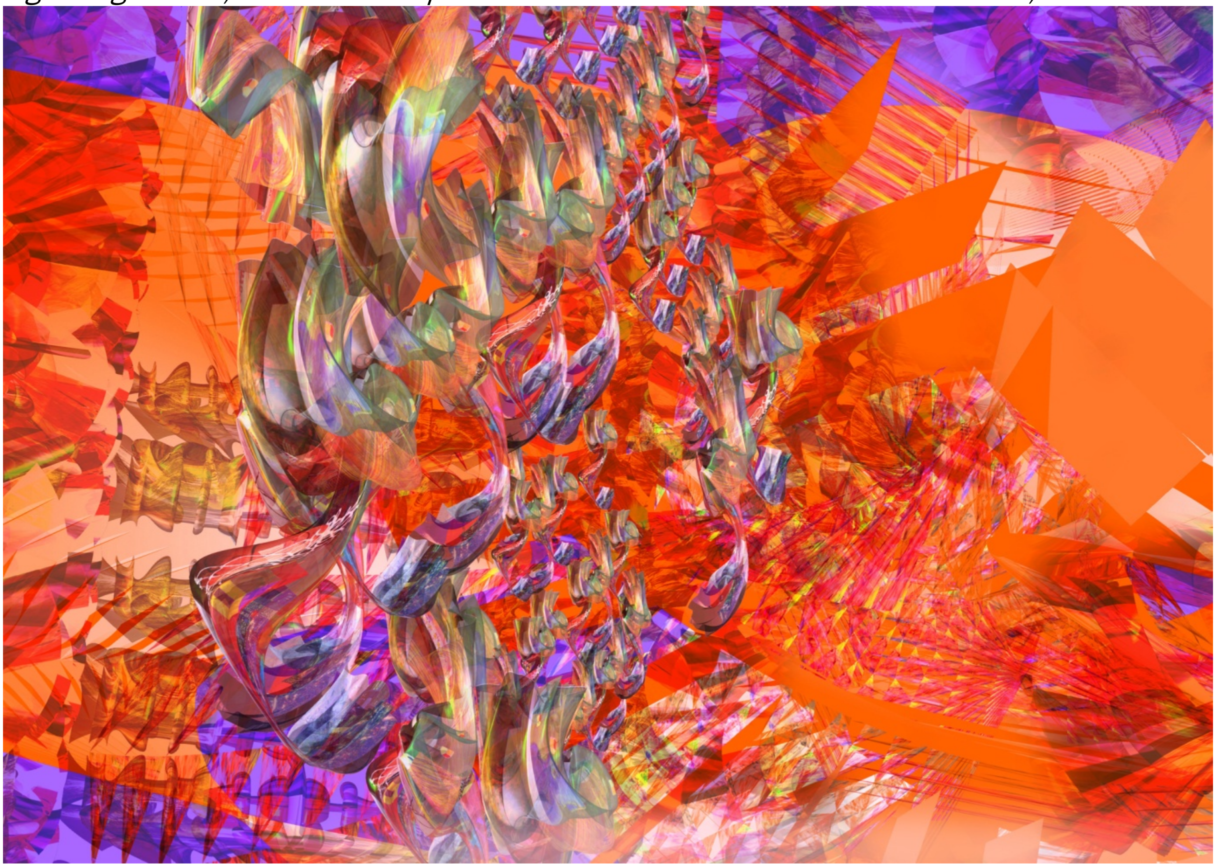

Fig.5

Digital Art, renders: Compositional Archontextures-Smart Structures, 2015.

2. Digital Art in Virtual Reality.

In 2016 I wanted to make the step from my digital artwork into the project in virtual reality. But there are some rules that must be followed in virtual reality that I was not aware of. I didn't know how the transformation of 3D model works into Unity or Unreal Engine. I tried to learn with tutorials myself. I even was a part of VR hackathon in 2016 with VR specialists and programmers. But I was not able to work alone in those programs. In fact, it is not possible to design collages there in VR. The 3D model must speak for itself without 2D corrections. The only possible work in 2D is on textures for 3D models.

I realized that I must simplify my models and use fewer textures and have no layers in 2D. By that time, I designed case study Magic Flower in 2016 and together with the help of MSF Digital office, we created Magic Flower. The size of this 3D model was as large as the size of a room in a virtual gallery. But this scale of it was not enough for me so the next step was to put this 3D object in the city. I redesigned the 3D model and changed the scale to the size of the city. We created in a team of 3 people (Jindřich Ráftl and Marek Kulkovský, the tutor was Miloš Florián) a video Green Travelling. The idea was that in the future people will travel in virtual reality in the body of an avatar to the virtual cities that they cannot visit personally in reality or meet friends and family there.

Fig.6 Art for Virtual Reality – Magic Flower, 3D object and background, 2016.

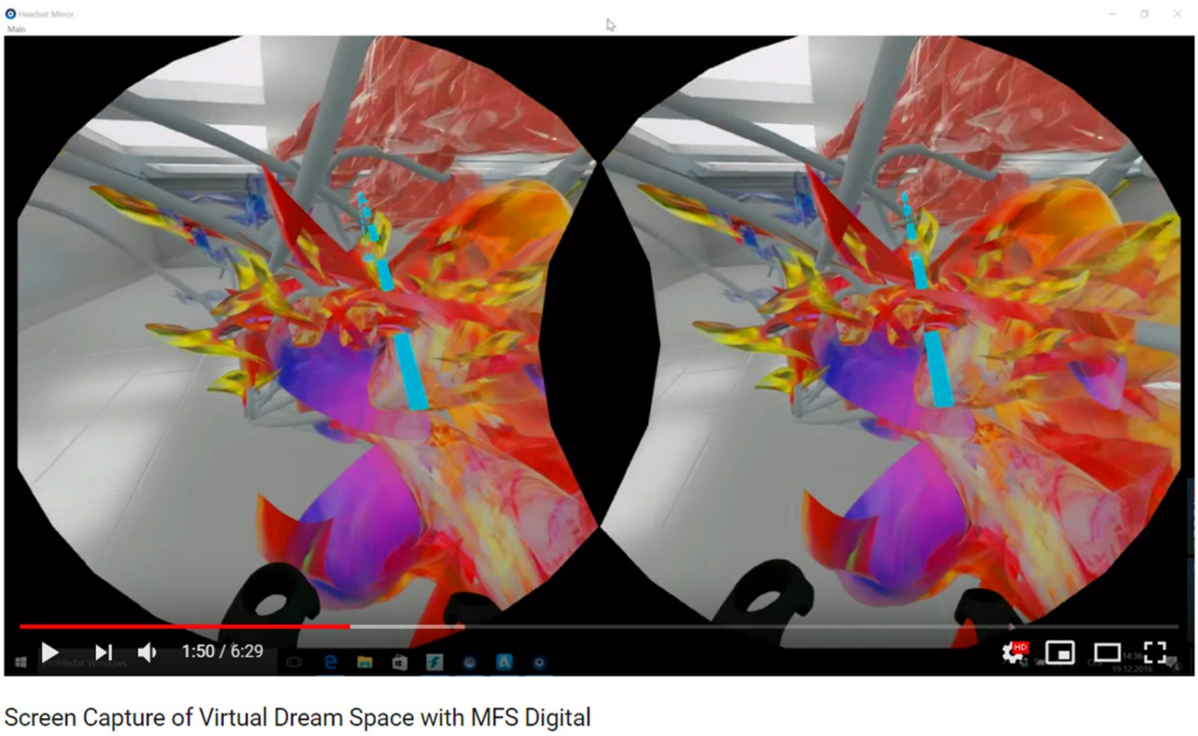

Fig.7 Art for Virtual Reality – Magic Flower, 3D object in VR, 2016.

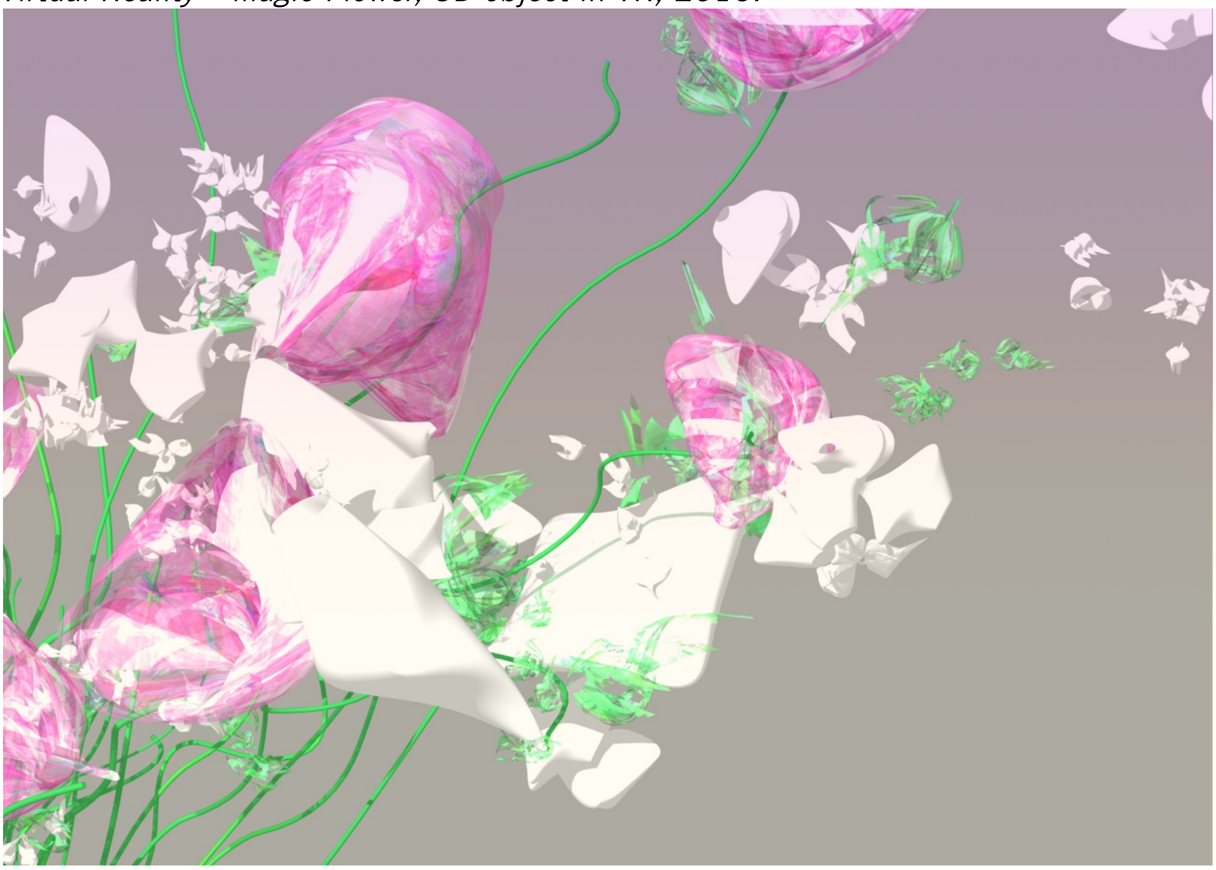

Fig.8 Art for Virtual Reality – City Flower, 3D object for animation, 2017.

Fig.9 Art for Virtual Reality – City Flower, 3D object for animation in Blender, 2017.

My method of research is the research by design. I just love the quote from Atelier olschinsky [5] from Vienna, that was founded by Peter Olschinsky and Verena Weiss. They are operating in various fields such as graphic design, illustration, photography and art direction. Their motto is: ***"It is just so important to work as much as you can, to learn and to be open to new things. The journey is the award."***

I completely agree with this method. My method is learning by doing, testing as many possible designs as I can, try on reflect of what I did and never give up! I was imagining Architecture for Virtual Reality that can be inhabited by the humans in a body of an avatar in VR. I observed existing social VR platforms like VR chat [6], Rec rooms [7], Altspace VR [8], Facebook Spaces [9], Sansar [10], and new VR platform High Fidelity [11]. To be honest, I admire how these platforms, how they technically work in VR, but I am not happy with the design of that virtual environment. If you look at how buildings and interior of those spaces look like, it does not correspond at all with the spatial possibilities that the VR space has. And the design of the environment of IT specialists does not get close to the contemporary architectural scene in design computing.

In Green Travelling video and 3D model, I was missing a ***real interpretation of the architecture***. I realised that the Architecture for Virtual Reality should be ***site specific.*** Why? Because if we are creating complicated spaces for virtual meetings we also need to deal with the time, in fact, spacetime. Let's just guess that in the future there will be a very complex system of the virtual environments and people need to meet in them. It is easy to copy the existing time and time zones if we relate existing real places to virtual sites. In fact, if you are virtually in Barcelona and, you are in New York and you are meeting someone from Tokyo, it is easy to check the real time in Barcelona and set the meeting for Barcelona time zone. About time, information-time-space writes also Manuel Gausa [2]: "Today we are conscious of a radical change in our interpretation of space (and in its associated idea of order), associated with the recent understanding of the theories of chaos and quantum physics. Causal (absolute) time and space and modern (relative) time-space have been succeeded by ***'information-time-space '***, open to the action of the local upon the global, and which gives rise to greater indetermination (and instability) ***in our understanding of the universe***. At the same time, it has enabled us to introduce, definitively, the influence of combinatorial and diversified, universal and individual information (and its dynamical effects) into the spatial manifestation of processes."

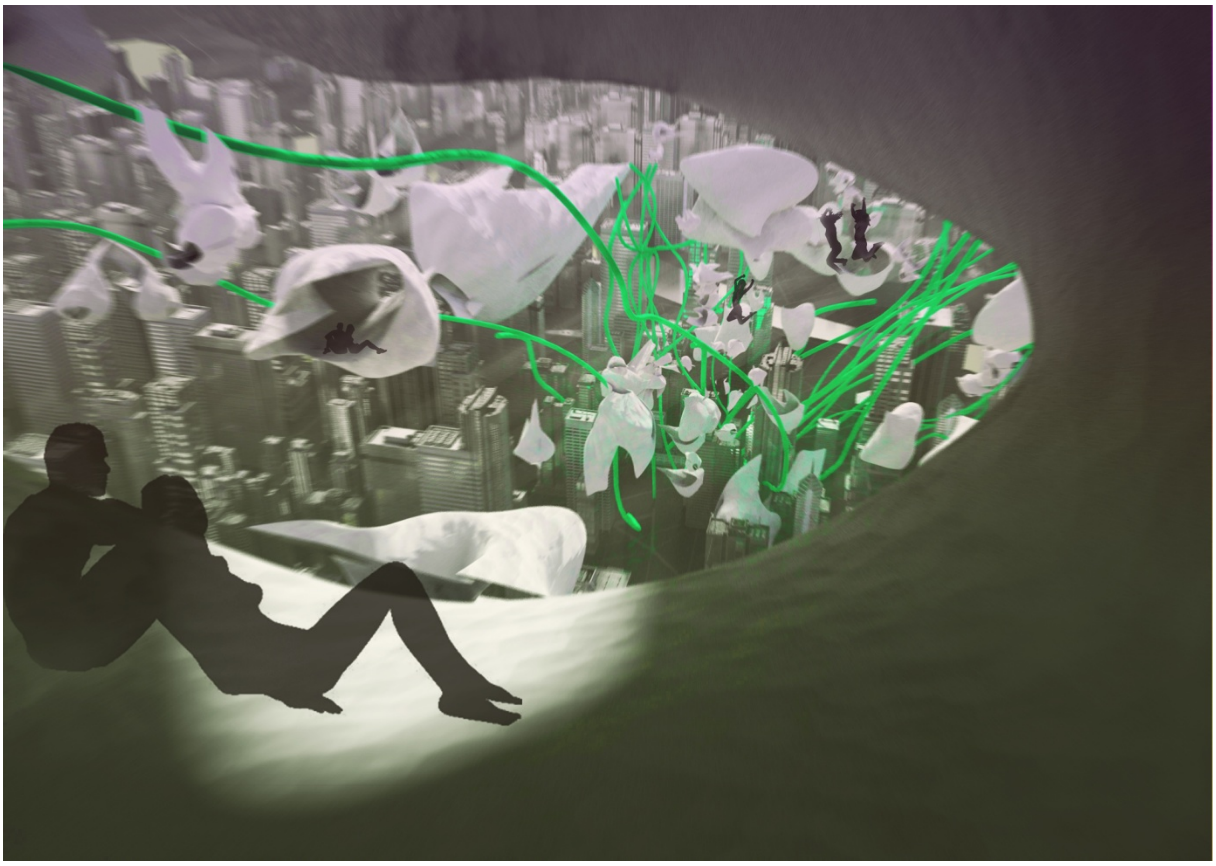

Fig.10 Art for Virtual Reality – City Flower, 3D object for animation in Blender, 2017.

When we design as architects, we use o lot of information from the real site and real conditions, also we have the task from the client. We search for the urban plan of the area, plans of the site, we build a model and 3D model of the site. We work with square meters of the program, we organize the program into volumes, we must deal with the light, legislative rules for the site, we search for construction system and we interpret our vision of architecture as well. What would be different in Architecture for Virtual reality?

3. Architecture for Virtual Reality.

Fig.11
Architecture for Virtual Reality – Interpretation of A. Gaudí's Casa Mila and I. Cerda's urban plan Eixample in Barcelona into Architecture for Virtual Reality.

I wrote during the visiting research at School of Architecture ETSAB Barcelona in 2018 the Manifest how to design Architecture for Virtual Reality, there are some parameters that seem to be constant. During the studies, I used books about urban plan of Barcelona and about Gaudí's architecture [12,13,14,15]. It is the confrontation between the real city, real architecture and my project:

1. Spacetime: Find a place on Earth (the real city) and copy real time on Earth and connect it with the virtual 3D model. If it is for ex. Barcelona, it will have the same time, day, night like on Earth.

2. Context: Observe and study contemporary conditions in this place (the real city), but also historical urban plans and architecture, find unrealized and urban utopian plans for that place and architectural visions. Find out about more about local art.

3. Observe Virtual functions in that 3D model of the virtual city: new functions in VR, meeting of avatars, communication of avatars, relaxation of avatars, work of avatars, shopping, trade.

4. Interpretation of architecture and art of the locality (the real city) in 3D for VR: Be inspired by existing sources like plans, sections, experiences from this real place, photos.

5. Delete from the plans the function that does not exist in VR or they are not needed: Space for sleeping, toilets, bathrooms, lifts, stairs, corridors. Delete bearing construction of the building. Transport in streets by cars, bus, bikes. Delete from architecture in VR doors, windows, ceilings, chimneys, technical support of the building. Create openings that are needed.

6. Create 3D space, that reflects those new virtual function, use textures from the real place (the real city). For example, various areas in Barcelona would require similar approaches to designing architecture in VR. It is similar problem when we built architecture in the real city, it depends on the selected area in the real city and how we can derive the architecture in VR from that. I didn't try various locations in Barcelona, but I tested many variants in the

same area. My perception of my research goals/problem changed when I made the VR models for Barcelona.

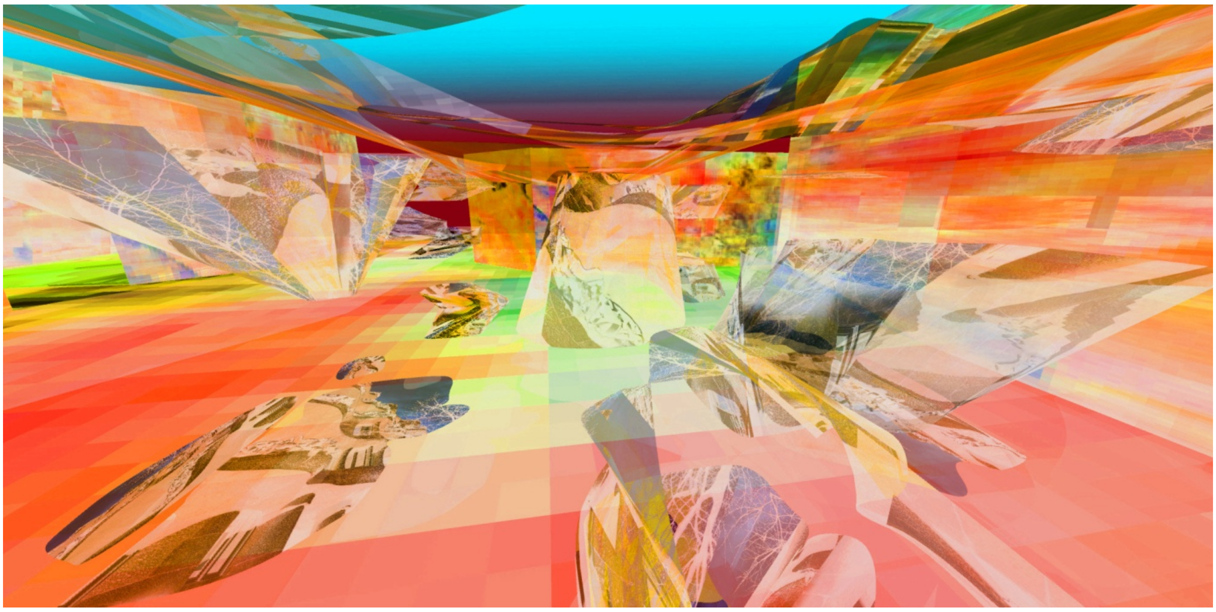

Fig.12
Architecture for Virtual Reality – Interpretation of A. Gaudí's Casa Mila and I. Cerda's urban plan Eixample in Barcelona into Architecture for Virtual reality, day summer.

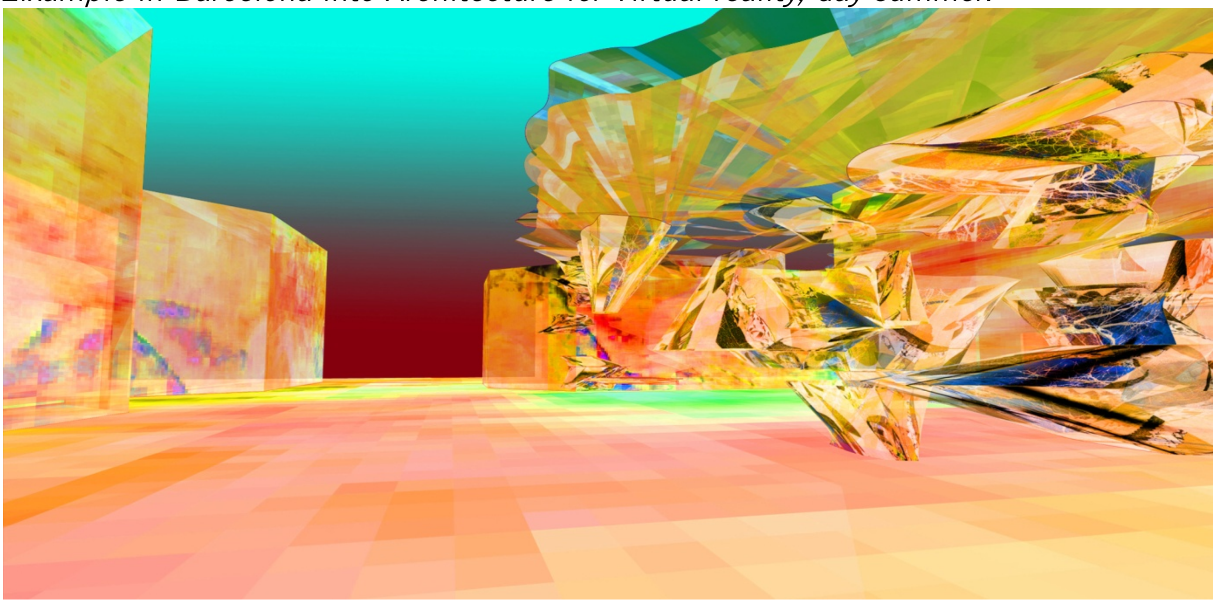

Fig.13
Architecture for Virtual Reality – Interpretation of A. Gaudí's Casa Mila and I. Cerda's urban plan Eixample in Barcelona into Architecture for Virtual reality, day, summer.

According to my Manifest Architecture for Virtual Reality, I designed and interpreted area in Eixample in Barcelona with the Casa Milá building. I was thinking about the different light condition and different temperatures that should be also interpreted into a 3D model in virtual reality. I used 3 textures for the 3D model and I changed colours in renderings afterwards. I used warm colours for warm days in summer and during the daytime. I also used different a palette of colours for night time.

I figured during the designing case study Barcelona Architecture for Virtual Reality, that almost half of my design process was the architectural way of thinking and the rest was my artistic approach.

Another question was how the ***avatar should look like***? I wanted to delete differences between people. Avatars would have no visible: sex, age, race, occupation, identity in virtual public spaces.

Avatars should have the human figure with green colour because green is not associated with male or female. Avatars would be able to reveal their identity and a 3D scan of their real personality if they wanted, in private spaces or even in public spaces.

Fig.14 Architecture for Virtual Reality – Interpretation of A. Gaudí's Casa Mila and I. Cerda's urban plan

Eixample in Barcelona into Architecture for Virtual reality, day,

summer.

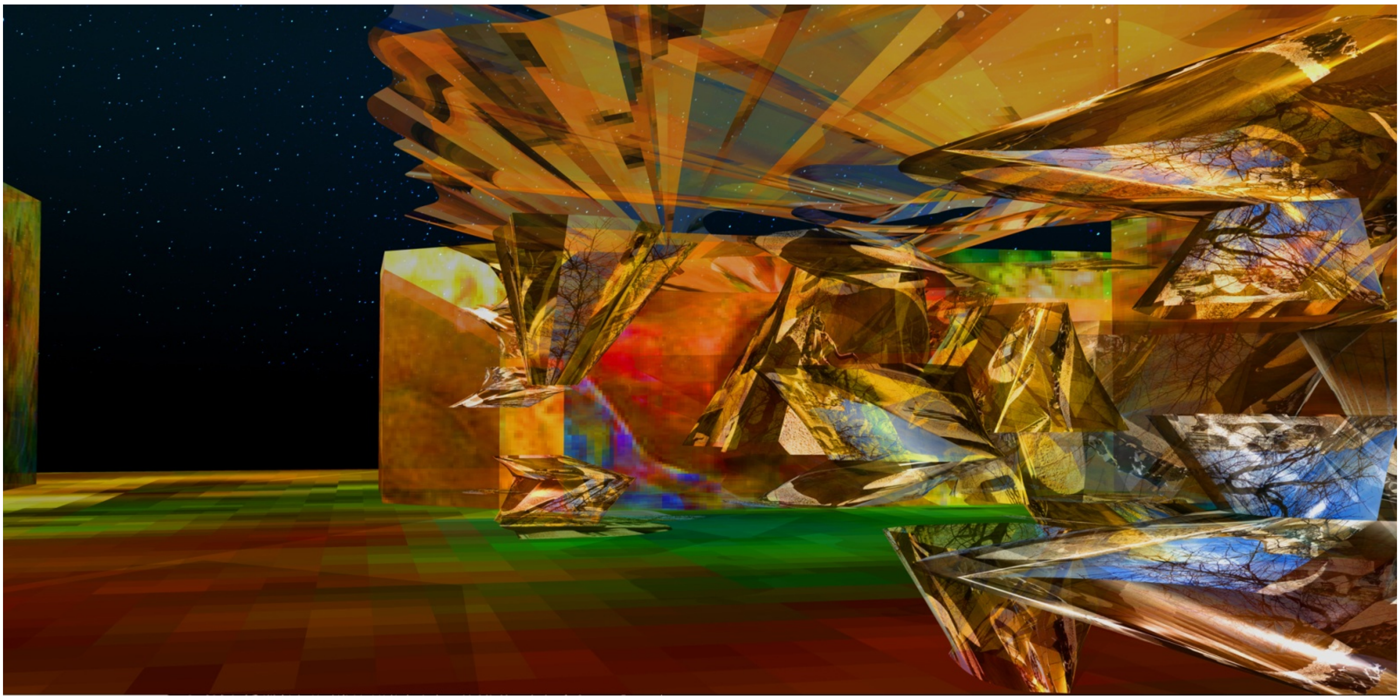

Fig.15 Architecture for Virtual Reality – Interpretation of A. Gaudí's Casa Mila and I. Cerda's urban plan Eixample in Barcelona into Architecture for Virtual reality, night, winter.

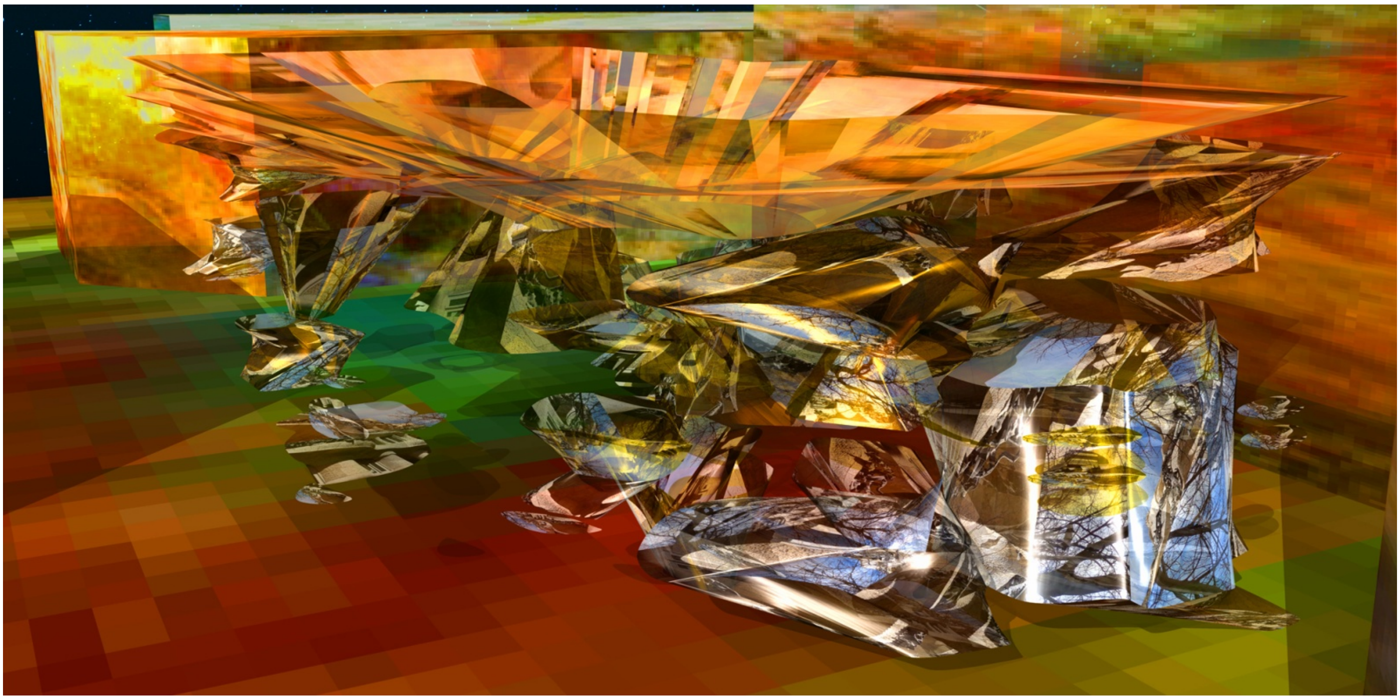

Fig.16 Architecture for Virtual Reality – Interpretation of A. Gaudí's Casa Mila and I. Cerda's urban plan Eixample in Barcelona into Architecture for Virtual reality, night, winter.

4. Conclusion, Findings.

After so many tests with digital art, I have to say it would be easy to say that it is not enough for me to present the digital artwork only in 2D renders. I was searching for a long time the right medium to transform digital models into 3D, so you can experience them as a virtual space. With the technology of virtual reality is all that possible and I tried to define a new direction in architecture and that is Architecture for Virtual Reality. I also I formulated also a new manifest for architecture in VR:

1. Architecture in VR can float in space, can exist without gravity.

2. Architecture in VR can have no bearing structure or structure that has not connected parts.

3. Architecture in VR can change shapes, colours and can move.

4. Architecture in VR can exist without project documentation.

5. Architecture in VR can be made without many pieces.

6. Architecture in VR architecture can disappear.

Celestino Soddu [16] wrote in his paper for Generative Art Conference in 2017:
"My generative approach in the early eighties, ***I defined my aim: representing my vision in architecture with codes, following the Renaissance cultural approach: art and science together as a logical interpretation of existing and possible worlds.*** This changed my design approach from forming to transforming, from shapes to processes, from drawings to algorithms. But I didn't change the structure of my creativity that continues to follow the structure of mosaic: rhythm, riffs, and melody. This approach had a chance: the possibility to directly design my vision, my idea of

architecture and Ideal cities before carrying out any possible result, together with the possibility to directly managing the complexity.
The Idea is performed by constructing something like an artificial DNA, a generative code able to generate endless variations of 3D models of cities and architectures, all characterized by my vision but all different, unique and unpredictable, as in Nature."

I think that we as architects, we are constantly working on different approaches how to design architecture and we are redefining what architecture embraces. I hope that media like virtual reality will bring other possibilities how to creatively develop the new direction in architecture, Architecture for Virtual Reality.
Just like in the past the invention of computers influenced how architects design architecture by design computing methods.

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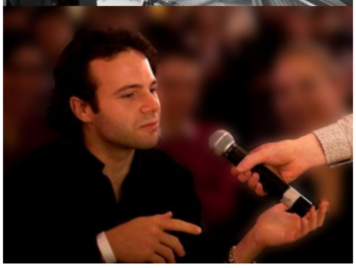

RENEWING CONTEMPORARY MUSIC COMPOSING, PERFORMING, AND LISTENING EXPERIENCE – IMMERSION AS PART OF THE CREATIVE PROCESS AND RECORDING
(Full Paper and Live Performance)

Topic: (Music, Gamification, Audio, Immersive Experiences)

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Abstract
The potential of virtual reality tools and the variety of software suitable for creating interactive music systems and sound environments provides artists, sound engineers, and music listeners more technical and artistic room than ever before. On top of enriching and facilitating the creative process of professional artists, VR technologies can also bring the music and visual contents of an artwork nearer to the audience, allowing them to better immerse themselves in the experience. Moreover, implementing such systems may help to bring more audiences to experimental contemporary music, thus also playing an important role in renewing the classical music culture. Hans-Peter Gasselseder produced the first ever virtual reality ambisonic recordings of two entire operas, "She" (2017 by Maria Kallionpää) and Croak (2018, composed by Maria Kallionpää and Markku Klami). We argue that on top of the artistic value of the musical compositions, a complete virtual reality recording has artistic value on its own right. We will discuss both operas from the composer´s perspective, as well as present their recording processes as case studies from the viewpoint of the sound engineer. As an example of future work, we will also present a new virtual reality recording concept, using Maria Kallionpää´s interactive Disklavier Composition "Climb!" (2016-2017). The work is simultaneously a virtuoso piano composition for a professional pianist and a computer game, that also uses a specifically designed smartphone application for audience members. Although the work contains visual stimuli also in the live performance situation, we argue that the listeners could better enjoy the interactive game element if they could follow the events directly from the performer´s perspective. Our model will focus on bringing the audience members in the middle of the actions of the virtual environment of the computer game.

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Key words: interactive music systems, opera, virtual reality, ambisonics, computer games

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Renewing Contemporary Music Composing, Performing, and Listening Experience.

Immersion as Part of the Creative Process and Recording

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Abstract

The potential of virtual reality tools and the variety of software suitable for creating interactive music systems and sound environments provides artists, sound engineers, and music listeners more technical and artistic room than ever before. On top of enriching and facilitating the creative process of professional artists, VR technologies can also bring the music and visual contents of an artwork nearer to the audience, allowing them to better immerse themselves in the experience. Moreover, implementing such systems may help to bring more audiences to experimental contemporary music, thus also playing an important role in renewing the classical music culture. Hans-Peter Gasselseder produced the first ever virtual reality ambisonic recordings of two entire operas, "She" (2017 by Maria Kallionpää) and Croak (2018, composed by Maria Kallionpää and Markku Klami). We argue that on top of the artistic value of the musical compositions, a complete virtual reality recording has artistic value on its own right. We will discuss both operas from the composer´s perspective, as well as present their recording processes as case studies from the viewpoint of the sound engineer. As an example of future work, we will also present a new virtual reality recording concept, using Maria Kallionpää´s interactive Disklavier Composition "Climb!" (2016-2017). The work is simultaneously a virtuoso piano composition for a professional pianist and a computer game, that also uses a specifically designed smartphone application for audience members. Although the work contains visual stimuli also in the live performance situation, we argue that the listeners could better enjoy the interactive game element if they could follow the events directly from the performer´s perspective. Our model will focus on bringing the audience members in the middle of the actions of the virtual environment of the computer game.

1. Introduction

Opera as a music genre possesses a distinct distinguishable character that has prompted a multitude of opinions about its design and structure. Correspondingly, the observed wide range of production styles reflects a multitude of fundamentally different aesthetical ideologies. Whereas traditional opera aesthetics appeal to certain audiences, some others may reject it. Opera, as well as other musical forms with a centuries long history (for example symphony and sonata), require a constant evolution in their design to stay interesting for the audience, as well as for music creatives. We argue that implementing innovative technologies in contemporary opera performance, composition, production, and recording opens up new aesthetical paradigms that can also reciprocally inform the aforementioned disciplines. This may also lead to reaching a wider audience among demographic groups that would normally not be inclined to the genre. Drawing on insights from legacy recording techniques, the realm of artefacts exhibited by guidance, orientation, and empathic externalization/deixis can inform hybrid approaches for immersive productions. A concerted effort to combine these methods within the context of technologies typically associated with virtual reality (VR) may hold the potential to transport listeners into the middle of the stage action, leading to a genuinely immersive audience experience. Most importantly, by means of the abovementioned interaction between stage production and dialectics arising from the recording artefact, these experiences may be accessible to and favorably affect all audiences alike.

In this paper we focus on two VR opera recording case studies by Hans-Peter Gasselseder: “She“ (2017) composed by Maria Kallionpää and “Croak” (2017-2018), composed by Maria Kallionpää and Markku Klami. These are first ever VR recordings made of entire operas that devise 3-dimensional 360-degree high resolution video and 3rd-order Ambisonics sound from multiple perspectives within a bespoke software interface. We argue that, in addition to the artistic value of the operas themselves, the recordings as artefacts per se evolve the experience of a ‘stage presence’ for the audience in synergy with the stage production to a degree that the newly united form stands as an artwork in its own right.

1.1 Evolving Contemporary Music

Composers throughout the history have been eager to evolve and renew their art form. The pursuit of creating something new and unique exists among contemporary composers perhaps more than ever, which may also be facilitated by the fact that they, unlike their predecessors, have a plenitude of high level technological solutions in their disposal. For example, machine learning, algorithmic composition techniques, gamification, interactive music systems, and different variations of mixed-media solutions can be applied for creating innovative music compositions, and Virtual Reality recording techniques have brought the art of music recording to a whole new level. However, the versatility of available software, faster computers, and other technical options also brings up new challenges with regards to the aesthetics, essence, and identity of musical compositions, composers, performers, and sound artists. This brings us to the question on how to make use of such technologies in a meaningful manner. We argue that technological advancements should never be an end to themselves in an artistic context, but should be used for obtaining such superior results that human artists would not be able to achieve normally. For example, Maria Kallionpää’s interactive game composition “Climb”, which will be further discussed in this paper, engages an interactive system that generates piano texture that could not be playable by a live pianist: for example, the work contains such overly fast tempi and simultaneous playing on various octave ranges that the physical or instrumental capabilities of a human performer would not allow. Rather than just demonstrating what such a system can do, the purpose for designing the music engine of “Climb” was to contribute to the concept of a virtuoso composition. The tradition of attempting to widen the limits of both the performers and their musical instruments started with the great virtuoso composers such as, for example, Niccolo Paganini, Charles Alkan, and Franz Liszt. We argue that modern, computers, software and other technological tools enable the composers and performers of today to further develop the concept of a virtuoso composition, thus providing more interesting artistic experiences for their audiences.

2.Composing Two Operas: “She” (2017) and “Croak” (2018)

The two operas by Maria Kallionpää, “She” and “Croak” (the latter work in collaboration with Markku Klami), were largely composed simultaneously, and the composition process of the interactive Disklavier composition “Climb” also took place within the same time period, which is why we find that these composing and recording projects should be jointly discussed. The VR recordings of all three works were produced by Hans-Peter Gasselseder. However, as each project was rather different from the others, also the approach with regards to the recording techniques and perspectives was defined according to their individual requirements. For example, whereas the two-dimensional staging of “She” called for the cameras and microphones to be placed further from the happenings onstage, the situation was completely opposite with “Croak”, in which they were placed in the middle of the stage, to make the viewers better understand the storyline and the interactions between the different characters of the opera. Whereas the staging of “She” suggested a two-dimensional, fairytale-like environment (Henry Rider Haggard´s novel “She” was selected as the plot of the opera due to its timeless and dramatic time travel adventure story that the composer found to be well adaptable for this kind of a musical drama), “Croak” was set to be a first-person experience, which had to be taken into account when customizing the recording plan.

Although “Croak” and “She” have many points in common (for example, the use of harmonies in both works is relatively similar), they differ from each other in terms of orchestration, storytelling, and staging. Whereas “Croak” engages a traditional middle-sized orchestra, “She” uses an ensemble with singular instruments only, with exception to the strings section, which is of a regular size. Moreover, the composer uses extended instruments in the latter work: the combination of Theremin and Magnetic Resonator Piano underline the divine characteristics of the main protagonist “She”/Ayesha. Rather than just using these instruments because of their exceptional sonic qualities, their function is to serve the drama and structure of the work. Furthermore, whereas composers typically write for Theremin very similarly like they do for voice, in “She” the Theremin part often utilises the extreme instrumental registers. Such orchestration refers to Kallionpää’s previous composition “The Song of War (2014) for orchestra, soprano, and Theremin soloists, which was composed for Theremin virtuosa Lydia Kavina. The unusual way of instrumental writing resulted from the tight-knitted composer-performer interaction and collaboration. Similarly to “She“, also “The Song of War“ contains a superhuman female main character whose presence is emphasized by using this non-traditional instrument.

Conversely, rather than in its instrumentation, the originality of “Croak” mainly lies in its staging: the work is the very first puppet theatre opera produced in the Nordic Countries. From the composer´s perspective the main challenge was taking into account the constant presence of the human-sized puppets that were specifically manufactured for the needs of this project by Viktor Antonov. How to consider the timing and the movements of the puppets, as well as the noises that they might cause? Both the stage design and the looks of the puppets were developing simultaneously to the composition process of the music. Although the original setup plan was aesthetically rather traditional, Antonov and the stage director Anna Ivanova-Brashinskaya decided to modernize it to better match to the musical material that they found to be stylistically more experimental than they had expected. Because of this, Antonov changed the design of the puppets: the new ones were made of lighter materials than the originals, and also the stage design became more minimalistic. Because many visual effects (such as, for example, Croak swimming under the water) were made by using a large and flexibly moving canvas of thin plastic, its rustling also put its mark on the sonic world of the work, as well as on the VR recording that will be discussed below.

3. "Climb!": An Interactive Game Composition for Disklavier

The concept of a "game composition" was originally presented by Kallionpää and Gasselseder in 2016 [1]. "Climb!" was the corner stone of Kallionpää´s artistic postdoctoral research project "Automatizing Musical Expression in Real-Time Performance Settings: Procedural Music Systems as a Composition Technique" that was hosted by the Aalborg University and the Mixed Reality Laboratory of the Nottingham University. The work is a result of the long-term collaboration between the researchers of the Mixed Reality Lab and Kallionpää: on top of artistic practice itself, this interdisciplinary project involved research in the fields of computer sciences, engineering, and visual arts.

"Climb!!" is a non-linear musical composition that combines the ideas of a classical virtuoso piece and an interactive computer game. The performer plays with and against the machine in a virtual game environment, meaning that the pianist performs together with a Disklavier that is controlled by an interactive system. "Climb!" is a super instrument work that intends to multiply the capabilities of both the instrument and the performer. With the combination of the pianist, Disklavier, and live-system, such effects that would not normally be reachable can be achieved. These include, for example, playing the piano in multiple octave ranges simultaneously, choosing fast tempi that would be otherwise impossible to play, and using complex rhythms that only a computer would be able to perform. The pianist and the computer form a seamless unity that enables virtuosity that exceeds the physical and cognitive limits of a human performer.

Computers can have a profound impact on music composition and performance, the works of Iannis Xenakis (1922-2001), Karlheinz Stockhausen (1928-2007), Pierre Boulez (1925- 2016), and their many other contemporaries being illustrative examples of this [2]. "Climb!" is its composer´s most technologically inspired work, as it engages an interactive digital score, Yamaha Disklavier, interactive visuals, a smartphone application (on which the audience members can follow the progress of the game/musical performance), and an online archive that saves all the performances. The composer regards the online archive to be an artwork itself, a collage: so far it consists of various concert performances by three pianists (Anna Veinberg, and Zubin Kanga, and Maria Kallionpää). The interactive system of "Climb!" is based on the Muzicodes software that was developed by the Mixed Reality Laboratory. By embedding codes (musical motifs or fragments that the system recognizes and uses for triggering its programmed functions) in the digital score, the composer created a nonlinear entity in which the pianist or avatar navigates. The structure of the entire composition depends on how the performer plays the codes. Depending on whether the program recognizes the codes or not, one lands at the different point in the score. There are two kinds of codes, namely the simpler ones that just to trigger effects (for example, inform the system when the Disklavier should play) and the "challenge codes" that are more complex and that have a structural meaning. The latter function similarly like leitmotifs, as they are musical "keys" that define the course of the performance. Moreover, various functions of the system are randomized. For example, different kind of filters (for example reverberation or alteration of the sonic spectrum) are applied onto the musical performance in an arbitrary order. These symbolize the weather conditions that are part of the narrative of the game.

3.1 The Form and Narrative of the Composition

As discussed above, "Climb!" got its inspiration from the modern computer games. The game narrative is based on a story of an avatar climbing on top of a mountain. On their way to the summit, they face challenges, animals, landscapes, wanderers, hallucinations, and various other situations. The story is communicated to the audience with pre-composed contemporary classical music miniature pieces that together form a large-scale virtuoso composition with a duration of between 25 and 30 minutes, supported by the interactive visuals and the smartphone application. A relatively abstract picture of a mountain is reflected on a canvas in a concert space. The mountain changes its colour and shape in accordance to the music, and the smartphone application shows in which part of the mountain the avatar is located, the route they used, the approaching challenges, as well as the names of the movements that the pianist is currently playing. Moreover, the routes taken in previous concert performances can also be viewed on the application.

"Climb!" consists of three "macro compositions" that symbolize the three paths to the summit. The pianist or gamer chooses one of them by playing one of the three default codes at the end of the very first movement ("Basecamp"). The abovementioned challenges and encounters are interpreted into music by creating "micro compositions" ("events") that occur in the course of the three main paths. Within every performance the paths and events get organized differently, as they branch to each other depending on how the pianist interprets the musical codes. Moreover, the randomized sound processing ("the weather conditions") also affects the sonic colour and the sense of acoustics, to which the performer has to adapt their interpretation.

4. The Immersive Opera: Producing a VR Experience

In addition to their artistic considerations, the operas "She" and "Croak" featured some strong technical aspirations that set them apart from previous offerings in the genre. To the best of the authors' knowledge, both productions represent the first full-length recordings of an opera in an immersive format that supports 3-dimensional 360-degree video and audio for playback and control in virtual reality (VR; i.e. head movements as well as six degrees of freedom facilitated by volumetric simulations in "CROAK VR"). Apart from an implementation for VR, a further desideratum of the recording plan was to maintain high compatibility with legacy as much as next generation formats, with supported playback setups ranging from traditional channel-based systems (such as 5.1 surround sound) to full 360-degree object-based surround (either rendered binaurally or on an arbitrary number of loudspeaker pairs). Whereas both operas share a common paradigm in their recording philosophy, that is to offer the spectator a perspective otherwise unattainable to an audience member of the live show, they also showcase differences in the application of immersive recording techniques due to circumstantial requirements set by the stage design/directing, musical material/orchestral layout as well as legal considerations.

With regards to the video material, for "She", a two-dimensional 360-degree format was to account for the entirety of stage properties being simulated by projections on a translucent screen positioned anterior to the characters on stage. This positioning allowed spectators in VR to move around in the scene, looking at the stage in the front and at the orchestra at the back Due to the play directors' intentional use of a stage design that was to mimic a two-dimensional perspective in reference to the mythological character of the narrative, it was decided to uphold this quality while extending its immersive potential by placing the main camera rig (Insta360 Pro in 2D at 8k resolution, see [6]) closer towards the characters on stage (approx. 2 meters to camera objects) as compared to standard setups in VR production (approx. 4-6 meters if shot close-up). This allows users to experience the characters from up close but also to zoom out of the equirectangular source (an option provided in the user interface of the bundled software) as to get a view of the overall 'canvas' that the stage design was intended to convey. For audio, the same rationale came to effect by placing a prototype 3rd-order Ambisonics microphone (Zylia ZM-1d; prototype kindly provided by the manufacturer Zylia [5]) in front of the orchestra (i.e. at the level of the conductor). This acoustic perspective was chosen to underline the staging (i.e. everything placed in front of the spectator), but also to add the sense of place (i.e.

offering a more holistic acoustic representation of the situational context with less direct and more reverberant sound reaching the microphone) by positioning the microphone further back from the camera rather than placing both at the same position (, which would represent the standard dictum in VR productions, see [4]). In addition, the flexibility achieved by recording in Ambisonics allowed to focus on different sound sources during post-production as much as during real-time playback in the final product. To give an example of a typical use case, turning ones' head towards the magnetic resonator piano at the left side of the orchestra pit will turn its sound more prominent in comparison to the otherwise dominant orchestral texture within the mix.

When reflecting on an early review of the methodological insights gained while recording "She", for the visual domain, on the one hand, the added sense of 'being there' was achieved by moving closer and thus offering more detail on the character interactions. For audio, on the other hand, the counter-approach seemed most effective by moving further away from the scene and subsequently adding a holistic sense of space and situational context to the experience (see [3] for some theoretical considerations related to this finding).

In contrast, the production of "Croak" exhibited a rather different set of criteria to be respected by the recording. Whereas the staging of "She" necessitated a two-dimensional approach with added depth (for the sake of supporting the sense of involvement as much as 'being there'), the production of "Croak" posed a challenge in the opposite direction. The production made little use of stage properties but rather had its characters move a lot and explore the depth of the stage to large extend. Moreover, the nature of the main characters being represented by life-size puppets controlled by puppeteers would have made spectators prone to confuse character relationships if the same two-dimensional recording setup had been used as in "She". Thus, rather than positioning the recording gear close-up (visual) / far-off (audio), the recording rationale opted for a wide and more distant view of the stage that embraced depth by means of a three-dimensional video (as compared to the two-dimensional approach applied in "She") and a more surrounding audio experience. This allows spectators to differentiate the suggested layers of diegesis that are inherent in puppet theater where the representative characters ("puppets") are accompanied by puppeteers, and in the special case of opera, also by individual singers. Where "She" required depth in its depiction of the stage, "Croak" necessitated a sense of segmentation of the different hierarchical diegetic layers suggested by the positioning of individual actors/singers. With puppets commonly positioned in the mid-front, singers at the side edge of the stage, and puppeteers further behind the former two, a three-dimensional video in 360-degrees enables spectators to differentiate these (hierarchical) layers. Another complexity specific to "Croak" posed the stage lighting, which varied in color and, in combination with the shadows cast by the puppets, caused interesting reflections onto the sides and rear of the concert hall. These reflections were mainly visible from the audience's perspective. In order to capture the depth of the stage as well as an alternative perspective of the hall from the audience's view, the main camera rig (Insta360 Pro in 3D at 6k resolution, see [6]) was placed approximately 6 meters at the edge between stage and orchestra pit. Furthermore, the primary rig was extended by a secondary 360-degree camera setup (2x Kodak SP360 4k, see [7]) positioned between the first row of the audience seating area as well as above the conductor in the orchestra pit. For the final VR experience, this configuration enables a change of perspectives during playback when zooming out from the footage recorded on the primary camera and blending over to the material that was shot on the secondary camera rig. Due to the lack of available software allowing for the playback and control of different camera perspectives in VR, we developed a custom player accounting for the aforementioned requirements within the game development platform Unity 5. Opting for a 2.5D paradigm that involves the mapping of flat surfaces onto 3D-objects, the player software devises cube projections and static displacement maps to place the camera footage within a 3D-environment. The footage obtained from either camera perspective can be assigned to individual hotspots. These come to effect upon reaching a threshold value of the zoom control parameter and allow for seamless transitions and blending of both camera perspectives.

In this way, if the user decides to switch perspective or focus on another object shown on stage or in the audience room she/he is always presented with the highest resolution of the chosen perspective.

Moreover, as different perspectives are being blended between two pseudo-rooms of the same scene (i.e. stage and audience room), a careful consideration of camera positioning holds the promise to generate transitionary scenes within the virtual environment (i.e. extrapolating new virtual perspectives, not shot with physical camera positions, but generated from footage obtained from available physical perspectives) and approach a six-degrees-of-freedom (6DoF) volumetric simulation paradigm where users could move around freely within the captured video footage as part of the tracking along the translation axes within a virtual environment rather than to be limited to rotational orientation alone. To explore this idea, an in-development version of “CROAK VR” uses a mixture of photogrammetry of a static scene while blending in extra layers that exclusively contain the moving parts of the scene (i.e. puppets and puppeteers). As only the primary camera position was recorded in stereoscopic 3D, the required depth information (i.e. depth map using shades of black/white to represent distances from the camera) was projected from the primary onto the secondary camera rig. However, this procedure involves a lengthy process of rotoscoping and shading moving objects onto the corresponding depth map of a scene. By the same token, the extrapolation of virtual perspectives may suffer of artefacts related to the lack of resolution and spatial synchronization between depth maps obtained from the different camera models and positions. Moreover, due to the nature of the flat capturing inherent to video, we are missing out on information that lies behind those objects facing the camera (i.e. accuracy of textures is two-dimensional but displaced within a three-dimensional volumetric simulation). Whereas this working method would pose the risk of artefacts separating acting characters from the remainder of the scene (as in the lack of accounting for shadows and blending silhouettes), the specific staging situation of Croak allowed to make such sacrifices at the benefit of the overall experience. In this connection, it was found that in comparison to the unprocessed footage, the artefacts resulting from unsynchronized depth processing contributed to an appearance of puppet characters that was more abstract and divorced from reality, whereas the remaining acting parties (puppeteers, singers, orchestra/conductor, audience) were almost left untouched by the alterations. It is believed that this technique supports the user in distinguishing the different layers of the diegesis, which suggests three acting parties (puppet, puppeteer, singer) as an agent of a single character and thus has to tackle the issue of assigning agency of various expressions (appearance, action, singing) to a single originator.

As for audio, the staging as well as setting of “Croak” implied moving closer with the Ambisonics microphone (Zylia ZM-1d prototype) towards the stage action. Therefore, the microphone was placed between the stage and the orchestra (rather than in front of the orchestra as in “She”) and also functioned as the center of a Decca tree setup that was supported by an additional 12 spot microphones. The reasoning for a closer acoustic perspective for “Croak” was two-fold. First, the lack of a contractual agreement between the producers and the orchestra meant that no orchestral material could be released on a public recording. Thus, a solution had to be found that would allow separating the voices of the singers and choir on stage from the orchestra, which would later be replaced by realistic virtual orchestrations. For that purpose, a drier (i.e. less reverberant) signal was preferred from which voices could be isolated during post-production. This was made possible by a bespoke procedure that focuses individual sound sources in a first step (with the help of directional focusing achieved by Ambisonics recording techniques; as realized in software such as Zylia Studio Pro, see [9]) and separate these from the remaining interfering signals during a second step of post-production (i.e. using spectral editing as well as specialized software such as Audionamix ADX Trax Pro 3, see [8]). Subsequently, a multitude of isolated signals derived from the virtual microphones of the Ambisonics signal is used to phase-cancel harmonic noise and sum the target sound source (i.e. the voice of a soprano during a loud orchestra tutti). Being able to isolate individual voices and instruments from a single physical microphone position allows for elaborate post-production techniques that facilitate mixing in object-based audio formats and thus enhance quality and flexible adaptation of immersive audio content for different output formats. The second rationale for a closer acoustic perspective goes in line with the previously outlined reasoning behind the camera setup. The recording intended to capture the singers more up-close as to enable spectators to locate the source of a voice and identify characters at a higher accuracy, thus facilitating diegetic orientation. As a result, the audio tracks of the VR presentation place spectators in the middle of the action, with the singers and choir positioned at the front and the orchestra at the back of a 360-degree sphere.

Conversely to the findings on “She”, the sense of spatial awareness within the audio recording of “Croak” was less invested into the room/environmental aspects of the concert situation rather than the dramaturgic nature of character relationships and its construction of absorption (see [3]). In contrast, the video material served as a means of enhancing the sense of space and context, a function that in “She” was predominantly covered by the audio recording. Following this, the varying conditions of two opera productions led to two quite different recording approaches of immersive content for VR, a format that in other genres holds the common notion of standardized camera and microphone configurations. However, these two examples demonstrate the need to consider the individual requirements of the specific content as well as its associated genre. Whereas an opera recording in a legacy format (i.e. two-dimensional 16:9 aspect ratio) leaves it to the film director to edit camera cuts and foci of the action, VR hands over such responsibility to the spectator/user. It is thus even more important to suggest the user with specific contextual functions respective to the visual and acoustic domain of the presentation to establish guiding markers of the diegesis between the meta-virtual (i.e. the depiction of the stage performance) and its (infra-) virtual realm informed by the nature of the physical environment (i.e. the concert hall). If made aware of these roles on an implicit level during initial contact with the content (i.e. the overture of “Croak”), users are more likely to recognize the meaning structures as well as the extend of possible actions on different layers of abstraction (i.e. what’s to be depicted on stage versus what physical setting it is being staged in). Giving users of VR an initial understanding of the relevance and modal representation of each of these realms builds an authentic representation of a truly immersive experience that is more than a documentation of its original performance.

5. The Immersive Concert: Recording for Volumetric Simulations

The third offering of our VR lineup tried to account for the shortcomings and improve the efficiency of the production pipeline in use during the previous two recordings. Furthermore, it considered the time limitations of the setup inherent to the location (Abbey Road Studios, London; Studio 2) and occasion of the concert (FAST research network at an open event as part of Abbey Road RED). In contrast to “She” and “Croak”, the performance “Climb!” does not belong to a representative dramaturgic genre per se, but rather showcases an affinity towards programme music. Despite its focus on a narrative as part of the conceptual and compositional structure, the audience finds itself as part of a concert setting that deviates from the normal by means of an interaction between the player and the piano. Because “Climb!” does not rely on a uni-directional performance paradigm but affords a constant change of focus between two agents, the recording plan had to account for two protagonists rather than one; that is the pianist and the motorized piano itself. If not presented with the auto-performing piano en face, the audience would have difficulty in entrusting the performance as being authentic. This is true especially in the light of the electro-acoustic setup that was used to simulate the weather conditions (i.e. filter effects applied onto the audio stream obtained from microphones positioned inside the piano). Naturally, under those conditions the audience would be presented with sound originating from the acoustic instrument as much as with the processed signal output by speakers. Thus, it was important to support the users’/audiences’ awareness of the two interacting agents, where the first would impersonate the human nature of the climber while the other laid out the circumstances and challenges of the environment where artificial, superhuman powers (i.e. weather or natural adversaries/challenges) outreach human limitations (note: ironically, it appears to be the most efficient path to mimic nature in music by opting for a rendering of artificial otherness that lies beyond the human grasp). Hence, the user would have to witness the action on the piano keyboard itself to understand the struggle between these two intersecting worlds. In order to account for these requirements, a first-person perspective was chosen where the main camera (Insta360 Pro in 3D at 6K resolution) was positioned right above the pianists' head. This perspective places the action of piano keys and hands of the pianist as well as the overall happenings inside the studio (i.e. technicians, audience) at the center of attention while the head of the pianist would be positioned in the periphery of vision at about 150-degrees vertical.

Ultimately aiming to allow the user to walk around the piano in 180 degrees towards the right of the VR environment we set out to put in practice a more efficient method to capture the information required for the methods tested as part of the alpha "CROAK VR" experience. In total, four stereoscopic camera rigs were positioned in a half circle around the piano. Apart from the aforementioned first-person perspective, the second camera rig was placed towards the right of the performer at 45 degrees (2x Kandao QooCam in 3D at a combined 8K resolution; custom mount), the third rig at 90 degrees (2x Kandao QooCam in 3D at 8K) and the fourth rig at 180 degrees (2x Kodak SP360-4K in a stereoscopic configuration). In addition, a further camera (Insta360 Pro in 3D at 6K resolution) was positioned within the ranks of the audience's seating area.

Similar to "CROAK VR", the in-development "CLIMB! VR" experience will enable users to switch and seamlessly blend between these camera positions. However, the exclusive use of stereoscopic cameras facilitates the process of deriving depth information for the application with displacement maps (for a detailed overview see Gladstone, 2018a; and the Stereo2Depth python script, Gladstone, 2018b). A bespoke procedure of spatial synchronization (i.e. pixel-by-pixel mapping of depth maps between camera positions) of the footage allows us to benefit from the relatively high number of stereoscopic 360 cameras surrounding the piano. Hence, it is possible to combine these perspectives and blend between depth maps and their associated displacement vertexes from each position at a relatively low count of artefacts. The blending between positions occurs at a relatively low threshold when the user moves outside the hotspot area of an active camera position to the degree that 6DoF related artefacts along the horizontal plane outweigh artefacts from a neighboring camera position. By making use of these methods, "CLIMB! VR" will allow its users to roam around the piano and experience different close-up perspectives of the performance, as in following the key action right above the shoulders of the performer or stepping over to observe the piano hammers and strings or to look at the pianist and audience from behind the grand piano. More importantly, 6DoF and volumetric simulations enable users to explore what lies in-between these camera positions and disclose a more immersive experience than what was originally bargained for with traditional stereoscopic recording equipment.

6. Conclusion

Opera is an intriguing space to work when one wants to explore the design and development of new technologies that might impact up the composition, performance and staging of such work. Working in such spaces are complex, but there is value in understanding the way that this art form can offer exciting and new possibilities to further understand the way that new technologies relating to autonomous systems for compositional practice, Virtual Reality spaces for performing and non-linear narrative/performance structures can be developed and applied in the real world. However, technological development should never be an end to itself, but to function as a vital part of the artistic methodologies used in a classical music composition. If used this way, the evolution of technological tools can significantly enrich the creative outcome and allow the listeners, as well as the performers and composers, to experience an opera performance in an immersive and artistically meaningful manner.

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FROM LINES TO CIRCLES: RETHINKING DESIGN COORDINATES
Paper

Topic: Design AND Architecture

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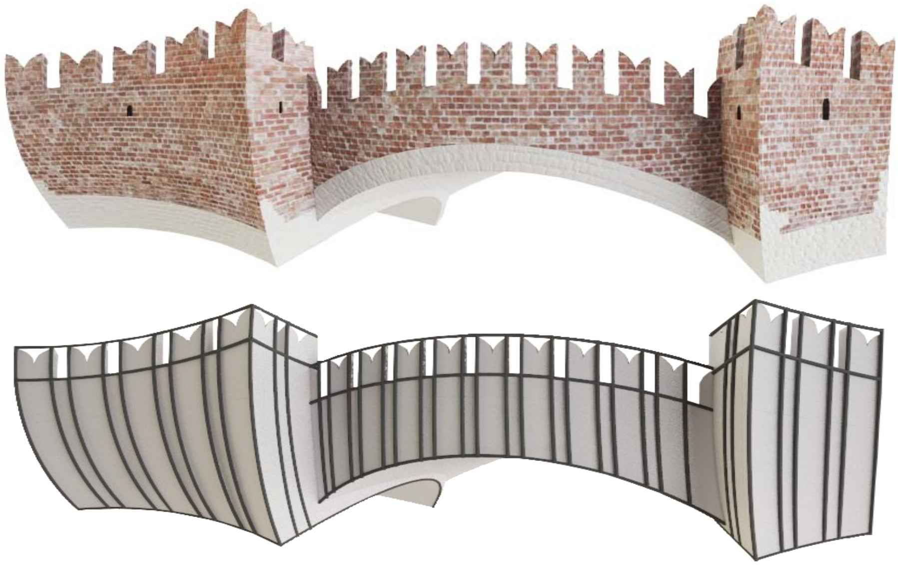
Abstract
"Mathematics, rightly viewed, possesses not only truth, but supreme beauty—a beauty cold and austere, like that of sculpture, without appeal to any part of our weaker nature, without the gorgeous trappings of painting or music, yet sublimely pure, and capable of a stern perfection such as only the greatest art can show." Bertrand Russel

Typical design thinking takes place within a rectangular coordinate system of non-curved three-dimensional Euclidean space. The usual coordinates, Cartesian coordinates, provide a natural way of segmenting space into rectangular prisms, and these are then used as a basis for thinking about, and constructing shapes within, that space. This approach, however, is pretty rigid, given that there are many more interesting, curved ways of segmenting space. Here we will propose a paradigm to break out of that restriction by using curved space, but while still using a rectangular coordinate system. Inspired by [2], we will describe coordinate systems in which straight lines become arcs of circles, and thusly, rectangular prisms become ones with arcs of circles for edges, and with faces that are swept out by circles, as parts of Dupin cyclides. We will discuss how one could use these systems of coordinates to re-think design in three-dimensional space.



Generation of part of the *Ponte di Castelvecchio* in Verona in curved space; the lower image shows, in black, the "grid lines"

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Key words: ***c***urved space, coordinate systems, Dupin cyclides

Main References:
[1] Bobenko, A.I. & Huhnen-Venedey, E. Geom Dedicata (2012) 159: 207. https://doi.org/10.1007/s10711-011-9653-5

FROM LINES TO CIRCLES: RETHINKING DESIGN COORDINATES

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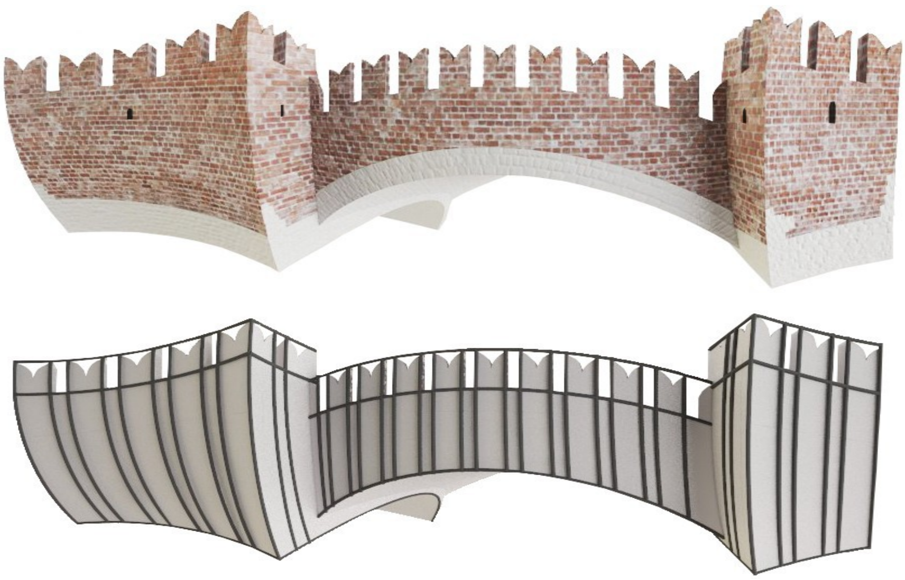

Generation of part of the *Ponte di Castelvecchio* in Verona in curved space; the lower image shows, in black, the “grid lines”, which are arcs of circles, that were used for the basis of the design.

Key words: curved space, coordinate systems, Dupin cyclides

0. Philosophical interpretation

Since ancient times, humans have sought to find ways to discern the spatiality of the real world, and the best way to handle interacting with, and designing within, it. With the help of the tools of perception, like perspective, they have directed with the laws of Nature to create and develop. In the case of perspective, this means finding a meaningful way to represent of objects from a specific viewpoint on a two- dimensional plane, using the key notion of relative dimension to convey depth. At the heart of this, is the natural, rectilinear use of rectangular (or Euclidean) coordinates.

And when it comes to creating, and handling, three-dimensional objects, people have gleaned much with this usual rectilinear approach. However, it is a system that is quite rigid, in that the main building components are non-curved – for example lines, planes, etc. While these are, in many cases, the most-graspable, and easy-to- draw, there is much more that three-dimensional space can be: namely, it can be *curved*.

To step in this direction, we consider the natural generalization, Möbius Geometry, where one uses circles, instead of lines, and spheres, instead of planes, etc.[3] By way of realization, and implementation, we do this motivated by the paper by Bobenko and Huhnen-Venedey [2], in which they formulate how one could segment three-dimensional space into specially-curved hexahedrons instead of regular cubes. For a comparison of these two, see Figure 0. The further novelty of this approach is that we developed a workflow to deform a rectilinear object, into a curved one, within this framework. The implementation, and example workflow, of this is discussed in Section 1, while the mathematical foundations of this are discussed in Section 2.

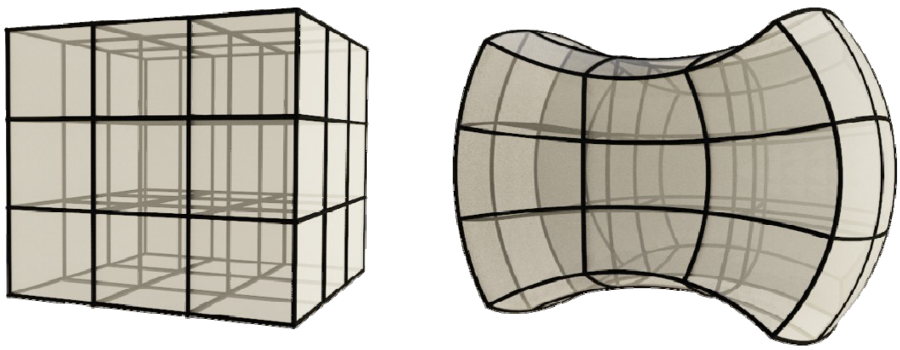

Figure 0: *Left* Cubes segmenting three-dimensional space. *Right* Specially-curved cubes segmenting three-dimensional space. (Made in Rhinoceros 5)

1. Motivation and Implementation

Motivated by the paper by Bobenko and Huhnen-Venedey [2], we have implemented a means of exploring and manipulating "discrete triply-orthogonal (coordinate) systems". These "systems" are formed of hexahedrons, in which the points of each face lie on a circle, and in our implementation, to reduce the number of degrees of freedom, we have used the further constraint that all points on diagonal also lie on a circle. Further discussion of this is in Section 2.

1.1 Application of Miquel's Theorem to Construct a Hexahedron

At the basis of our implementation, we use Miquel's Theorem in two dimensions. This theorem states that, given a triangle ABC with arbitrary points A', B', and C' on the respective sides BC, AC, and AB, the three circumcircles to the triangles $AB'C'$, $A'BC'$, and $A'B'C$ always intersect in a single point, called the *Miquel point*; see Figure 1 for a depiction of this.

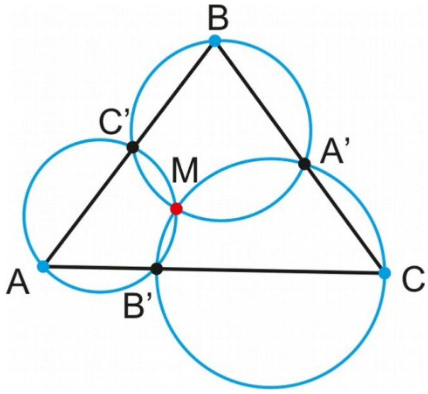

Figure 1: Miquel's Theorem in two dimensions. (Made in CorelDRAW x7)

In order to apply this theorem to a hexahedron with the aforementioned constraints, we first stereographically project the hexahedron to the plane; see Figure 2a. The result of this application of Miquel's theorem is summarized as follows, as shown in Figure 2a/b: given four blue points, and choosing the green point on the orange circle, the black points can be uniquely determined via Miquel's Theorem, and the red point is the Miquel point.

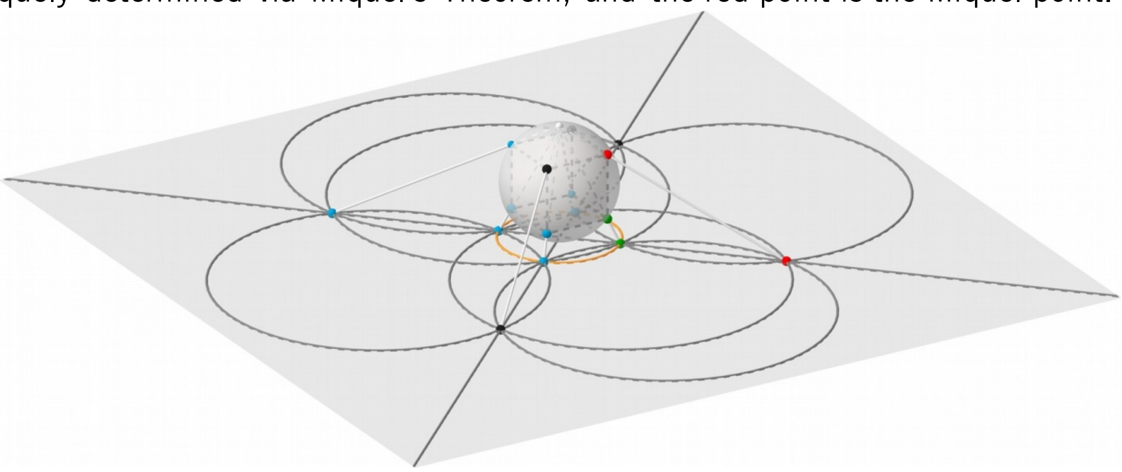

Figure 2a: Stereographic projection of a cube. (Made in GeoGebra 5)

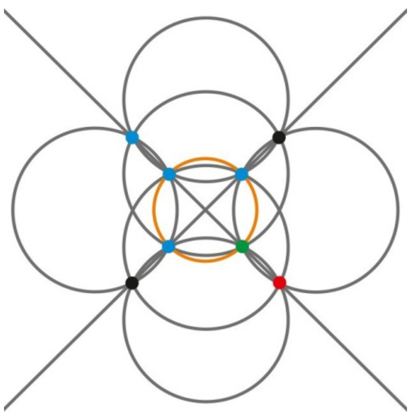

Figure 2b: Projection of the cube on the plane, with the circles from the three-dimensional version of Miquel's Theorem. (Made in CorelDRAW x7)

1.2 Discrete Triply-orthogonal System

We are going to focus on the lattices with an equal number of hexahedrons in their three spatial directions. For this type of lattices, the number of manipulable points is $3n-2$ with one point being chosen on a circle, where n is the number of hexahedrons in one direction – this is $9n-4$ degrees of freedom – shown in Figure 3, left. In this way, if we move any one of those points, the entire lattice will be modified so that the faces, and diagonals, lie on circles.

Once we have defined the lattice, we can pick a frame at one of its points, which we will use to create faces, which will be discussed more in Section 2. This frame is propagated across the mesh by defining it at adjacent points with a reflection across the bisecting plane. From these frames, circular arcs are determined between adjacent points, so that it is tangent to the frames at each point, as in Figure 3, right.

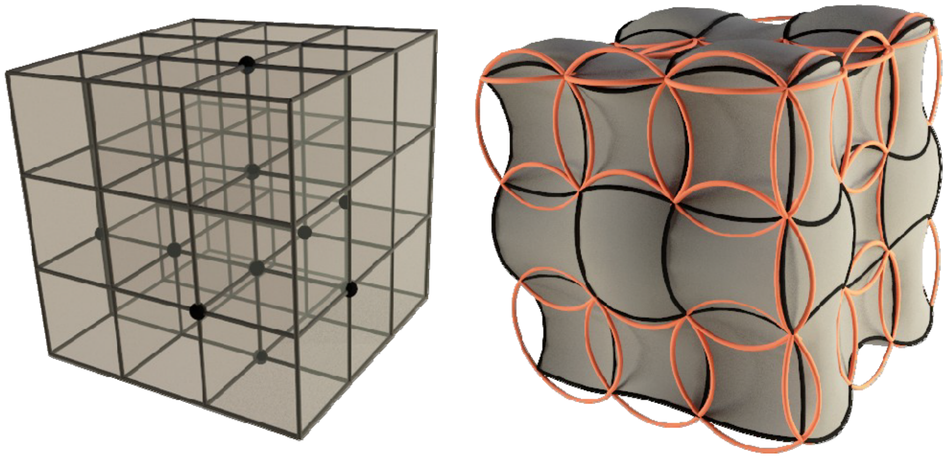

Figure 3: *Left* Manipulable points in the lattice. *Right* The resulting discrete triply-orthogonal system.
(Made in Rhinoceros 5)

1.3 Example

To better understand design within this framework, we will go over an example of how it can be used to create curved elements in three-dimensional space. We will break out of the restrictions of the traditional (non-curved, Euclidean) space by using the curved space from the discrete triply-orthogonal systems discussed before.

For the choice of object to be represented, we think that there is no better option than a part of the *Ponte di Castelvecchio* located in Verona, as in Figure 4a, top. First, we delineate the model into hexahedrons, as shown in Figure 4a, middle. Then, we choose a frame at one of the corners, to generate a curved version, as shown in Figure 4a, bottom. Lastly, we refine the model using the circular arcs from the faces to construct details, obtaining the final model, as shown in Figure 4b.

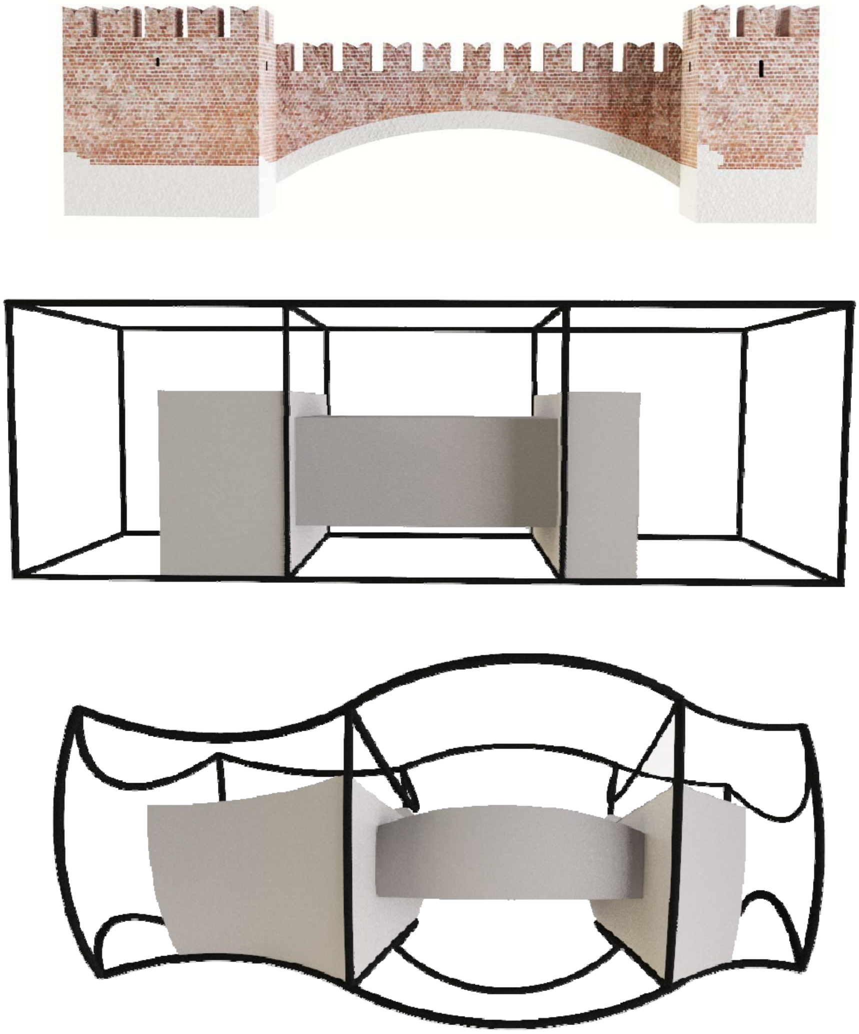

Figure 4a: Starting steps in workflow to generate a curved model: *Top* Starting model. *Middle* delineating the model into hexahedrons. *Bottom* Getting the curved model after a choice of a frame. (Made in Rhinoceros 5)

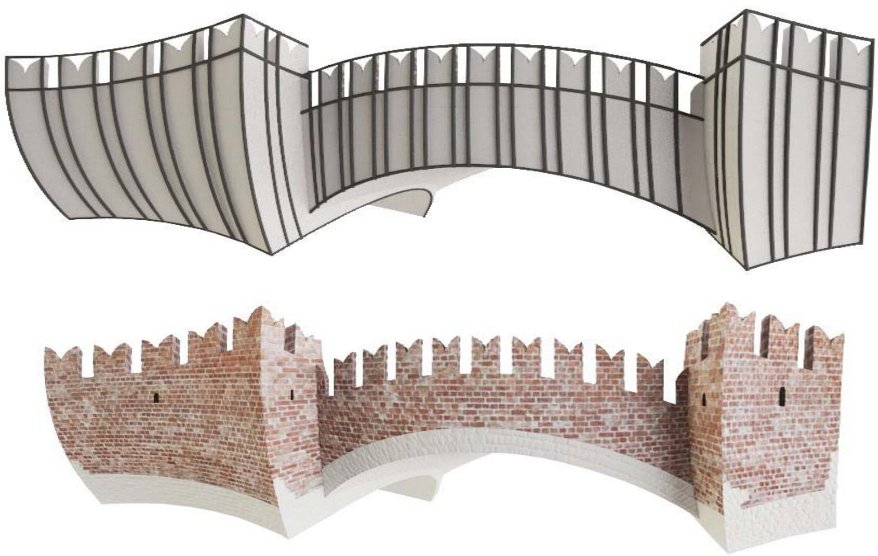

Figure 4b: Last steps in workflow to generate a curved model: *Top* Refined curved model using circular arcs. *Bottom* Final model. (Made in Rhinoceros 5)

2 Mathematical Structure

In this section, we will go over the mathematical underpinnings of our article. The majority of it comes from the paper by Bobenko and Huhnen-Venedey [2], which formulates a notion of a "discrete triply-orthogonal system".

2.1 Smooth Case

A "triply-orthogonal system" is best described with a familiar example, Figure 5: the usual way of thinking about three-dimensional space, in which, at every point, there is a natural notion of the x-, y-, and z-directions. These directions are, at each point, all orthogonal to each other, which is to say, they are *triply-orthogonal*. Moreover, these directions are consistently parallel: all the x-directions are parallel to each other, and so are the y- and z-directions, respectively. The collection of these directions at each point is called a *frame*.

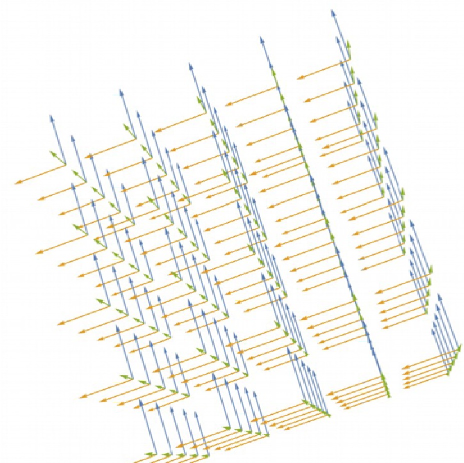

Figure 5: The usual triply-orthogonal system used in three-dimensional space, shown as a collection of frames. (Made in Mathematica 11)

To generalize this, one could think about what would happen if the choice of frames at each point was allowed to vary, keeping the triple-orthogonality but relaxing the parallelity, as in Figure 6. In this way, one would obtain generally a triply-orthogonal system.

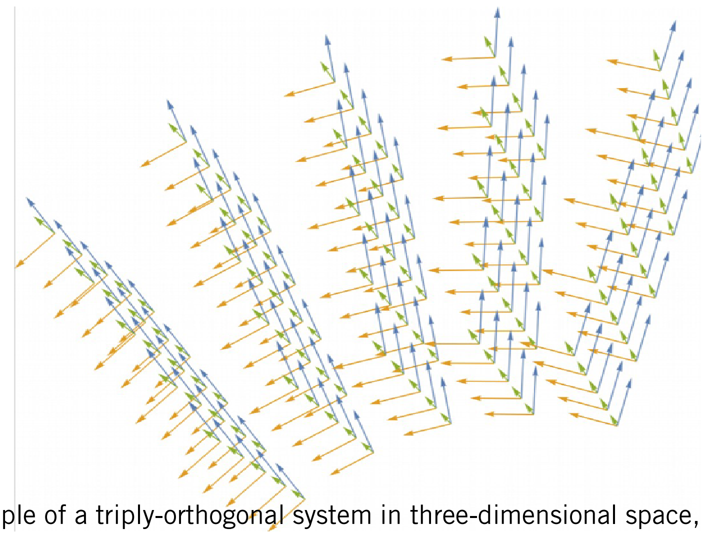

Figure 6: Another example of a triply-orthogonal system in three-dimensional space, shown as a collection of frames. (Made in Mathematica 11)

2.2 Discretization

To make a triply-orthogonal system more tangible and more-easily implementable, it is possible to discretize the notion, as is done in a paper by Bobenko and Huhnen- Venedey, [2]. Building off well-established discretization theory for surfaces, they call a lattice of points a *circular net* [2, Definition 3.1], which is a *discretized* triply- orthogonal system, if there is the constraint that all corresponding sets of points lie on circles, as depicted in Figure 7. With that constraint, there are many examples in which the points are not regularly-spaced, as in Figure 8.

Figure 7: A circular net, which has regularly-spaced points: there are circles through sets of points corresponding to each face of each cube. (Made in GeoGebra 5)

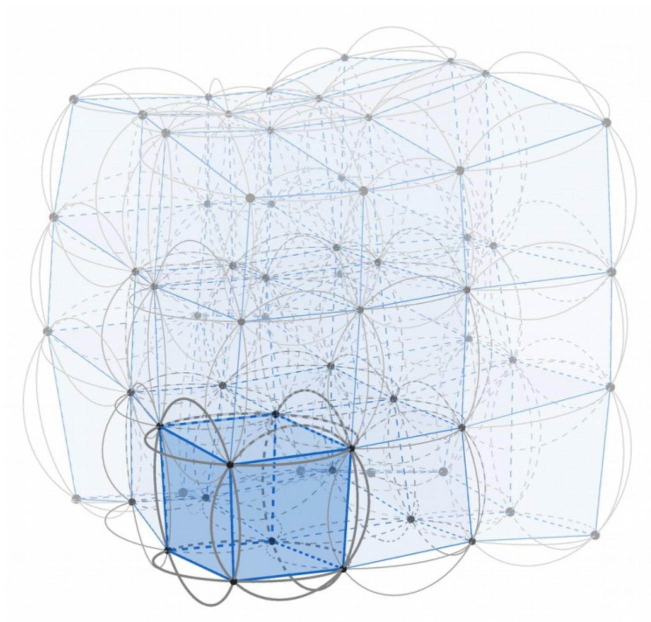

Figure 8: A circular net, which does not have regularly-spaced points. (Made in GeoGebra 5)

To allow for more deformation, Bobenko and Huhnen-Venedey add in a choice of a frame for any single point of the lattice; this frame is then propagated across the lattice to form a *cyclidic net*.[2, Definition 3.3] This frame enables sections of special surfaces, called “Dupin cyclides”, to form the faces, instead of simple planar ones, which gives rise to the qualifier *cyclidic* in their name. These surfaces, *Dupin cyclides*, are surfaces characterized by being made up of two perpendicular families of circles, in a special[1] way, which is that they follow directions where the surface curves most. An example of a Dupin cyclide is in Figure 9, along with a highlighted section, which could be a face in a cyclidic net. And, an example of a cyclidic net is in Figure 10. In this way, they have described a way of breaking up three-dimensional space into *cyclidic hexahedron* pieces, determined by a lattice and a frame.

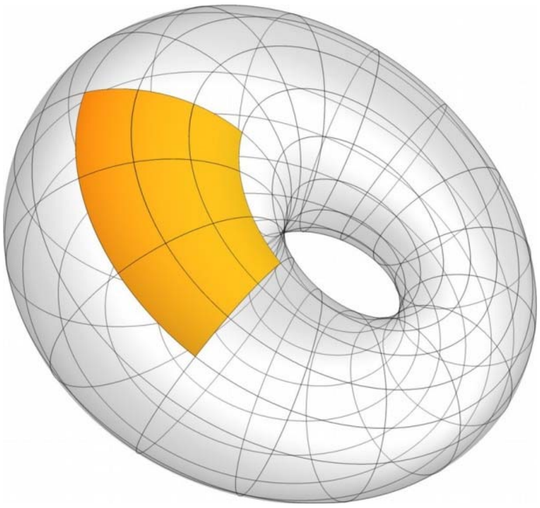

Figure 9: A Dupin cyclide, shown with its two special families of circles, and a highlighted section. (Made in Mathematica 11)

1 These two families of circles are the principal curvature lines of the surface.

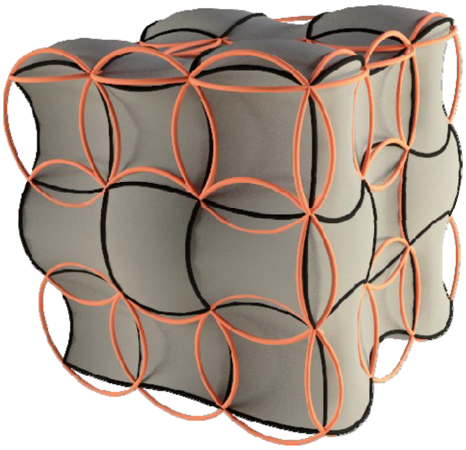

Figure 10: A cyclidic net, shown with orange circles, which constrain the lattice, and with black circular-arcs, which are edges of the cyclidic hexahedrons. (Made in Rhinoceros 5)

The natural next question is: how does one think about the inside of those cyclidic hexahedrons, so that it is consistent with this discretized triply-orthogonal system, of which it is part? Luckily, this question is answered by Bobenko and Huhnen- Venedey: they show that it is possible to parametrize the inside of each one of those cyclidic heaxhedrons with their own three families of triply-orthogonal Dupin cyclides. [2, Theorem 3.9, Corollaries 3.10 & 3.11] This is done in such a way that the intersection of any the Dupin cyclides in any of those families with the faces of the cyclidic hexahedron, is part of a circle from the families of circles that make each of them up. See Figure 11 for a depiction of that.

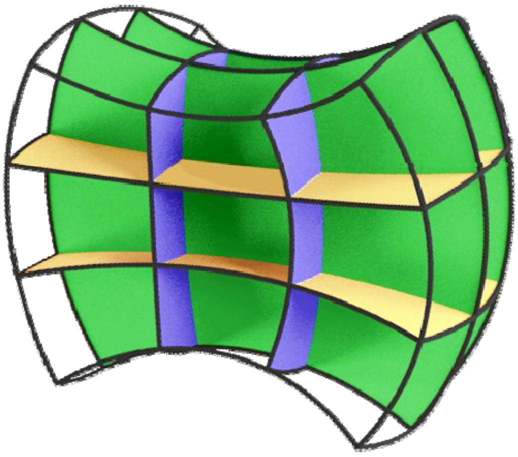

Figure 11: Parametrization of the inside of a cyclidic hexahedron, with two Dupin cyclides shown from each three families, distinguished by colors. (Made in Rhinoceros 5)

3.3 Remark on the Implementation

In order to simplify implementation, more circles were used to constrain the lattice, thereby reducing the degrees of freedom; see Figure 12.

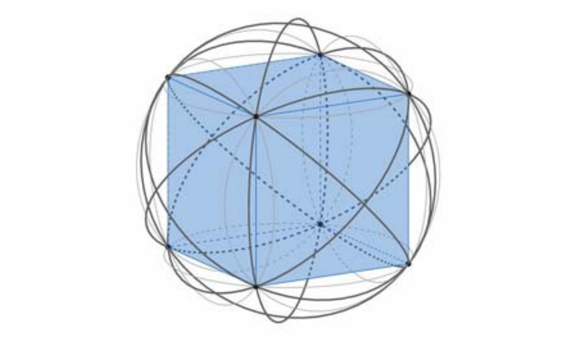

Figure 12: These are circles constraining the lattice in the implementation, where the circles in a darker color are the circles not present in the constraints of a generic circular/cyclidic net. (Made in GeoGebra 5)

With these further circles and a choice of a frame at one of the points, there is a further implication that the resulting cyclidic hexahedron is a Möbius transformation of a regular cube; this is to say that the cyclidic hexahedron can be gotten from a regular cube after a series of translations, scalings, rotations, reflections, and inversions about spheres.[1]

Acknowledgements

We are grateful to Gudrun Szewieczek for her many helpful conversations, developing the ideas for this article in its nascence, and for her guidance through essential concepts. And, we are also grateful for the discussions with Christian Müller and Mason Pember.

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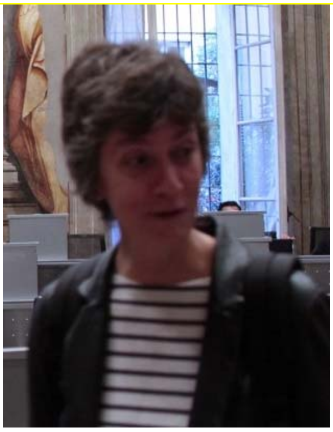

DISTANT FORCES GENERATING FORMS

Topic: Architecture

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Abstract

Distant forces are actually very common in the physical world : gravity, magnetism and electricity, later confounded into electromagnetism, are the most obvious ones. The absence of direct contact between interacting elements in these different forces bothered scientists till 1905, and they invented an "aether" in order to explain the transmission of them. This conception is nowadays obsolete, and is replaced by that of "field", and waves, even most recently for gravity.

Those forces may be attracting or repelling: gravity is attracting, magnetism and electricity are repelling between elements of the same sign, and attracting if their charges are of opposite sign. The magnitude of these forces depends on the distance between elements, along some well known rules.

Distance, *attraction*, *repulsion*, abstractly explored for themselves, or related to actual physical phenomena, used in static or dynamic models, are sufficient to generate numerous interesting forms, from very simple to more sophisticated ones. The models go from maps to multi-agent systems.

This paper gives me the opportunity to look at some models I showed at previous GA conferences in a different way, and to present other experiments, sometimes carried out a long time ago too, but never shown: Chladni-like patterns, "magnetic" maps, phyllotaxis, etc.

The gist of those experiments is to consider forms as the result of self-organising processes, as the emergent outcome of rules involving primarily, if not only, the *distance* between elements. They may (or may not) inspire architectural design, and this possibility is discussed in this paper too.

This paper is a tribute to Paul Coates (1945-2013) and to Frei Otto (1925-2015), whose works very much inspired me, and also to some of my students, whose ideas and expectations stimulated me in exploring new fields.

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Key words: *self_organisation, emergence.*

Main References:

[1] Paul Coates, "*programming.architecture*", Routledge, London and New York, 2010
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Distant Forces Generating Forms

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Preamble: a tribute

This paper intends to be a sort of landmark for me, looking back at people that made me progress and be more confident in my work.

First of all, this is a tribute to Generative Art Conferences, to Celestino Soddu and Enrica Colabella, who have organised these marvellous meetings for twenty years now. I started to work on what I did not know was generative art a long time ago but, honestly, I felt very lonely... Few people around me were interested in this kind of research. I am not sure now but I think I heard of GA Conferences through Renato Saleri, a fellow researcher at ENSAL (Lyon). The first time I came, in 2004, it was a revelation. It was amazing to meet so many different people whose work I was interested in, whatever their field was. I participate sometimes in other conferences too now, but GA is still my favourite: it is the most open-minded, and you never know what discovery you will make, from somebody you did not imagine to have the opportunity to meet. It is the warmest too, and I do not refer to the climate. Milan in December can be very cold... No, I refer to the people, and to the diligent though friendly organisation.

Among all the people I happened to meet with benefits, and that I cannot all enumerate, I want to evoke Paul S. Coates, professor and researcher at Centre for Environment & Computing in Architecture (CECA), University of East London, who unfortunately died five years ago. Beyond what he brought to me intellectually, and is recorded in his essential book [1], I want to recall the person he was. I met him the first time I participated in GA in 2004, but he was a recurrent participant himself, since nearly the first conference. This first encounter was not mild. He could be abrasive in questioning my work, and I had a hard time understanding his perfect English (himself was unable to speak one word of French, though he owned a holiday house in centre Brittany (Bretagne), not far from where I live...). But I learned to appreciate him, his congenial sense of humour, even if I was unable to catch all his jokes. He was a very generous teacher, and was often accompanied by some of his students, beyond his collaborators, and always valorised their work. He complained about the difficulties some of his foreigner students had to get their visas. Luckily, through his too early death, he had not to know the Brexit...

I did not know Frei Otto personally, obviously, and he apparently does not belong to this world of generative art. This architect is well known for his lightweight structures, but I discovered in 2010 a rather different aspect of his research through his very precious small book [2], where he questions many ways in which forms and configurations emerge, are generated through simple rules and physical laws.

Last, I want to thank my students. The school of architecture where I teach is a small one (around 500 students in all, for 5 years of schooling), and very few students choose my seminar, which is an option among a lot of other ones, some very attractive, and certainly more professionally oriented. Having to learn coding is a repellent for the majority, but those bold (or thoughtless) enough to take the plunge generally do not regret it, and tell me so sometimes long afterwards. Anyway I must say I benefit a lot from them, first because you never completely understand what you are doing unless you have to teach it, and also because their fields of interest expand mine.

Introduction

Distance is at the core of our conception of space. A metric space is a set defined by the type of distance one defines between members of it. The Euclidean space is the one we are convinced to live in, a 3 dimensions space as I recalled in my paper of GA 2005 [3]. It is not before the 19th century that mathematicians invented non-Euclidean geometry, in which distance between two points is not the length of a straight line drawn from one to the other. Actually, would Pythagoras and Euclid have lived on a much smaller planet, say the Little Prince's planet, they would have conceived a very different geometry, at least for figures drawn on the surface of their planet...

All the processes investigated here deal only with *distance*: distance between elements, distance from elements towards some specific ones. The first part deals with static processes, where distance, distant forces, modify elements but without moving them, and the second part deals with dynamic processes, where those forces make elements move, whether they where static at first, or already moving.

1. Static models: maps

What I call a map is, referring to geographic maps, a plane (a 2D space), on which some informations are put in a visible way (colour). More precisely, I consider that a map is a bitmap, a set of pixels, where the colour of each pixel is determined by any process you can imagine. For instance, the pictures of Mandelbrot sets are maps, in which the colour of each pixel (x,y) is determined by the way the iterated function $f_c(z)=z^2+c$ (where c=x+iy) evolves from z=0.

A map is in this case a sampling: the complex place, as well as the real plane, being continuous, while a bitmap is discrete. The coordinates of pixels correspond to only a few of the points of the complex plane, and when you "zoom" in, you actually sample more densely a smaller part of the plane, but it is still sampling.

Actually the way we draw geographic maps today is always through sampling. A digital elevation model is a map where the altitude of some points (but obviously not all of them) is recorded. And you can interpolate, because there is no chance at all that between two points the altitude will change dramatically. The same goes for other data: direction and strength of the wind, temperature, and so on.

1.1 Distance maps

I showed my first distance maps in 2005 [3], and as I recalled in this paper the idea came from "medial axes" [4]. A distance map is a set of pixels in which the colour of each pixel depends on its *distance* from the nearest element of a given set of points (called sites). There are diverse ways of translating this distance into colour. The first is to give the pixel a colour arbitrarily affected to the nearest site, which is the classical rendering of Voronoi diagrams (which distance maps are, actually); the second one is to give the pixel a level of grey proportional to that minimal distance, which leads obviously to a 3D interpretation by translating the levels of grey into altitudes in a mesh; and then you can give the pixel a level of grey proportional to the sine of the minimal distance.

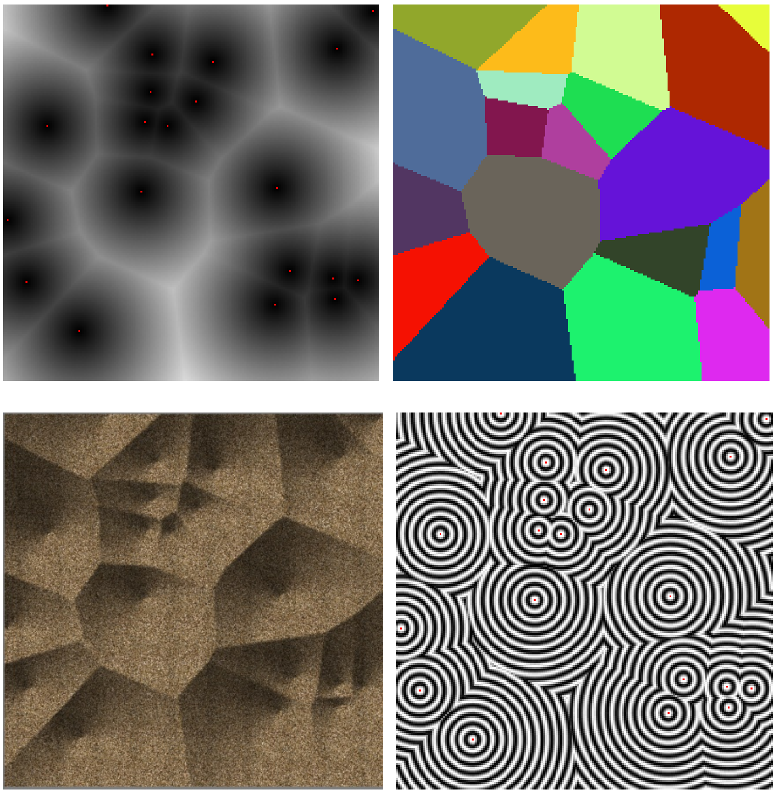

Fig. 1: four renderings of distance maps for the same set of sites

The relief obtained in the mesh representation may be interpreted as the one sand leaking from a box through holes drilled in its bottom (at the position of the sites) would produce. As sand has a characteristic slope, at least ideal sand would produce concave cones with their summit at the sites, and crest lines resulting from the intersection of these different cones; sand piling under the box would produce the inverted relief of intersecting convex cones.

I never bothered to realise this experiment with sand, and was very excited to discover that Frei Otto described the very same experiment in [2]. I developed the consequences of this in 2011 [5]. But recently a further step has been taken: while Frei Otto seemed to consider this experiment more as a thought experiment (it is not sure he actually did it: there are sketches of the proposed device, but no photographs), the research one of my student did on granular matter revealed that some people, not only made a "real life" experiment, but managed to solidify the surface of the relief in order to create an architectural model...

It was interesting to see that what was a purely intellectual preoccupation could actually be useful for design, even though I think that doing it digitally would be much better, because modifying the parameters of the experiment (the location of the sites/holes, particularly) would be much easier. And what is the purpose of such an experiment if you can not easily change the conditions of it?

The last representation consists in giving the pixel a level of grey proportional to the sine of the distance. I made those pictures first because the reference I had was about Japanese Zen gardens, and that monks most often rake the gravel around the stones (which were the so-called sites in that model). But I discovered again later that it could be linked to Frei Otto's proposal of a thought experiment with seeds that would expand in a concentric way, year after year. The circles drawn by

Otto were nicely depicted by the concentric waves of the sine-distance maps [5]. One could even simulate the different speeds in which seeds would grow.

I wanted to experiment further for this paper by applying a non-euclidean distance. The space is the Poincaré disk model, an open disk, where “straight” lines are, first, the diameters of the disk, and, if the two points are not on a diameter, the arcs of circles orthogonal to the boundary of the disk. It demands some geometry in order to draw those lines, but it is not undoable. The distance between two points A and B is then ln(PB.QA/PA.QB) where P and Q are the intersection of the “line” (which is actually a circle) with the circular boundary. Again, not simple, but not undoable... It is then possible to make distance maps for this distance, and compare them to euclidean distance maps for the same sites.

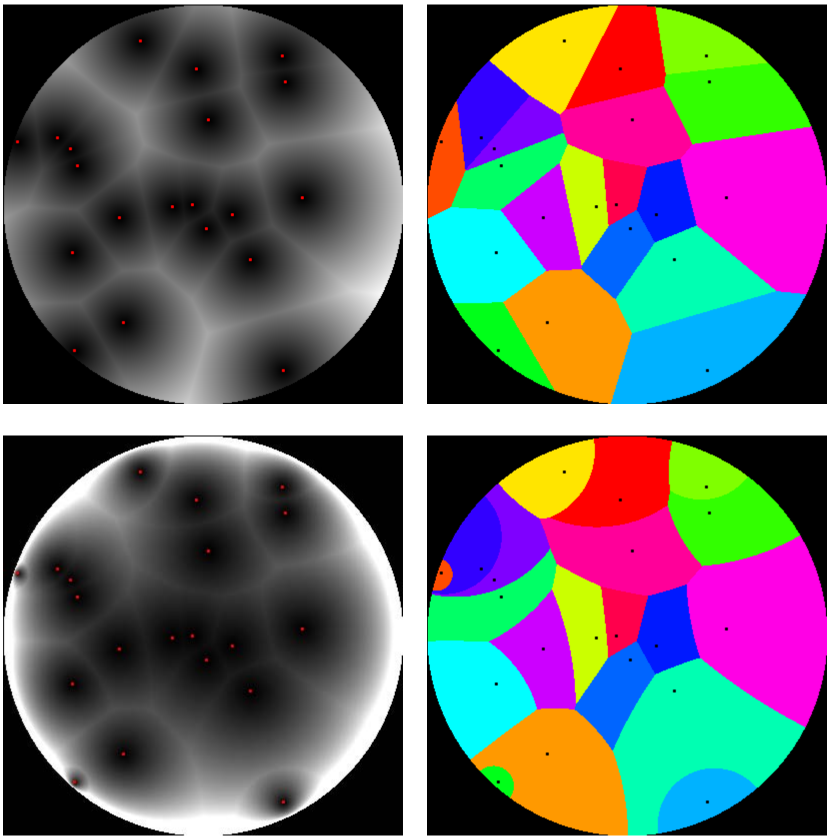

Fig. 2: distance maps with the same 20 sites; above: euclidean distance; below: non-euclidean distance

1.2 Wave maps

The sine-distance maps lead to another idea: those waves could be those happening from throwing rocks in a pool of water at the location of the sites. But weirdly those waves timidly interrupted themselves as soon as they encountered another one... That is not what happens with real waves, where altitudes (calculated from the surface of the still water, and can then be positive or negative) add themselves in every part of the field.

Now, considering those pixels for which the resulting altitude is zero or close to zero, and exhibiting them with a contrasting colour, we have what Chladni did using acoustic waves instead of water waves: the sand he poured on his metallic plate was ejected from parts of the plate which were vibrating, and assembled themselves where it was still, the nodal lines. It has to do also, maybe more so, with cymatics. Those references were well exposed at the last session of Generative Art [6].

The principle of wave maps is very simple: you calculate for each pixel the sine (or the cosine) of the *distance* (actually $d*l_w/2\pi$, l_w being a wavelength arbitrarily chosen) to each site, and you add those values. With only one site, and if you neglect the boundaries (you consider your screen as a window on an infinite universe), it is very disappointing, you only get concentric circles... But it suffices to introduce the reflection of the wave on the boundaries (as it actually happens for a rock you throw in a small basin), which is done by introducing virtual sites, symmetric from the initial one along each side of the boundary, for the patterns to actually look like Chladni's ones.

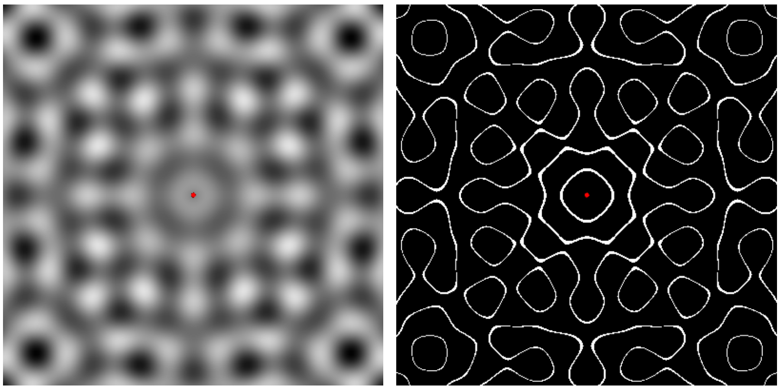

Fig. 3: wave map and Chladni-like pattern

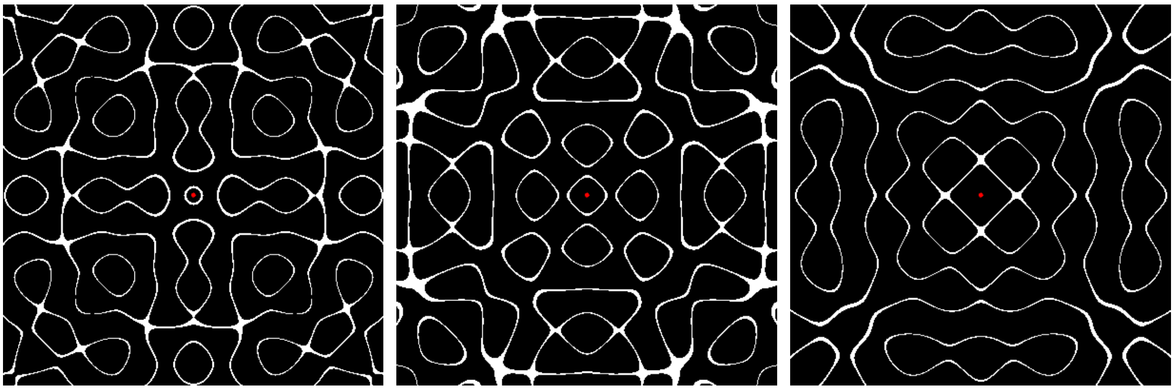

Fig. 4: patterns for a square plate with the fixed point at the centre

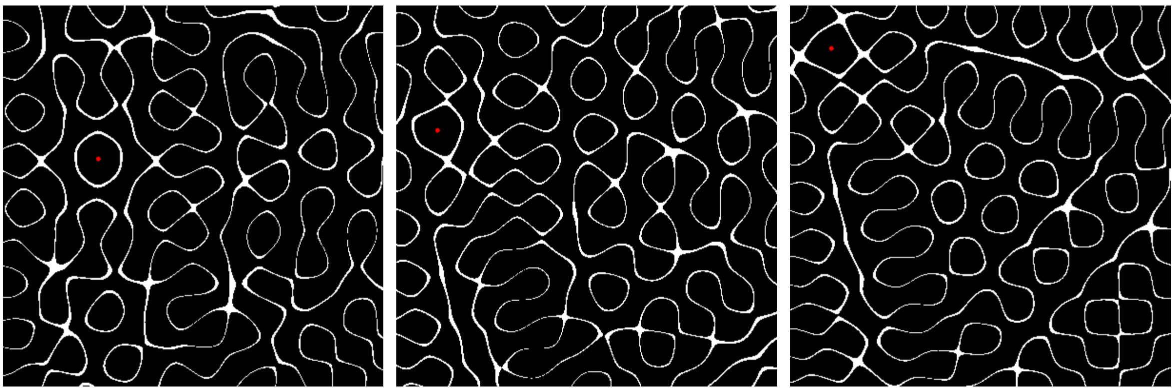

Fig. 5: patterns for a square plate with displaced fixed point

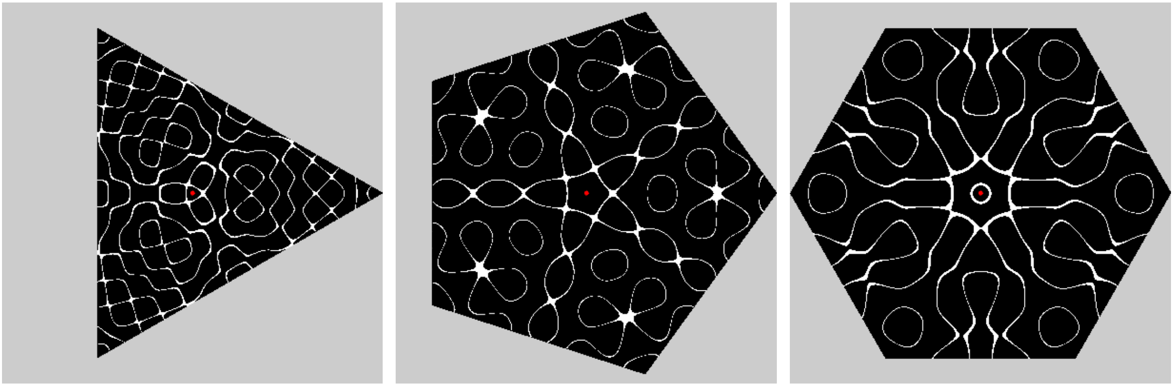

Fig. 6: patterns for other polygonal plates

One should not be fooled by the resemblance though, which is why I call these patterns "Chladni-like patterns". The physics involved in proper Chladni's patterns is more complicated, the natural frequency and the normal modes of the material of the plate are crucial, and I am not sure the edges of the plate are reflecting the acoustic waves.

Choosing the sine or the cosine means a different role for the initial site. Though being a map, and so a static figure, such a pattern is a sort of instant photography of a dynamic one: the sinusoidal wave oscillates vertically, the nodal points (those that have a zero altitude) being the only ones that do not move. As sin(0)=1 and cos(0)=0, using the sine function is more relevant for the water wave analogy (because where the rock is thrown there is obviously some displacement of water), while the cosine function is more appropriate for referring to Chladni's figures, where the centre of the plaque is fixed.

I did those experiments many years ago, just for the pleasure of it, but as [6] suggests, those patterns could be useful in architecture or design in general.

1.3 Magnetic maps

The idea of working with magnetic fields was that of one of my students, David Berger. I was very sceptical at first, I did not see what it would lead to, but I was wrong as we will see. David was first attracted (without joking) to this topics through the well-known pictures of magnetic lines of force of a bar magnet shown by iron fillings, an experiment probably any child has done at school.

Our first experiment was to translate this process into an algorithmic one. A dipole is represented by two sites, a "North Pole" and a "South Pole". The iron fillings are represented by little segments randomly distributed. They do not move, but their orientation results from the attraction-repulsion created by the dipole. In each point, you can calculate the vector resulting from the attracting force of one pole, and the repelling force of the other. Those forces are inversely proportional to the square of the distance. So the *distance* of each point from the poles suffices to define its specific orientation.

After having verified that our model was consistent with the physical one, we extended it by involving two dipoles, and see what happened with the segments. Interesting configurations were obtained, and we expanded our research in two directions.

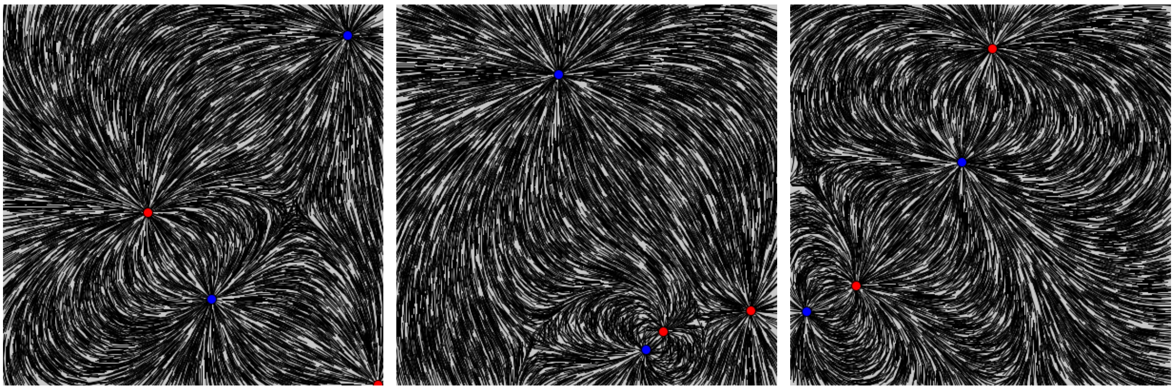

Fig. 7: two dipoles acting on segments

The first one was to make a proper map, similar to distance maps. In each pixel we calculate the orientation, and translate it into a level of grey. The result was fine, a little hypnotic when rotating the dipoles about their middle point.

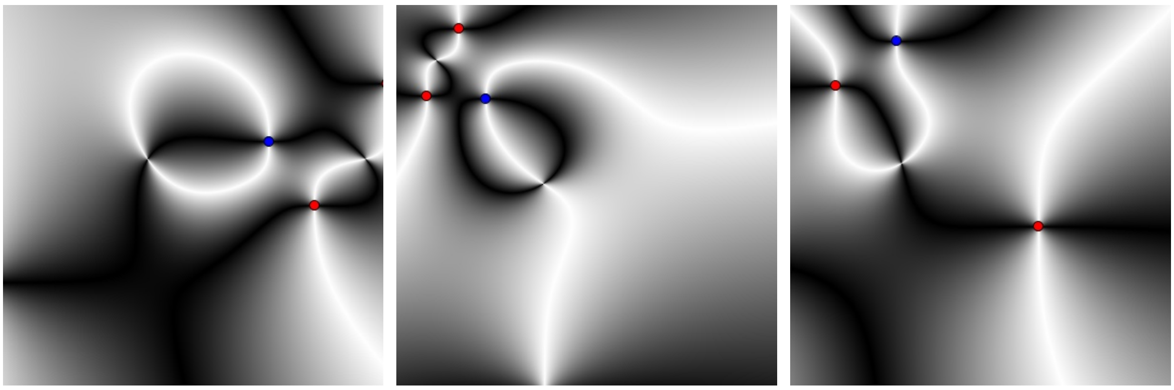

Fig. 8: angle maps for two dipoles

But David had another idea, which consisted in starting from one of the repelling poles in a random direction, and going step by step in the direction given by the orientation proper to the attained point, towards an attracting pole. Here again, the strength is not taken into account, all the steps are equal. The results were fine enough to let him interpret them as a structure, which he built in cardboard, and also integrated in a CAO model.

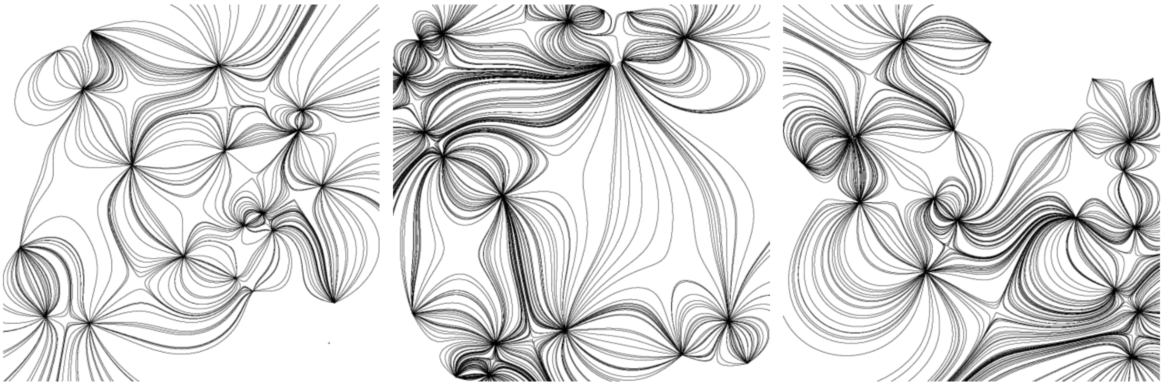

Fig. 9: trajectories in a magnetic field with 10 dipoles

All our experiments stuck to this idea that the magnetic field is a field of orientations, we did not involve the strength of the resulting force.

2. Dynamic models: emergent patterns

The previous models, generalised as "maps", may have involved distant forces, as in the magnetic field, or even when we interpret distance maps as sand flowing through holes under the force of gravity. But those models were not actually dynamic, nothing was really moving.

Here we shall see models where agents are actually moving through attracting and repelling forces, towards or from each other, or/and towards or from particular sites, and in all these models, *distance* is the key parameter. A great difference between these models and the previous ones is the type of space involved. Maps lay in the discrete space of pixels, while the models we shall see now involve a continuous space, even if we visualise their behaviour through pixels.

2.1 Optimised distributions

The first model we can think of, involving only repelling forces, consists in launching a number of particles, and enjoin them to repel each other. If there is no boundary, very soon all particles will disappear from your window, bound to an infinite journey through the universe! We deal with that in two ways: either we install a boundary, that particles cannot pass, or we consider a torical (also called periodical) topology, in which particles that disappear at one side reappear on the opposite one: a finite space without boundaries.

Frei Otto [2] experimented with small rod magnets, all oriented in the same way, floating on water (the rods are driven through a little swimmer, probably a small piece of polystyrene or cork). The distant force here is then the magnetic one. The edges of the basin obviously are dead ends, and indeed a majority of the rods get stuck to them. I showed in [5] some digital experiments simulating these devices.

I encountered the same topics in [1]. Paul Coates experimented with repelling forces among “turtles” (the name of the agents in the Netlogo language he uses), in a square with torical topology.

But what does “repel” mean in these models? In Otto's physical model, each rod is repelled by all the others, with a strength inversely proportional to the square of the distance, at least if one does not take friction into account. In Coates' digital model, each turtle takes “one step back” from the closest turtle, whatever this minimal distance is.

The result is always the same, and tells a lot of the nature of the 2D space: the particles distribute themselves along an emergent triangular lattice, which is the one that optimises the space, i. e. that permits to each particle to be the more distant from any one else. The Voronoi cells, dual from this triangular distribution, are hexagonal. Those triangular and hexagonal grids are not absolutely regular, because there is a conflict between the shape of the space (even when it is “limitless”, but finite, as in the torical topology) and a hexagonal tessellation, as we discussed in [7]. Regular hexagons tile the 2D space, but only when it is infinite!

Distance maps are used here to show more clearly the tessellations produced by the distributions.

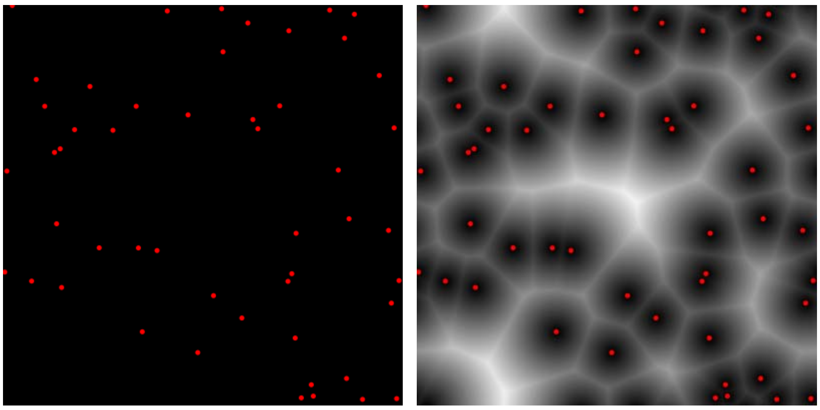

Fig. 10: initial random distribution of particles

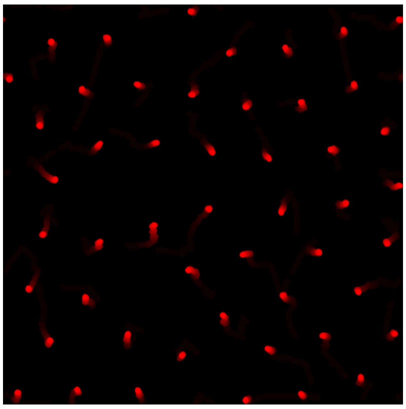

Fig. 11: wriggling particles repelling each other

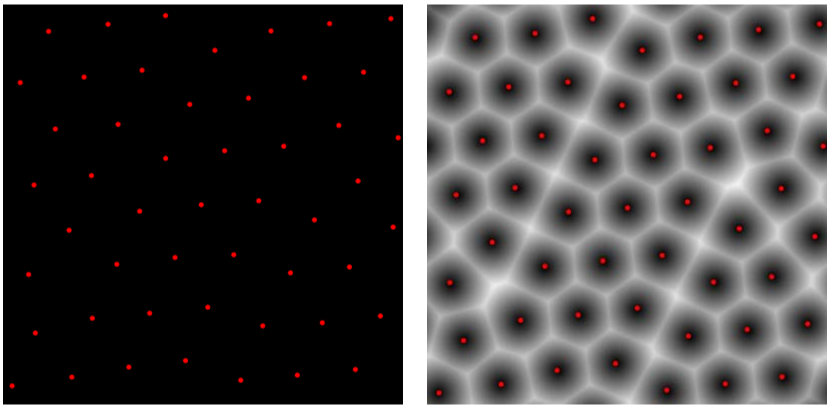

Fig. 12: resulting optimised distribution of particles

I also experimented with repelling forces as in Coates's model, but with the use of the Manhattan distance (where distance from (xa,ya) to (xb,yb) is |xb-xa|+|yb-ya|). Results show Voronoi cells which are no more mostly hexagonal, but mostly squares, with some interesting configurations as octagonal cells. It is interesting how those results, without being orthogonal grids in whole, look a lot like urban plans.

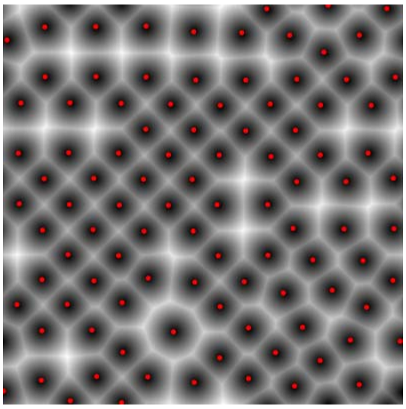

Fig. 13: optimised distribution of particles under Manhattan distance

2.2 Circles

This example is directly drawn from Coates' book [1]. It is very easy to draw a circle, by its equation, either the Cartesian or the parametric one. But by using only attracting and repelling forces, one can also obtain a circle, as an emergent pattern.

The algorithm is very simple: a centre is given, and a radius, and particles randomly distributed are affected by an attracting force towards the centre if their distance is superior to the radius, and repelled by it if it is superior. A circle emerges, but it is a little uneven. So another repelling force is introduced, this time between particles themselves: each particle is repelled by its closest neighbour.

This time the circle is more regular, and you get a "bonus" result: is the radius is small, and the repelling force between particles strong, all particles cannot fit in the circle, so they are ejected. But most of them do not go to random places, but form other circles instead. Which is quite surprising!

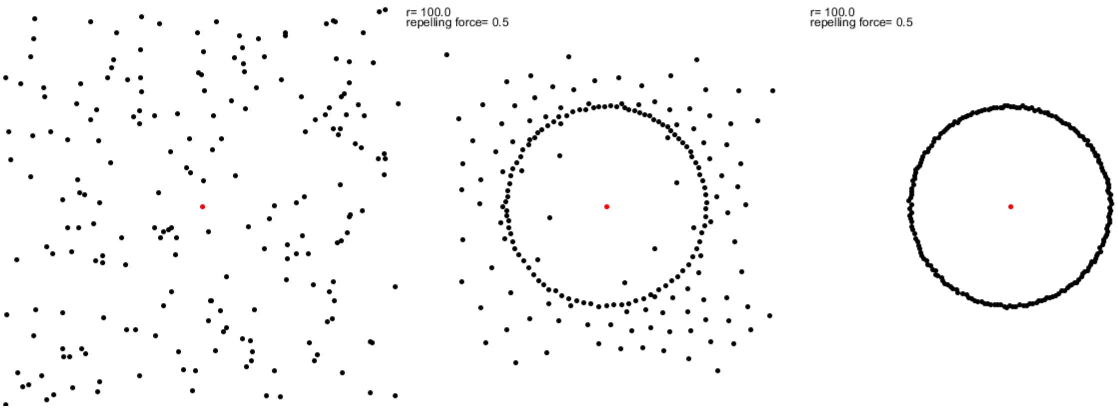

Fig. 14: emergence of a circle

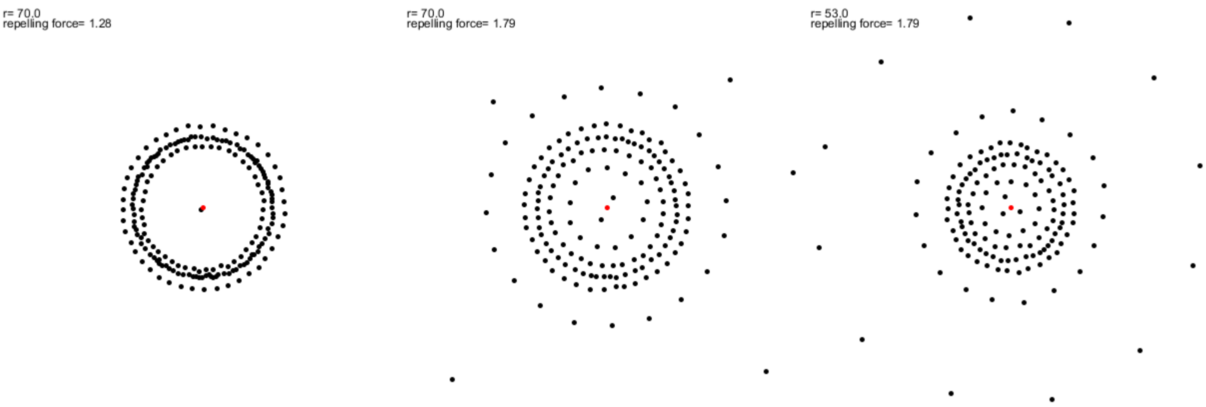

Fig. 15: emergence of additional circles

2.2 Spirals

This last model is not inspired by Otto nor Coates, but is the algorithmic interpretation of an experiment made by S. Douady and Y. Couder in order to explain the emergence of spirals in plants [8].

The apparatus used by these physicists is simple: drops of a ferrofluid fall at the centre of a dish filled with silicone oil and placed in a vertical magnetic field. So the drops are repelled from the centre. The centre of the dish has a small bump, so that *a priori* the drops fall in a random direction, and continue in that direction until they reach the edge of the dish (where they fall into a ditch).

But the drops are repelled from each other as well. So that a first emergence appears: the direction of each new drop will depend on the repelling effect of one or more of the previous ones. A steady regime of divergence (the angle between the direction of two successive drops) establishes itself, which leads to the fact that the drops are points of a spiral.

Depending on a certain parameter G, corresponding to advection, this divergence angle may change. $G = v_0T/r_0$, where v_0 is the initial velocity of the drops, T is the periodicity of the fall of the drops, and r_0 is the initial distance of the drops to the centre.

For at least some divergence angles, a second emergence occurs, which is the one we admire in sunflowers and many other phyllotactic spirals: what we perceive in them is not the generative spiral itself, but secondary spirals, which happen to be in Fibonacci numbers.

Douady and Couder have transposed their physical experiment into a numerical one involving a repulsive energy from previous particle, determining the “place of birth” of the new particle. I chose to stick more closely to the physical model, by placing each new particle at the centre, and determining its moving direction through the repelling forces of all the previous particles. The first few particles (3 in the case of the illustrations) have got a random direction. Rapidly, a steady divergence angle establishes itself. The velocity of all particles is the same, and is fixed at the start. It is the crucial parameter in this model. I found that a velocity of 1.385 lead to a divergence angle of $2\pi(1-\varphi) \approx 137.5°$ where $\varphi = (\sqrt{5}-1)/2$, the golden number, and so to Fibonacci spirals.

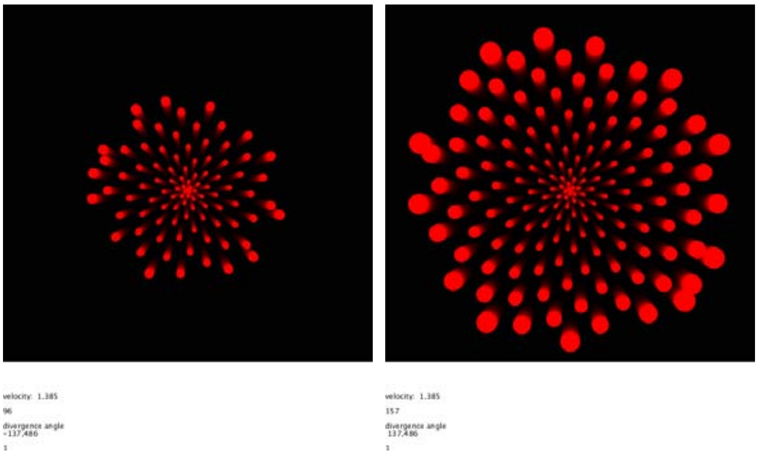

Fig. 16: rendering of the process showing particles moving straight from the centre

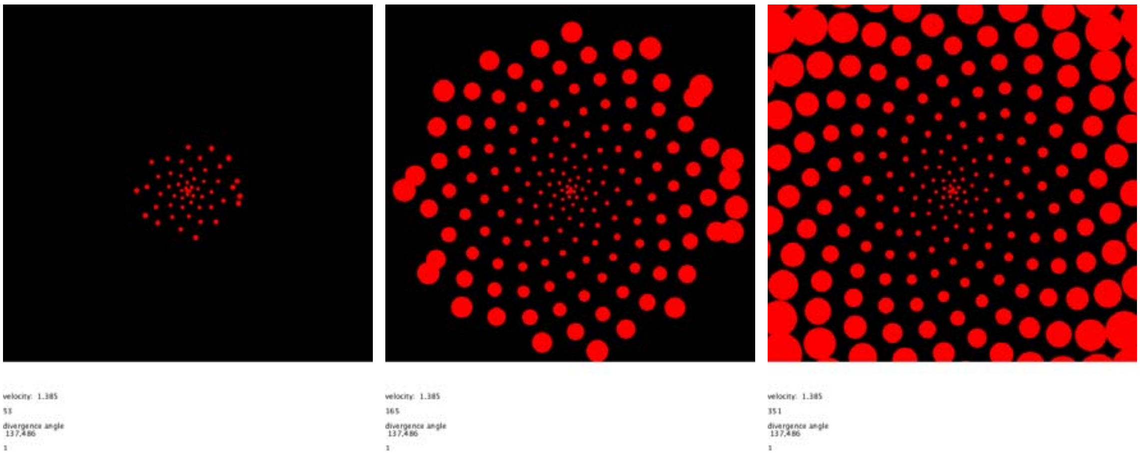

Fig. 17: process with velocity = 1.385 leading to divergence angle = 137.49°

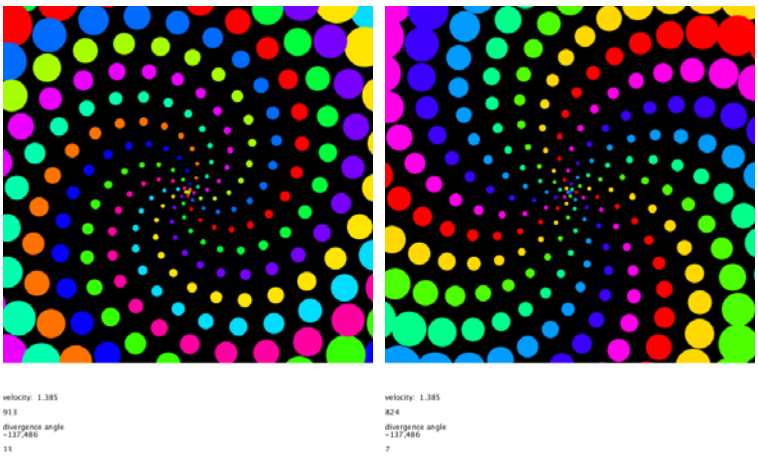

Fig. 18: emerging Fibonacci spirals (13 and 21)

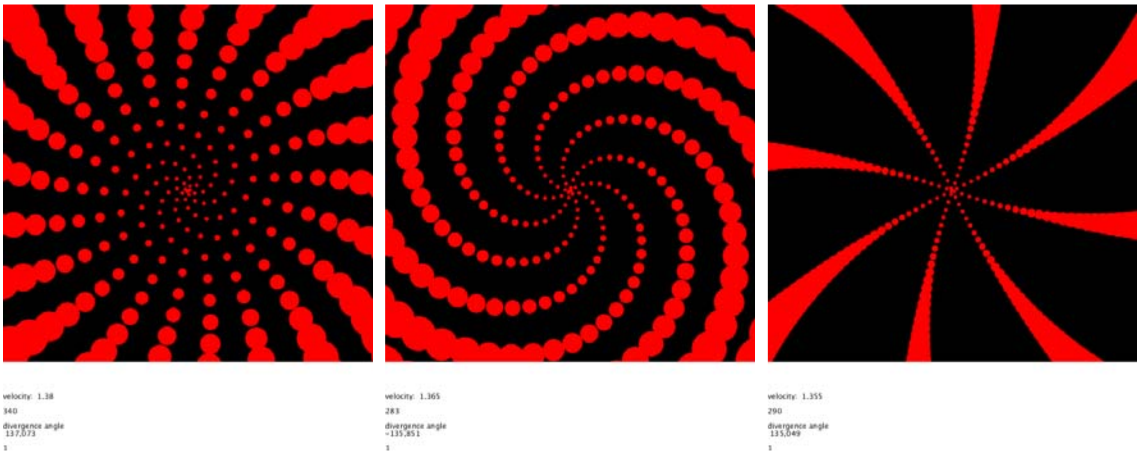

Fig. 19: other values of velocity leading to other divergence angles

These experiments will be prolonged. The question of transposing this process into a designing one is still at stake.

To finish, I would like to show what one should never show: the consequence of a stupid error… I wanted to “kill” the particles when they get to the boundary, but I forgot to remove not only their positions, but also their displacement vectors. The process became a little wild, and produced some weird, but interesting results… That is called serendipity!

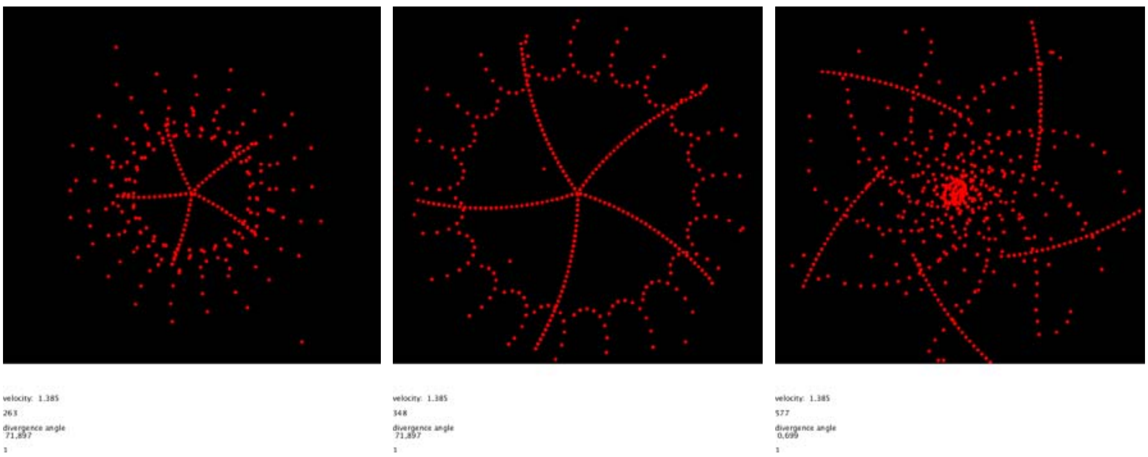

Fig. 20: surprising results due to a little error in the code!

Conclusion

This paper did not aspire to be exhaustive regarding models involving distance, and distant repelling and attracting forces. Swarming, for instance, is a very elaborate model where distance is at stake too. But, looking at my previous work, putting aside models like fractals, or cellular automata, I realised that a lot of models I had explored had that notion of distance at their core, and found it would be interesting to assemble and confront them.

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SOUNDS AND COMPUTER – ARTISTIC MESSAGE

Paper/Presentation

Topic: Music

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Abstract

Since the end of the 20th century, experimental techniques of sound generation have become the basis for composing the new intermedial creative music. A musical work in which the composer, in order to create the artefact, includes computer systems as an additional medium of distribution may be recognised as an artistic product of generative music. Computer software and specialised electronic devices enable the creation of a composition which is not only a strictly musical one but also an intermedial one, constituting a so-called "media hybrid". The analysis and interpretation of a conceptual work of art requires, on the one hand, a study of the software and, on the other, an assessment of its axiological values.

The speech will focus on presentation of partly improvised compositions by contemporary Polish composers – Krzysztof Knittel and Agnieszka Stulgińska – in which the sound is generated live from various media and is transformed by the computer. For the work free for(m) macwin2 (2012), Knittel used electronic sound generators, i.e. the ISA infrared programmable harp which detects body movements, as well as the iPhone and iPad. Stulgińska, in turn, in her composition Three Women for three women and 10 instruments (2017), makes use of the Polesie (a region in eastern Poland and the Ukraine) folk music and the sounds of traditional instruments besides various realistic effects which are subject to electronic transformation in real time. In the score, the composer additionally described the non-musical parameters of the intermedial discourse, including the scenery and lighting. The two compositions create a spectacle of a kind, which uncovers the symbolic meaning of sound emission that interacts with body gestures, visualisation or another electronic medium, thus creating an integrated artistic message.

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Key words: contemporary polish music, intermediality, generative music, media hybrid, body movement

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Sounds and Computer – Artistic Message

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Abstract

Since the end of the 20th century experimental techniques of sound generation have become the basis for composing the new intermedial creative music. A musical work in which the composer, in order to create the artefact, includes computer systems as an additional medium of distribution may be recognised as an artistic product of generative music. Computer software and specialised electronic devices enable the creation of a composition which is not only a strictly musical one but also an intermedial one, constituting a so-called "media hybrid". The analysis and interpretation of a conceptual work of art requires, on the one hand, a study of the software and, on the other, an assessment of its axiological values.

The paper will focus on presentation of partly improvised compositions by contemporary Polish composers – Krzysztof Knittel and Agnieszka Stulgińska – in which the sound is generated live from various media and is transformed by the computer. For the work *free for(m) macwin2* (2012), Knittel used electronic sound generators, i.e. the ISA infra-red programmable harp which detects body movements, as well as the iPhone and iPad. Stulgińska, in turn, in her composition *Three Women* for three women and 10 instruments (2017), makes use of the Polesie (a region in eastern Poland and Ukraine) folk music and the sounds of traditional instruments besides various realistic effects which are subject to electronic transformation in real time. In the score, the composer additionally described the non-musical parameters of the intermedial discourse, including the scenery and lighting. The two compositions create a spectacle of a kind, which uncovers the symbolic meaning of sound emission that interacts with body gestures, visualisation or another electronic medium, thus creating an integrated artistic message.

1. Introduction

Intermedial creative music as an example of generative art is becoming more and more popular among contemporary composers. This phenomenon is encouraged not only by well-developed transfer of new media theory to *software studies* but also by the transfer of traditional stylistic trends into technological context. The composer, moving across the advanced algorithmic optics does not limit his/her creation merely to abstract artefact. Musical work, for the creation of which the composer incorporates modern tools and computer systems as additional distribution medium may be viewed as artistic product of generative art, which is also characterized by high aesthetic value. Digital technologies which were made use of in the act of artistic creation make it possible to compose a final product which "is brought into being as a result of decisions progressively made by the designers, who are simultaneously willing to accept spontaneous, intuitive and »non-programmed« modification" [13]. The artist becomes a creator of hybrid discourse making use of such innovative techniques as *live electronic music*, *electronic media art*, *digital art* and *new media art*.

The most popular environment and language of programming in Poland dedicated to synthesizing and processing sound in real time and to algorithmic composition is SuperCollider, Cubase, Max MSP and Ableton Live software, used also by Krzysztof Knittel and Agnieszka Stulgińska. These tools become specific sound generators. SuperCollider programming environment is made up of the server (*scsynth*) and the client (*sclang*) that communicate with each other by means of *Open Sound Control* communication protocol , which allows musical instruments or other multimedia devices to exchange data in real time.

Two contemporary compositions were chosen for the purpose of analysis and interpretation: *free for(m) macwin2* by K. Knittel and *Three Women* for three women and 10 instruments by A. Stulgińska. In both of these works sound is generated live by various media and processed with the use of computer. Those musical pieces also manifest the synthesis of different techniques and means of expression occurring in various types of art: music, choreography and theatre, constituting an intermedial work of art according to Dick Higgins.

It is worth pointing out here that intermediality is an interdisciplinary discourse which consists in synthesizing different ways of conveying information where media build up a new, integrated message. As a phenomenon of post-modern culture it constitutes one of the significant paradigms of contemporary comparative studies. The elements of broadly defined medium in case of discussed compositions are not only sound generators, i.e.: classical medium, electronic or digital medium but also elements of choreography and scenery of dance theatre.

2. Methodology

The compositions featuring elements of performance selected for analysis represent the type of artwork in which the phenomenon of intermediality is present. „Intermediality does not mean either a sum of various medial concessions or situating particular works in between media but rather integrating aesthetic concepts of particular media in the form of a new medial context" [10]. These works adopt methods of representation and creation of meanings from other media. In the interpretation of intermedial work the notion of hybridization and theory of intermediality by Werner Wolf appear to be fundamental. The theory assumes the presence of different interrelations between a given medium and other media, resulting in a case of multimediality, so called 'medial hybrids".

Within the scope of intermediality theory, developed earlier by Steven Paul Scher, based on relations between music and literature, Wolf distinguishes between:

- "***intracompositional intermediality***, referring to the work in which more than one medium takes

part in the signification process, and their presence can be distinguished and quoted (*overt intermediality*) or it cannot be distinguished or quoted and is only implicit (*covert intermediality*),
- ***extracompositional intermediality***, which apart from intracompositional relations refers also to reflections on mutual relations between various media"[15].

INTERMEDIALITY
(***broad sense***)

extracompositional intermediality

intracompositional intermediality
(***intermediality, narrow sense***)15

intermediality/ transmediality

intermedial ***transposition***

covert intermediality/ intermedial reference (using a single semiotic system)

overt plurimediality (displaying signifiers that appear to belong to more than one semiotic system)

implicit reference (intermedial ***imitation***)

explicit reference (intermedial ***thematization***)

intermedial ***fusion***

intermedial combination

- narrativity of music and lit.
- variation in music and lit.

novel into opera

- musicalization of fiction
- programme music ('music in lit.'; 'lit. in music')

- discussions of music in lit.
- composer characters in fiction ('music in lit.')

performance of opera

- textual basis of opera ('music and lit.')

Figure 1. System of intermedial relations illustrated with musico-literary examples, Source: W. Wolf, Intermediality Revisited Reflections on Word and Music Relations in the Context of a General Typology of Intermediality, in: Word and Music Studies: Essays in Honour of Steven Paul Scher and on Cultural Identity and the Musical Stage, Amsterdam – New York 2002, p. 28.

Within the form of intracompositional intermediality the interactions between the given media (fusion, merging) may also be transferredto other media such as music theatre, ballet, comic book,

sound film, illustrated novels or opera, creating so called *new syncretistic medium* [16].
Discussed works are examples of fusion (see: *Figure 1*, notions marked red), where it is not possible to separate particular media from one another – they make up a uniform multimedia message. This conceptual fusion of different means of communication generates an intermedial interplay of music, theatre and choreography.

3. Generative music

3.1 Three Women for three women and 10 instruments

Agnieszka Stulgińska's composition is an example of modern dance theatre, whose subject revolves around hardships of women's lives. Dramatic structure of this work is based on four scenes, depicting the title women in different situations (conductor, vocalist, flutist). Each of the women was assigned by the composer a different role to play in the music spectacle (sitting, singing, conducting, sifting grains, decanting water or stirring in the pots). These activities are closely related to the message contained in a particular folk song. In her work Stulgińska made use of authentic ceremonial folk songs from Polesie region (territory of Ukraine): in scene 1 a song entitled „Oj u w sadu sadu” is sung in white voice by the old and the young folk singer whereas in scene 3 they sing a song about a widow entitled “Oj szczo eto za werba”; the songs were an inspiration for the creation of the work. Scene 4 presents vocal improvisation of women with a-o-u-e phones generated for bass pulse, accompanied by white voice.

Musical piece turns into an original intermedial spectacle, in which spectators' attention is turned towards sounds generated by different sources but also to the elements of its scenery. The divisions in scene arrangement throughout the work are very clearly marked – the composer accentuates them by changing the intensity of scenery lighting (scene 1 – no lighting, scene 2 – the appearance of blurred light embracing the person of the conductor, then - the woman sitting on the floor who breaks up twigs, leaves and shells, puts them into a bowl and stirs, scene 3 – no lighting, just like scene 1, scene 4 – full lighting embracing three women: conductor and two women stirring beans, rice and cat wood chips in aluminium bowls to the specified rhythm) (*See: Photo 1*). The lighting, apart from creating interesting visual effects constitutes the form-shaping element of the musical work - it endows the content presented on stage with a distinct character, as in the theatrical performance. The absence of light "is in turn the psycho-acoustic element – it shifts the focus to listening to the voice from behind the wall and the sound from the small loudspeaker”[1]Throughout the whole scene sequence the changes take place also in terms of sound content, folk melody and the cast of performers.

Various media become the essence of the composition and their fusion results in complementary integrity and the final artistic result. The music created in this way is bothgenerated live and reproduced from tape. Sounds produced by the instruments, props and by singing women are reinforced by microphones, which transmit the signals to the quadraphonic system and the small loudspeaker. The sounds of melosphere and sonisphere as well as electro-acoustic effects are transformed (mainly by the changes of frequency) by the computer software and then placed in space.

The way performers and loudspeakers are arranged on stage is also worth noticing. Stulgińska's

[1] The information comes from a composer – Agnieszka Stulgińska

concept is to place the instrumentalists outside the stage but in such a way as to enable the conductor to maintain eye contact with the band. The female conductor and the women are on stage. The woman who sings using white voice moves across the adjacent rooms and the other one is to sit on the floor "like a little girl"[14]. In scene 4 all women are sitting on chairs forming a semi-circle surrounding the conductor (see: *Photo 1*).

Photo 1. A. Stulgińska, Three Women for three women and 10 instruments, scene 4. Concert 27. Portraits of Composers 2017. Anna Karpowicz, Lilianna Krych, Marta Bogusławska-Grzywacz (photo by A. Stulgińska)

The citation of particular media is possible only in case of witnessing a live performance of the spectacle or watching it in the form of video recording. The soundtrack alone does not convey the precise message inscribed by the conductor in the score. For the creation of polymedial musical form Stulgińska used the following media:

- classical medium: traditional instruments (string quintet, wooden and metal simtra, baritone saxophone, flute, white voice of the folk singer - Maniucha Bikont, and objects generating sounds of percussion: grains, bowls, dry leaves, twigs, pine cones and nut shells, water)
- electronic medium: tape with recorded white voice of an elderly woman - Dominika Czekun, singing folk melody from Stari Koni village in Polesie Równieńskie region (played from a small loudspeaker)
- digital medium: computer with Ableton Live software for processing the sounds made by human voice and instruments.
- theatrical medium - division into scenes, actors' performance, scenery with props
- medium of light - lighting of the scenery.

3.2 free for(m) macwin2

By contrast, Krzysztof Knittel's composition is computer-based music in which the intermedial artefact is created by sound generators built by Piotr Sych in Windows operating system, patch MaWe created by Marek Chołoniewski and Marcin Wierzbicki and designed on the basis of Max/MSP program and modern non-musical devices iPhone i iPad, with applications by Apple (See. *Photo 2*).

Photo 2. Media in free for(m) macwin2 performance by K. Knittel during the concert being a part of Międzynarodowy Festiwal Muzyki Współczesnej [International Contemporary Music Festival] "Warszawska Jesień", 2012 (photo by K. Knittel)

The device which deserves to be paid special attention to is the generator manufactured by Piotr Sych i.e: programmable ISA infra-red harp in the shape of a square frame plugged into the computer with creative digital tool - Cubase. This interactive instrument is made up of 32 invisible strings - infra-red beams, forming a grid. The device detects the movement of the hand or the body and by means of software generates pre-programmed sound bases and visualisation integrated with signals.
The performer by generating movement within the framework of the harp may switch on several functions in the instrument, e.g: intensity of sound, tempo of the musical piece or sound distribution in quadraphonic system.
The application of Sych's instrument in the composition allows to join the elements of performer's movements with the music. The author of movement choreography in real time music creates music with movement artefact.
The discussed work of Knittel is the example of intermedial work of art in which the addressee has the opportunity to freely follow the correspondence between the creators representing different art disciplines (music, choreography or conducting).
Knittel, in order to create an intermedial spectacle, used the following media in his musical performance:

- electronic media,
- digital media,
- choreography (body movements/hand movements while conducting) – playing ISA harp.

The composer himself was the creator of hand movement in the frame of the harp and he also controlled the equipment during the premiere performance.

The work does not have a traditional score; it is a freely improvised musical piece. The musical occurrences and technology of generating electro-acoustic effects are recorded in the form of graphics and text where along with their real timing there is a note on the type of electronic effects generator.

The composer also designed the instrument (equipment) layout, which should be followed while performing the composition. (See: *Figure 3*)

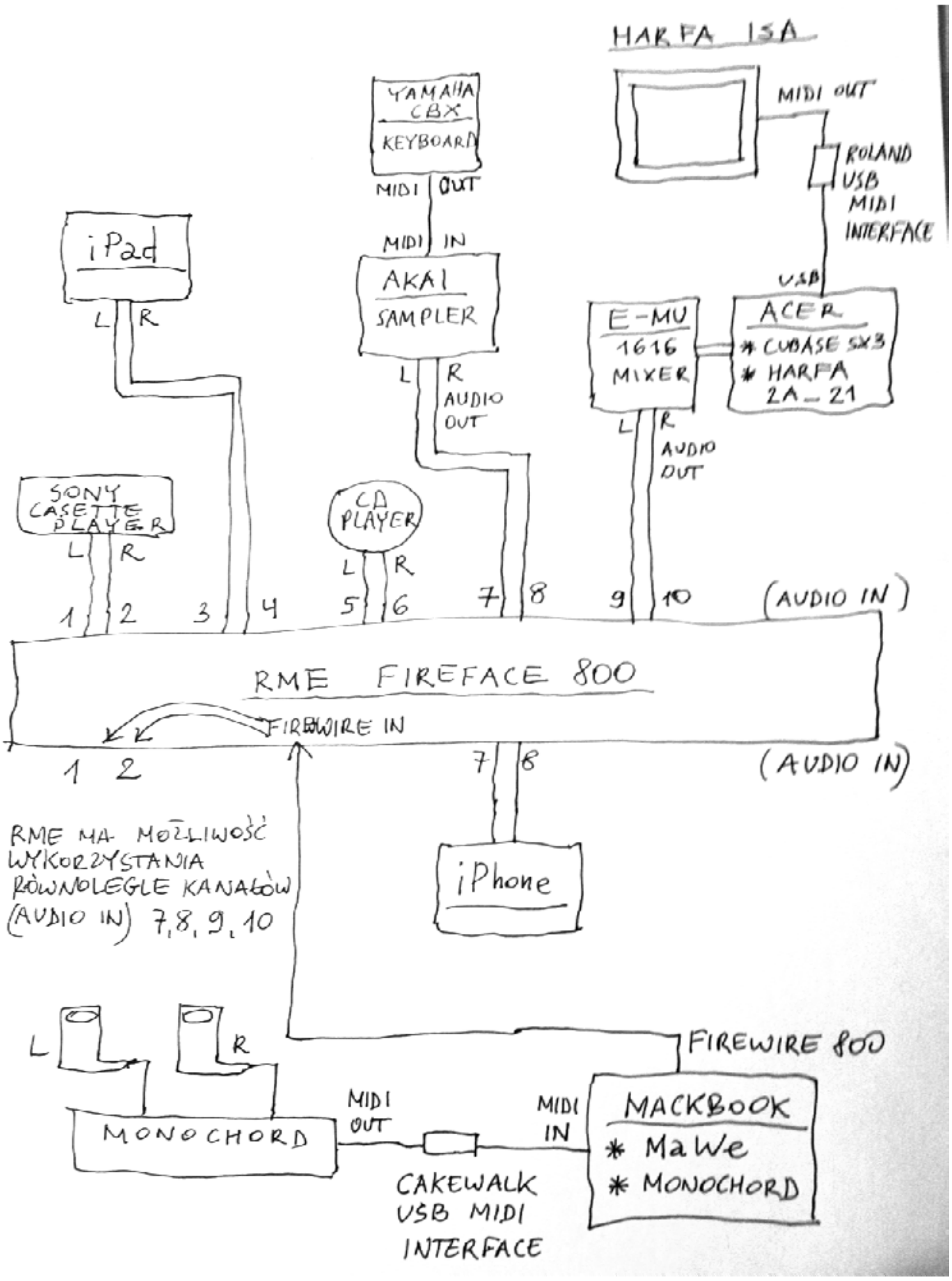

Figure 3. Instrument layout - scheme by K.Knittel

4. Artistic Message

4.1 Body movement as a music-generating factor

In the context of discussed musical works the computer is incorporated into the process of improvisation and creation of the generative art work. Computer software then "interprets the performance of the work and displays variable response depending on the input signal and programmed operating rules, modifying the course of music generation or changing parameters of sound transformation"[2].
Body movement also plays a major role in the discussed works, where, being a part of scenery, on the one hand it manifests emotions and expression encoded in the musical work and on the other becomes a music generating factor.
What deserves special mention in both discussed works is the activity of conducting, applied in a non-traditional manner.
In the composition *Three women* the composer assigned the conductor a symbolic function; she becomes one of the characters of intermedial performance, inspired by the narrative written in the lyrics of the folk song. Besides coordinating the performers she improvises gestures to accompany the voices of the women and musicians (circular, straight and sharp movements) and participates in the spectacle. In scene 2 the conductor's gestures (Wom. 2) are further repeated by the woman sitting on the floor (Wom. 1), who stirs the contents of the bowl with her left hand and with her right hand mimics the conductor's gestures (See: Figure 4). Hand movements of both women become additional elements of choreography. In the composition there are also extracts where the composer precisely transcribed the conductor's movements, which should be synchronised with the band and sounds or subjugated to the shapes of sounds.

Figure 4. A. Stulgińska, Three Women for three women and 10 instruments, scene 2, t. 45-44

In scene 2, as it is explained in the commentary to the composition, "the conductor manifests the whole spectrum of intelligence and control, pursuit of the inner song and transformation" [14].
Another element which is worth highlighting in this scene is the improvised singing of one of the

women and drawing the shapes of the orchard, flowers and garden - interpreting in this way the song from Polesie region.
The element of hand movement in Knittel's work, which may be identified as the movement of conducting the music played from the equipment, are the composer's gestures inside the frame of ISA harp. The composer apart from generating sound in real time simultaneously becomes the participant of the spectacle.

The final result Free for(m) macwin2 in turn became an inspiration to create movement composition. Here we witness a process which is opposite to the one put forward by the composer. For the interpretation Anna Galikowska-Gajewska selected the extracts of the work which were created as an outcome of using ISA harp by Knittel. One of such fragments is the extract timed 6'00"-7'30", in which sound objects are generated by monochord and ISA harp. Sound effects intended to be created in Knittel's concept are the sounds made by helicopter, flutes and wood. If the movement composition created by the author of choreography had been used in Knittel's work a new outcome in terms of sound would have been produced, connecting two intuitive approaches to the process of creation.

4.2.1 Movement interpretation of musical piece – artistic form of Dalcroze's method – origin, tradition, present day

The author's idea of movement interpretation of the musical work in question springs from Dalcroze's concept of reflecting music in movement.

At the beginning of the 20th century Emil Jaques-Dalcroze - a prominent pedagogue, gifted musician, sensitive and generally talented person, created the Eurythmics method, which is based on movement resulting from music.
Eurythmics method consists of 3 interconnected links: Eurhythmics with *plastique animée*, Solfége and Improvisation.
Eurhythmics is the basis of the method: 'It is a form of musical education, based in the first place on listening and teaching of movement [...] [12]. Eurhythmics, with its sources in rhythmic and movement exercises, simultaneously trains and develops many different skills and dispositions.

Solfège is a reinvention of traditional ear training and sight singing, which develops an integrated and expressive understanding of pitch, scale, and tonality through activities emphasizing immediate aural comprehension and vocal improvisation.

Improvisation is an expression of an understanding of musical concepts, form and meaning through spontaneous musical creation using movement, voice, and instruments. Improvisation gives the opportunity for music and movement creation. Improvisation is the basis of Dalcroze's method. Its importance is certified by the words of F. Marin "Improvisation is the basis, nothing more and nothing less" [3].

Emil Jaques-Dalcroze also developed his own art form - initially called by its creator — *plastique animée*[2].
Plastique animée, called nowadays the movement expression, is a crucial element of movement interpretation of music, which builds the artistic dimension of the Eurhythmics Method. The

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[2] Plastique animée — a definition introduced by Emile Jaques-Dalcroze himself. It is currently included in the Polish curricula under the name of 'Technique and movement expression' or ' Exercises in movement expression', see E. Jaques-Dalcroze, Selected writings, pp. 63–84.

essence of the movement interpretation of music is a close relation between music and movement.

“Three elements of Eurhythmics intertwine and supplement one another, creating a multifaceted system of music education granting the access to the world of music, its exploration and experiencing it in motion. The uniqueness of Eurhythmics is to be perceived also in the context of its comprehensive impact on the human activity, in the physical, psychological and mental sphere” [11].

According to the author of this article: “The Dalcroze method of teaching music is based on the assumption of comprehensive human development in numerous spheres. Movement being the basis of the Rhythmics leads to harmonious progress of the whole human organism” [6].
The origin of the method is very well explained by Dalcroze himself: “I dream about such system of teaching music in which the human body will be playing a direct role between the sound and the thought, it will simply become an instrument of expressing our sensations” [3].

Furthermore, the creator's interest in ancient Greece's legacy contributed greatly to the creation of the method. Emile Jaques-Dalcroze reached for the legacy of the Greek culture, whose noble ideas of education and shaping people’s hearts, bodies, and minds became an unattainable ideal for many generations of creators. The most conspicuous reflection of this was Dalcroze's fascination with Greek sculptures. He had been studying the construction of Greek sculptures from which he extracted 20 gestures, subsequently applied to plastique animée. Simultaneously, Dalcroze was trying to find a kind of movement that was not just movement for movement’s sake. This movement should be subjected to music and follow it to cause ‘[…] the body to become music’ – he used to say [8].

In the first movement interpretations the Eurhythmics creator revives 20 gestures. Hence in Hellerau[3] Emil Jaques – Dalcroze staged Gluck’s opera ‘Orpheus’ (the second act in 1911 and the

[3] Institute in Hellerau was founded by German brothers Dorn for Emile Jaques-Dalcroze. Hellerau, which was a garden city, is now a European centre for teaching and performing according to the guidelines of the Eurythmics Method.

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entire work in 1912). Janina Mieczyńska – Lewkowska, a Dalcroze's student, when describing this event, said: "It was an amazing show. In one time and one place resounded music conducted by Dalcroze, musical movement picture, choreography was presented by a great team of performers

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who followed the example of ancient Greek players clothed with tunics; movement and lights were closely related to each other" [9].
Music is the epicentre of all activities undertaken within the scope of Dalcroze's method. Dalcroze's words prove its utmost importance: "My whole system of education by rhythm is based on music, because music has a strong psychic force which, by its power of evoking action and then regulating it, can harmonise our whole being" [7]. The creator of Eurhythmics affirmed also that "Man is the most perfect of instruments and his body is the sensitive, dynamic instrument through which he can attain his highest potential" [7].

The essence of movement interpretation – art form, however, remains constant, perfectly expressed by Friedrich Schiller: "When the music reaches its noblest power, it becomes a shape in space" [1]. For what is interpretation but a moving shape of music presented as expressive movement of performers in space? In this creative form, the concrete dimension of music is realised by the human body in movement. The art of creating movement interpretations of music consists in continuous construction of relations between the music and the human body, between movement and space. It is this perspective and the personal store of experiences that affect how an individual understands and defines the discussed subject. For the author of the article "Movement interpretations of a musical piece are the most beautiful and the most perfect way of reflecting music by means of spatial-movement measures. They constitute the synthesis of music and movement, thanks to which they allow a deeper experience of music that is embodied in the movement of the human body" [4].

The basis for creating movement interpretation is movement improvisation.
Performing improvised movements to the music, like every kind of improvisation (instrumental or vocal) "[...] leads to manifesting oneself, to a certain type of individualisation, allows one to get rid of inhibitions in terms of movements, stimulates the imagination, makes a person open for others and for the surrounding world" [5].
Props play an important role in the creation of movement interpretations, particularly those of contemporary music.

"The props can be used in movement interpretations in a number of various ways. They can be a kind of set design – decorations on the stage. The props include also stage costumes and various objects used to express the emotional character and expressiveness of music in movement. Lighting is an indispensable element of stage presentations as well. The range of the newest stage means of expression that we take advantage of nowadays when presenting movement interpretations on stage include multimedia presentations or more advanced animations and visualisations" [6].

Her wealth of experience in the field of creative activities within the scope of Dalcroze's method has finally made Anna GG convinced that contemporary music is her biggest inspiration. Its versatility resulting first and foremost from the richness of musical sound, offers enormous flexibility in creating and exploring original spatial and movement solutions. Contemporary music has a very strong impact on human imagination and is a great incentive for continuous exploration of movement, the limitations of which may result only from the anatomical features of the human body.

One result of the recent years of her strenuous artistic and research work related to contemporary music is a completed and published work of art: a DVD, a book and a photo album, published as a combined work under the title

The sound in movement interpretation of a music piece. Debussy, Cage, Penderecki, Szalonek, Dobrowolski, Olczak, Kaiser.

Anna GG for many years has been a specialist in creating choreography for contemporary music.

4.2.2 The outline of creative concept in movement interpretation of Free for(m) macwin2 work by K. Knittel

The musical work of Knittel, analysed above, or, more precisely, its extracts, posed a fresh challenge for the author. She was searching for movement qualities originating from diversified sounds generated by electronic media, digital media and sounds made by ISA harp. Anna GG - the creator of choreography as well as the performer, experimented in terms of making use of human body as a direct medium reflecting music and its expression. Rich, full-range sound of the musical work existing in multiple sound fields triggered off the use of multimedia to create movement visualization compatible with sonic image of the musical work.
The author's own creative concept is an individual suggestion making use of contemporary media - video recordings, visualizations of selected sound fields and movement performed live in the space on stage. The suggested artistic concept represents typical Dalcroze-like solutions referring to presenting music in movement and space, in which the movement expression of the performer is reinforced with modern media tools, giving it a new - intermedial dimension.

5. Conclusion

This article is an attempt at demonstrating that computer, as a digital instrument, with a system different from traditional ones, which is "played" by the composer may be used to create a "generative" musical composition, in which the process as such is regarded as the primary medium of creative expression.
The analysed compositions create a specific polymedial spectacle, a performance original in its content and form of communication, which reveals symbolic meaning of sound emission, interacting with choreography, light, theatrical form and other electronic medium. The corporeal aspect, so meaningful for theatrical performance here also became one of the media, allowing the verbal communication as well as communicating by means of gestures, body and movement with the addressee.
Movement interpretation of a musical work fits perfectly into the contemporary discourse concerning polymedial spectacle. It constitutes another structural element of the multidimensional multimedia spectacle, endowing it with greater momentum and dynamism.
Body movement, along with other media may become, as in the discussed compositions, a generating factor of musical expression, gestures and also, through computer, of the musical matter - sounds.

ESCHE BACH
Paper

Bioarts, Music

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Abstract

The name of the project comes from the homonymy between "ECCE BACH" ("Here is Bach" in Latin), and the first letters of the full name of the bacterium E. coli, escherichia coli.

The project itself consists of coding several musical pieces of J.S. Bach into DNA strands, using a four-letter coding that corresponds to the four nucleobases that enters in the composition of this molecule, forming the basic elements of the genetic code, namely adenine, guanine, cytosine and thymine, identified by their initials A, G, C T.

The DNA strands thus encoded are injected into the genome of E.coli bacteria and of yeast micro-organisms. They replace some of the silent sections of the genome. These sections, whose role is just beginning to be understood, do not normally express themselves during morphogenesis and therefore have no known impact on the appearance of the micro-organisms (phenotype) or on their vital functions. Several bacteria and yeasts are prepared, each carrying a given piece. They are released into a nutritious substrate where they are left to evolve on their own for several weeks.

During this period, they grow and reproduce a very large number of times; a single generation lasts 20 to 30 minutes. By means of natural mutations and other phenomena, all sections of the genome, including the one where the musical piece is coded, are transformed and modified. At regular intervals, samples of bacteria and yeasts are retrieved. Their DNA is extracted and decoded at the precise places where the musical pieces were recorded. The modified nucleotide sequences are then converted back to music, resulting in a set of variations from the original themes.

These variations will then transcribed on classical music scores, in anticipation of a performance / concert where a selected sample of them will be performed by a quartet of classical musicians, accompanied by a pianist, and, depending on the playability of the vocal sections, by two choristers. The première of this concert is expected April 2019.

ESCHE BACH
In vivo musical variations

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Abstract

The name of the project comes from the homonymy between ECCE BACH ("Here is Bach" in Latin), and the first letters of the full name of the bacterium E. coli, or Escherichia coli. The project itself consists of coding several musical pieces of J.S. Bach into DNA strands, using a four-letter coding that corresponds to the four nucleobases that enters in the composition of this molecule, forming the basic elements of the genetic code, namely adenine, guanine, cytosine and thymine, identified by their initials A, G, C T.

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At regular intervals, samples of bacteria and yeasts are retrieved. Their DNA is extracted and decoded at the precise places where the musical pieces were recorded. The modified nucleotide sequences are then converted back to music, resulting in a set of variations from the original themes. These variations will then be transcribed on classical music scores, in anticipation of a performance /concert where a selected sample of them will be performed by a quartet of classical musicians, accompanied by a pianist, and, depending on the playability of the vocal sections, by two choristers. The première of this concert is expected April 2019.

1 • Introduction

Esche Bach is a research-creation project that draws his name from the homonymy between "ECCE BACH" ("Here is Bach", in Latin), and the first letters of the full name of the bacterium Escherichia coli, a.k.a. E. Coli. The project itself consists in coding several musical pieces by J.S. Bach into DNA strands, using a four-letter coding that correspond to the four amino acids that constitute the alphabet of this molecule and form the basic elements of the genetic code, namely adenine, guanine, cytosine and thymine, identified by their initials A, G, C and T.

The DNA strands thus encoded are injected into the genome of E. coli bacteria and of yeast mirco-organisms. They replace some of the so-called silent sections of the genome. These sections, whose role is not yet fully understood, do not express themselves during morphogenesis and therefore have no obvious impact on the appearance of the bacterium (phenotype) or on its vital functions.

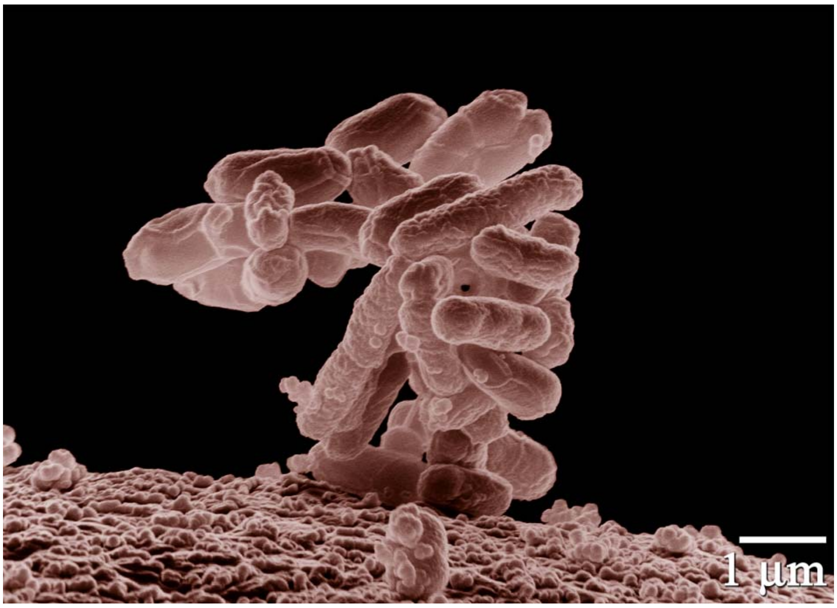

Fig. 1 • E. coli bacteria.

Several bacteria are prepared for the experiment, each carrying a given musical work. They are then released into a nutritious substrate where they are left to evolve for several weeks. Since the delay between two generations is about 20 minutes, they grow and reproduce a very large number of times. Through different modes of natural mutations, all sections of the genome, including the ones where the musical pieces are coded, are transformed and modified.

Samples of micro-organisms are collected daily. Their DNA is extracted and decoded, so the mutated pieces can be retrieved and converted back to music, resulting in a set of bio-musical variations from the original themes. The variations are then transcribed on classical music scores, in anticipation of a performance / concert where a selection of the mutated pieces will be performed by a small classical ensemble.

2 – Framework of the project

Fig. 2 • A fossil of senftenbergia plumosa, a fern that existed more than 300 million years ago.

The project was born from a questioning about the ability of living beings to preserve the information for times that are considerably longer than those typical of inert matter. When looking at a 300-million years old fossilized fern, one of the most amazing things is that it can be recognized and identified by its close similarity to the ferns we know today. This means that the information that determines the morphology of the fern has travelled during all these years, being relayed from individual to individual, without significant alterations. 300 million years is the time for a mountain range to be born, to peak in the stratosphere and to flatten into a peneplain, and even sometimes, as in the case of the Pyreneans, for a second chain to rise over its remnants. A symbol of permanence for millennia, which is demonstrated by monuments such as pyramids, which adopt the shape of mountains to carry the body of illustrious people towards eternity, the mountain has lost its status in recent decades: it is now well pale compared to the living in its ability to guarantee the permanence of information. We now begin to realize that reaching eternity, which has been one of the main mythical concerns of human beings since the dawn of time, calls for the strategies of the living, and no longer by the properties of inert matter. This question is now the object of advanced research programs : several laboratories are currently working on the design of DNA memories, which, through the replication of the information contained in these molecules, by the quasi-astronomical level of redundancy provided by the rapidity of cell replications, and thanks to all the self-repair mechanisms and control processes that exist in all living cells, could ensure the transmission of information towards the future for durations that are unimaginable today.

Although the preservation of genetic information is extremely efficient at the species level, the situation is, as we know, very different for individuals, whose chromosomes are submitted to several kinds of transformations, from mutations caused by radiations and cosmic rays to genetic cross-over, some of which being able to introduce considerable changes. They allow individuals to evolve through differentiation, in order to maintain a high-level of adaptability in the event of critical environmental variations.

Our starting hypothesis was that the transformation of existing musical pieces by these same phenomena could become a process of musical composition capable of producing unexpected propositions. Although this is outside our area of expertise and outside the specific scope of our project, the method also presents possibilities for transfer to biology and genetics : it is not unrealistic to think that this form of sonification could produce new knowledge about the precise unrolling of genetic mutations, and of the channels by which information is transmitted from one individual to its offspring.

3 • Experimental framework and methodology

The project is the concretization of an idea that I had several years ago, but which was difficult to implement at the time, due to the complexity and costs involved by the production of genes and the insemination of bacteria. Since the beginning of the current decade however, a new gene editing procedure has been developed. Called CRISPR-Cas9, it makes it possible to perform these manipulations with great efficiency and at costs considerably decreased [1]. Developed by the French biologist Emmanuelle Charpentier assisted by the American Jennifer Doudna [2], this technique is revolutionary enough to place its inventor on the list of potential Nobel prizes, which would already be done if legal challenges had not occurred in the meantime, but these considerations are also out of the scope of this paper.

The musical insemination of bacteria and yeasts can follow two paths. In the first one, the coded DNA strands is directly injected in the micro-organisms. In the second, the DNA of a virus (*phagus*) will be modified. The virus will then attack the micro-organisms and contaminate it : it will be used only as a vehicle to enter the cell. Since viruses evolve much faster than bacteria, this second method ensures faster replications and maximizes the possibilities of mutations and evolution within a given time. The modification of the genome of a phagus however is a more delicate operation. To maximize the chances of success, the two paths will be followed in parallel.

The decision to use musical pieces by J.S. Bach was taken for several reasons :

• Many pieces of Bach’s repertoire are known enough to allow most audiences to easily identify the variations from the original.

• Much of Bach's repertoire has a clear and rigorous formal structure. Some pieces, like the Goldberg Variations, have been elaborated by posing it a priori, even before the composition process; not only the pieces, but also the whole set of variations, are based on a strong structural pattern [3].This also facilitates the precise identification, location and nature of the modifications, even for people that are less knowledgeable in music.

• Bach's scores have no indication of expression, giving the performer complete freedom to accentuate the play or dynamics of the different passages. This results in a vast spectrum of potential interpretations, which for the Variations range from Glenn Gould's ardency to Evgeni Koroliov’s restraint and refinement. Unlike the musical notation itself, which lends itself rather easily to numerical quantization, indications of expression are qualitative: it would be very risky to attempt a formal coding, which would be necessarily blurred and biased by subjective concerns. Starting from Bach's scores, the musical notation obtained at the end of the process will remain as close as possible to the composer's initial will, leaving the performer the totality of his expressive freedom.

For these reasons, as well as for other reasons that will be outlined below, the current list of potential candidates includes the Goldberg Variations, 2- and 3-voice Inventions, as well as four-voices chorals.

4 • E. coli : in vivo considerations

In the early phases of the project, the decision was taken to start from musical pieces already coded by the MIDI protocol. Developed in the beginning of the 80's and still heavily used by contemporary musicians of about all possible styles, it includes, directly or indirectly, all the information required for the project, thus allowing to streamline the transposition of the piece into the genetic code.

Once coded, as can be seen in the picture of the program interface below (Sect. 7, Fig. 7) , the piece is first submitted to different simulations based on mutation rates whose values come directly from biological observations. Different coding methods can be tested during this phase. Hypothesis can be made about the time required by the in vivo mutations to generate perceptible transformations, and eventually about the necessity to optimize the mutation rate, either through radiations such as UV rays, or by bio-genetic methods, such as the use of phagi, as mentioned above. Last but not least, it allows to test the whole process with different musical pieces, in order to select those in which the changes will be important enough to be noticed without completely upsetting the original themes.

The first piece we considered was the Goldberg Variation No XVIII, or Canon to the Sixth. We are also experimenting with our other candidates, but this one is used as a reference piece for the present paper. Mutation rates for the simulations are set from E.coli natural rates.

E.coli are unicellular micro-organisms that enter the vast category of prokaryotes, meaning that they have no cell nucleus. Their genome, certainly the most studied of all living organisms, includes between 4,6 and 5,3 millions genes, allowing them to code between 4200 and 5300 proteins. At 37 Celsius, they reproduce at the rate of three generations per hour. Given enough nutriments, one single bacterium can thus produce a population of more than 100 million in one single night. Being deprived of nucleus, they cannot evolve through processes such as chromosome cross-over : genetic mutations are essentially caused by replication errors or environmental causes, such as mutagen substances, or natural or artificial radiations.

The central dogma of molecular biology, the one that describes the unrolling of events during cell replication and reproduction for all living beings on earth, states that the DNA encodes all the information required for the production of biological matter. This information is first transcribed into RNA strands. These very long molecules then carry the information in specific locations of the cells, where they are translated into proteins. Some of these newly created proteins are sent back to control the translation and transcription of the RNA information, but the vast majority becomes the main components of the organism's body. Three kinds of RNA actually exist; the one that is in charge of carrying the genetic code is called "messenger RNA", often abbreviated as mRNA.

ALA	Alanine	GCT	GCC	GCA	GCG		
ARG	Arginine	CGT	CGC	CGA	CGG		
ASN	Asparagine	AAT	AAC	AGA	AGG		
ASP	Aspartate	GAT	GAC				
CYS	Cystéine	TGT	TGC				
GLN	Glutamine	CAT	CAC				
GLU	Glutamate	GAA	GAG				
GLY	Glycine	GGT	GGC	GGA	GGG		
HIS	Histidine	CAT	CAC				
ILE	Isoleucine	ATT	ATC	ATA			
LEU	Leucine	TTA	TTG	CTT	CTC	CTA	CTG
LYS	Lysine	AAA	AAG				
MET	Methionine	ATG					
PHE	Phenhylalanine	TTT	TTC				
PRO	Proline	CCT	CCC	CCA	CCG		
SER	Série	TCT	TCC	TCA	TCG	AGT	AGC
THR	Thréonine	ACT	ACC	ACA	ACG		
TRP	Tryptophane	TGG					
TYR	Tyrosine	TAT	TAC				
VAL	Valine	GTT	GTC	GTA	GTG		
STOP		TAA	TAG	TGA			

Second Letter

First Letter	T	C	A	G	Third Letter
T	TTT TTC Phe TTA TTG Leu	TCT TCC TCA TCG Ser	TAT TAC Tyr TAA Stop TAG Stop	TGT TGC Cys TGA Stop TGG Trp	T C A G
C	CTT CTC CTA CTG Leu	CCT CCC CCA CCG Pro	CAT CAC His CAA CAG Gln	CGT CGC CGA CGG Arg	T C A G
A	ATT ATC ATA Ile ATG Met	ACT ACC ACA ACG Thr	AAT AAC Asn AAA AAG Lys	AGT AGC Ser AGA AGG Arg	T C A G
G	GTT GTC GTA GTG Val	GCT GCC GCA GCG Ala	GAT GAC Asp GAA GAG Glu	GGT GGC GGA GGG Gly	T C A G

Fig. 3 • Two inverse representations of the redundancy of the genetic code. Left : the 20 main amino-acids and the STOP instruction, followed by the 3-nucleotides codons that produce them. Right : to find the amino-acid produced by a given codon, take the first nucleotide on the left of the table, the second on the top and the third on the right. The resulting nucleotide appears on the corresponding cell.

DNA and RNA molecules are made of chains of nucleotides, themselves composed of a nitrogenous base, or nucleobase, a sugar with five atoms of carbon (ribose in the case of RNA, deoxyribose in the case of DNA), and one or several phosphate groups. In both cases, there are four possible nucleobases : adenine, guanine, cytosine, uracil, designated by letters A, G, C, U. In DNA, thymine (or T) replaces uracil.

The basic elements of the coding are triplets of nucleotides, called “codons”. During the proteogenesis, each triplet produces a particular amino-acid, which is the basic component of all proteins. About 500 amino-acids are known today, but the DNA/RNA coding produces only the 20 varieties that are required for living beings[1]; it also produces a terminating instruction (a STOP codon) which specifies the moment where the protein molecule is completed and can be released within the cell cytoplasm.

Considering that each element of each triplet can take four different values (A, G, C or U), the genetic code can yield 64 different outputs (4^3), which means that there is a high level of redundancy. The two tables below (Fig. 3) show the correspondences between the triplets and the amino-acids they generate.

One can see immediately that the outputs of the code are not equally distributed : amino-acids such as leucine or serine can be produced by six different codons, when others, such as methionine or tryptophan, are generated by a unique codon.

As we will see in the following section, this repartition became a central element of the code we developed for transposing musical sequences into genetic sequences, namely the ESCHE BACH code.

5 – Musical bio-variations : towards the ESCHE BACH code.

At the coding level, there are many ways to transpose a musical score into a four-letter alphabet. Several possibilities have been explored. They are all based on the fact that the DNA sequences impose a codon vocabulary of three signs, each one taking one of the four values A, G, C or T. A codon can then take 64 different values. This is not a high number : as we will see below, it imposes important constraints on the type of coding that will be used.

We first tried to use a generic code that could be used for about all classical music pieces. Its basic principle consists in coding each note by four codons, yielding a basic word, or template, made of four triplets :

111• 222 • 333 • 444

The individual digits can take any of the four values A, G, C and T. The sequence of the letters between each triplet must be ordered so as to correspond to the sequence of the first integers; it was arbitrarily decided to define AAA as the lowest number and TTT as the last one, meaning that the ordered sequence, from the lowest to the highest value, would look like :

AAA, AAG, AAC, AAT, AGA, AGG.... (...) ... TCC, TCT, TTA, TTG, TTC, TTT

Corresponding to numbers 1 to 64.
Each triplet has a different meaning :

- Triplet 111 indicates the position of the bar containing the note in the score.
- Triplet 222 determines the position of the note within the bar.
- Triplet 333 indicates the height (or frequency) of the note, in semi-tones.
- Triplet 444 indicates the duration of the note, counted in multiple or sub-multiple of the basic note of the score, as read on the metric indication at its beginning.

As mentioned above, the MIDI protocol is used for describing each note. Some data like the height of a note, can be directly extracted from MIDI messages; it is represented by an integer value between 0 and 127. Other can be indirectly determined : the duration of a note, for instance, must be computed by comparing the moments where the note begins ("Note On") and where it ends ("Note Off"). Since the number of possibilities for parameters such as note duration is much lower than 64, this first coding used a cycling numbering process : if we had only 8 possible durations, then the 9th element of the code would go back representing the first duration, the 10th would represent the 2nd, and so on.

The situation was different for the height of the note, since the number of possibilities (128) is twice the possible number of "words" of the corresponding triplet. We then had to consider a first adjustment to our code : since our reference piece had an ambitus of 52, we considered only the 64 values starting 6 notes under the lowest note, and ending 6 notes over the highest. The ambitus was then precisely centred within the 64 possible values.

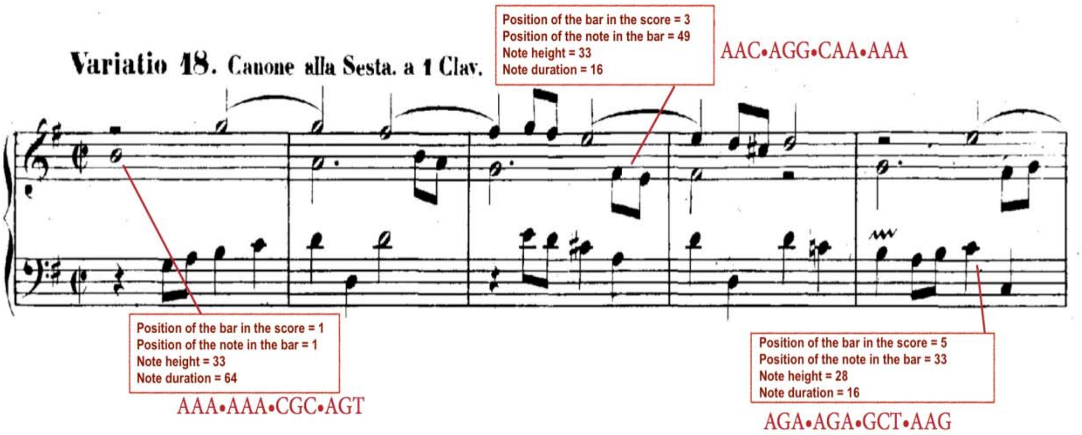

Fig. 4 • The first bars of J.S. Bach's Goldberg Variation No XVIII, or Canon to the Sixth, with three notes represented by the corresponding quadruplets of codons in the ESCH BACH code.

Any classical score can be seen as 2-D coordinates frame, where time lies along the horizontal axis and frequency along the vertical one. Since frequency is the inverse of a time (1/t), any score is the spatial representation, or recording, of a strictly temporal phenomenon. The main interest of our basic coding is the fact that it determines an absolute time-positioning system in this frame. Each note is precisely defined by its height (frequency), coded in the third triplet, the very moment it occurs within the piece, coded by the two first ones, and its duration, coded in the last one. Each quadruplet then carries all the information required to completely define the corresponding note: even a random list of quadruplets will allow a precise reconstruction of the whole score.

6 • The ESCHE BACH coding

Unfortunately, despite the simplicity of this process, and as opposed to what we had initially hoped, several attempts led us to conclude that, even by proceeding to specific adjustments for height or other parameters, no straightforward unique code could be established for all possible pieces. We could have bypassed this problem by using longer codons, but we would have lost the correspondence with the genetic coding; the resulting chains of codons would have become useless in a real biological environment. Sure, we have no idea of the potential impact of musically crypted strands of nucleotides in a living cell, but we wanted from the beginning to preserve a maximal level of similarity between the genetic and the musical codes : we wanted our coded data to be theoretically able to generate proteins when reinjected into a bacterium - even if no one can predict which kind of proteins would be produced, or if they would be viable.

In order to work within these constraints, we decided to do our first experiments with scores including a maximum of 64 bars. Each bar is divided in 64 time intervals, with notes mapped to a 64-steps frequency scale, and a maximum duration of 64 times the smallest time increment of the piece.

These factors could have been seen as strongly limiting. They actually proved quite relevant for our experiments. Using a biological analogy, a musical piece, when played, can be seen as the phenotype produced by the score, which plays the role of the underlying genotype. If we want the evolution of this individual of a particular species not to diverge towards quasi-random sequences, and thus to lead to an entirely different musical species, it becomes essential to start from the main musical features of the original piece and to ensure that the coding will be able to preserve them. It was then decided to submit the piece to a pre-processing analysis during which a unique coding key is generated. This key will be required for the inverse coding and will always travel with the piece. It includes all the information specific to the piece, such as its ambitus, or the list of all note types and heights.

As seen above, the ambitus of our reference piece, or the interval between its lowest and highest note, is 52 : the lowest and highest notes are respectively A1 and C6, which corresponds to MIDI notes 33 to 84. Eight different durations and thirty-seven different tones are encountered. The coding key will insure that the evolution occurs between the ambitus interval, using only durations and tones existing in the original piece. These constraints will preserve the kinship with the original musical phenotype, and also, on a more pragmatic level, make sure that the resulting score will not incorporate sequences that would be impossible to play with classical instruments.
The coding of note durations has been the object of several discussions and attempts. The final decision was to base it on the metric of the score, which, for our piece, is 2/2, as indicated by the C-bar at the beginning. The duration unit is defined by the denominator of this fraction, corresponding here to a half note. To this duration, we give the value 1. All other durations take their values from there : a whole note will take the value 2; a dotted half will be 1,5; a quarter note will be 0,5; an 8th note will be 0,25, a 16th note will be 0,125, and so on. One half of the value of a given note is added to generate its dotted version. Each note of a triplet will use the value 2/3 of the two equivalent notes in the score. The absolute duration of a note, measured in milliseconds, will thus depends both on the metrics of the piece and of its indicated tempo.

By analogy with in vitro mutations, during the equivalent musical mutation, existing notes can be deleted, and new notes can be added, at different locations in the mutated score. To deal with this phenomenon, the precise structure of the MIDI code allowed us to explore two alternatives. The first one is based on the absolute positioning of each note in the score : a suppressed note will generate a silence; if a note is added, or if the duration of a note is increased, the tones will superimpose and the listener will hear a short polyphonic sound. The second one is based on a relative positioning : the position of each note is determined relatively to the previous one. This means that the introduction or deletion of a note will result in a temporal shift for the remaining of the code. Our simulations have shown that the second possibility opens on a very rich landscape of unexpected rhythmic variations. Examples of both possibilities have been computed. They will be presented during the lecture, and are available on the project web site.

The question of the coding redundancy has been addressed by using a ponderation table for the evolution of duration and height parameters. The genetic coding redundancy will be represented here by a wheel diagram (Fig. 4) :

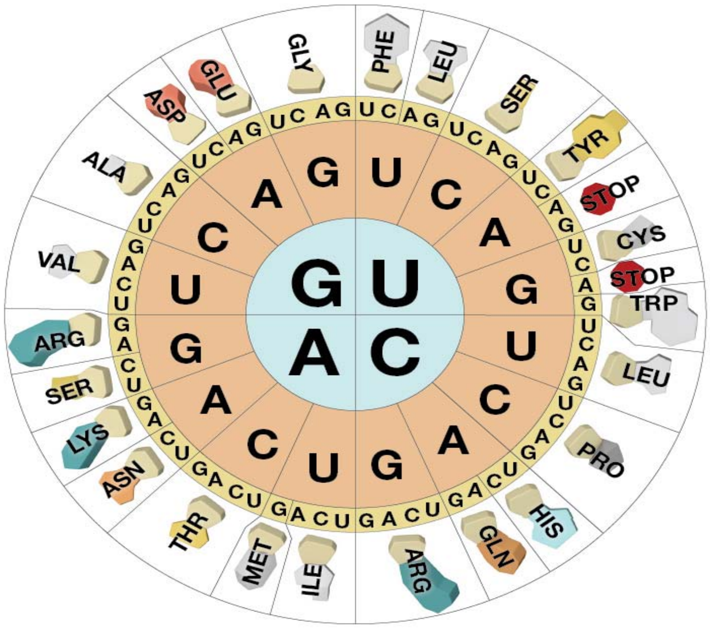

Fig. 4 • Another representation, in form of a wheel diagram, of the amino-acids that are produced by the different codons, in the case of mRNA.

To know the correspondence between a nucleotide triplet and an amino-acid, we start by choosing a letter in the centre of the wheel (in blue), for instance G. Then a second letter is selected among the four corresponding possibilities in the light brown section, for instance C. A final choice is made in the yellow section, for instance C. The amino-acid that will be produced can be read in the external ring : we can see that the GCC triplet produces alanine (abr. ALA). We see also that the last letter does not really matter in this case, since all triplets beginning by GC will lead to the same amino-acid. On another hand, the AUG triplet is the only one that will yield methionine (or MET).

Our ponderation table is established by a direct mapping between the frequencies of each musical parameter in the piece and the occurrence frequency of each amino-acid : the notes that appear more often in the piece will get a ponderation similar to the amino-acids that are produced by the largest numbers of codons. Since the number of values for each parameter differs most of the time from the number of possible amino-acids, a scaling is required : the frequency of occurrence of the 8 possible notes durations, and of the 37 possible heights or tones, is computed; the most frequently encountered values are associated with the amino-acids that are produced by the most triplets.

For the duration and height parameters of the reference piece, the process yields wheel diagrams similar to the one above :

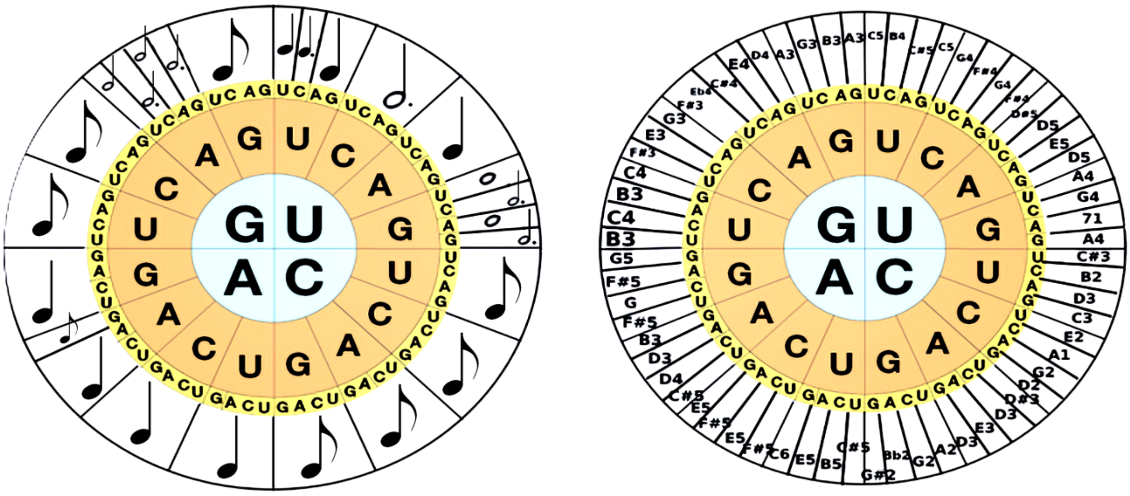

Fig. 5 • Wheel diagrams showing the pondered correspondences between codons and note durations (left), and between codons and notes (right), for the final ESCHE BACH coding. The durations and the heights include only those that are encountered into the original piece.

The evolution of the piece will thus generate musical mutations in which the relative frequency of these two parameters will be mapped to the relative frequency of occurrence of the 20 main amino-acids, so as to maintain a kind of bio-correspondence with their frequencies on the original piece. Since this ponderation varies for each musical piece, it is recorded in the coding key.

7 – The ESCHE BACH software interface

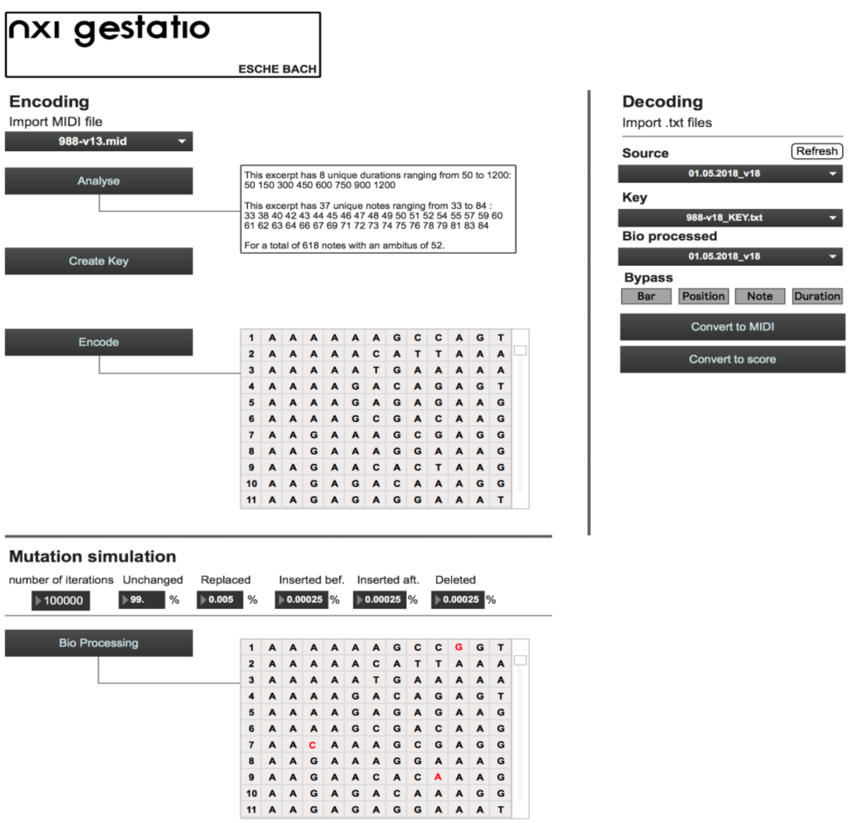

Fig. 7 • The ESCHE BACH interface.

Using the MAX/MSP platform, we developed a program that allows to go through all the steps of the encoding-decoding process, for simulations (*in silico*) as well as for real (*in vivo)* explorations. To start the work, the user first selects a MIDI file with the upper left box (see Fig. 7). By clicking on the "Analyse" button, he extracts the required musical parameters : ambitus, list of durations and heights, total number of notes... The "Create Key" generates the coding key specific to the piece. The "Encode" button converts each note in 3-nucleotides quadruplets, generating, for Variation Goldberg No 18, a 618-quadruplets list that can be either directly sent to the genetic engineering firm in charge of producing the real DNA strings, or used for computer simulation. The list itself appears in the top scrolling window.

The bottom section is meant to explore the effect of different parameters on the mutation. The composer can enter numbers derived from real biological data, in order to predict the modifications that will occur after a certain amount of generations, but he can also enter numbers completely different, so as to use the simulation module for direct musical explorations unrelated to genetic evolution, thus skipping the *in vitro* phase. The bottom scrolling window shows the mutated nucleotides. They are displayed in red, so that the composer can see immediately observe the rhythm of changes along successive generations.

For *in vitro* mutations, the DNA strands, once received from the firm that assembled them, are injected into bacteria and yeasts, which are then let to evolve for a certain period. Even if the simulation phases allow a certain level of predictions about the results, it remains difficult to precisely determine the optimal evolution time after which potentially promising results can be obtained. From the mutation parameters, as well as from our discussions with bio-geneticists, it appears that several weeks are needed. We decided to start with a one-month experiment.

During that time, samples are collected every day and put in a freezer. At the end of the experiment, the genome from the last generation is sequenced to see the level of modifications introduced by the mutations. If it proves too important, or unsatisfying for any reason, samples from previous generations, taken at various intervals, are thawed. Their DNA is sampled and analysed, and the most promising sets of variations is selected. The corresponding lists of codons can then go through the following phases.

In the Decoding section, the composer must input three files : the original piece, the corresponding coding key, and the processed piece; the last one can indifferently result from in vitro or in silico mutations. The Bypass section allows to select the variations introduced by one or several of the four parameters : he can for instance limit the variations to height or durations, for instance, leaving the two addressing parameters (address of the bar and address of the note in the bar) unchanged. The conversion of the results to MIDI files ("Convert to MIDI") allow to listen to the different bio-modified pieces, to submit them to a preliminary evaluation, and to select those that will be played. Finally, the "Convert to score" button generates the scores for the small classical ensemble that will interpret them during the final performance.

8 • Conclusion : arts, cures and disasters, or the ambiguous potential of genetic engineering.

Since the beginning of the 90's, innumerable attempts have been made to analyse, generate, compose or simulate music through computer algorithms inspired from biological phenomena :

neural networks, cellular automata, genetic algorithms... Genetic algorithms of several kinds, all inspired by the ways chromosomes and genes evolve in natural cells, remain especially popular [4]. Looking at the amount of experiments and attempts in this field, one could easily suppose that this fascination for biological and genetics simulations would have quickly resulted in the implementation of *in vitro / in vivo* experiments, using real chromosomes and micro-organisms. Such attempts are surprisingly rare. They did not, to our knowledge, produce any valuable result. One of the reasons for this is probably, as mentioned above, the complexity and costs of the equipment and resources required for such attempts. Since the invention of the CIRSPR-Cas9 method however, things have changed, and it is now possible to foresee the moment where biologists and geneticists, professional or amateurs, will be able to afford and use desktop genetic engineering devices – a potentially frightening situation.

ESCHE BACH is an art project that addresses directly the complex problematics created by the possibility of cheap, efficient and easy genetic manipulations for everyone. It comes at a time when critical questions arise in terms of the risks and potential of genetic manipulation in particular, and in genomics in general. Some of these issues are worrisome. Apart from the obvious and dreadful risks of genetic terrorism, how can we ensure that methods that efficient and that accessible will not be used to modify the human genome, with potentially devastating consequences for the entire species? How can we prevent genomic techniques to drift towards eugenics, or to lead to situations where only a few companies, thanks to patenting strategies, will determine future researches on living beings? How can we prevent potential employers to use people's gene pool as a criterion for hiring, by government agencies as an immigration criterion, or by insurance companies as eligibility criteria? How to balance all these risks with the huge potential benefits of these same techniques for the treatment of rare diseases, or for food production?

We do not have answers for these questions. Since our project proposes a new method for musical composition, aiming at the creation of new musical pieces, its objectives are essentially artistic. However, as it is the case for many works from bio-arts, the use of genomic methods as part of a creative process is both a way of staging these techniques and to make the general public aware of their ever-growing presence in our daily life. By revealing their power and their stakes, not only do we try to demonstrate to new audiences their potential for explorations in research-creation, but we also hope to stimulate discussions, and even controversies, over their potential uses in all fields and disciplines.

NOTE

1 • Living matter is actually made of 22 amino-acids, but we concentrate here on the 20 that are directly generated by the genetic code.

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[4] - The page https://link.springer.com/article/10.1007/s00500-012-0875-8 includes a list of references that shows the level of activity in the field of genetic algorithms applied to music.

ILLUSTRATIONS

All illustrations by Nicolas Reeves & NXI Gestatio, except :

Fig. 1 • E. Coli bacteria. Photo by Eric Erbe, digital colorization by Christopher Pooley, both of USDA, ARS, EMU. - ARS Image Gallery Image Number K11077-1 Public Domain, https://commons.wikimedia.org/w/index.php?curid=130129.
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Fig. 2• Fossil leaves of the plant species Senftenbergia plumosa, Upper-Carboniferous. Specimen ca 40 cm in width, collection of the Universiteit Utrecht. Photo by Woudloper, Bern (Switzerland), 2008.
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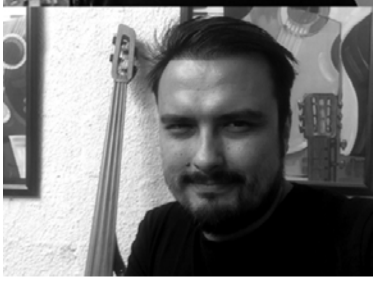

Digital Lutherie and Digital Sound Sculptures In the Context of Sound Plasticity (Paper)

Topic: (Sound Art)

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Abstract
At the beginnings of the 20thCentury, Luigi Russolo, with his "Intonarumories," gave one of the rather early definitions of the Sound Sculptures, and strengthened it by *The Art of Noises*–one of the first and most durable manifesti of the field. In parallel with this, there happened a cognitive revolution by the "Ready Mades" by Duchamp, a workfield opening up huge possibilities for new dimensions in plastic arts. In addition to this, dadaist works, including those of Duchamp, such as "Sculpture Musicale," "With Hidden Noise," have been inspiring in the rise of the concepts "sound sculpture" and "sound object." In accordance with the requirements of the time and the developing technologies, the boundaries of music and works of sound have been expanded, and the concept of sound object has brought in new dimensions to the field upon Pierre Schaeffer's '*Musique Concrète*.' The *4'33"* breakthrough of John Cage and the revolutionary works of Edgard Varèse, especially their early exemplars of electronic music have resulted in the scrutinizes of the very concept of sound. The contemporary artists have concentrated more on sound and this resulted in the emergence of "Sound Art" after 1960 as a pure, independent art form, and particularly the studies on sound regarding the technological developments from the 80's to the day have brought new dimensions to that conception. As to the lutherie, a profession which is constantly developing in relation to sound art, a respective process is in question—the object of design becomes moreover digitalized, similar to the other plastic art forms. Within the slope of the 21st century, the enhanced works of sound art, and sound sculptures as well, get their self-share from this drastic change, and find their places in several digital media. At the same time, the paths of sound sculpture and lutherie are crossing over, and it is becoming harder to define the boundaries of those two. The music—or better: the audial design—of the age, and the creative tools and methods used by/for it; its crossings and interferences with other digital arts/platforms and media organs make it even more difficult. Within the context of the plasticity of sound, on the other hand, the sound—overshadowed by visual and plastics arts for a long time—has now begun to be represented with the elements of digital design to a far broader scene. In this study, digital lutherie and the representative examples of sound sculpture; the relationship between design elements and plasticity of sound will be scrutinized.

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Key words: Sound, Sound Art, Digital Sound Sculpture, Digital Lutherie, Sound Plasticity

Digital Lutherie and Digital Sound Sculptures

In the Context of Sound Plasticity

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Abstract

At the beginnings of the 20thCentury, Luigi Russolo, with his “Intonarumories,” gave one of the rather early definitions of the Sound Sculptures, and strengthened it by The Art of Noises–one of the first and most durable manifesti of the field. In parallel with this, there happened a cognitive revolution by the “Ready Mades” by Duchamp, a workfield opening up huge possibilities for new dimensions in plastic arts. In addition to this, dadaist works, including those of Duchamp, such as “Sculpture Musicale,” “With Hidden Noise,” have been inspiring in the rise of the concepts “sound sculpture” and “sound object.” In accordance with the requirements of the time and the developing technologies, the boundaries of music and works of sound have been expanded, and the concept of sound object has brought in new dimensions to the field upon Pierre Schaeffer’s ‘Musique Concrète.’ The 4’33” breakthrough of John Cage and the revolutionary works of Edgard Varèse, especially their early exemplars of electronic music have resulted in the scrutinizes of the very concept of sound. The contemporary artists have concentrated more on sound and this resulted in the emergence of “Sound Art” after 1960 as a pure, independent art form, and particularly the studies on sound regarding the technological developments from the 80’s to the day have brought new dimensions to that conception. As to the lutherie, a profession which is constantly developing in relation to sound art, a respective process is in question—the object of design becomes moreover digitalized, similar to the other plastic art forms. Within the slope of the 21st century, the enhanced works of sound art, and sound sculptures as well, get their self-share from this drastic change, and find their places in several digital media. At the same time, the paths of sound sculpture and lutherie are crossing over, and it is becoming harder to define the boundaries of those two. The music—or better: the audial design—of the age, and the creative tools and methods used by/for it; its crossings and interferences with other digital arts/platforms and media organs make it even more difficult. Within the context of the plasticity of sound, on the other hand, the sound—overshadowed by visual and plastics arts for a long time—has now begun to be represented with the elements of digital design to a far broader scene. In this study, digital lutherie and the

representative examples of sound sculpture; the relationship between design elements and plasticity of sound will be scrutinized.

Introduction:

While sound progresses in relation with music and other art forms, it has been shaped in accordance with the experiences of human beings and the aesthetic values of the era it belongs to. The human being who has sought to imitate the sounds of nature and discover new sounds, has designed the songs, dances, and the instruments in favor of protection and spiritual practices. The human being, who is a designer, has developed the definition and plastic values of sound and music in accordance with their desires and needs throughout the history. And has by continuing their musical discoveries, has never given up seeking new sounds. While music has been shaped in parallel with the aesthetic values of the era, the instruments have also undergone transformations in accordance with this change. Whilst several musical genres have emerged through new instruments, the human being, who chases different sounds and timbre with the new instruments, has intensified their relationship with sound.

The technology and studies on sound which were rather slowly progressing until 19th century have hastened within (19th) century. Through the studies whose foci are sound, acoustics and psycho-acoustics, in cognitive and conceptual contexts there has been considerable developments. The most important advancement in the (19th century) is a recording dated by *Edouard Leon Scott de Martinville* (as) April 9, 1860, a French folk song called *"Au Clair de la Lune"* [1]. This recording which is distinctive as being the first recording of the time, is a messenger of the revolution that is about to take place in the following century, sound being recordable and replayable would essentially alter the conception of sound and music. In conjunction with this, while (the habits and (novelties) introduced by mechanization of the 19th century to the daily life), crowded urban life and its unusual sounds and the concept of "noise" was pushing people towards a chaotic lifestyle, people were also pushed to rethink about sound.

By the 20th century, Luigi Russolo, one of the pioneers of futurists in plastic arts, which especially focus on speed, sound and movement, has given one of the most important (propositions) of the era. With his musical instruments - *Intonarumories* and by giving one of the preliminary definitions of Sound Art and Sound Sculpture, Russolo has consolidated this with *"The Art of Noise"* which is considered to be one of the founding works in the field [2]. In line with this, Marcel Duchamp's Dadaist works "With Hidden Noise", "Sculpture Musicale", in between 1912 and 1916, are distinctive in being the first works where the concept of Sound Object is used in. These works are inspiring in terms of early sound and music definitions before concepts such as Sound Art and Sound Sculpture. Through the needs of the era and the developing technologies, the boundaries of music and artistic sound studies has been widened, and with the "Musique Concrete" of Pierre Schaeffer, beyond sound and place, the concept of Ready Made has widened the boundaries of perception of sound. Furthermore, John Cage's 4'33" and Edgard Varèse's early exemplars of electronic music have brought new dimensions to the concept of sound.

It is a well known fact that the more and more accelerating life structure of 20th century, which is much more dense and gapless when compared to the previous centuries, has brought about changes worth a-five-centuries-period. Again, the artistic works and manifesti of the futurists, and the kinetic art movement, arising in parallel of these at the beginning of this century, provided new dimensions to the plastic arts. And an art form that is focused on sound and movement has begun to give its preliminary exemplars.

In this study digital lutherie and digital sound sculpture will be under investigation, which are the subbranches of sound art and lutherie, shaped by the multidisciplinary understanding of 20th and

21th centuries. The concept of sound sculpture has started to grow mature in the last century, and has been spreading over a wide area. And it is sometimes difficult to determine with its boundaries with experimental musical instruments, in fact has a half-century history with this name. It is very difficult to distinguish those two closely related fields, which have gained different dimensions due to the technological developments of the last centuries (especially after the invention of electricity), when the old technologies are concerned. However, it is not possible to disregard the fact that the foundations of sound art are formed by the fields of sound sculpture and musical instruments. Those interdependent fields are being digitalized as the time goes by, and at the last stage of music and sound studies, concepts such as digital sculpture and digital lutherie, which provide their early works, can be encountered frequently. It is not always possible to make a distinction between the method and appearance of sound production being used, and especially the experimental musical instruments and sound sculptures of the previous centuries. In this sense, the luthier, whose material is sound and aim is sound design, are important in providing early sound propositions, and in being inspirational for the early developments of sound art. Though the term luthier, builder and designer of musical instruments, is applied only to the producer of stringed and bowed instruments due to a conceptual confusion, the term, in fact, encompasses all instrument production, including experimental instrument production. However, experimental instruments within the scope of this field are examined under a different group in order not to create a confusion.

While the plasticity of sound and music is concerned in relation with time and place, the transformation of the concept of plasticity to a raw material of sound design manipulates our perception in audio visual terms. The fact that the sound art, which is in frequent relation with plastic arts, has a wide perspective and has remained untouched in comparison to other art forms, attracted the attention of other art forms within today's multidisciplinary understanding of art, and this area has been used frequently because of its richness in expression and the background it creates. (Nevertheless, sound is still an unknown for us since the studies done in this field grounded the unreachable character of sound in terms of what is visual) Sound is a phenomenon that human beings have been trying to make senseof for thousands of years, in obscurity and fear. Sometimes along thunder, sometimes along the rustle of leaves, the flow of a waterfall or river, waves crashing into the rocks, or the eruption of volcanoes and many other natural phenomena, sound has been a wonder inducing mystery for human beings. (At first, the human being who had begun to experience the sounds of nature, began to imitate sounds and animals in nature, and in parallel, sound has begun to be used as a means of communication.) (Sound has remained as a sacred mystery during the long period where it could not be defined, it has stood for what is sacred and invisible.) The human being who has discovered rhythm and melody used sound to reach a state of trance and strengthen their spiritual rites. Beginning with more routine rhythms and effective sounds without a specific understanding of tone and harmony, this process, which started with rituals for magic and worship, has evolved into an (feast) artistic dimension over the centuries. The sound, which gained different meanings in different periods, is now one of the basic materials of design. And undoubtedly, the most artificial material that has gained much more importance than the sound itself is *silence*. Sound and silence, during the undulating process between them creates an aura, and this aura with its density, whether we are aware of it or not, manipulates our affections and by doing so makes us a vibrating part of it. The effect of sound on out affections and thought is a well known fact, and this effect of sound has been noticed, experienced, and used for various purposes. And the most well known design of sound is music. As Ahmet Say states [3];

> *"The human being, who is considered to have a history of two hundred million years, is born into a sound universe, is intertwined with the universe of sound and interacts constantly with the sounds it perceives. The human being, who is a bio-psychic, cultural and social organism, has been analyzing and evaluating the sounds he has perceived since ages and transforming the sounds into a form of narration. This narrative art with sounds is called music (Say,1995)."*

In this context, we can interpret music as a pattern of organized sound formation within a period of time whose material is sound and silence. Furthermore, from a cultural and social aspect, we can conceive music as a means of cultural communication which forms a strong bond between humans. However, sound is more than these; it is also an instrument of design. The effect of deliberately chosen and organized sounds in a musical piece is due to the sound mass that the composer discovered and inspired in. Each and every sound that is discovered means a new narration and emotional richness, and it is an obligation to not limit sound with music but to treat it with a broader perspective.

Generally, the sound has been overshadowed when its relationship with the art forms other than music is concerned. Especially, while in plastic arts other design elements have continued to develop for centuries, the sound has remained as a representative of the skies, nature, spiritual and divine, its development had been much slower than that of the visual arts. Perceptually, sound has transferred its effects to the other art forms where it had crossed with them, and has been perceived as a plastic factor. On this account, it has been overshadowed by the visual arts. Nevertheless, where our life is built upon what is visual, and seeing is at the foreground in structure of life, this fact is not a very surprising one. The effort of humanity to depict what is invisible has been realized by what is visual, what one had experienced more than sound, and to depict what is abstract by likening it to what is concrete has been limited, shaped with the boundaries of language and visual perception. For this reason, sound and music have been plasticized consciously or unconsciously from the beginning, and are characterized by plastic elements. Sound sculptures on the idea of a predetermined sound proposition or sound often create a plasticized element in the audiovisual relationship.

Sound is a complementary element in the shadow of plastic arts. At the beginning of the 21th century, where every aspect of life is becoming digitalized as the time goes by, in order to reflect their age art and design update their language and material. Although the artistic sound works emerge as sound art especially after 1960s, since then the borders of sound art and other branches of art cannot be clearly determined.

With the development of digital audio technologies and becoming an indispensable element of the new sensory media, sound, that was used to plasticize ideas (as a side element), has become an indispensable element in determining the design, not only a complementary element. And conversely, digital resources have become a determining element of sound.

If we both look at digital lutherie and the development of digital sound sculptures, the movement of "piezo music" plays a crucial role in the development of these areas. Nicolas Collins, in his *"Handmade Electronic Music: The Art of Hardware Hacking",* defines Davies as the first pioneers of "piezo music" [5]:

> *"In the aftermath of Cage's 'Cartridge Music' many sound artist sought affordable techniques for amplifying mechanical vibration and microscopic sounds. Since the mid-1970s the Proliferation of 'Piezo Disk' in beeping appliances has effectively put contact mikes within Reach of anyone with a soldering iron… The disks have insinuated themselves into surprisingly diverse corners of our recorded sound scape, and have given rise to a genre of 'Piezo Music' Hugh Davis (1943-2004) (UK) and Richard Lerman (USA) were two of the earliest innovators. Davies began inventing piezo-amplified instruments in the 1970's."*

Piezo first emerged in 1880 by Pierre Curie and Jacques Curie. The effect of piezo-electric is a reversible one, viz., on the one hand when force is applied to a material that is piezo-electric it is able to produce currency, on the other hand when the same material is electrified there happens a mechanical motion in the material. Further, piezo ceramic that can be used for the same purpose as piezo crystal is developed in the 1940s and it has become widespread. After piezo became common in electronic, it was not only used with those experimental instruments, but also used with the standardized instruments such as guitar and bass guitar, and is still being continued to be used.

This important invention and the midi technologies, which later gained importance in the process from analog to digital, have hastened the developments in musical equipment technologies. The increase in computer usage has brought about the midi technologies, and by laptops falling into the hands of the younger generation music has become codable and programmable. A new era started with the development of various coding languages and interfaces. A new era started with the development of various coding languages and interfaces.

Digital Lutherie

Digital lutherie and digital instrument design is an extensive subject including the technologies such as electronic, sensor technology, sound synthesis, data processing, programming, and the humane disciplines such as psychology, physiology, ergonomy and the like.

Digital lutherie, which has emerged with the development of sound technologies and the facilitations of novel possibilities to music, has started to hasten with the recent technology. At first, digital lutherie has evolved as an experimental field under the heading of music technologies, and later with the development of electronic music and its growth as a major industry, digital lutherie has become a discipline in itself as a branch of instrument technologies. Huge Davies (1943-2005) and Sergi Jordà (1961-) greatly contributed to the definition of the field.

As Mooney points out, Davies has been the pioneer of this field and the younger generation with *"do it yourself"* and *"lo-fi approach"* trends and work on his laptop. His instrument-building practice can be defined at an intersecting point in the boundaries of avant-garde music, improvisation, new musical instruments, lutherie, and sound sculpture. Davies improvised his experimental work with a laptop (by coding) and opened the doors of an entirely new world. Davies performed this innovative music practice by presenting the live screen performance of the computer screen by projecting the computer screen to the audience with video projection. Thus, the viewer was able to monitor the influence of written code on music.

Sergi Jordà, in his thesis, supports the use of the laptop as a musical instrument with the following excerpt; "*When asked what musical instrument they play, few computer musicians respond spontaneously with I play the computer. Why not?"* [6].

Musical instruments are more than a machine, they are energy transformation devices which have a meaningful end. Designers of the new musical instruments can only partially be responsible for the development of music. When designing new instruments, they cannot limit their designs with sonic abilities and algorithms. Furthermore, they must consider the conceptual aspects of those instruments and how they are imposing or suggesting new ideas to the performers. The designers must also consider new ways to establish relationship and interaction, new ways to organize time and textures [7].

In his thesis "Digital Lutherie Crafting musical computers for new musics' performance and improvisation", some of the 25-point recommendations he made for the Digital Lottery were as follows;

- *New musics tend to be the result of new techniques, which can be both compositional and instrumental.*

- *New instruments will be able to survive and succeed in the measure they are truly innovative; i.e. they have something new to bring to music, and not merely because they are based on novel, previously unavailable technologies.*

- *Learning from the past does not merely mean emulating it. It also means to try avoiding or improving upon passed errors and limitations (the past was not perfect).*

- *One of the aspects that should be clearly improved is that of efficiency. Traditional instruments take years to master, whereas, given the speed at which technology and fashion shift in our current 21st century, new instruments have to hook from the first minute. We cannot rely anymore on persistent parents that insist on bringing their children to the conservatory, or on patient students to whom we promise the light after ten years of sacrifice.*

- *These new 'traditionally-modeled' instruments with increased efficiency may appeal to non-musicians and to dilettante, which is good. However, it will be much harder for them to appeal to advanced musicians as well. Advanced musicians will preferably look for new-fangled possibilities.*

- *By running processes at different temporal and formal scales and different levels of complexity, new instruments naturally surpass the one-action to one-event model inescapable in all traditional instruments. New instruments are not only sound producers, they become music producers too.*

- *Performing with such powerful instruments should not mean leaving all the musical decisions to the instrument, though. Just like the traditional composer is responsible for the music played by the performers, so should the new performer be responsible of the music performed together with the instrument. Playing music is a 'serious' activity, different from 'playing with music' (also very important but not studied here).*

- *The performer must thus be able to affect all these dimensions: both the metacontrol of ongoing processes and the microcontrol of final parameters should be permitted. All of them with the maximum simplicity, flexibility and speed.*

- *To allow this type of control, new instruments have to be 'wider' rather than 'deeper'. 'Wide' instruments permit a better direct access to all of their complexity.*

- *The potential of computer graphics for representing and monitoring complex processes is not easily surmounted. This is probably the reason why many of the more interesting recent instruments, are screen based. While, the mouse is a very limited controller that we should definitely try to avoid.*

- *For including realtime interactive visualizations and, at the same time, overcoming mouse limitations without adding indirections, interfaces should be able to reflect their own states and behaviors. They should integrate, like the abacus, both representation and control [8].*

As seen above, Jordà clarifies some of the characteristics of the instruments which can be improved by current technology in 25 steps. It is constantly emphasized that these instruments should be simple and plain.

> *"There is the desire on the part of some computer music researchers to create new instruments that should "know" what to do and require very little skill to play. Though this might allow beginners and amateurs to enter into music making quickly and enjoyably, this trend might ultimately limit a person's understanding of music. The question is whether these instruments will stimulate due to their immediate accessibility, or suffocate due to a kind of atrophy of learned musicality* [9]*."*

A qualified music instrument must have a balanced action and reaction and certain qualities such as making the musician satisfied. Simple devices or instruments cannot provide a rich experience. Complex devices, on the other hand, alienate the musicians. A proper instrument, indubitably, must be easily learned and played, while it must also be ergonomic.

The important question, at this point, is how the new digital instruments should be in the sense of ease of use. Is it necessary for new instruments to be difficult as a violin or a piano? This question is crucial whereas it is beyond the boundaries of the current article.

Digital Sound Sculpture

Sound Sculpture; It can be defined as sculpture, object or structures that can produce sound when it is driven by its own internal mechanism or by environmental elements such as wind, water, sunlight (not always musical).

The most important common point of certain types of sound art is their visuality and plastic quality, and they practically always use "space" as dominant value or material.

Interdisciplinary production is considered to be a genus in which what is a perceptual overlap with what is visual and plastic. And according to some definitions, it is where performance and media art overlap, interacts. The most dominant subtype of it is the products of sound sculpture. Sound sculpture can be defined in various ways. This includes variables such as an object producing melodic or rhythmic motives, either by itself, or by means of sound or sensual data triggered by the audience or an object with sensual reference [10].

If the scope of current technology is taken into account, sound sculpture can be defined as sculpture whose design material is sound.

Design environment or material of sound sculptures in 21st century's art environment are digital and they are influenced by chaotic art environment of this century. Moreover, it builds up a more complicated area for itself because of the fact that it combines new digital media means with its ambiguous area which is mingled with plastic arts.

Sound sculpture with its uncertain boundaries and experimentality is in an integrated structure with digital musical instruments and new digital media arts.

The crucial point is that the ambiguity and unidentifiability of sound tools, musical instruments, sound objects and sculptures that have been improving in the sense of communication for centuries is because of the fact that they are being re-used within the digital media in this century. It is because each experimental instrument has similar characteristics with sound sculptures with regards to creativity and schematic and functional qualities.

Examples for digital sound sculptures created with new digital media can be given as; *"Augmented Sound Sculpture, 2018"* with Lucia Ruggiero [11], Gabrielle Petrillo and Massimiliano Annibali's *"Sphere 2.0 Digital Sound Sculpture, 2017 (it is similar with digital luthierie)[12].* And Andy Thomas's *"Whip Bird Sound Sculpture, 2016"* [13].

Sound Plasticity Within The Boundaries of Digital Lutherie & Sound Sculpture

Whether it is a digital music instrument, a digital sound sculpture or a musical group of sound, volumetrical activity of sound can be plasticized in a visual-audial platform because of the jesticilation and plastic items.

Even though manipulative effect of sound makes plastic items meaningful and focuses them into audial environment with the aid of digital sound technology, especially with regard to use of music technology, sound environments renovate themselves with auxiliary means containing artificial items and interfaces.

This process begins with the *"workbench"*, especially with computer use which currently has become design media: Worldwide industry of music technology made an illusion that everybody can create something only with a computer, and they aimed to extend their market. A decade ago, the highly complex functions were put into use by the visual interfaces that are thought to be much more advanced or busier than the sensory perception by using computer games, *Lego* or visual editing kit. However, this type has begun to dominate the visual fiction and plastic sensory field in the production of the screen. A music design, photographic imagery (such as Photoshop and concepts used in the photo processing software) is examples of how he dominated the following terms: *"The grain"* for the sound particles, *"sample"* for audio samples, *"layer"* for layers of sound, *"blocks"* for sound clusters, *"snap-shot"* for instant transfer on a sound item or *"preview"* for test playback preview of a assigned value etc... While constructing music, the concepts used in video editing are referenced. As an example, a "monopoly MAX built on the IRCAM-MAX-Apple Macintosh triangle in recent years can be mentioned: Here, a particular mode of production is imposed or even fetified by a software (MAX-MSP), a device (Apple Macintosh Computer System) and an organization (IRCAM71). This software, which is believed to give "serious and professional air" to the curriculum in most institutions that teach in music technology, is a long, laborious, complicated, sometimes magnificent, like counterpoint homework where the composition students are locked in the period when tonal music has a sacred value; however, it has helped to increase academic efforts that rarely go beyond a dry process. The main reason for this is that the music design environment consists of a small computer screen: Processes are defined on a visual platform by associating architectural modules. By looking at how impressive the reflections of the reflections on the visual plane, the complex processes used and the intricate structures obtained are fetishized, and the staggering of the sensory results of the fictions and processes in this environment are overlooked. The fact that the laptop is placed in every scene as the dominant instrument raises a major problem, despite all its imaginative charm: Almost all kinds of music production (with the exception of a few traditional music practices) are managed with eyes rather than ears. The results of such a deliberate positioning of sensory perception are naturally reflected in music: *"Plasticity"*, as well as *"artificially"* meaningful place in music, when *"the time"* element was abused but "the massive structures increased", in a music culture, visual elements prevented sensory qualities [14].

Conclusion:

Digital technologies are redefining the concept of sound sculpture or musical instrument, and these definitions renew themselves each day in line with the technological utilities. It is a fact that the digital music of the new era is still in pursuit of new instruments, and it is clear that these new instruments will be more functional in contrast to the traditional instruments.

During the creation of new digital instruments it is important to note that technology should be used without limiting the process of creation. A policy should be adopted, and this should not be a consumer based one, rather it should be a policy that will enable the idea of making music to evolve to a more conceptual process. In the industry of music technologies unfruitful marketing strategies, which are based on the paradigm of *"making one's own music",* should be left behind.

These two dominant fields, which are still growing mature with the technologies of today, progress in a close relation with each other, sometimes they become indistinguishable. If there arises a need to distinguish the two, this is only possible by determining their means of design, and a categorization would be possible in terms of the functions they serve. However, the new musical instrument designs that suggest new notions as being experimental, can bear the quality of being digital sound sculptures, hence they bear artistic value.

When the design of digital music instruments is concerned, the most important responsibility on behalf of the luthier is to suggest a design that will not manipulate and limit the creativity of the performer, a creative setting, which is free from plasticized elements that will be resulting in limiting gesticulations, should be provided.

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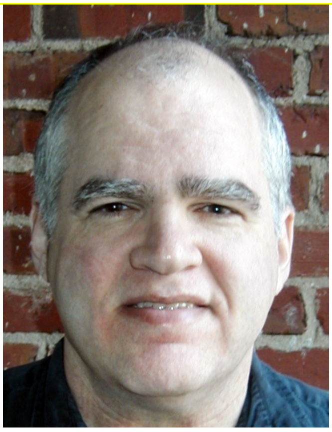

Problems in Generative Art Theory and Artificial Intelligence
(Paper)

Topic: Generative Art Theory

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Abstract
In a previous chapter titled Generative Art Theory I introduced a series of problems. These are not problems in the sense that they require single correct solutions, but rather are questions that the artist will want to consider when making a piece; that critics and historians will typically address in their analysis; and that insightful audience members will ponder. They are problems that typically offer multiple opportunities and possibilities.

It is notable that, for the most part, these problems equally apply to both digital and non-digital generative art; to generative art past, present, and (it is hoped) future; and to ordered, disordered, and complex generative art. In addition, these same problems or questions are trivial, irrelevant, or nonsensical when asked in the context of non-generative art. In a sense the applicability of these questions can cleanly divide art into generative art and non-generative art.

These problems include:

The Problem of Authorship
The Problem of Intent
The Problem of Uniqueness
The Problem of Authenticity
The Problem of Dynamics
The Problem of Postmodernity
The Problem of Locality, Code, and Malleability
The Problem of Creativity
The Problem of Meaning

Since the publication of this chapter a new form of neural network-based artificial intelligence called “deep learning” has appeared on the scene, and has been applied to digital art. This technique, sometimes called “inceptionism”, fits well within my previously offered complex-systems-based definition. In this paper I explore whether the problems in generative art noted above hold up well in this new artificial intelligence context for generative art.

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Key words: generative art theory, neural networks, inceptionism, deep learning, artificial intelligence

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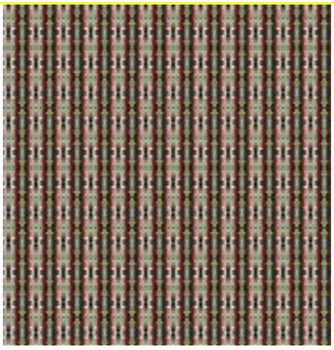

The Piano Automaton as an Instrument for Algorithmic Music (Paper)

Topic: Music

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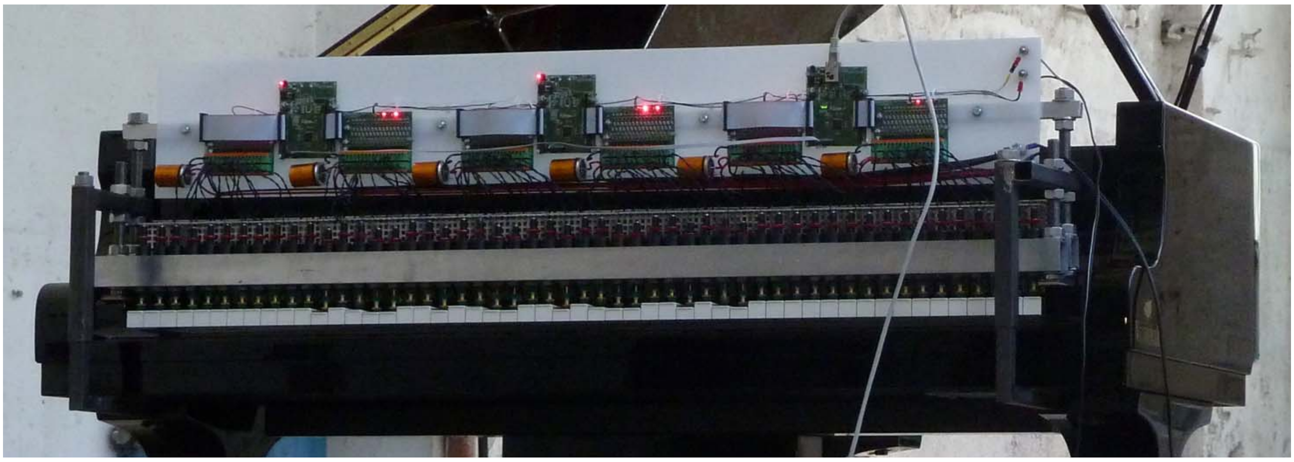
Abstract
The *Piano Automaton* ("Klavierautomat") was conceived and built by the Austrian artist Winfried Ritsch. It is a device to be mounted on any ordinary piano in order to turn it into a computer-controlled instrument.

From an artistic standpoint, several aspects of this system seem interesting. As it connects an acoustic piano to a computer, it is apparently well suited for the performance of computer-generated algorithmic music. Moreover, it allows for several forms of "unhuman" musical expression because the Piano Automaton can not only play faster than a human pianist, it can also play many more keys at the same time – all 88 at once if necessary. And even though the music is computer-generated, there is no electroacoustic sound, but rather the acoustical and physical presence of a real piano.

This paper describes the technical details of the Piano Automaton as well as the compositional concepts of several short generative *Etudes* that have been realised so far.



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Key words: generative music, algorithmic composition, robotic piano player.

Main References:
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The Piano Automaton as an Instrument for Algorithmic Music

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Premise

The piano automaton was conceived and built by the Austrian artist Winfried Ritsch. It is a device to turn an ordinary piano into a computer-controlled instrument. From an artistic standpoint, several aspects of this system seem attractive. As it connects an acoustic piano to a computer, it is apparently well suited for computer-generated music. Moreover, it allows for several forms of 'unhuman' musical expression because it can not only play faster than a human pianist, it can also play many more keys at the same time – all 88 at once if necessary. And even though the music is computer-generated, there is no electroacoustic sound but rather the acoustical and physical presence of a real piano.

1. Introduction

The piano automaton is a device that can be mounted on any ordinary piano in order to turn it into a computer-controlled instrument (see figure 1). This paper describes the piano automaton as well as a few short musical works that were specifically created for it during the summer of 2018. The description begins with an overview of the automaton's background, followed by a report on the author's familiarisation with the characteristics of the automaton. The process of familiarisation turned out to be a method that built a bridge from a more technical to a more musical way of thinking. Eventually, this process led to an artistic result.

A piano automaton is a machine; therefore, it can play music that is beyond the possibilities of a human pianist. Furthermore, it is a computer-controlled device. For that reason, one can argue that the piano automaton is particularly well suited for the performance of computer-generated algorithmic music.

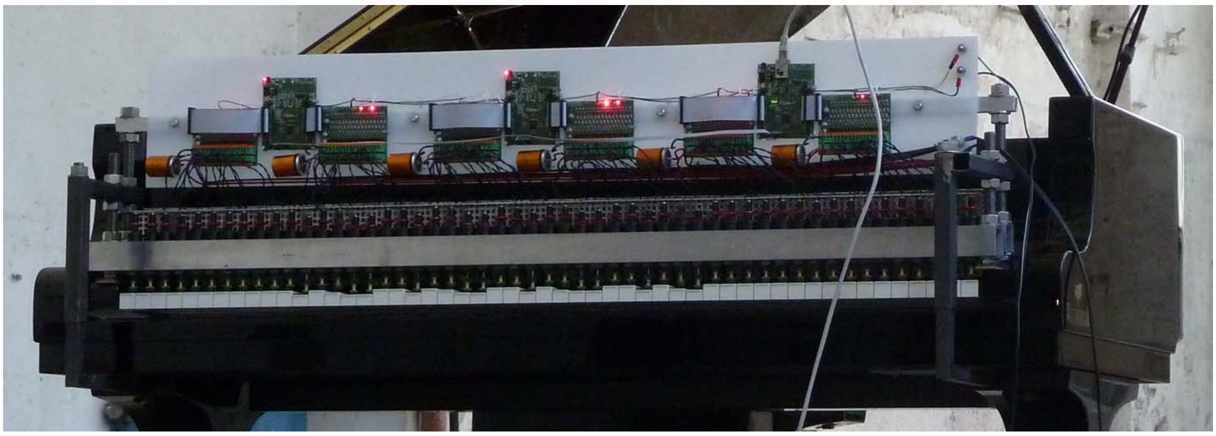

Figure 1. The piano automaton.

2. Background

2.1 History of the piano automaton

The piano automaton was conceived and built by the Austrian artist and researcher Winfried Ritsch in his *Atelier Algorythmics* [1, 2]. Ritsch attempted to realise a specific kind of music that required an instrument with specific features that only a computer-controlled piano could provide. For instance, it was necessary that the piano could play at a very high speed. This required not only sufficiently fast mechanics but also electronic components suitable to facilitate a high data transfer rate. Furthermore, the piano should be able to play and hold down a large number of keys at the same time. Ritsch's research revealed that existing midi pianos (e.g. the Yamaha Disklavier or the Bösendorfer SE) could not completely satisfy these requirements. As it turned out, the main problem was that all these pianos could only play a restricted number of keys at once. This restriction was not surprising considered the fact that these pianos were designed to play classical piano literature. They were not meant to play more notes at a time than a human pianist could strike with his or her ten fingers.

Another criterion that guided the development of the piano automaton was the flexibility of handling. To achieve the desired flexibility, it seemed reasonable not to use a player piano with a built-in playback technology but rather to construct a 'robot piano player', that is, a self-contained device to be put in front of the piano keyboard. This decision was informed by the fact that ordinary pianos are common instruments that are likely to be found in many places, e.g. in music universities or concert halls. Moreover, it is much simpler to transport only a player device than an entire piano. Therefore, Ritsch designed the piano automaton as a player device and attempted to make it easily transportable and readily mountable on any grand or upright piano. After having constructed two prototypes, Ritsch arrived at the final version that he named *Rhea*. Eventually, he built twelve devices of this version one of which has been sold to the Institute of Computer Music and Sound Technology in Zurich in 2018.

Ritsch's piano automaton is closely related to the music of the Austrian composer Peter Ablinger. The realisation of Ablinger's music was, in fact, the main driving force behind the development of the piano automaton. Ablinger explored a musical concept that he named 'phonorealism' (a neologism built in analogy to the word photorealism). With photorealism, the visual arts possess a concept of appropriation of reality. Ablinger tried to achieve an equal phenomenon in music. His work cycle 'Quadraturen' consists of several sound installations and concert pieces that apply techniques similar to those used in the graphic arts to render photographs into prints. To this end, Ablinger makes a frequency analysis of an audio recording and subsequently reduces and quantises the data to make it playable on an acoustic instrument.

One can regard this quantisation of data as a sonic analogue of pixels [3, 4]. Although the frequency analysis data is reduced, it still requires a huge number of notes to approximate the original audio recording. Thus, the computer-controlled piano with its ability to play many notes at a very fast speed is the most suitable instrument for this kind of music.

2.2 Technical details

The piano automaton consists of 88 solenoids to hit the keys of the piano keyboard. These solenoids are attached to a robust metal frame, and their tips are cushioned with felt to avoid unwanted hitting noises. Three microcontroller boards actuate the solenoids. The metal frame is mounted on a piano with two clamps on both sides. The details of the piano automaton are depicted in figure 2.

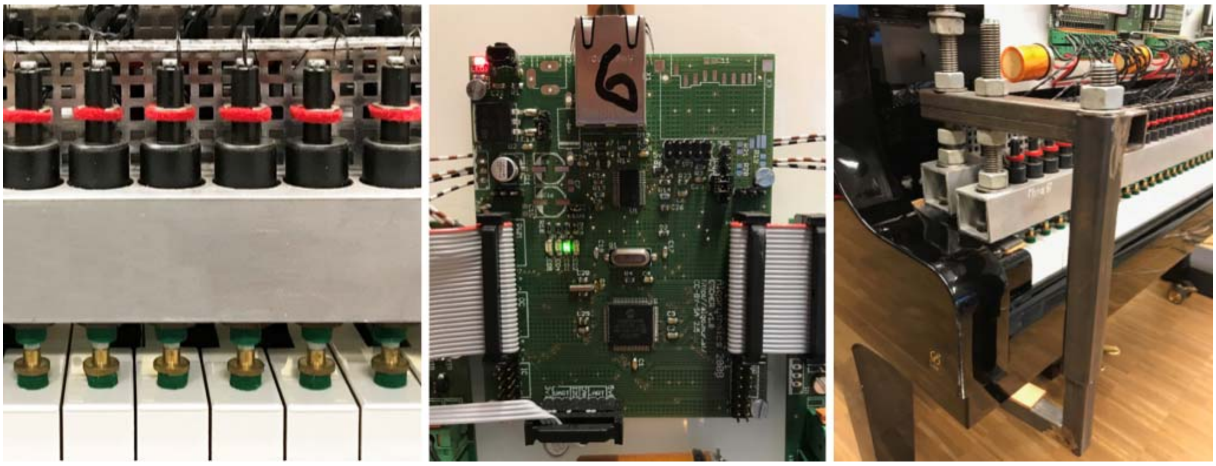

Figure 2. The solenoids, one of three microcontroller boards, one of the clamps to fix the automaton to a piano.

A control software communicates with the piano automaton. This software can receive note-on and note-of commands via the Open Sound Control (OSC) communication protocol. This allows for any OSC-compliant program to run a generative algorithm (see figure 3). Furthermore, the control software can also read and play MIDI-files.

Another important task of the control software is data mapping. For each note, the corresponding solenoid has to be addressed, and the note's velocity has to be scaled to generate the appropriate loudness. As the numbering of the solenoids does not conform to the MIDI key numbers and the transformation of velocity values into a perceived loudness is quite uneven among the solenoids, one must carefully calibrate the automaton before using it. Once this calibration has been executed, its values can be stored in a text file.

Ritsch implemented the original version of the control software in the pure data programming environment. The author has developed a new version in C++ with the JUCE library [5].

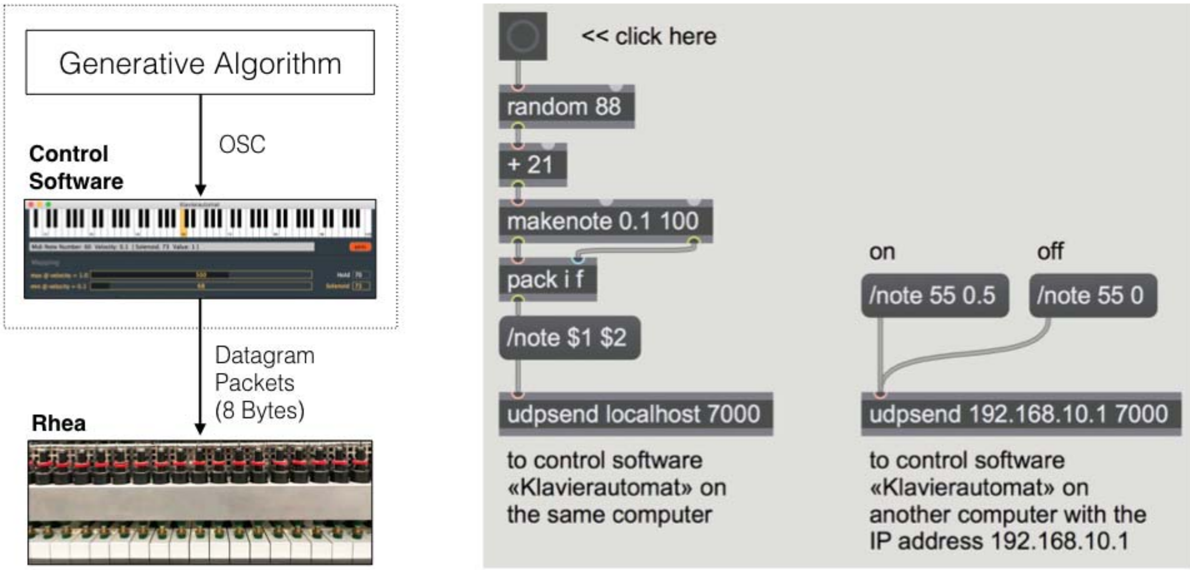

Figure 3. The data flow used for real-time generated algorithmic music (left); an example how to send notes from Max (right).

3. Approaching the Instrument

Once the piano automaton had been delivered to Zurich, the author spent several weeks familiarising himself with the characteristics of this device. Apart from learning how to fix the automaton on top of a piano, it was most important to find out efficient strategies to calibrate it. The calibration procedure turned out to be quite intricate as there are several, interdependent parameters that influence how loud a note is perceived. These parameters include not only the velocity of the solenoid but also the duration of the note, the height at which the key is to be held down by the solenoid and several mechanical conditions such as the position of the automaton relative to the piano keyboard. Due to the interdependence of these parameters, it was only possible to arrive at an even loudness over the whole range of the piano by finding reasonable compromises. The calibration procedure was considerably facilitated by equipping the control software with a helper function that repeatedly plays keys at various velocities.

To further explore the automaton, several tests were carried out to find out about the maximum speed at which a key could be repeated, about the maximum loudness that could be achieved and so forth. This process of approaching the automaton turned out to be very important to eradicate some incorrect assumptions about the precision and the uniformness of the automaton's playback.

As the process advanced, the focus gradually shifted from technology to music. Originally, the only purpose of the test series was to explore the physical limits of the automaton. After a while, these tests became gradually more playful and more informed by musical criteria. It seemed to be important not only to fathom out the technical possibilities of the automaton but also to find the artistic potential within these possibilities. Finally, it was a small and logical step to proceed from these test series to artistic studies.

The author eventually realised six short pieces entitled *Etüden für Klavierautomat* ("etudes for piano automaton"). These pieces do not deny that they stem from test series. They are all quite short (1.5–2 minutes) and concentrate on one single idea which can be either a technical aspect, a (psycho-)acoustic phenomenon or a musical concept. The following sections describe these etudes in detail.

4. Works

4.1 Etüde #1 ("Moiré")

This etude is about the temporal precision that can be achieved with a computer-controlled piano. The music consists of 14 different superimposed tempos. The pitches E and *F* in all octaves are repeated at different speeds (see figure 4). The inter-onset intervals of these repetitions are 198 ms, 199 ms, 200 ms and so on up to 211 ms. The result is a slowly changing musical texture in which several moiré patterns appear.

As this music is harmonically very reduced, it directs the listeners' attention to the temporal phenomena. In its superimposition of several only slightly diverging tempos, this etude relates to the concept of 'phasing' in minimal music.

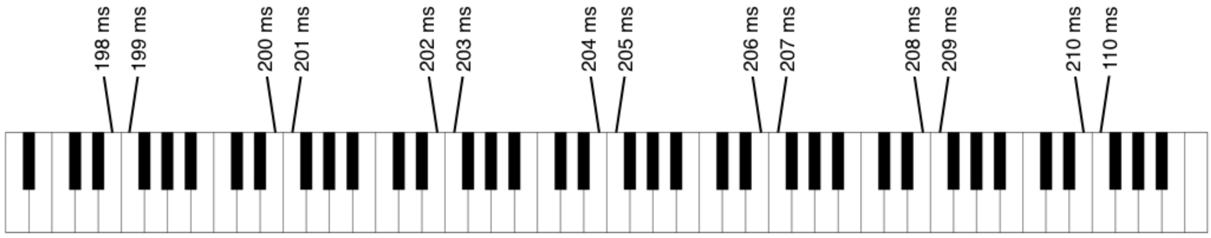

Figure 4. The inter-onset intervals at which the pitches are repeated in Etüde #1.

4.2 Etüde #2 ("Scales")

This etude explores the effect of harmonic colour in monophonic music. It consists of scales played downwards across the whole keyboard. The speed at which these scales are performed slowly oscillates between 20 and 200 notes per second. Even though there is always only one note simultaneously played, the music creates a notion of harmony. This is particularly due to the fact that these notes are played in a fast tempo.

The choice of pitches in this etude is constructed as follows. The 88 keys of the piano are subdivided into four groups of 22 keys. A pattern of ten intervals is randomly generated and applied to each of these groups (see figure 5). The notes thus obtained are played in a swift movement from the top note downwards. Upon reaching the lowest note, a new interval pattern is generated, and the next descending movement starts. Another process, which spans over the whole piece, is a slow but continuous decrement of the size of these patterns. As a result, the descending movements become more and more sparse and perforated. The change of pattern induces a variation of the harmonic colouration of the music.

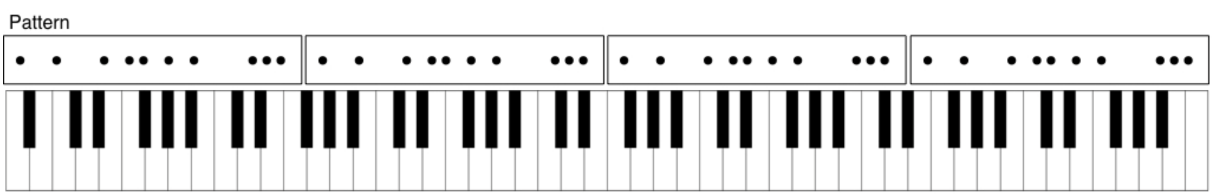

Figure 5. The same pattern is applied four times to construct the harmonic structure of Etüde #2.

The way in which these patterns lead to a harmonic colouration somehow relates to tonal music. In our tonal system, all pitches can be subdivided into groups of twelve chromatic steps because the perceived quality of pitch repeats every octave (a concept known as ‘pitch class’). Every scale or mode, apart from the chromatic scale, can be understood as a pattern applied to these groups. A diatonic scale, for instance, is a specific choice of seven pitches out of twelve. Depending on the structure of this pattern, we can determine the mode of that diatonic scale (major, minor, etc.) and consequently hear a specific harmonic quality.

4.3 Etüde #3 (“Shadow Harmony”)

The basic idea of this etude is auditory masking, i.e. the effect of a louder acoustic signal covering a quieter one. Throughout the piece, there are always two chords played at the same time; one is very short and loud, the other one quiet. An interesting sound effect results from the loud chord masking the attack of the quiet one. The timbre of the piano is characterised by its attack and its percussive quality. As the quieter of these chords seemingly lack an attack, it gets an unreal, shadowy quality as if these notes would appear from nothing.

All the chords are randomly generated. Their harmonic quality, however, changes back and forth between two types. These changes always take place after approximately 15 chords have been played. The masked chord is atonal for the first type of harmonic quality and tonal (i.e. a minor triad) for the second type. The masking chord, however, is always atonal.

4.4 Etüde #4 (“Glissandi”)

This etude is about the rapidity of the piano automaton. At a speed of 200 notes a second, chromatic scales are played up and down. The keys are hit so quickly that some of them almost do not speak, which lends the music a volatile and hasty character. The generative process for this etude operates on two temporal levels. On the first level, it produces a chromatic scale that runs up and down between a lower and an upper boundary. Whenever the scale hits a boundary, the movement is mirrored, and the chromatic scale runs in the opposite direction until it reaches the other boundary, and so on. On the second level, the generative process sets the two boundaries to new random pitches about twice a second (see figure 6). The ever-changing boundaries lead to a constant metamorphosis of the glissando gestures.

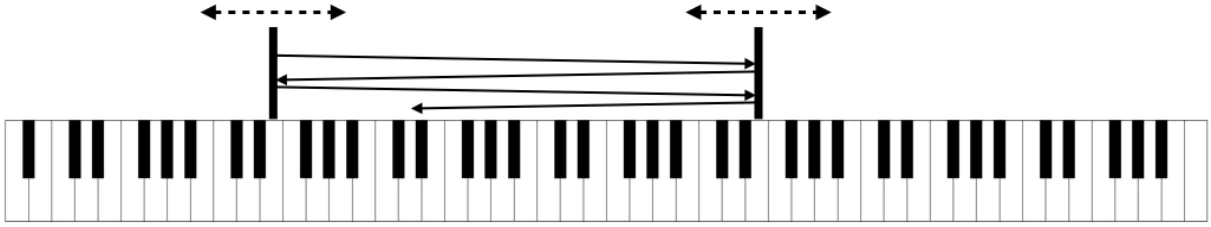

Figure 6. Rapid chromatic scales are played up and down between two moving boundaries in Etüde #4.

4.5 Etüde #5 ("Stairs")

Shepard tones inspired the fifth etude. This auditory illusion, named after the cognitive scientist Roger Shepard, creates the effect of a tone that endlessly ascends or descends in pitch. If a Shepard tone, for instance, ascends one octave, which is unambiguously perceivable as an upward movement, it paradoxically arrives at the same pitch as where it started. Usually, Shepard tones are electro-acoustically created; here, this illusion has been as close as possible approximated on the acoustic piano. Every pitch is doubled in all octaves over the whole range of the piano. The loudness is at its maximum for the note in the middle octave and decreases towards both sides (see figure 7).

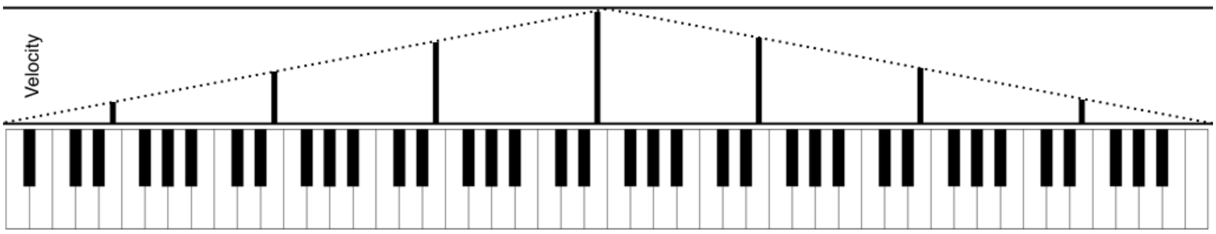

Figure 7. The distribution of velocities among the parallel octaves

At the beginning of this etude, an ascending chromatic scale is played. After a while, this regular movement becomes increasingly distorted. More precisely, all melodic intervals are initially ascending minor seconds. Over the course of the piece, the probability for larger intervals rises, that is, the occurrence of ascending major seconds, minor thirds, major thirds and so on becomes gradually more likely. The increased probability for larger intervals leads to the emergence of manifold melodic patterns.

4.6 Etüde #6 ("Repetitions")

This etude is about sound masses. A generative algorithm randomly chooses pitches. For each chosen pitch, it starts a process that repeats this pitch 120 times at a randomly chosen, but steady rate. During this repetition, the velocity of the keystrokes gradually raises from very soft up to maximum force. Of course, the duration of this process varies due to the diversity of the randomly chosen rates.

Several of these processes run concurrently. Over the course of the piece, the time to wait until a new pitch is chosen and a new process is started gradually becomes shorter. As a result, the sound becomes increasingly more massive, and the large number of simultaneous pitches generates different sound colours, which is an effect vaguely resembling additive synthesis. Moreover, several rhythmic textures emerge due to the different superimposed tempos.

5. Conclusion

The piano automaton possesses several characteristics that make it a most suitable instrument for generative music as exemplified by the six etudes described in this paper. First of all, it is a computer-controlled device; hence, playing computer-generated algorithmic music is an obvious thing to do. In addition, the piano automaton allows for 'machine music', that is, it facilitates a kind of musical expression that no human pianist could possibly master. The machine music properties can be assigned to the six etudes as follows:

- speed: especially Etüde #4, but also Etüde #1 and Etüde #2.
- loudness, massiveness: Etüde #6
- precision of time: Etüde #1 and Etüde #3
- precision of loudness: Etüde #3 and Etüde #5

Two of these properties, speed and massiveness, are always connected with a large number of notes. Generative algorithms are a convenient means to control them. For instance, the composer specifies a meta-process and leaves the details to the algorithm, e.g. a random generator.

Composers might be attracted by the piano automaton because it enables to realise computer music on an acoustic instrument. As every mechanical instrument, the piano automaton possesses certain physical limitations and irregularities. The choice of instruments always confronts the composer with certain restrictions and idiosyncrasies. Very often, working around and against such limitations can stimulate the creative process as these restrictions pose problems that the composer has to solve. In this respect, they become a driving force for the creative process.

This applies in a similar vein to the process of getting acquainted with the piano automaton. The exploration of the automaton's characteristics provided the basis for subsequent artistic work as it gave the impetus for further musical and compositional thinking.

Last but not least, a 'non-musical' quality of the piano automaton must be mentioned as well: The appearance and the physical presence of the piano automaton holds a strong artistical attraction. The visibility of the circuit boards and all the other mechanical and electrical components lends the device a very technical look which stands in stark contrasts with the traditional aura of the piano.

6. Outlook

To further explore the piano automaton, the author, as well as other composers, will try to realise longer pieces. In contrast to the short etudes described in this paper, those works will not only be much richer in details but also built on a real musical narrative as opposed to just one single idea. It seems also worthwhile to explore other scenarios such as a combination of the piano automaton with acoustic instruments played by human beings in a chamber-music setting or to control the piano automaton in real-time with different kinds of sensors in an interactive improvisation setting.

Several technical developments are planned as well. The firmware of the microcontrollers needs reprogramming to allow for even more subtle dynamics, and especially the possibility to silently depress and hold keys. Furthermore, some parts of the hardware need improvement as well. The springs that pull back the solenoids are quite prone to breaking, hence, they have to be remade in a different material or shape. Finally, it is planned to build a 'pedal automaton', a companion device to operate the pedals of the piano. Having such a device would be most desirable for many composers.

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Şaha ASLAN

THE SENSES IN BASIC DESİGN EDUCATION
(Paper)

Topic: Basic Design Education in Interior Architecture

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Abstract

Throughout its history, mankind has designed material and spiritual needs. Some of these designs disappeared, some of them have survived to the present day. The changing economic order in the development and the change of the world, especially by the nineteenth century, has made it a part of the design and designer's professional life. The twentieth century with its ground-breaking scientific studies, evolving computer technology and digital technologies, which name the century we live in, quickly changed and increased what was expected from the design and the designer.

Today, while AI studies are still in progress, it is clear that designers have a significant share in the work to meet the needs we recur. This situation shows us that the approach of a designer's way of conceiving the world of the day to the design problem, field dominance, intellectual accumulation, education, and quality is crucial. Accordingly, one of the important conditions that allow such criteria to occur in a designer is that the designer's ability to reason with the five senses one has perceived outside of one's own and to reach a conclusion.

The five senses are the means by which one can reach the world outside. The most important talent of a designer is to analyse the data the designer has collected with the five senses according to the designer's own understanding and plasticizing the idea. In this paper, the conceptual projects carried out by TOBB Interior Architecture students in the scope of "Basic Design Studio" course of 2017-18 Spring semester were developed with a focus on five senses.

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Key words: Design, Basic Design, Concept, Perception, Senses, Sensation, Emotion, Creativity, Generative

The Senses in Basic Design Education

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Abstract

Throughout its history, mankind has designed material and spiritual needs. Some of these designs disappeared, some of them have survived to the present day. The changing economic order in the development and the change of the world, especially by the nineteenth century, has made it a part of the design and designer's professional life. The twentieth century with its ground-breaking scientific studies, evolving computer technology and digital technologies, which name the century we live in, quickly changed and increased what was expected from the design and the designer.

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The five senses are the means by which one can reach the world outside. The most important talent of a designer is to analyse the data the designer has collected with the five senses according to the designer's own understanding and plasticizing the idea. In this paper, the conceptual projects carried out by TOBB Interior Architecture students in the scope of "Basic Design Studio" course of 2017-18 Spring semester were developed with a focus on five senses.

1. Introduction

Although different methods are used under different frameworks, in common, the first year studio of Interior Architecture [and Environmental Design] education can be defined as *the environment where the first exercises on the transformation of human experiences obtained with senses to a plastic perception in a volume that can be defined as a space* .

This environment was fictionalized under the name of *Basic Training* for the first time between 1919 and 1933 at the Bauhaus School operating in Germany with the aim of preparing a suitable environment for the interaction between the two fields of work by eliminating the wall between the Applied Arts and the Fine Arts, The aim here is to create an area of experience where students can experience form, color and material without a specific purpose, and they are encouraged to produce their own subjective designs based on their own subjective perceptions [1]. This training, based on the master-apprentice relationship, aims to create a 'utilitarian' environment in which students can think with the aesthetics perception and build with the technology of the period they live in.

Although today's educational approach creates a completely different platform where new aesthetic senses are justified with the newest technologies; in the last 100 years since the Bauhaus, the first year studio of design education encourages students to think about the basis of design under the name of *Basic Design* with similar concerns but different approaches which are as varied as the number of institutions. In general, the main aim of the course is to make *students question the principles that form the basis of the images created by the sensory experience in consciousness*[2].

This questioning is the first stage for the students to learn "a new language". The form, the most basic indicator of language, can be produced with the *design knowledge* that can exist together with technology and ideology. Thoughts develop through language and become reality; spatial considerations can also be shared through design language. It is expected that the student will be able to develop a way of thinking and then transfer this way of thinking. In general, the student is obliged to ensure the traceability of the design process followed to create the design knowledge.

The main element that justifies the traceability of the process is that the student gains awareness of the creation process. Because the design language requires developing a way of thinking, the way of thinking requires creativity, and creativity requires interpretation. Interpretation, defined as '*explaining an event according to another view*', can be considered the attribution of meaning by human beings to themselves in their environment as the most basic form of existence, and it is one of the basic foundations of design education. This basis has the same content as the concept of creativity defined as '*establishing relations that have not been established before*' [4]. In other words, creativity is a process of interpretation, not invention.

Interpretation depends on perception, and the subject of perception is versatile. It is a state that is acquired through the senses, corresponding to the synthesis of sensory data, rather than the sensory impression. The process takes place by the transformation of the data acquired by the sensory receptors to sensation, and sensation to emotion and knowledge; that is actually the definition of how the perception mechanism works with the simplest expression.

One of the theories of perception based on the view that perception is acquired through sensory experiences and the role of personal experiences is a factor in these experiences is the *Theory of Probabilistic Functionalism* developed by the Hungarian Psychologist E.Brunswik (1903-1955). Brunswik, due to the nonmeasurability of perception, defines the relationship of the organism with its environment as uncertain/probabilistic, suggesting that the reality affects senses, senses affect the perception, and the perception affects reality [5]. The new reality created by the perception that is realized through an objective reality is itself a subjective reality. Therefore, the same space is a different experience area, a different emotion production for each user. Hence, the awareness of the role of senses in space design not only creates awareness about the perception of space, maybe more about the development of the design language.

In other words, the sensation through the senses is not only the tool of the mind, but also the evaluation mechanism, such as the language that can be considered the starting point of knowledge [6]. Thought develops through language and becomes reality; spatial considerations also acquire a sharable quality through the design language.

This study focuses on the impact of the change and transformation of the individual's perception of the world in the last century on the Basic Design Studio, which is included in the first year of Interior Architecture education.

2. From Machine Aesthetics to Digital Technologies

Two important developments in the second half of the 18th century caused major changes in the course of the world. The French Revolution, which took place between 1789 and 1799, revealed political and social changes in general. The British Kingdom, which won the Battle of Plassey against the French on June 23, 1757, took control of the Mughal Empire of Turkish Hun origin [7] and brought the Empire's treasury to Britain, increasing the financial opportunities in the British Kingdom, which enabled the realization of technical inventions.

The invention of the first steam engine, which can be stated as the first one of the technical developments, in 1763 by a Scottish James Watts, is considered to be the beginning of the Industrial Revolution. Thus, the beginning of the mechanization process has fundamentally changed the definition production and consumption, naturally, the economy, law, society and state / political systems have undergone a process of rapid change. The scientific developments accelerated in the 19th century has also brought along many new technical developments and these developments have involved in social life.

The fact that mass production replaces the single production model of the artist/craftsman (master) of the past leads to the emergence of the concept of a designer. The changing production makes it necessary to redefine the concepts such as '*art ', 'artist', 'artwork', 'art market'* whose meaning changes with reproduction methods. These redefinitions begin to create new forms of perception, such as the fact that an aristocrat used to appoint an artist to make his own portrait, and then he/she asks a photographer to take his/her photographs.

An important suggestion put forward in terms of the fundamental concepts whose remembrances changed comes with the article called "*The Work of Art in the Age of Mechanical Reproduction*" (Das Kunstwerk im Zeitalter Seiner Technischen Repoduzierbarkeif) written by the German literary critic and thinker Walter Benjamin (1892 - 1940) in 1935) [8]. While '*art', 'artist'* and '*artwork'* continued their adventure in the 20th century with new meanings, the newly emerging concepts of industrialization such as '*designer'* and '*design*' – '*product design* started to make their own way.

Scientific developments in the twentieth century, especially in mathematics, geometry and physics, continued with rapid progress, while electronic technologies and computer systems developed with the great influence of two world wars and space studies form the basis of digital technologies to be developed generally in the post-1970s.

In short, the story may begin with the development of the first microprocessor called Intel4004 in 1971 by Intel Corporation. This development starts the age of microcomputers. Computers are now portable and everywhere. The packed electronic communication networks (the Internet) that connect the computer systems such as ARPANET, NPL, Merit Network, which were developed at the end of the 1960s, lead to the system of WWW (World Wide Web). The CERN (The European Organization for Nuclear Research) forms the basis of today's internet world by realizing its own data flow and communication via the Internet (www) system developed for registration procedures. Digital recording, imaging systems, robotic technologies, cell phones, visual reality, 3D printers, e-shopping, e-games and similar developments consist of digital technologies and play an important role in the development nanotechnologies. In summary, digital technologies, which play an important role in meeting the needs of today's world, are the main determinants of the 21st century.

Scientific, political, and social changes in the 19th century, the transformation of definitions of concepts such as producer - production, consumer - consumption, and the digital developments in the second half of the 20th century require the redefinition of today's world. Now, digital space-time has begun to be experienced in the real world.

3. Space and Space Feelings in Interior Architecture

It can be said that the developments in mathematics, geometry and physics in the 19th century have revolutionized the perception of the world.

The French mathematician and philosopher René Descartes (1596 - 1650) made it possible to identify the figures through the numerical systems and to make calculations with the analytical geometry developed as a result of previous works. This contributes to the study of Euclidean geometry along with other discoveries in the fields of mathematics and geometry. The work called "Elements", consisted of 13 notebooks attributed to Euclid, the mathematician who was thought to live in Alexandria between AD 323 and 283, includes the basic subjects of mathematics such as arithmetic, plane geometry, number theory, irrational numbers, the geometry of solids objects [12]. 5 of the 10 axioms in the first book of the Elements are described as postulates. In particular, the fact that the 5th of these postulates is open to interpretation (which has no clear proof in the Euclid notebooks) by the end of the 18th century caused great developments in the field of geometry in the 19th century.

The mathematicians called C. F. Gauss (1777-1855), N.I. Lobachevsky (1792-1856), J.Bolyai (1802-1860), B. Riemann (1826-1866) interpreted 5 postulates differently and identified different geometries (called elliptical and hyperbolic geometries) besides the geometry whose foundations were laid by Euclid. B. Mandelbrot (1924 - 2010) reveals the subject, on which G. Cantor (1845-1918), G. Peano (1858-1932), D. Hilbert (1862-1943), W. Sierpiński (1882-1969) studied, as a whole for the first time and defines ***Fractal Geometry*** '(B.B. Mandelbrot released the first publication on the subject with his article called "Fractal Geometry: What Is It, and What Does It Do?" in 1989.) Parallel to these studies, the works of H. Poincaré (1854-1912) constitute the basis for the development of ***Topological geometry***.

In addition, many developments in science, particularly *Noether's Theorem* , in which the mathematician A.E. Noether (1882-1935) associates the *Conservation Law* with symmetry, and the physicist A. Einstein's (1879- 1655) *Theory* of *Photoelectric Effect* and *Theory of Special - General Relativity* , provide a better understanding of the world and the universe in which it belongs, and gives an idea about the geometries it has [13]. The different dimensions and spaces of these dimensions now have become important subjects of science and technology.

Developments in digital imaging technologies in the second half of the 20th century, in addition to theoretical studies in the fields of mathematics, geometry, and physics, pave the way for limited interpretations in plastic / visual arts. When the signals collected by vehicles managed with signals sent to the space exploration vehicles such as Voyager at the speed of light reach the world, they turn into wonderful space photographs thanks to high digital imaging technologies.

All these developments will change the problem definition of today's people, especially modern day space designers who focus on problem-solving in space.

Form and Atmosphere

Geometry can be regarded as the equivalent of the so-called form in design and art, and even as the main generator. Undoubtedly, the change in the main generator of a structure will be reflected in the whole structure. The indicator of real space is form; therefore, any kind of change in the language of form will lead to a change in the meaning of the atmosphere that enables to understand the space and space perception.

Especially the invention of the camera in the 19th century has caused a change in the meaning of image. Previously, the image obtained with the art of painting, has become quickly producible/reproducible with this invention. Both production techniques have different stain geometry, therefore, different aesthetic values.

The change of geometry in the application of thought can be easily followed in the art of painting. For example, the works of artists such as P. Cézzanne (1839-1906), C. Monet (1840-1926), V. van Gogh (1853-1890), H. Matisse (1869-1954), H.E. Cross (1856-1910), V. Kandinsky (1866-1944), P. Klee (1879-1940), P.Picasso (1881-1973), J. Miro (1893-1983), P. Modrian (1872-1944), U.Boccioni (1882-1916), M. Duchamp (1887-1968), S. Dali (1904-1989) are important examples of this 'new space perception'.

An architectural example of the atmosphere created by the form language, formed by the different geometries, in the created spaces is the La Sagrada Familia cathedral, which A. Gaudi (1852-1926) began to build in 1882 and left unfinished due to his unexpected death. The building with traces of gothic style bridges between late medieval and modern times with the form language and atmosphere revealed by its original geometry dominated by hyperbolic geometry.

The effects of non-euclidean geometries in plastic arts in the early 20th century have been observed in the fields of architecture, interior design, industrial design etc. since the end of the 20th century. With the opportunities offered by digital technologies, the non-euclidean geometry, which have an important role in realizing the most appropriate designs for human nature, enables the creation of highly complex systems that cannot be imagined before with fluid / amorphous form conceptions and computational design tools.

4. Design Education

All this change and transformation naturally requires the questioning and redefinition of the education system. In order to justify this necessity, it was required to go back in time again. Only a limited number of people had access to education before the 18th century, and it began to spread with the Industrial Revolution that followed the French Revolution. The German linguist, philosopher, statesman Wilhelm von Humboldt (1767-1835), with his works on education and especially higher education, laid the foundations of today's universities [9] [10].

During the 19th century, the change of economy increased the need for and diversity of qualified workers; In order to meet the needs of industry, education at all levels had become a necessity due to the fact that the formation of designer cadres created by this period did not respond to new needs. Today, the content of the concepts of aesthetics and art that had been included in education since ancient Greece has changed.

Even though the traditional approaches in art and technical education continued until the first quarter of the 20th century, the first course for design and designers started to be given Bauhaus School, Germany, in Humboldt's country, under the name of *Basic Design*. Thus, with the process of the Industrial Revolution, the changing social structure, increasing needs and developing techniques began to take part in art education.

The developed technical facilities, the variety of materials, functionality, the simplicity (basic volumes) which reduces the labor cost and enables mass production are the main reasons for the new education model to be close to '*Design Education*', rather than *'Art Education*'. A momentum for this new approach, which made Bauhaus to be accepted as an ecole, not just as a school in a short time, is undoubtedly Russian Constructivism.

As the traditional education models did not suffice for the needs of their time and caused the birth of Bauhaus in its own context, along with the digital developments after the second half of the 20th century, the Bauhaus model has become insufficient for the needs of the 21st century and weakened. The transformations experienced in the 19th century and in the process that followed were on the real plane, the digital world started to appear on the stage.

Now the design space has to create its existence in a second space-time perception, and the Bauhaus approach does not sufficiently support the design processes that can be associated with this perception. The questions faced by the designers in the changing world perception are new and different approaches should be developed for the solution.

Today's designers have to develop more analytical approaches to the production processes of design knowledge in more scientific and technological knowledge bases. Because design has shifted to a more interdisciplinary field than in the past.

The process of higher education, beginning with Humboldt, was shaped by specialization in a single area at the beginning of the 20th century. It can be said that specialization in a single area brings with it some kind of isolation. Today the information is cumulative; The solution proposal developed for the production of ideas in any field, no matter in the fields of social sciences, science or design, requires the use of information outside the field from different branches of the same discipline or from different disciplines (Among the discussions on this topic, the book called "Mission of the University" (Misión de la Universidad) by José Ortega Y. Gasset'tin is noteworthy [11]). Therefore, the process, which is dealt with in a very general framework, reveals the necessity of re-evaluation of design and design education.

Until the end of the 20th century, design education defined an extremely rational, pragmatic and solution-oriented structure that could produce the space form based on the Ancient Period and came into presence with Euclidean Geometry in the most optimized way. However, the approaches in today's design education should create a completely different platform looking for the possibilities of the new form of language, in which new aesthetic perception patterns are justified and defined by new technologies.

These new forms of perception in design education are reflected in the design studios, which form the backbone of education, through the reconsideration of both *production knowledge* and *design knowledge*.

Production information refers to the tools used in design education. This situation can be defined as transferability of the design via virtual reality environments with digital representation tools such as CAD-CAM technologies, instead of traditional representation tools such as sketches, technical drawings, single/double / three-point perspective expressions, models, etc. In other words, production knowledge defines the expression process of the design, not the design process. Digital media tools should, of course, fundamentally express a design approach; and design knowledge defines exactly this approach. The change in the space perception triggered by the changes in the individual's perception of the world leads to the change in the design knowledge he/she produces. At this point, technology will be considered as a means of thought production, not as a means of expression.

This study aims to make a suggestion on the reflections of the changing paradigms of the 21st century in design education with design knowledge, not production knowledge. Therefore, the sample defined through the Interior Architecture and Environmental Design Training was defined through the students of the 1st Grade Design Studio who did not yet have the production knowledge of the education program they attended.

5. Sense, Sensation and Emotion Production

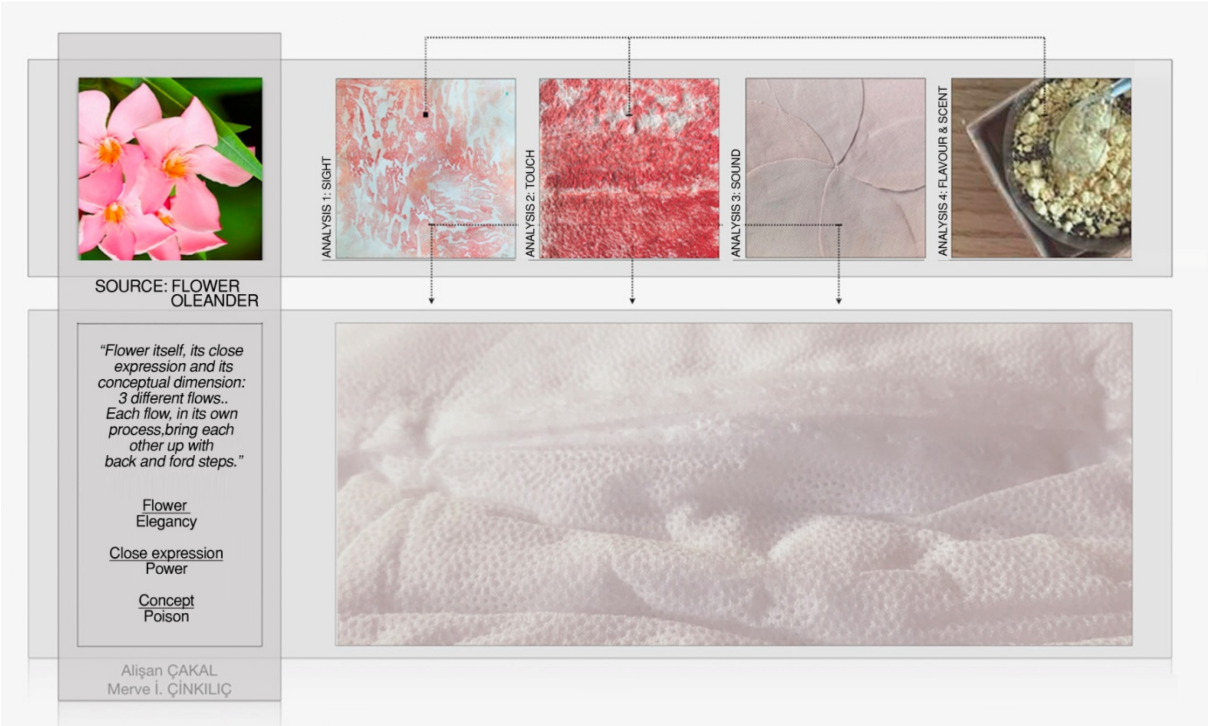
From the Bauhaus School that produces the Emotion of the Space through concepts such as modularity and standardization, to the present day, which can produce the Space of Emotion through a multi-dimensional and dynamic space structure, the design education should have the ability to be as rational and intuitive at least as much as it was at the beginning of 20th century. Because the mentioned multidimensionality will be related to the processes of perception through sensation and sensory mechanisms.

In this context, over a two-semester program carried out in TOBB University of Economics and Technology, Faculty of Architecture and Design, Interior Architecture [and Environmental Design] education, 1st Grade Basic Design Studio, the process, in which rational and intuitive approaches in the design process are evaluated together, is opened to discussion. It is aimed to create an experience space related to the construction of the emotion of the space with the process defined rationally, and the construction of the space of emotion with the process described intuitively. In the 2017 - 2018 Academic Year, in the First Grade Schedule, Basic Design I and Basic Design II courses by Şaha ASLAN, Ferhan KIZILTEPE, and S. Selcan DÖKMEN AYKAŞ provided an opportunity for experiencing the rational process and the intuitive process, respectively.

The process followed in the Basic Design I course was the process of building a three-dimensional abstract space with a defined analysis study through a photo frame taken from the TOBB ETU Technology Center, which also included the studio where the course was followed. The process of transformation had developed on the definitions of the gathering of form elements such as point, line, surface, volume with the principles of formation.

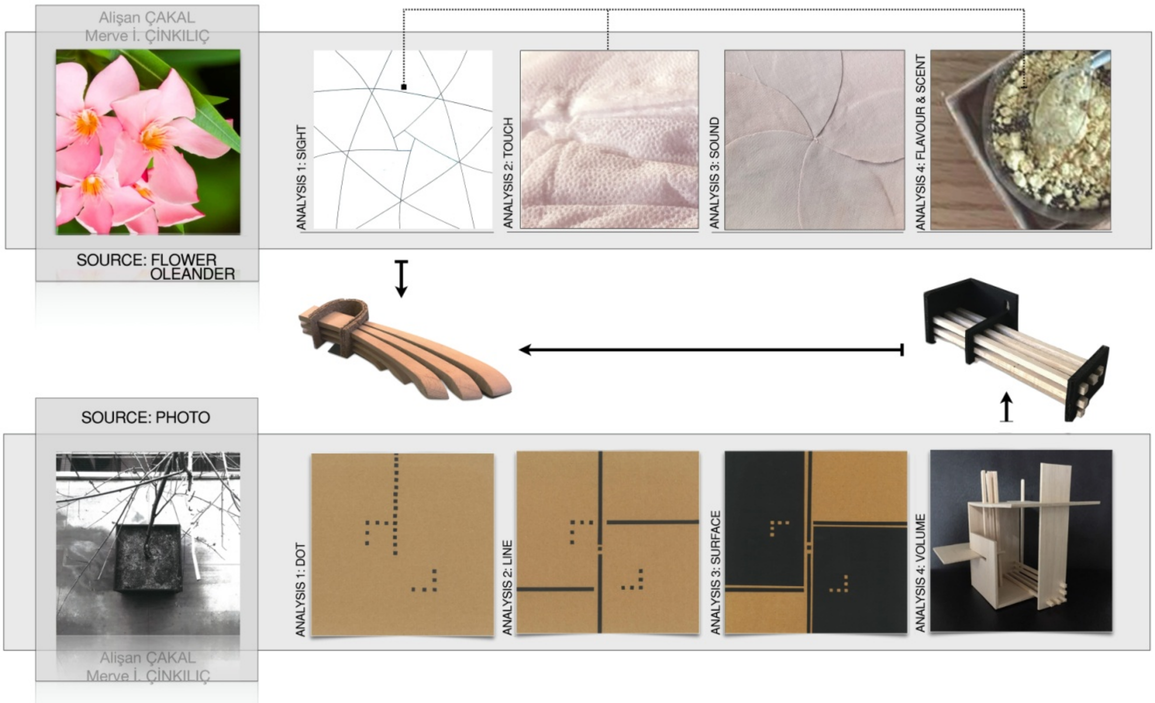
The form language developed here was associated with a function in the next step. This function was a single or multi-directional sitting element that could be used in public spaces, allowing more than one person to use. In this context, the student was obliged to transfer the design gene related to the design language he/she had developed to the sitting element; the first awareness of ergonomics and human anthropometry was also expected to be developed in this process.

The process followed in the Basic Design II course was defined by a flower chosen by 15 groups in total, each consisting of 2 students who took the Basic Design I course and were successful. The groups produced sensation by focusing on the different sensory mechanisms each time, through their flowers, which were defined as the starting point and had an objective reality, and formed a holistic story that they plasticized in different ways. The objective here was the problem of transformation the subjective experience acquired through the senses into an objective knowledge as a result of a cognitive performance.



Unlike the rational process followed in the Basic Design, I course, whose stages were defined, in the process followed through the flower it was avoided to make any definition about the way to follow. Some groups progressed through chemical data such as the toxicity or sedative effect of their flowers, while some groups began the story with the climatic characteristics of their flowers, and some groups with formal references of their flowers. The first channels in which the groups communicated to identify their flowers, in other words, how they received the flower, had created a special and subjective beginning.

At the end of 8 hours/week / semester, a total of 24 weeks defined in the program for both courses and content, students were asked to transfer the emotion they defined in Basic Design II course to the form they defined in Basic Design I. In other words, the concept of FLOWER was expected to be associated with the form of the SITTING ELEMENT. The expected hybrid and reproduced form language can be defined as a Morphogenetic evolution in which the design gene, which is defined by Euclide Geometry, is transferred to Non-Euclidean Geometry.



Today, the assumption that the sense of sight is at the top of the hierarchy of the senses, followed by hearing, causes the other senses to remain in the background. The nature of the space, which stimulates all senses, creates a space of movement in which the students of interior architecture who are responsible for producing information through the space do not have the chance to ignore the senses in the background. The aim of this study was to create awareness that each experience was experienced in a way that more than one sensation was involved, and that each experience was gained in the leading role of one sense, with the help of other senses, and these roles were not stable.

No matter what sense the focus receptor uses, the senses were capable of being plasticized by texture despite being produced in their own form characters [sound existed with sound, odor with odor, taste with taste], and they could be represented by texture in accordance with the method of sharing of the message [with text and visuals]. This representation reveals the qualified characteristics of the texture, emphasizing to what extent it plays an important role, how a strong a mediator it is in the transmission of emotions.

Another aim of this study was to investigate how the perceptions produced by other sensory mechanisms can be integrated into education rather than a dominant sense in the basic education of Interior Architecture students. Each study is a creative work in which new relationships that have not been established before being established with flowers. Each emotion produced is a study that could monitor the production process where the image of the flower, in which the traces of the flower were designed, including the concept of the flower, was produced although the intuition was at the forefront.

6. Conclusion

The production knowledge that societies create is based on the auxiliary tools used to produce. For example, the Stone Age, which is described as the oldest age in the history of the world, covers a period in which the stone was processed and transformed into tools such as a knife, saw, ax, arrow, etc. and the requirements were met with these tools. The Bronze Age, where the stone was used together with the mine, created a new area of thought with new materials. This way of thinking has led to the development of spatial perception as well as commerce, and the formation of cities and city-states. In other words, in retrospect, the change of a single material has led to a change with the effect of building cities.

From the stone age to the age of knowledge, the point where technology has come today causes the world perception to evolve in a different direction. The new principles of production have been transformed into new insights and new ways of seeing which can be defined by topics such as Interoperability, Virtualization, Self-Deciding Systems, Rapid Data Collection, Analyzing Capabilities, and Flexible Adaptation Systems. The thought, which is the cause/result of all these activities will be as consistent as it can justify/exemplify the action.

The new space perception defines the universe as a multi-dimensional interaction field and a dynamic pattern network rather than restricting it into to a three-dimensional space and linear time construct. In other words, space begins to refer to different spatial dimensions beyond its perceptible three-dimensionality. At this point, the perception has to move from the focus on the sight that has come into prominence since the Renaissance and to pass to a multi-sensory system in the awareness of other senses.

The aim of this study was to provide the students with the experience of cognition and emotion in two different processes evaluated focusing on rational and intuitive methods; and to raise awareness of that both processes were basically a process of interpretation even though the paths they followed were different, and it was successful in these terms. On the other hand, the experience has made a proposal to describe both form and emotion production.

In this context, how the skills and awareness gained will contribute to the students in the following years or in what ways they will weaken them will be observed in the future and the method will develop itself with the positive and negative aspects over time.

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TITLE

Generative Pedagogy: Lost in Transition

Topic: Architecture Pedagogy

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Abstract

This paper along with poster introduces an alternative approach for the challenges encountered in algorithm-based pedagogy and digital methodology within the architecture courses that deal with the processes of Generative design, materialization and fabrication. The method requires the students to comprehend the principle of morphogenesis through biomimicry and form-finding approaches in order to find the solution for demonstrating functionality, optimization and sustainability. Digital architecture as an accurate pattern is the result of the execution of prefab codes in artistic activity. In other words, digital architecture could be considered as an instrument rather than a specific subject or topic. In addition, the outcomes of interpreting digital coding into physical fabrication will be lost in transition and create imprecision, which is the natural characteristics of the creative space within the contextual subject matter of this methodology. On the other hand, the prerequisite dynamic of the creativity is the spontaneity within the realm of artistic creativity.

email/address

Key words: Generative Design, Performance-Oriented, Architecture Pedagogy and Digital Methodology

Main References:

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Generative Pedagogy: Lost in Transition

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Abstract

This paper introduces an alternative approach for the challenges encountered in algorithm-based pedagogy and digital methodology within the architecture courses that deal with the processes of Generative design, materialization and fabrication. The method requires the students to comprehend the principle of morphogenesis through biomimicry and form-finding approaches in order to find the solution for demonstrating functionality, optimization and sustainability. Digital architecture as an accurate pattern is the result of the execution of prefab codes in artistic activity. In other words, digital architecture could be considered as an instrument rather than a specific subject or topic. In addition, the outcomes of interpreting digital coding into physical fabrication will be lost in transition and create imprecision, which is the natural characteristics of the creative space within the contextual subject matter of this methodology. On the other hand, the prerequisite dynamic of the creativity is the spontaneity within the realm of artistic creativity.

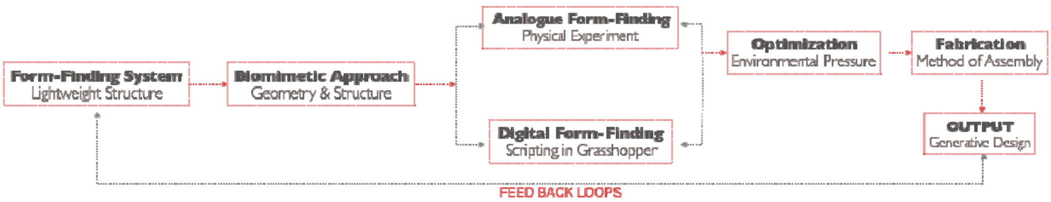

Figure 1. Design Process.

1. Introduction

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Studio design is a flexible studio that demands a high level of independent researches. Furthermore, such a design demands for a high-level digital integration to support the development of a design solution. The design of a pavilion given to the students is a rather a simple program; therefore, they can mainly focus on generative design processes. “Generative Design is a morphogenetic process using algorithms structured as non-linear systems for endless unique and unrepeatable results performed by an idea-code, as in Nature" (Soddu 1992). In this paper, selected projects exhibit a set of case studies that represent the transition from an analogue to digital medium, and from the digital simulation to production and fabrication. The strategies of instruction are an evolutionary process inspired by natural elements. In this paradigm, the form is generated step by step through a defined algorithm which contains a series of mathematical rules: not the actual geometry but the logic behind the geometries. At the same time, the techniques for designing fabrication aspects are driven by natural forms and behaviours which are also adaptive to the local environment. The complexity generated through these processes gives a range of possibilities and solutions by easily changing variables to get new output and results. In addition, this method of thinking allows students to gain a better understanding of how to incorporate the bottom-up design with top-down rules established by them. However, the fluctuation in the sequence of actions between digital feedback and physical matters can cause imprecision and loss of data during the transition.

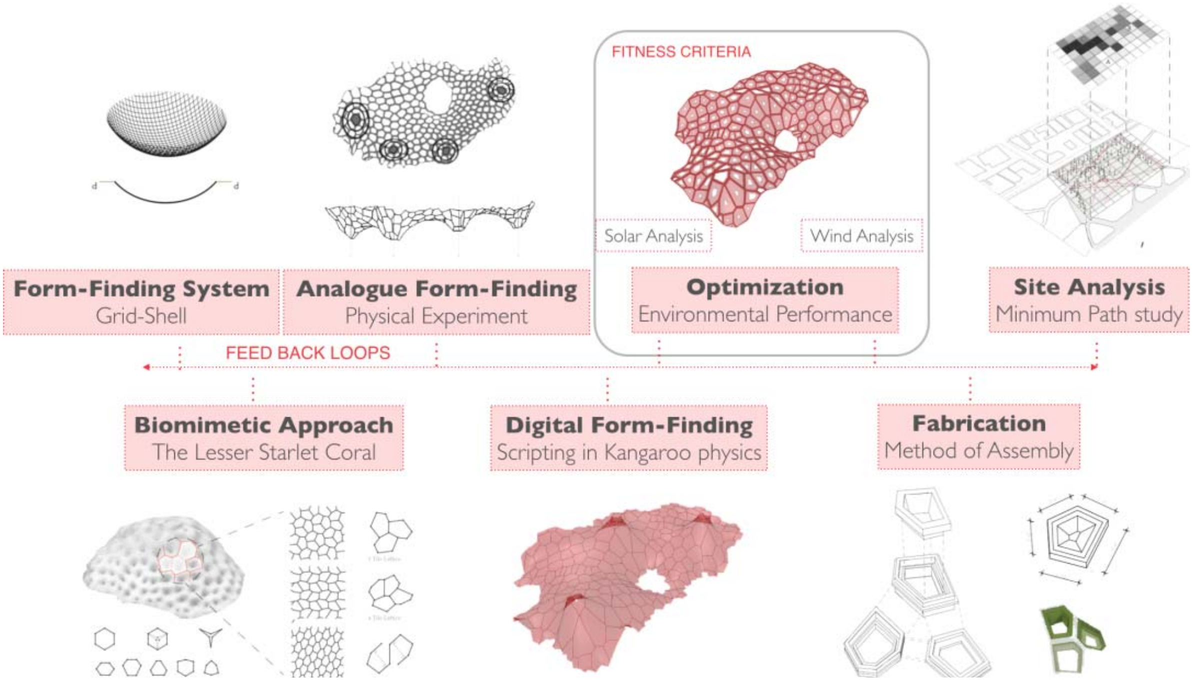

Figure 2. Algorithmic Design Process.

2. Biomimetic Approach

2.1 Nature Driven Project

During past two decades, architects and other designers become more aware and concerned about their environment due to the global ecological challenges; as a result of this awareness, they are trying to learn from the nature itself to find out solutions to deal with these concerns. Architecture, like other fields of design, develops into a more multidisciplinary and research-based career than before. “Moreover, the endeavors guided by a sophisticated knowledge of natural systems have the potential to counteract the increasing fragility and the degradation of natural environment.” (Brownwell and Swackamer 2015). This course encourages students to have a deeper observation of their surrounding and into the Nature by focusing on its principles such as follows:

- Uses a simple rule to create rather complex shapes.
- Is dynamic and adaptive.
- Is very tight to use extra materials but generous with the intricacy of its design.
- Regenerates to adapt new changes and conditions.
- Gives sustainable solution.
- Demonstrates functionality and optimization.

2.2 Decoding Nature

In the initial exercise, each student will be given a specific light weight monolithic structural system, like branching, grid-shell, membrane, net, or pneumatic. According to the given structural system, students selects a natural inspiration. The selected projects in this paper are mainly focusing on the grid-shell structure. The design process begins with intensive scientific research studies which are translated into mathematic codes and structural performance. To discover the laws within the selected inspiration, each student needs to intensively research on science-based resources to understand the main language of nature which translates into mathematic codes. For example, the group who selected Chamber Nautilus as their inspiration, Figure 3, discovered that the growth pattern in this species is following a logarithmic spiral with radii expanding at a constant rate and close ratio. As Ball explains “mathematics enables us grasp the essence of pattern and form. It is the means of description at its most fundamental level, and thereby facilitates our seeing what features need to be reproduced by an explanation or a model.” (Ball 2001). Decoding nature mainly focuses on the geometrical behaviour and patterns or growth process in specific scale, in a way that “scale has to be carefully considered if principles are abstracted from biodynamic system for use in architecture.” (Jeronimis 2004). Although mathematical code gives a precise response, the procedure of decoding nature by students, inevitably can be done unmethodical and randomly. As a result, we observe that students with similar biomimetic research usually have dissimilar outcomes.

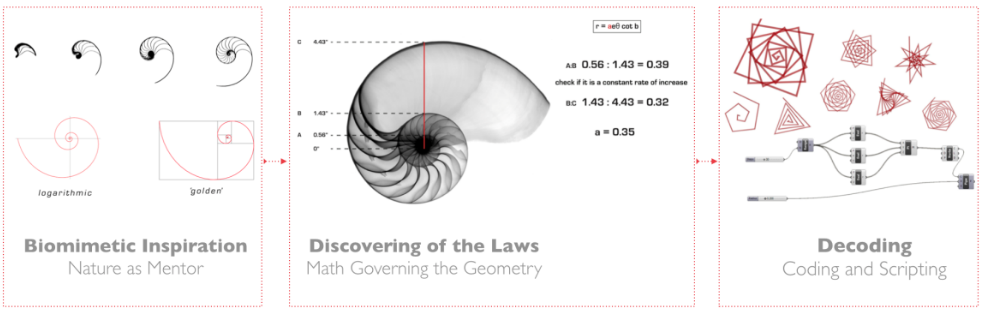

Figure 3. Decoding Nature’s laws

3. Form-Finding

3.1 Physical Form-Finding

This traditional method is reintroduced by academics through the practice of digital architecture. As Oxman defines “form finding is a significant concept that changes the traditional meaning of performance by integrating formation and generation processes.” (Oxman 2008). In the following design process, students explore and research on the work of initiators of form-finding like, Gaudi, Otto and others based on their assigned structural system, nevertheless, these works are essentially monolithic and emphasizing on lightweight structures. After the research done, they start a hands-on exercise and perform various experiments to explore the structural integrity of their introduced systems. For instance, in Figure 4, a couple of students explore the principles of the self-organization in an inverted shell structure. In addition, the overall geometry and tessellation over the surface are extracted from the molecular arrangement of Radiolaria and the material system used consists of plaster, canvas cloth and compression elements. The following experiments are somehow precise and meticulous but at the same time give more freedom and flexibility to get manipulated. They have been encouraged to execute physical performance prior to the digital computation. This allowed students to have a better understanding of the physical performance of a material towards compression and tension forces in the relation to gravity and also get an overall feasibility of their proposed design.

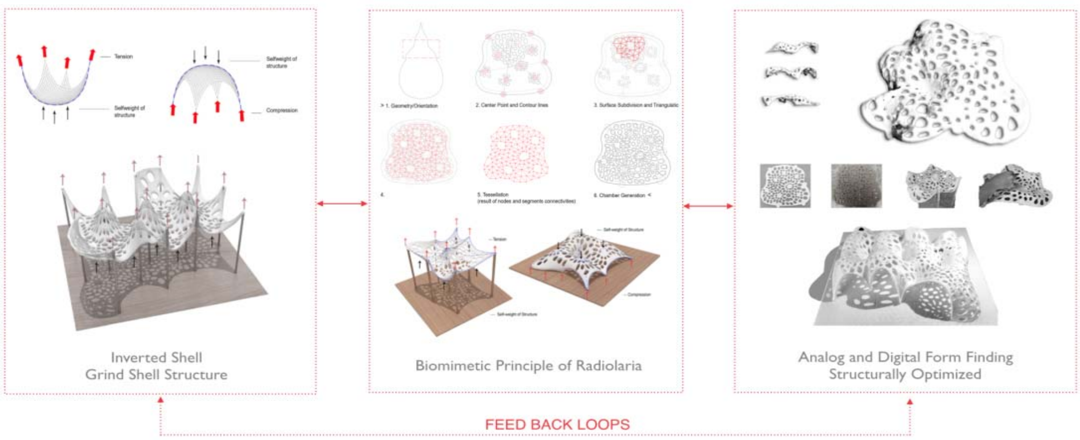

Figure 4. Physical Form-Finding

3.2 Digital Form Finding

Oxman describes that “in digital form finding the designer, rather than creating the one-off design, design an ad hoc project “generative system”, a modeling system that includes parametric digital morphing of the topological design space of the model.” (Oxman and Oxman 2014). In this phase students transfer a set of parameters obtained from bottom-up physical modeling into digital form-finding software such as Grasshopper plugins (Kangaroo Physics, Karamba and Rabbits), which simulate material behaviour by using physical forces like gravity, tension, compression and elasticity. As shown in Figure 4, this process is followed by extracting the mathematical codes for the initial natural inspiration to create a generative-based design using Karamba plugin, a parametric structural engineering tool which provides accurate analysis of shell structures. Furthermore, this gives possibilities to manipulate the generated form in more precise manners to create variation by simply modifying the parameters.

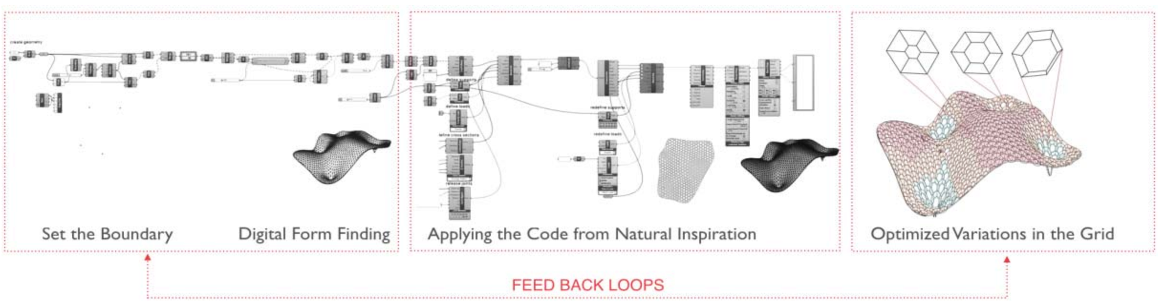

Figure 5. Physical Form-Finding

4. Performance Oriented Design

During the course, students are asked to incorporate optimization strategies into the design by implying the defined fitness criteria that integrates a rigorous process of various assessments on environmentally oriented behavior along with structural stability. In order for students to explore analytical process through computational processes, they are required to have a general understanding about morphological behavior, structural integrity, material performance of the designed form in specific sites with defined environmental pressures. The feedback data taken from environmental analysis, followed by form-found digital geometry have profoundly influenced the systematic strategies dealing with the site-specific project. In this selected project, Figure 6, students are identifying multiple fitness criteria such as structural integrity, requested program and environmental stimuli (solar radiation and wind force) which are the main constraints on the initial generated form to create diverse and site-specific variations. The number of constraints has an impact on the degree of optimization. However, our expectation for the digital optimizing tools and programs has to be faultless and precise, but often they dissatisfy this need due to the deficiency of the software or the lack of knowledge on what to feed into the inputs or even how to analyze the output.

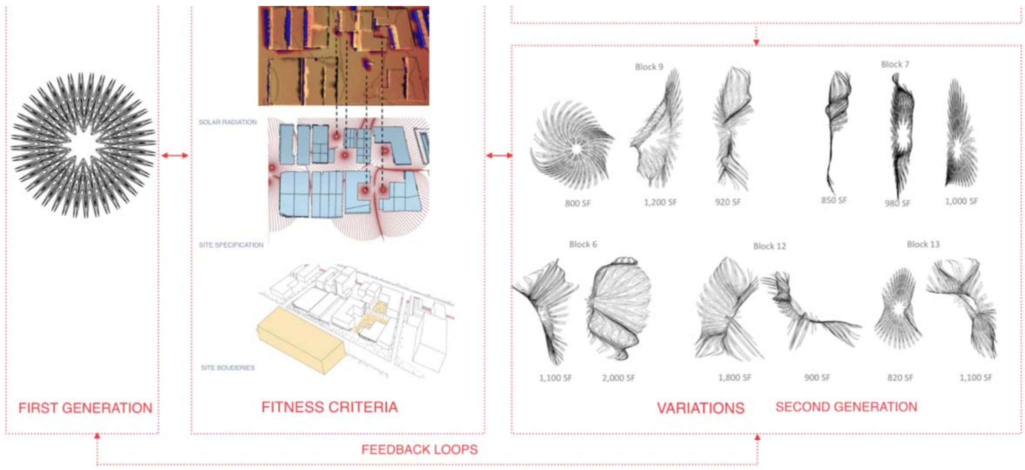

Figure 6. Physical Form-Finding

5. Fabrication and Method of Assembly

Digital tectonics had a critical influence on how to design in the past two decades especially in academic realm. The relationship between fabrication processes and the design intent as well as the geometric form and material properties are the other challenges that students are encountering during production and fabrication. Moreover, it is also clear that a range of new digital tools and techniques are appearing that not only challenge our previous understanding of the term “design”, but also hold out the promise of new, more efficient ways of generating or searching for possible solutions. (Leach 2014). One of the crucial principles in the design process is to embed the fabrication and construction logic at a very early stage to achieve efficient and homogeneous fabrication system. As a result, “they bring the ability to control fabrication digitally, to drive cutting, bending and assembly; to simulate and optimize material performance, to control of the craft of material.” (Glynn & Sheil, 2011). In the following project, Figure 7, the proposed assembly technique for the pavilion is to utilize a waffle framework system to overlay the mesh to construct the computed curvature for the shell structure. In addition, at the micro scale level, students suggest using a lightweight, recyclable and cost-effective material-system which consists of paper tubes, 3D printed joints and recycled textile. Although the process of fabrication appears to be digitalized and less complicated, its design method is linear with a complicated procedure and follows a traditional way of production technique. Whenever there is a flaw in the output, the designer needs to digitally remodel, reprint and test each part until he/she discovers the desirable product.

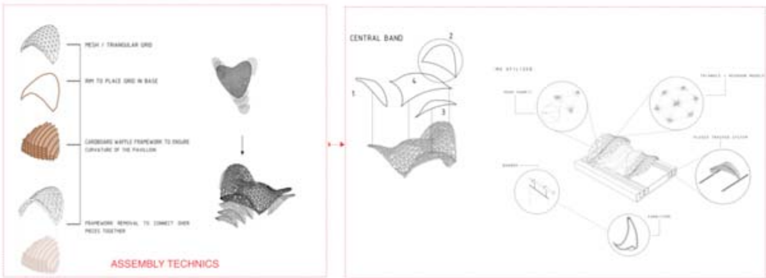

Figure 7. Optimization and Design with Feedback Loops

6.Conclusion

The aim of the course is to establish an elaborate system to manage and analyze various possibilities through series of physical experiments and digital analysis based on the environmental condition. Teaching students through generative design methods helped them to achieve and explore more dynamic design processes which can constantly updates through the feedback loops. This pedagogy method approves Tedeschi opinion: “Algorithmic design enables users to design a process rather than just a single object.” (Tedeschi 2014). In addition, the biomimetic approach gives students the opportunity to learn how to translate natural formation into the mathematical code, as well as, interpreting the monolithic structural principles by using form-finding experiments. Not all algorithms can serve the same purposes and there is no universal algorithm that can serve all types of problems. Also, “algorithmic thinking differs from almost all other forms of thought, in order to create a robust and optimize design, we need to have capability to comprehend the principles of this methodology which is inherited from computer discipline.” (Schumacher 2014). The precision is the key point when it comes to scripting; on the other hand, the method of selecting the specific rules or code, relies on personal decision-making and perception which often result arbitrary and imprecise outcomes. Since, the process of design is constantly exchanging information through analog and digital procedures, it is very likely that some data will get lost during this transition. In conclusion, there is a gap to achieve the ‘ideal’ accuracy within digital methodologies but, at the same time, the impreciseness of the physical material world can promote authenticity and ingenuity in the design. In other words, the challenges of integrating material physics and generative rules and their interactions leads to “imprecision”, i.e. the precision will be lost in transition. Thus, the spontaneity in the realm of artistic ingenuity generates the innate characteristics of the creativeness within the contextual subject matter.

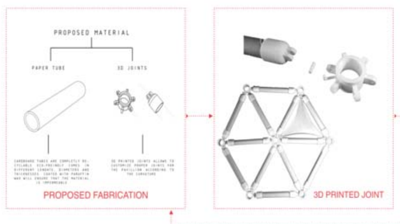

Figure 7. Selected Pavilion Project from the Studio Course

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TITLE
Futurism Art and its significance to Computational Generative Art

Topic: Art and Technology

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Abstract
With the invention of new imaging technologies such as chrono-photography, futurist artists studied physical exertion as a mean to depict movement in still images. When a continuous action was broken into its constituent elements,

it was observed that continuity could also be described as a kinesis of sequential iterations. Advance use of machinery allowed sophisticated tasks to be analysed in detail to construct its building components to formulate a fabrication system. Consequently, futurist artists were heavily inspired by the flourishing technological advancements in the early 20th century and portrayed these inspirations in the various forms of art.

However, due to its provocative uncanny manners, Futurism Art has not been embraced extensively in the scope of art discourse. Despite its far-right political connotations, futurism art has been influential in many art forms and techniques including Computational Generative Arts. In this paper, the author aims to explore aesthetic constituents and procedural methodologies shared between Futurism Art and Computational Generative Art.

The code generated art aesthetics will be in the focus of this study to inspect similarities between the examples of Futurism Art and the contemporary generative artworks built with creative coding methodologies.

Major artworks from Futurist Art movement will be investigated and their associations with generative manifestations will be analyzed with respect to computational systems.

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Key words: Futurism Art, Computational Generative Art, Computer Art, Creative Coding

Futurism Art and its significance to Computational Generative Art

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ABSTRACT

With the invention of new imaging technologies such as chrono-photography, futurist artists studied physical exertion as a mean to depict movement in still images. When a continuous action was broken into its constituent elements, it was observed that continuity could also be described as a kinesis of sequential iterations. Advance use of machinery allowed sophisticated tasks to be analyzed in detail to construct its building components to formulate a fabrication system. Consequently, futurist artists were heavily inspired by the flourishing technological advancements in the early 20th century and portrayed these inspirations in the various forms of art. However, due to its provocative uncanny manners, Futurism Art has not been embraced extensively in the scope of art discourse. Despite its far-right political connotations, futurism art has been influential in many art forms and techniques including Computational Generative Arts. In this paper, the author aims to explore aesthetic constituents and procedural methodologies shared between Futurism Art and Computational Generative Art. The code generated art aesthetics will be in the focus of this study to inspect similarities between the examples of Futurism Art and the contemporary generative artworks built with creative coding methodologies. Major artworks from Futurist Art movement will be investigated and their associations with generative manifestations will be analyzed with respect to computational systems.

Keywords: Futurism Art, Computational Generative Art, Computer Art, Creative Coding

INTRODUCTION

Art, in its marching augmentation, has brought about a multitude of artistic movements with their distinctive characteristics that emerge from the sensational influences of various times of history. These movements have been generally influencing each other with transitional boundaries. Occasionally distinct artistic movements form over time as a reaction or a derivation of a certain style and conception. Furthermore, art has been mainly influenced directly by the environment in which the society is in, and the content of art continues to shape with the changes in society. Futurism Art has also been featured in history as an art movement deeply influenced by the revolutionary political and technological developments in which the world is engaged with. In 1909, Futurism Art was acquainted for the first time with the large audiences by Filippo Tomaso Marinetti’s article "The Founding and Manifesto of Futurism", which was published in the front cover of the newspaper Le Figaro in Paris (Rainey, Poggi, & Wittman 2009, Poggi 2009, Humphreys 2003). Marinetti, a son of a wealthy family, was a daring character who was eagerly paying homage to technology in every aspect of his life. His enthusiasm about speed was prevalent in the way he was driving his car dangerously and a serious accident he had been through in 1908 is regarded as a reference to his Futurist Manifesto (Carey 2015). His controversial attitude was on such a patriotic level that he would not hesitate to consider a roaring car with an explosive breath to be more beautiful than the famous Victory of Samothrace sculpture.

When we examine Marinetti's past in the practice of art, we see that in the early periods of his artistic production he was often engaged in a literature-oriented occupation. Marinetti published his first poem "L'Échanson" in 1898 in a magazine published in Milan called Anthologie Revue. His early poetry works have been reflecting a remarkable scent of brutality and controversy that his incendiary language has made him be distinguished severely from the existing art climate. In a very short amount of time after emerging as a new trend in the areas of literature and poetry, Futurism has become widely impressive in many areas of contemporary art and design such as painting, sculpture, architecture, theater, cinema, music, fashion, gastronomy and product design. In this respect, Futurism must not be considered only as an art movement but also as a sociological change that has delivered ambitions towards revolutionary consequences.

In 1930, the Manifesto of Futurist Cuisine was published on an Italian newspaper La Gazzetta del Popolo and in this writing, specific rules for the activity of a perfect lunch were listed in detail (Marinetti, Brill, & Chamberlain 2014, Berghaus 2001, Rohdie 2009). In furtherance of ruling out all the previous traditions, Futurist cuisine aspired to encourage knives, forks and traditional dishes to be removed in favor of tactile pleasures and flourish the ground with the measured use of accompanying music, poetry and even perfume to be paired with the flavors and colors of dishes. Likewise, a similar attitude is apparent in the way the music has been formulated by the Futurist artists. Two provoking manifestos were written by Francesco Balilla Pratella in 1911 and Luigi Russolo in 1912 which dictated rudimentary statements about the way the music was defined by the Futurists. According to Pratella, "the progress and the victory of the future will consist in researching and realizing the enharmonic modes of music" (Rainey, Poggi, & Wittman 2009:81). The composers should combine harmony and counterpoint to write polyphonic compositions that would echo the musical spirit of the technological age. Moreover, Russolo claims that musical sound is too narrow in its selection of timbres. He claims that "We must break out of this restricted circle of pure sounds and conquer the infinite variety of noise-sounds" (Rainey, Poggi, & Wittman 2009:134). It is observed from Russolo's "The Art of Noises" manifesto that there is a tendency to embrace the use of noise as a compositional element because of its reference to the new emerging technological sounds such as factories, trains, electrical machines, cars etc. The same reference to enlarging the field of sounds is still relevant to today's musical understanding (Cascone 2000, Russo & Warner 1987). In order to perform noise as a musical constituent, Russolo built a set of mechanical acoustic instruments named "Intonarumori" that were producing enharmonic possibilities. While he was able to transform the noise with the use of these instruments, the listeners were deceived to hear a resemblance of a timbre relation with the sonic experience. Russolo's analysis on this experience is noteworthy and it foreshadows the underpinnings of "musique concrete" of which the theoretical basis was developed by Pierre Schaeffer in the 1940s.

> Noise therefore loses entirely its character of result and of effect, which is bound to the causes that produced it (motive energy, percussion, friction through speed, bumping, etc.), causes resulting from, and inherent in, the purpose of the machine or object that produces the noise. (Russolo 1913)

According to Schaeffer, musique concrete is a conceptual comprehension of sounds as solid abstractions with the absence of reference to their original causes. Thus, the listening activity is relieved from the encapsulation of cause and effect reasoning. Therefore, Russolo's reference to noise as a musical constituent reflects us another precedent for the transitive characteristic of the Futurist Movement.

ABSTRACTION IN FUTURISM ART

Futurist artists were profoundly dominated by the charming elevation of the power of the machines. Consequently, Futurism Ideology aims to convey the dynamism of the modern world with an understanding deeply influenced by the rapid advancements of the era of science and technology. When their avant-garde approach to the arts was flavored with the praising of the technology, their works of art primarily reflected the range of notions such as speed, power, movement, temporality, electricity, cityscape, mechanical modes of production, modernity etc. In Russolo's music composition "Wake Up a City" ("Risveglio di una Citta"), we are witnessing a birth of a new musical loudness, in which the sounds associated with the name of the piece, urban sirens, and factory whistles are elicited extensively. With its irregularly vibrating sonic content, the piece portrays a sense of sound-walking in a modern city of the day. Although the name of the composition is self-explanatory about its premise, the inclusion of noise materials creates an abstraction of a spectrum of sounds as a detached listening experience from its causality.

In a like manner, futurist painters have tried to break down a visual experience into its abstract elements. With the influence of chronophotography on futurist painters, the notion of transforming movements into a sequence of silhouettes became a subject of interest for the composition of paintings. In 1900, when Giacomo Balla encountered Etienne-Jules Marey's chronophotography works, he was fascinated by the framing of the suspended kinesis in the appearance of a stasis (Poggi 2009). Balla's approximation in depicting a movement on a painting was celebrated in his famous painting "Dynamism of a Dog on a Leash ("Dinamismo di un cane al guinzaglio") in 1912. In this painting, the rapid movements of the dog's feet and the lady's walk cycle were superimposed to capture their motion on a single moment. The suspended moment of temporality and dynamic equilibrium have contributed to the feeling of the painting with an exalted feeling of desire to elongate in a fourth dimension. In the early twentieth century, artists in almost every major modern movement were influenced by the fourth-dimension conceptualization (Henderson 1981). In another masterwork by Umberto Boccioni named Unique Forms of Continuity in Space, the motion was laid on a bronze sculpture with a wavy man figure leaning forward in space. According to Boccioni "Dynamic form is a kind of the fourth dimension in painting and sculpture that does not take on real life without the full affirmation of the three dimensions that determine the volume: height, width, depth" (Boccioni 1913). With its dynamic form, this sculpture portrays an abstract manifestation of an intrinsic potential for a flow and a dissolution of a solid matter.

As it is observed in all the mentioned artworks above, it is evident that Futurism has been maintaining its discourse in an ongoing relationship with the abstraction in art. Basically, abstraction in art aspires to create conceptual forms that do not carry any direct reference to the observed reality. This subject has been frequently visited during the 20th century in the various fields of art including painting, sculpture, photography, and cinema. Even though it is considered controversial to follow the traits of the notion in the past, as a precursor one may point the Neandertal cave art paintings in Spain which is taught to be 64.000 years old (Hoffmann 2018, Marris 2018). Distinct forms of dots, rectangular shapes and handprints are easily recognized in these astonishing red and black paintings. These abstract shapes merely represent any resemblance to a visible reality. An outstanding figure, the ladder-like form in this finding is a fascinating drawing of an unknowable geometric shape with deliberate touches of hands. Furthermore, on the top-left side of this structure, there is a curvilinear shape composed with several dots almost evenly ordered on a proper grid layout. This repetitive figure discloses an intentional behavior in generating a specific pattern and configuring an order in a composition of a painting. Repetitive forms in arts have been embraced in various other artworks by artists such as Claude Monet, Wassily Kandinsky, Kazimir Malevich, Rene Magritte, Andy Warhol and others.

REPETITION AND RECURSION

Repetition is not superficial. It has been observed in nature in various circumstances. On a macro lens, a cosmic example would be the dawn of the day, on the other hand on a much microscopic level we observe that a cell of an organism has repetitive properties as well. The concept of repetition has been studied as an important philosophical debate by Deleuze in his writing "Difference and Repetition". According to Deleuze, there are as many constants as variables in laws of nature and repetition can be described as an extreme resemblance or perfect equivalence (Deleuze 1994). As there is a certain or zero approximation in the repetitive action on a theoretical dimension, it could also be relevant to the works of arts as well. In Yves Klein's Blue Monochrome series, we are seeing an abstraction of a single blue color hue with repetitive applications of a specific pigment on different canvases. Even though one may easily describe these painting as identical from a distance, Klein states that all his paintings are different, and their pictorial quality is immaterial and invisible (Duve & Krauss 1989).

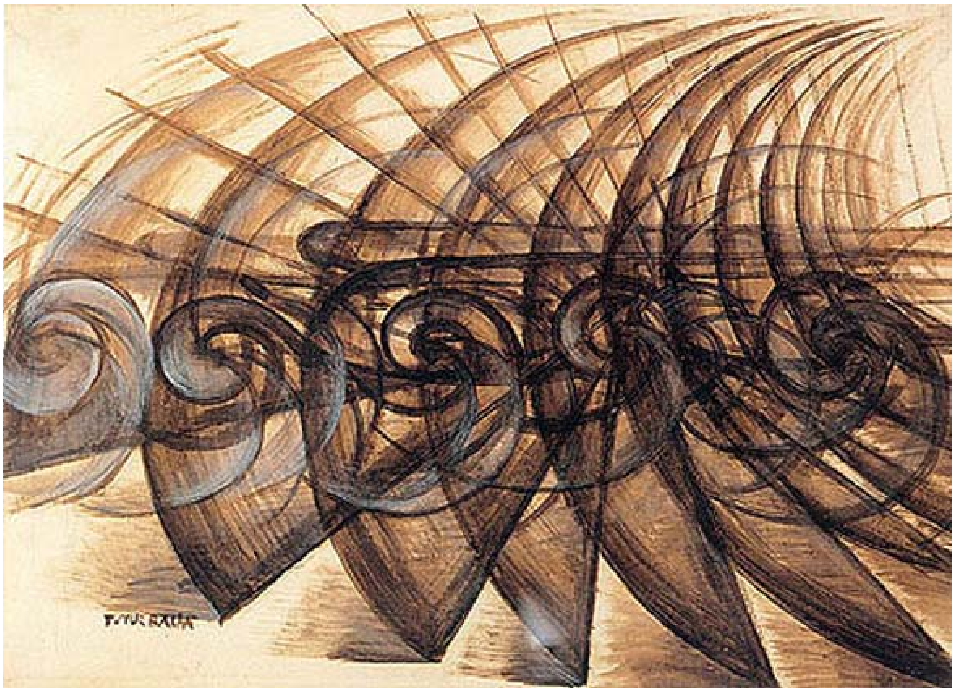
Exhibition – Yves Klein

Klein's repetition series calls for some references to Deleuze's separation of two types of repetition: static and dynamic repetition. According to Deleuze, static repetition refers to an "abstract effect" whereas dynamic repetition refers to an "acting cause". In the dynamic repetition, the concept of representation is transformed into an Idea that forms the dynamism of the totality (Deleuze 1994). Thus, with reference to Deleuze's the dynamic repetition, an analysis of Klein's Blue Monochrome series is not only pertained to a symbolic meaning of a distinct color, but the repetitive conduct of the artworks implicates an artistic reality of its own with internalized nuances.

Use or repetitive forms on canvas have been frequently implemented in futurist painters' compositions. In Giacomo Balla's artworks that are based on the themes of speed and movement, we are extensively observing the adoption of repetition techniques in his painting style. In his painting titled "Lines of Movement and Dynamic Succession" (1913), the layering of geometric shapes and curvature representation of sequential copies of visual elements on superimposed juxtapositions implies his vigorous attempt to portray the infiltration of the movement into imagery. Placement of a flying bird's repetitive appearance in a consecutive structure enhances the idea of illustrating a continuous movement as a breakdown of precise discrete samples.

Giacomo Balla - Lines of Movement and Dynamic Succession" (1913)

His articulation of the same figurative approach may be observed largely in his other paintings including Speed of a Motorcycle (1913), Abstract Speed (1913), and Flight of the Swallows (1913). In a classic famous example of futurist paintings, "Speed of a Motorcycle", the repeated shell image designates an abstract shape to signify an accelerated motorcycle's displacement. While Balla attracts the viewers thoroughly into his radiant composition, he adopts the technique of using a sequential arrangement of the same geometric shape that has been recursively rotated from its center of origin.

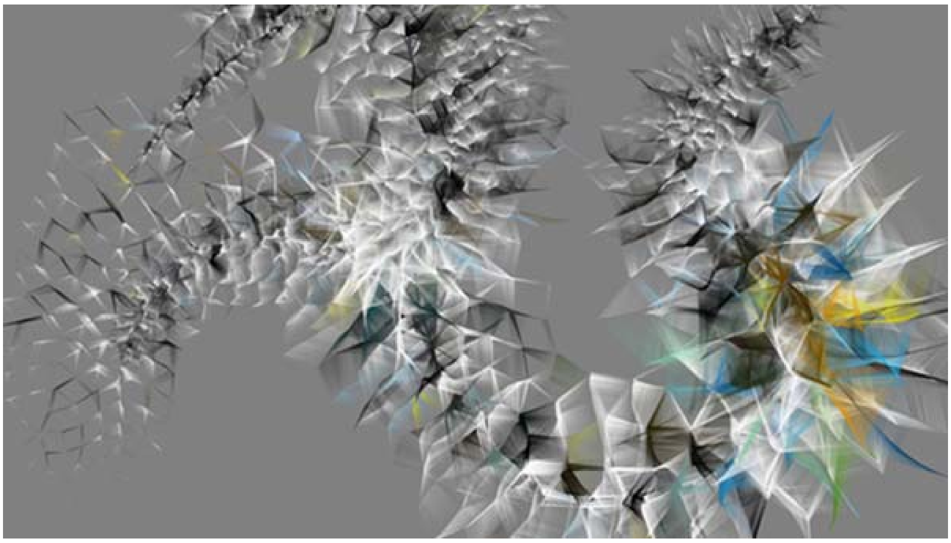


Giacomo Balla - Speed of a Motorcycle (1913)

In this painting, we are not only observing a repetition of a single object but a recursive manipulation of its replicas with variance on its positioning, rotation and scale properties. Similarly, handling the control of derivations in the building properties of a visual instance has been a crucial point of departure for the computer-based generative arts. Computer-based Generative Arts is a practice to produce artforms by executing a set of rules in a systematic collaboration between an artist and a computer. Generally speaking, the artist is usually predominant in controlling a creative system to authorize an autonomous generator. The artist explores various alternatives of iterations and a result is finally determined by the evaluation of the artist. According to Boden & Edmonds, generative artworks are developed by some partial action that is not under the artist's direct authority (Boden & Edmonds 2009). Additionally, Galanter provides a comprehensive description of the concept as;

> Generative art refers to any art practice where the artist uses a system, such as a set of natural language rules, a computer program, a machine, or other procedural invention, which is set into motion with some degree of autonomy contributing to or resulting in a completed work of art. (Galanter 2003)

What makes a computer-based generative system so effective is that its generative structure is mainly based on a parametric system. With the help of minor adjustments, the dynamic use of parameters enables one to render numerous alternative representations very quickly. As a consequence of the wide use of computers in creative fields, generative art has become an attractive field of investigation for many artists and computer scientists. People who are involved in creating artworks with computers treated software as a way of artistic expression. Casey Reas, who is widely known as the creator of the Processing programming language with Ben Fry, has been frequently building generative systems to create dynamic and static works of art. He establishes his art projects in the forms of software, prints, and installations. In his artwork series titled "Network A, a.k.a. Process 4", we are observing a repetitive structure that alternates a building element in various size, rotation, color, position and scale parameters. This artwork shares a similar kind of a visual dynamism that shimmers in Balla's Speed of a Motorcycle painting. Adopting an algorithmic system to generate compelling visual forms on a screen, Reas authorizes his software to form abstract environments that unfold glittering harmonies in shapes. He describes the methodology in building his artworks as an emergence from a system and a feedback into it.



Casey Reas - Network A, a.k.a. Process 4 (Installation 2) – Screenshot - 2009

Reas utilizes programming skills to draw computationally complex things that exceed his imagination. One of the tasks where computers outstrip human intelligence is accomplishing repetitive operations quickly. Taking an advantage of this condition, creative programmers frequently apply repetitive, iterative and recursive algorithms to establish generative systems. On another note, Joshua Davis uses the form of spirals to construct an abstract geometry with animating features in his artwork named "the Fatal Impact / Rainbow Hotness".

Joshua Davis - the Fatal Impact / Rainbow Hotness - Screenshot - 2014

Davis also benefits from software to create his compelling artworks with fancy colors. In this motion graphics artwork, multiple geometric shapes are morphing into each other while progressing in random patterns. Perfect circular shapes and their harmonious flow pulls the spectators into a cosmos of whirling spirals. It could be visually inferred that both Davis's "the Fatal Impact" and Reas' "Network A. a.k.a. Process 4" contain strong elements of dynamism in their compositions. Their shared appealing imagery is a result of a progressive development of a software articulated by the artists themselves. Obviously, when compared to the futurists, we observe no scent of unconditional longing for technology or imitation of a technological machinery. Instead, we are able to recognize a high degree of competency in using software skills to merge complex forms with an experimental set of actions. From an aesthetical point of view, futurist art and computer-based generative arts are sharing common figurative abstractions with repetitive juxtapositions. Recursive manipulation of geometric shapes as building blocks results in a proliferation of abstract forms that create an immersive pleasure with dynamic sensations.

CONCLUSION

Futurism art has been influential in many facets of life. Its ideology of denunciation of the past has provided it a radical personality in its discourse. Because of the political climate of the era, the movement did not endure its maturity, but its aesthetical features were survived until today. Today in the age of computers, many artists are implementing computational systems to explore new forms in arts. While analyzing the works of Futurism Art, it becomes evident that some illuminating pathways to today have been established by some artists. Its conceptualization of repetition and the dimension of abstraction is still applied by the computer-based generative artists of today. Both periods are inclined with the technological developments of their day, and like in the case of the Russolo's Intonarumori, the artist takes the active role to build their expressive systems to perform their creative tasks. This paper focuses on exploring the similarities between the Futurist and computer-based generative artistic schemes. With this in mind, a particular list of masterworks has been considered to compare their compositional structures. Inevitably, there could be as many differences as similarities between the two approaches and additional influences from other artistic movements are inescapable. However, this paper aspires to underline the specific resemblances with the inclusion of their appetites for creations.

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The Tacit Dimensions of Design
(Paper)

Topic: (Design)

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Abstract
Most of the countless interactions with physical objects that happen every day flawlessly dissolve in our usual behaviour, so we are hardly aware of these interactions. Brushing teeth, making a phone call, eating, washing our hands, driving a car, riding a bycicle, using public transport, working on a computer, writing texts – the only occasions when one of these interactions surfaces in our conscious awareness is when the interaction is either unexpectedly joyful or when there is an interruption in our intended flow of actions: a bottle seems impossible to open, an automatic door does not slide open as expected, I cannot operate the elevator because I am carrying groceries in both of my hands, buying a ticket at the ticket machine is so complicated or takes so long that I miss my bus. Most of the time the user knows what she is expected to do with certain objects, she can read the Affordances (Norman 1988, Gibson 1973) in her surroundings. But how is this kind of communication possible? How come I seem to understand what things are trying to tell me? In my dissertation I wanted to show on the one hand how these Affordances are designed into objects, on the other hand this concept needs the responding human being to be able to read or perceive what things are able to tell us. Therefore, ways of knowing and forms of (tacit) knowledge are of great interest for these questions. How is knowledge "distributed" between objects and users? And last, but not least, I will discuss the possibilities for and responsibilities of designers, who are able to design that process of „Translation“ (Latour).

The research process drew on the concepts of Grounded Theory (Strauss et al. 1970, 1994). 19 interviews were conducted with designers from London, Vienna, Graz and Salzburg. Complementing this research, I collected observations, short videos and photos of everyday interactions that would help me discuss certain aspects of the phenomenon under investigation. In the end, all the material was once more revisited and processed into a quite unusual shape: a virtual exhibition on "Implizite Vermittlung", taking place in a conceived room enabled me to convey my findings and allows for further insights.

Questioning our everyday interactions is important for designers. However, trying to understand the fundamental mechanisms of how the communication between humans and things actually happens is essential for everyone who is designing in the broadest possible sense of the word. By conceptionally grasping such an intangible but astoundingly common everyday phenomenon, I aim to facilitate fellow designers of all fields with conceptual tools that allow them to better think about, talk about and argue their work.

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Key words: perception and design, interface, Implizite Vermittlung, forms of (tacit) knowledge

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"Implizite Vermittlung"
The Tacit Dimensions of Design

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1. Abstract

Most of the countless interactions with physical objects that happen every day flawlessly dissolve in our usual behaviour, so we are hardly aware of these interactions. Brushing teeth, making a phone call, eating, washing our hands, driving a car, riding a bycicle, using public transport, working on a computer, writing texts – the only occasions when one of these interactions surfaces in our conscious awareness is when the interaction is either unexpectedly joyful or when there is an interruption in our intended flow of actions: a bottle seems impossible to open, an automatic door does not slide open as expected, I cannot operate the elevator because I am carrying groceries in both of my hands, buying a ticket at the ticket machine is so complicated or takes so long that I miss my bus. Most of the time the user knows what she is expected to do with certain objects, she can read the Affordances in her surroundings. But how is this kind of communication possible? How come I seem to understand what things are trying to tell me? In my dissertation I wanted to show on the one hand how these Affordances are designed into objects, on the other hand this concept needs the responding human being to be able to read or perceive what things are able to tell us. Therefore, ways of knowing and forms of (tacit) knowledge are of great interest for these questions. How is knowledge "distributed" between objects and users? And last, but not least, I will discuss the possibilities for and responsibilities of designers, who are able to design that process of „Translation“ (Latour).

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2. Introduction

Questioning our everyday interactions is important for designers. However, trying to understand the fundamental mechanisms of how the communication between humans and things actually happens is essential for everyone who is designing in the broadest possible sense of the word. By conceptionally grasping such an intangible but astoundingly common everyday phenomenon, I aim to facilitate fellow designers of all fields with conceptual tools that allow them to better think about, talk about and argue their work. For this research 19 interviews have been conducted, and countless photographs have been taken so far.

In this talk, I will first introduce Polanyis concept of tacit knowledge and elaborate a little on what it has to tell designers in terms of using tools.

Then I will talk about how I used the metaphor of an exhibition as a method in my dissertation.

And finally, in the third part I will explain the concept of "Implizite Vermittlung", why and how I use the term and how it is different from other concepts that seem to describe similar phenomena, and how it can help designers of all fashion to think about and talk about their work.

3. Research interests

Although there are several ideas around for how to call phenomena like the ones I described before, still there is a bit missing in every single concept, of which I would like to talk about later, because first I would like to list the questions that inspired my work:

The main research question is:

- What is "Implizite Vermittlung", and how is it facilitated by designers?

The three sub-questions are:

- How can you grasp this kind of mediation, "Implizite Vermittllung", conceptually? How does this non-verbal communication between people and things work at all?

- How is this kind of access to knowledge between people and things possible? What kinds of knowledge are involved? (What kinds of body-bound knowledge play a significant role? In which ways are tools used as tools for perception and thinking?)

- How can you find out as a designer the things that cannot be talked about? (Like for example: What would be perceived as a more "elegant" version of the prototype? How can I design this tool so that it can be used intuitively?) How to investigate all which is not accessible on a conscious level, but still is of vital importance for the design process?

4. Tacit Knowledge

I shall introduce this concept along the lines that Michael Polanyi used in his lectures in 1966, when he coined the term "tacit knowledge".

"We can know more than we can tell" is the most famous phrase in Polanyis work, but what it means exactly is of highest interest for designers. I would like to add here already that things have a way of telling us much more than we know to talk about.

It is just like in this title of a book: "Watches Tell More Than Time" – there is a certain image I get of the person I just met, when I ask them what time it is, depending on whether they look at their mobile display, at their wrist or draw out a pocket watch.

4. 1. The two terms of tacit knowing

Polanyi, as mentioned before, "reconsiders human knowledge by starting from the fact that we can know more than we can tell." [4] Tacit knowledge is the basis of all human knowledge and it combines two kinds of knowing. One is specifiably known, you can tell explicitly what you know and the other one stays subconsciously below all levels of speech.

Polanyi calls the first one the *distal term:* it is the thing or the meaning of a thing that we recognize based on other things we are not aware of (The *distal term* is the part of knowing which is conscious and can be talked about). The *proximal term* describes the single features which we rely upon in order to recognize the specific face or concept. (This part is not conscious!)

"Such is the functional relation between the two terms of tacit knowing: we know the first term only by relying on our awareness of it for attending to the second." [5]

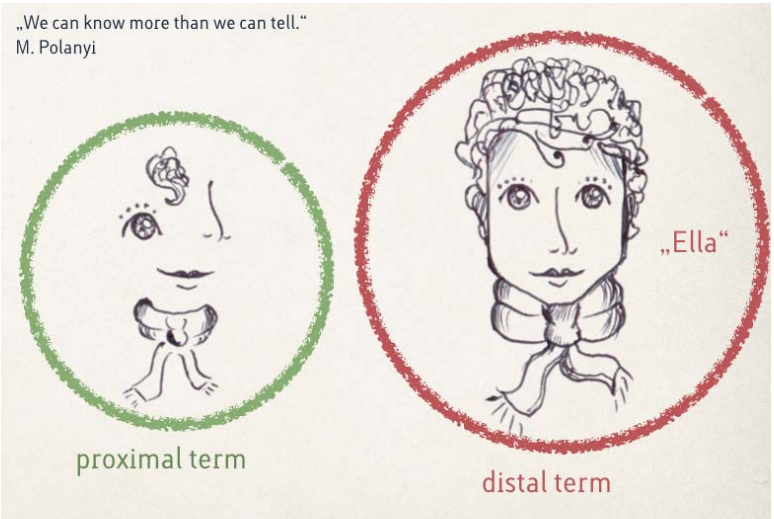


Image 1: Drawing of the relation between the proximal and the distal term of tacit knowledge

Polanyi gives the example of recognizing a face: We know a person´s face and can recognize them among thousands, even millions of other faces. But exactly how we know them we usually cannot put into words. The exact parts of the face by which we know the person are an example of the *proximal term* of tacit knowledge. The *distal term* is the meaning, the recognition of the face or of a certain expression on the face, which we can only grasp by relying on the *proximal term* discussed before. To sum it up: The part that stays subconscious is called the *proximal term* and the part that you can talk about is called the *distal term*.

4. 2. Tools within Polanyis Concept

In Polanyis way of thinking and what he introduces as the two terms of tacit knowing there is an interesting twist for designers when it comes to tools. I will build upon this the concept I call

1. p. 4; Polanyi, Michael (1966): *The Tacit Dimension.* Gloucester, Massachusetts: Peter Smith Publishers
2. p. 12; ibid.

"Implizite Vermittlung".

5. Implizite Vermittlung

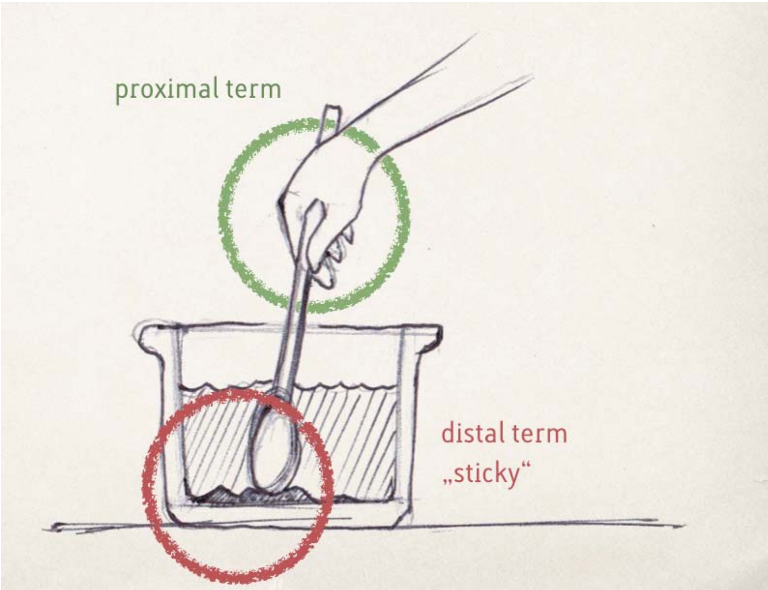


Image 2: Tools within Polanyis concept

When I am stirring a pot of soup, I can "feel" – with the help of a wooden spoon – the consistency of the soup. In this case, Polanyi talks about the "incorporation" of a tool within our body. Whenever we use tools for attending *from* them to other things, like in this case we use the spoon to attend to the consistency, the tools change their appearance. They somehow become a part of our body insofar as they suddenly seem *transparent*. Let me explain – what is striking about this notion of "incorporation" is the following:

What happens when I notice that there is something burnt on the ground of the pot? I can feel the burnt stuff not where the actual sensation is happening – in the palm of my hand, where I grip the spoon and the signals are transmitted to my brain – but I feel it as if I could feel it at the top of the spoon, where (as Polanyi would say) the meaning "solidifys". I actually sense the meaning at the tip of the spoon.

This phenomenon is comparable with the sensation I have when wearing glasses. The glasses become part of my body, I look at the world *through* the glasses as if they were part of my body. Such is the meaning of the term incorporation in Polanyis sense.

Now what designers do is creating, designing most of the "glasses" we look through in order to make sense of the world. Therefore, they are at a pivotal point of creating a view onto the world. Designers are designing how we all handle, treat and manipulate our world. And this is exactly because they design the tools that become quasi "part of our body".

6. Methods: Interviews

The interviews I conducted were a good starting point but only served as a way of refocusing the research interests, in order to reformulate the research questions and getting from original first questions that were more about learning in design to the tacit dimensions and the research questions mentioned above.

7. The Exhibition Metaphor

7. 1. A virtual Exhibition

The whole dissertation is a text in the shape of an exhibition – a conceived exhibition I guide my readers through. There are three rooms, each one dedicated to a certain sub-topic, within the rooms there are exhibits, each of which is a good starting point for the narrative, the "guided tour" through the rooms.

7. 2. room_1

Perception, cognition and creativity happen *with* and *through* the objects and technologies we use. Exhibits in room_1 are all about different forms of knowledge and possible explanations of

phenomena like in this one example of an exhibit in room_1:

Image 3: room_1: Example exhibit – where is the knowledge located?

In case you know how to type very fast, it is no problem for you to easily shape words with your hands and fingers on your keyboard. But if the keyboard were cleaned of all the letters, how long would it take you to re-place them on the keys where they belong? The question that arises here is: Do your fingers know something different than you do? Is the knowledge of "letters-on-keyboard" all the same and is there only a different kind of access to the same knowledge? Or does this exercise show us different kinds of knowing?

Exhibits in room_1 explore how tacit knowledge and design are to be seen in different constellations. The bridge to room_2 leads through "understandable things" and "intuitive usability".

7. 3. room_2

Things tell us more than we can talk about. This room is filled with exhibits that show examples as well as elements of this hypothesis. The narrative way leads from analysable single elements such as color, material, shape via temperature sensations and sound experience to complex situational settings and design research in general. Things "tell us more than words could ever say" and far more immediate than words. As an example exhibit I will present "NID – non intentional design".

Image 4: Examples for "Non-intentional-design"

In the examples above you see a paper cup that is skewered on a fence, in the picture in the middle of the above row you can see how my colleague helped herself to a zipper substitute when it was suddenly broken by using a paper clip. The picture above right shows a kind of hands-free-kit, practically built into the steering wheel. In a train I once saw how a telephone was charged – the problem was that the electrical socket was built into the panel with the ceiling lights and the cable of the charger was to short for charging the phone while it lies on the table or seat. So the clever girl used the coat hangers as a support for the phone while it was charging. In the picture below right I see a musician who makes use of the special acoustics in a subway in London.

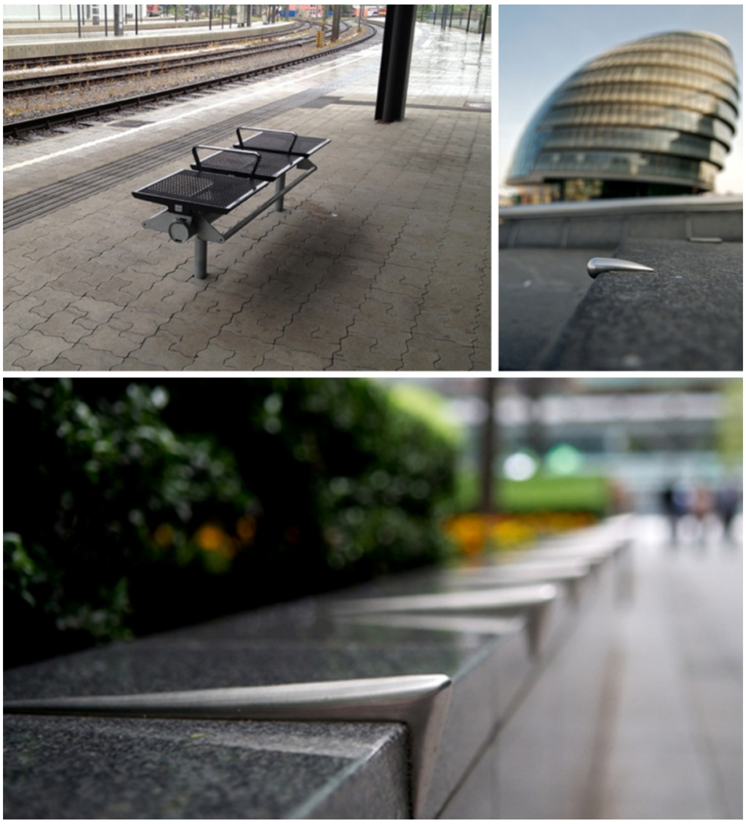
All these "workaround-solutions" show how creative most people are when it comes to substituting one thing with another or fulfilling tasks with whatever material is at hand.

7. 4. Atrium

In the course of the exhibition, after room_2 follows the atrium, where everything about "Implizite Vermittlung" can be found. It is about familiar terms and related concepts, about what is missing in some of the concepts and what needs to be added or combined. In the logic of the exhibition, the atrium comes before the third room, but for the logic of this paper, the atrium will be described after the three rooms.

7. 5. room_3

What is to be seen with all the arguments so far, is that one cannot *not* design. We *can* design things consciously, but in fact we *have to* design them consciously. Everything that has been explained so far leads to the conclusion that our relationship with things is shaped by the things we use and that phenomena such as power relations are built into the objects we use and that in using them, our relationships are shaped in return, just like in Winston Churchill´s famous saying: "First we shape our buildings and afterwards, they shape us." He said that in a speech in 1943 in order to illustrate that when the House of Commons was to be rebuilt after heavy bombing during World War 2 that he was influenced by the shape of the building as it was before it was destroyed. He said that there was a special atmosphere when it was crowded and that there was a special density due to the lack of space in the building.



In the examples below I can see certain orders or even bans integrated into objects.

Image 5: A) bench on a train station, B) benches in front of the Mayor´s building in London, C) seat dividers on the framing of a park in London

In picture A) I see a bench as they are provided on almost every train station in Austria. They are made of metal which makes them very often unpleasant to sit upon, because in winter they can get very cold and when it is summer, they can easily get too hot for sitting on them. Unfortunately, the elbow rests divide the seating area in three parts, which make it difficult for big people to sit on it, and it also makes it impossible for children – let´s say five of them – to share the bench. As for the other two benches in pictures B) and C): the same conditions apply – it is hard to sit there for people of more than average weight and it is quite unpleasant to sit there in the hot sun or on a cold winter´s day. But what is also important: these two benches are prone to be used as skater´s facilities. People with inline-skates or skateboards would probably love to use them as slides, but in fact they cannot – because of these small elements of metal on top of the walls. So we see here a ban built into the environment.

8. Atrium

In the atrium I have collected several concepts which basically adress the same phenomena that I want to describe, but some tiny elements are missing in each one of them or at least need to be combined.

8. 1. Affordances

The psychologist James Jerome Gibson discusses in his 1970s Book [6] *The Ecological Approach to Visual Perception* his concept of *Affordances*. He says: "The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill. The verb to afford is found in the dictionary, the noun affordance is not. I have made it up. I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment." [7] He continues to stress the relationality of affordances, meaning that the deciding part can neither be found in the world nor in the animal alone. Perception, also human perception, is highly relational also in terms of measuring. For example if there is a small river and it is for me to decide whether I am able to jump over it, it would not be of much help if my perception would allow me to tell if the river measures 1,5 or 2 meters exactly. But instead I have a feeling of my own jumping ability, so that I can decide for myself if the river "affords jumping over".

8. 2. Closure

Closure appears in the literature in different meanings, e.g. Trevor Pinch and Wiebe Bijker talk about closure as a stabilisation mechanism of *interpretative flexibility*: as soon as a new invention occurs, different versions of the invention occur which can look very different, but after some time, a certain shape becomes the dominant one – as it was for example with mobile phones before the iPhone occured. After that, smartphones started to appear pretty much in just one shape. That kind of stabilisation is what they call "closure".

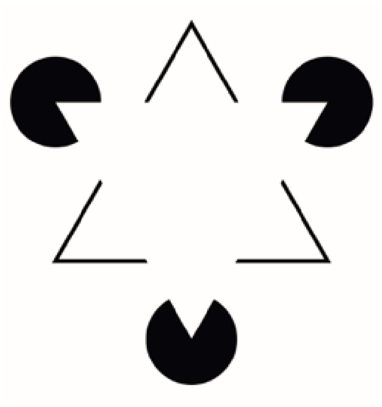


Image 6: Kanisza-Triangle

In gestalt theory, the phenomena of seeing some parts but perceiving a whole is called closure. When you see more than the sum of some parts, closure occured. A famous graphical example by Gaetano Kanisza is his "Kanisza Triangle" which he developed in the 1950s – see image above. The triangle whose tip points downwards can only be seen because the individual fills in the rest of the

3. see: Gibson, James J. (1979): *The Ecological Approach to Visual Perception.* Hillsdale, London: Lawrence Erlbaum Associates.
4. see: ibid.

implied triangle.

8. 3. Interface

Interface is probably one of the most important metaphors in design. Originally derived from the natural sciences it describes the surface where two phases of different states meet, e.g. water in liquid state and air in gaseous condition. The exact surface where these two states of aggregation meet is called "interface". The literal translation into the technical sciences describes the point where two hardware or software components meet: the point of interaction between a printer and my computer for example. But in design roughly the point where user and hardware meet is called an interface. Gui Bonsiepe talked about interface as a central topic of design in the 1990s [8] and described "interface" as a triangled space: He said that there is a "user", or a "social agent" wanting to complete a certain task. Second, there is the "task" at hand, wanting to be executed. And third, there is a "tool" which is used to complete the task at hand. In this described triangle, design interferes. It is important for Bosiepe, that design is not concerned only with the elements of the triangle but with the space that opens up in the middle and what happens there in between the elements.

8. 4. Translation

Bruno Latour describes in a lot of his papers on Actor-Network-Theory the process of "Translation" as a process that allows a network to be represented by a single entity. The process of "Delegation" can be shortly described as what happens when a certain set of actions is delegated to an object. He brings the example of the "sleeping policemen", or "road bumpers" [9]. The desired call to action – in this case: "drive slowly" – is delegated to a non-human actant, in this case a road bumper.

8. 5. Scripts

Very closely related to this concept are "scripts", as Madeleine Akrich calls them [10]. She says that the designer has a certain vision of how an object is going to be used. They kind of describe this vision like a director describes how the single person is going to act in a certain situation. She talks about "inscribing" this vision into objects.

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5. p.14; Bonsiepe, Gui (1994): *Das Interface Im Design-Dreieck.* Hochparterre: Zeitschrift für Architektur und Design, 7|3
6. p. 241: Latour, Bruno (1992): "Where Are the Missing Masses? The Sociology of a Few Mundane Artifacts." *Shaping Technology-Building Society. Studies in Sociotechnical Change*. Eds. Wiebe Bijker, and John Law. Cambridge, Mass.: MIT Press, 225-59.
7. see: Akrich, Madeleine (1992): "The De-Scription of Technical Objects." *Studies in Sociotechnical Change: Shaping Technology/building Society*. Eds. Wiebe E. Bijker, and John Law. Inside Technology. Cambridge, Mass.: MIT Press, 205-224.

Image 7: "Lucerne key" – key to a bathroom in a bookshop in Lucerne

The example above, the "Lucerne key" is an object I encountered in 2015 in a bookshop. When you need to go to the bathroom you are given this key and of course you are expected to return it afterwards. So, like in the example of the hotel keys of Bruno Latour [11] a certain weight is added, so that it would buldge my bag in an unpleasant way if I were to carry it with me accidentally, also the weight itself adds to the likeliness that it will be returned. But there is another special feature about this key: it has a kind of stand-up mechanism, so that the key, when placed on the side of the washbasin, will not get wet.

9. Outcomes

Implizite Vermittlung is

- situated

- immediate

- processual

- relational

By situated I mean that *Implizite Vermittlung* always happens in a situation and can hardly be described on its own. By immediate I refer to the effects of *Implizite Vermittlung*, for example how a loud sound signal like a siren affects me, there is no way for me to not get the meaning (as long as I can hear at all). By processual I mean that all important knowledge is embedded in processes, for example in certain scripts like how to use a rotary-dial telephone. Relational means that the important elements of *Implizite Vermittlung* can neither be found in the person or the object alone. Just like when a violinist and a violin meet – the music happens through both of them, not just one of the elements would suffice to describe the magic.

I´d like to end with words of the australian design researcher and philosopher Cameron Tonkinwise: "Whether they are conscious of it or not, designers do have the power to influence how people relate to things. Design semantics constrain, map and afford not just the instrumental use of what is designed, but how the designed is perceived and valued. Designers can, do and should design

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8. see: Latour, Bruno (1991): “Technology is Society Made Durable.” *A Sociology of Monsters Essays on Power, Technology and Domination*. Ed. John Law. Sociological Review Monograph N°38. Wiley Online Library, 103-132.

patterns of behaviour like rituals of care. They cannot design these in the way they specify materials and components, but they do, every time they design, emphasise, promote, and foster certain practical dispositions toward what they have designed." [12]

9. p. 76; Tonkinwise, Cameron (2003) "Beauty-in-use." *Design Philosophy Papers* 1.2: 73-82.

TITLE
Quipus, computation and generative grammars

Topic:
Generative art, computation, history

Author(s):
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Perú, Universidad de Lima, Faculty of Communication

Abstract
Quipus are systems of cables and knots of different forms and colours used hundreds of years ago by prehispanic Peruvian cultures as information systems, data storage and to perform some kind of mathematical operations. Some authors also consider the *quipu* as a writing systems, used to register poems and important social and military events.
Quipus have been widely studied, but how they exactly work is not completely understood.
One of the most important essays about *quipus* is Raimondo di Sangro's *Lettera Apologetica*, published in Naples in 1784. Based on contemporary evidences and historical documents, this book is an interesting hypothetical interpretation of *quipus* as computation and writing.
But this work does not receive, in digital art and computer science, the interest it deserves. Its generative potential is still undiscovered, even if the research of di Sangro do offer interesting historical knowledge on computational processes, such as data structures, and original insights on writing and generative grammars. The 17^{th} century Italian syntaxes and the baroque literary style of di Sangro certainly jeopardize the comprehension and evaluation of his theories.
So far, the goal of this paper is, in the first place, to present, in a clear and schematic way, the interpretation of *quipus* of this Neapolitan alchemist and inventor in the scope of generative art and generative grammars; in the second place, to test and verify its linguistic and computational capabilities, compared with other writing systems of ancient Peru, like *tokapus* and knot textiles.
First, I will explain what *quipus* are, considering state of the art new research on the topic. Then I will analyse and explain Raimondo di Sangro's hypothesis. Third, I will show how his ideas could be used to refine some generative processes and how *quipus* could be used to inspire digital creativity. Finally, I will present, as hypothesis for future research, examples of hypothetical computational techniques based on di Sangro's *quipus*.
This paper can provide scholars, programmers and generative artists some valuable historical references and material for future research.

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Key words: quipus, generative grammars, computation, history

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Quipus, computation and generative grammars

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Abstract

Quipus are collections of ropes with knots of different forms and colours used by pre-Hispanic Peruvian cultures as information systems, data storage devices and to perform mathematical operations. *Quipus* have been widely studied, and some scholars even consider *quipus* writing systems, capable of recording poems or social events. Nevertheless, we still do not know for sure how they were operated. In this sense, one of the most important essays about *quipus* is Raimondo di Sangro's *Lettera Apologetica*, published in Naples in 1784. Based on contemporary evidences and documents, this book is an interesting hypothetical interpretation of *quipus* that does not receive, in computer science and generative art, the interest it deserves, even if it clearly offers original insights on computational processes, data structures and generative grammars. So far, the goal of this paper is, in the first place, to present, in a clear and schematic way, the interpretation of *quipus* of this Neapolitan alchemist and inventor in the scope of generative art; in the second place, to test and verify its linguistic and computational capabilities. First, considering the state of the art research on the topic, I will describe what *quipus* are. Then I will explain and evaluate Raimondo di Sangro's hypothesis. Third, I will show how *quipus* could be compared to modern computational techniques and data structures. Finally, I will suggest creative recursive generative processes based on di Sangro's linguistic application of *quipus*. The conclusions of this paper can provide scholars, programmers and generative artists not only with some valuable historical references and material for future research, but also with some new creative approaches to generative art.

Introduction

The importance of cultural traditions in information technologies and computer science is often underestimated. Programmers are focused on practical problems (efficiency, speed, reliability, etc.) of digital media, while social sciences scholars consider only its impact overlooking the cognitive influence of computational processes (algorithms and interfaces) on the users.

However, considering the complex structure of software, it should be obvious that digital applications are culturally biased on philosophical, scientific and historical facts. Software are *texts*, in the sense defined by Barthes [9] and *archi-writing* in the sense of Derrida [1]. For instance, reckoning its empiricist and positivist roots, computer science is clearly an Anglo-Saxon heritage [7].

Such cultural values outline the form of computational processes, algorithms and interface designs globally distributed by internet. The outskirts of technological development (like Peru) suffer a sort of new colonialism and we can safely speak of silencing the subaltern [15]. The consequence of all this is digital divide, in other words, that possible contributions to digital media are limited by these biases and that a huge capital of knowledge is left behind [3, 4]. Digital technology is a double–edged weapon.

For these reasons, it is paramount to evaluate the links between cultural traditions, computation and digital divide. Not in the sense that cultural traditions are barriers to digital technology development, but because development should be culturally sustainable and stimulated by the

tradition itself. One interesting topic here is the computational value of pre-Columbian artefacts. *Quipus*, which use spread all over the Andes from Ecuador to Chile, are an excellent case of study.
Thus, this paper has two goals. First, to resume, in a clear and schematic way, the interpretation of *quipus* of the Neapolitan alchemist and inventor Raimondo di Sangro, prince of San Severo [5]. In the second place, to test and verify its linguistic and computational capabilities, an option sustained by other writing systems of ancient Peru, like *tokapus* and knot textiles [10, 17].The knowledge we can acquire from *Lettera apologetica* is, as I hope to prove, of the greatest interest for generative art and shape grammars.
To succeed, I will start explaining what *quipus* are, considering state of the art new research on the topic. Then I will analyse and discuss Raimondo di Sangro's hypothesis about *quipus* as writing systems. Finally, I will show how his ideas and *quipus* could inspire digital creativity and refine generative processes, such as generative grammars and L-Systems.

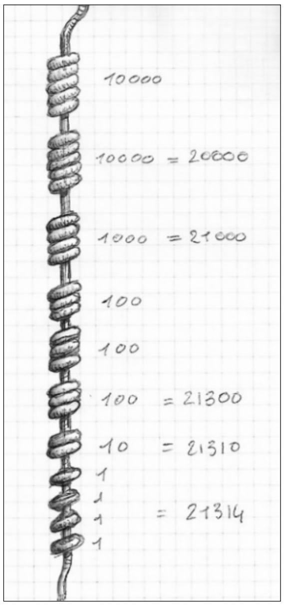
Quipus

Quipus are collections of wool ropes with knots of different shapes and colours, sequentially joined along a main cable. A *quipu* could hold even hundreds of knots sequences, forming huge artefacts of many pounds of weight. Prince di Sangro's analysis of *quipus* is the first attempt to understand these ancient Peruvian artefacts and still is the main reference for contemporary research (8, 13).


Fig. 1a: Quipu. (https://hidraulicainca.com). Fig. 1b: Quipu. (http://www.torontohispano.com)

His interpretation was grounded upon Blas Valera and Poma de Ayala original documents[13] and, even if the real usage of *quipus* is not completely understood, it is obvious that these knotted ropes were used by public administrators as computational systems to register agricultural production data and commercial transactions.

[13] Blas Valera Pérez (1545 - 1597) was a priest, scholar and historian. Felipe Huamán Poma de Ayala (1534 - 1615), was a peruvian chronicler during the Virreinato.



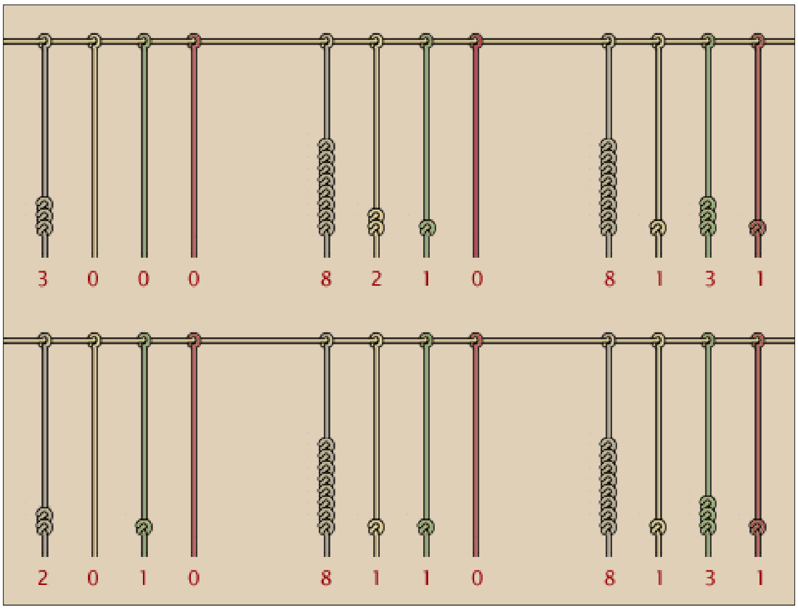


Fig. 2a. Copy by the author of the original di Sangro's illustration, explaining the record of the number 2314. Fig. 2b. Actual interpretation (Urton, 2014). The position of each knot represents the index, and the number of knots represents the numerical value.

However, following the primordial work of di Sangro, scholars generally accept not only that *quipus* were information systems, but also that these artefacts were a sort of writing system to register historical events and poems [2, 6, 8, 12][14].
Anyway, the field is open to further research. My contribution here is to expound di Sangro's interpretation (since the original text is quite difficult to understand and no translations are available) and to suggest how his theories could be used to experiment new generative techniques and algorithms.

The Lettera Apologetica: data and words

The most interesting part of di Sangro's work is his hypothesis of *quipus* as writing systems and the analysis of their linguistic advantages. It is important to reckon that the book of di Sangro is not a scientific research, but part an imaginary interpretation of contemporary evidences and part a work of fantasy and linguistic creativity. He even thought that *quipus* could be a better way to encode numbers and letters than our Latin and Arabic notations[15].
Ancient Peruvians possibly wrote words and sentences, following di Sangro, using a set of primary words (axioms, in L-Systems' jargon)[16] to generate new words, using primary words' specific set of syllables. Special icons or ornaments, like golden disks, small painted arcs and other jewelry designs, inserted at the beginning of the knots' string (fig. 3), identified each primary words and made possible the identification of the correct set of syllables and finally, the correct understanding of the new word.

[14] "*In 2015, I examined two khipus preserved by village authorities in Peru. Villagers state that these sacred khipus are narratives epistles about warfare. Analysis reveals that the khipus contain 95 different symbols, a quantity within the range of logo syllabic writing*" [6]. This cite makes reference to the *quipus* of Collata, probably written by local leaders during the rebellion of Inka Yupanki in 1783.
[15] We must consider that science still was intertwined with magic, alchemy, and superstition. Anyway, there is evidence in a book of Blás Valera, who reported an ancient poem wrote in *quipus*.
[16] In the sense that the noun axiom has in generative grammars, shape grammars and L-Systems, say, the starting symbol or symbols from which the substitution process begins.

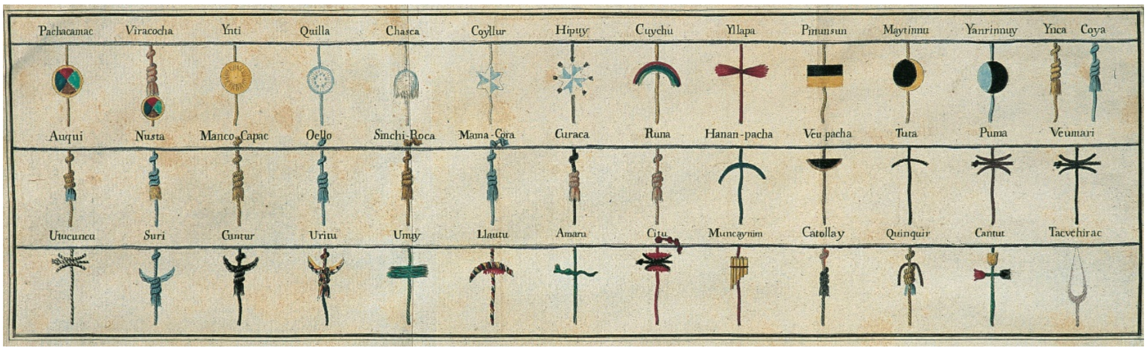


Fig. 3. Original illustration of di Sangro, showing primary words and their icons.

In figure 4 I made a map of the primary words (the axioms) imagined by di Sangro, and example of how new words could be formed using the syllables extracted from these primary words.

	PRIMARY WORDS	MEANING	SYLLABLES				#
1	PACHACAMAC	God, creator of universe	PA	CHA	CA	MAC	4
2	VIRACOCHA	God, human form	VI	RA	CO	CHA	3
3	YNTI	Sun	YN	TI			2
4	QUILLA	Moon	QUI	LLA			2
5	CHASCA	Venus	CHA	SCA			1
6	COYLLUR	Star	COY	LLUR			2
7	HIPUY	Comet	HI	PUY			2
8	CUYCHU	Rainbow	CUY	CHU			2
9	YLLAPA	Ray	YLLA	PA			1
10	PINUNSUN	Equinox	PI	NUN	SUN		3
11	MAYTIÑU	Sun eclipse	MAY	TI	ÑU		3
12	YANRIÑUY	Moon eclipse	YAN	RI	ÑUY		3
13	YNCA	King	YN	CA			1
14	COYA	Queen	COY	YA			2
15	AUQUI	Prince	AU	QUI			2
16	NUSTA	Princess	UN	STA			2
17	MANCO CAPAC	First Inca	MAN	CO	CA	PAC	3
18	OELLO	First Queen	OE	LLO			2
19	SINCHI ROCA	Second Inca	SIN	CHI	RO	CA	3
20	MAMA CORA	Second Queen	MA	MA	CO	RA	2
21	CURACA	Feudatory, noble	CU	RA	CA		1
22	RUNA	Man	RU	NA			2
23	HANAN PACHA	Sky	HA	NAN	PA	CHA	2
24	VEU PACHA	Hell	VEU	PA	CHA		1
25	TUTA	Night	TU	TA			2
26	PUMA	Lion	PU	MA			1
27	VEUMARI	Bear	VEU	MA	RI		0
28	UTUTUNCU	Tiger, (jaguar, otorongo)	U	TU	TUN	CU	2
29	SURI	Ostrich	SU	RI			1
30	CUNTUR	Condor	CUN	TUR			2
31	URITU	Parrot	U	RI	TUN		0
32	UNUY	Water	U	NUY			1
33	LLAUTU	Colored braid	LLA	U	TUN		0
34	AMARU	Snake	A	MA	RU		2
35	CITU	Sun honoring	CI	TU			1
36	MUNCAYNIM	Pan flute	MUN	CAY	NIM		3
37	CATOLLAY	Duel	CA	TO	LLAY		2
38	QUINQUIR	Student dress	QUIN	QUIR			2
39	CANTUT	Cantuta, flower	CAN	TUT			2
40	TACVEHIRAC	Sling	TAC	VE	HI	RAC	4
					TOT. SILABAS		76

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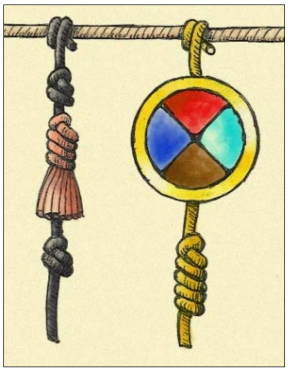
PRIMARY WORDS	SYLLABLES			
CURACA	CU	RA	CA	
PACHACAMAC	PA	CHA	CA	MAC
NUSTA				
	CU MAC NUSTA			
CATOLLAY	CA	TO	LLAY	
MAMA CORA	MA	MA	CO	RA
QUINQUIR	QUIN	QUIR		
	TORALLAY QUIN			
HIPUY	HI	PUY		
YANRIÑUY	YAN	RI	ÑUY	
QUILLA	QUI	LLA		
TUTA	TU	TA		
	PUYÑUY QUITA			
YLLAPA	YLLA	PA		
QUINQUIR	QUIN	QUIR		
CURACA	CU	RA	CA	
YANRIÑUY	YAN	RI	ÑUY	
	PAQUIR CAYAN			

Fig.4 Primary words, English meaning, syllables and part of the poem studied by di Sangro.

To write a word, first the writer must insert the symbol of the primary word. Then he must identify which portion (syllable) of the primary word will be used. For example, the primary word could be ***PACHACAMAC,*** represented by di Sangro with a golden disk divided into four sectors of different colors (fig. 3, 5a). To do this, the writer must insert a knot which form corresponds to the position of the syllable in the primary word: a simple knot for the first part/syllable, double knots for the second part, etc., as shown in fig. 5b.



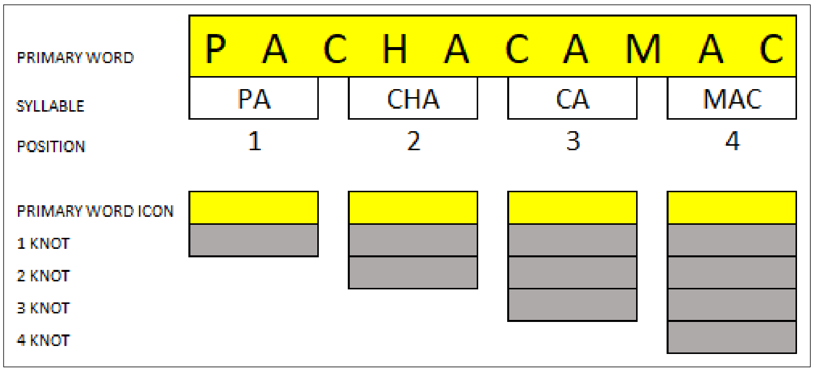


Fig. 5a. The designs of the primary words CURACA and PACHACAMAC (illustration of the author from the original of RdS). Fig 5b. Scheme of knots and syllable positions of the word PACHACAMAC.

Now, to form a new word, for example the word ***CUMAC*** as in di Sangro's example (fig. 4), you must use the firs part of the primary word ***CU**RACA*, and the fourth part of the primary word ***PACHACAMAC***.

Note that this literary interpretation of *quipus*, most an invention of di Sangro, certainly was the first attempt to find its meaning and practical usage in contemporary culture.

Quipus and alphabets

In this paragraph, I will explain how di Sangro encoded letters and numbers, using the knot system of the *quipus*, for the construction of new words and complete utterances in Italian or others European idioms. This is absolutely a product of the fantasy and creativity of our Neapolitan prince, it is not how *quipus* were used, but here we find the most interesting contribution to generative linguistic models.

The first problem is how to encode the vowels. Di Sangro's solution is to use a knot of a specific color for each vowel. He suggested to choose a color which name first letter corresponds (more or less, I should say) to the vowel, considering that the language of reference is Italian:

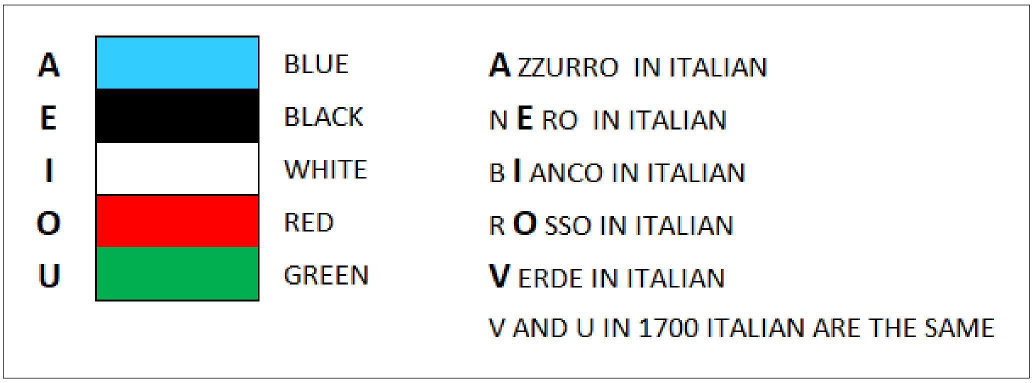
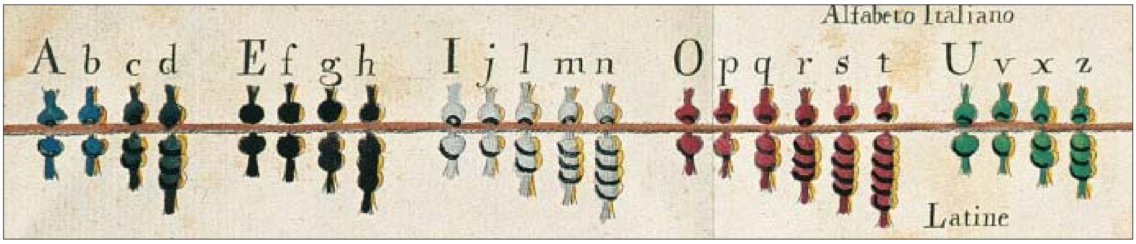


Fig. 6. Map of the match of colors, colors names and vowels.

On the other hand, consonants are identified and mapped using vowels as reference. Consonants, in other words, are grouped following their precedent vowel: "b,c,d" follow the vocal "a", "f,g,h" the vowel "e", and so on. The vowel that begins the consonant series is called the dominant. So "a" is the dominant of "b,c,d". Consonants are also represented with knots, which number depends from its distance from the dominant vowel (the bigger the farer they are from the dominant).



Dominant		Consonants	Distance from the vocal
a	>>	b c d	(b) 1 (c) 2 (d) 3
e	>>	f g h	(f) 1 (g) 2 (h) 3
i	>>	l m n	(l) 1 (m) 2 (n) 3
o	>>	p q r s t	(p) 1 (q) 2 (r) 3 (s) 4 (t) 5
u	>>	v x z	(v) 1 (x) 2 (z) 3

Fig. 7a. Scan of Raimondo di Sangros' original illustration. Fig.7b table of vowel-consonants.

Consonants' colors are the same of their dominants, but, to avoid confusion between them, the string of the knots of the consonants should be crafted using a string of the color of the dominant plus a yellow string (yellow also represents the color of empty space between letters or words). The following illustration is an example of a word using di Sangro's method:

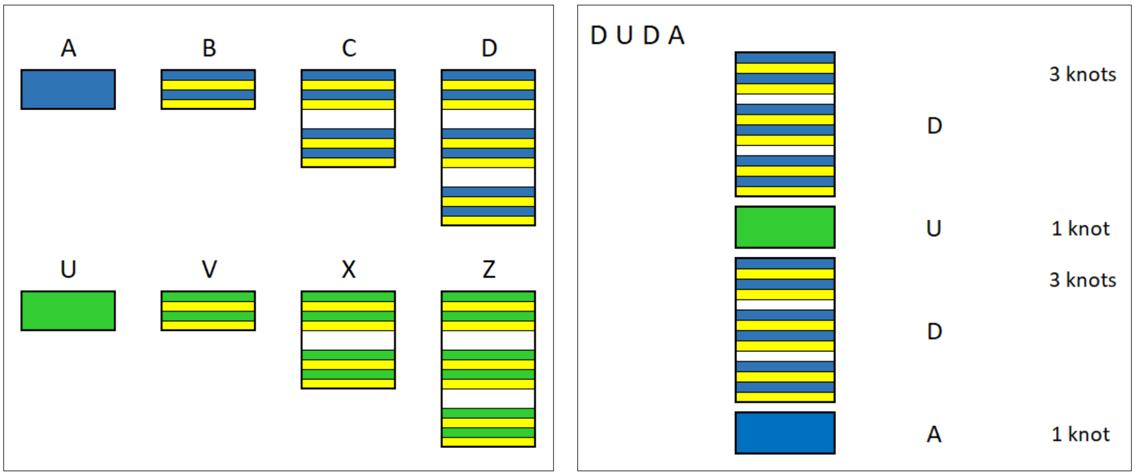


Fig. 8. Map of the consonants representation and a sample word (DUDA, meaning doubt) using the system of di Sangro.

Quipus, memory palaces and data structures

After this, I will try to test di Sangro's notation system from the computational point of view. The goal is to probe if the system can be of some utility for programming and generative grammars. In the first place, *quipus* and di Sangro's work can provide interesting algorithms or techniques for data and data structures. *Quipus* are certainly related with memory palaces, mnemonic tricks used in ancient Greece and Rome that were very popular in the Renaissance[17].

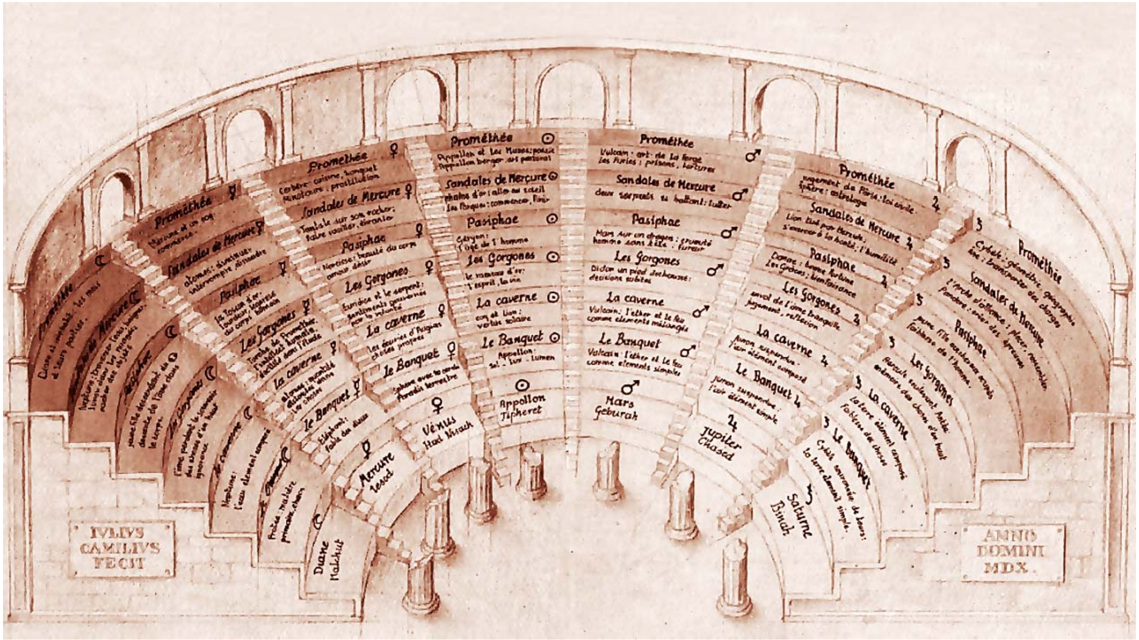


Fig. 9a. Giulio Camillo's memory theater, 1550. https://wsimag.com/culture.

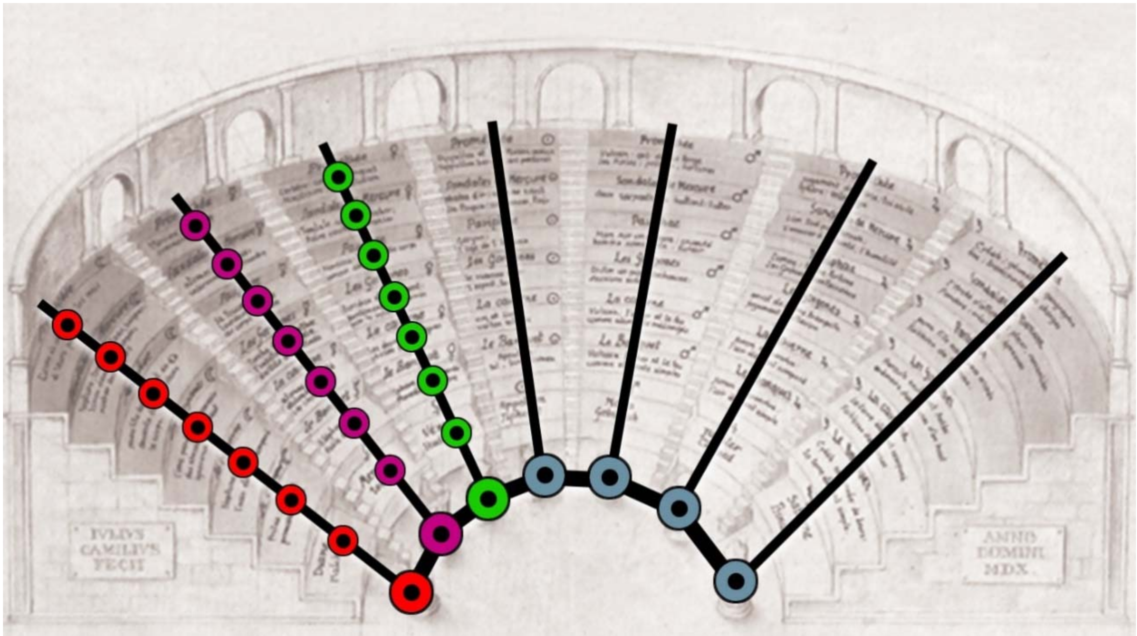


Fig. 9b. Giulio Camillo's memory theater and *quipu.*

The picture of Giulio Camillo's theater of memory shows clearly the relationship between *quipus* and the parts of the structure of theater used to link data: the inner circle is where the stairs begins, such as in *quipus* the main string is the point where are attached the strings, and the steps are the knots (fig. 9a and fig. 9b). Nowadays, we do not need memory palaces, since computer

[17] Thanks to humanists like Matteo Ricci. Memory palaces are mental architectures in which imaginary rooms we stores data and information. The relationship with the different rooms helps to strength links in our memory. Palaces and theaters of memory are similar to ancient Hindu systems like Melakarta, used to visualize notes and musical scales.

memory is a memory palace, whose locations we access using variables and pointers. The CPU does this work for us.
Nevertheless, di Sangros's system can teach something about data structures. For example, each *quipus*' string is clearly a sort of linked list, a data structure well known in computer science[18]. There is a similar logic shared by the knots of a *quipu*'s string and the nodes and pointers of a linked list.

DOMINANT A	NEXT DOMINANT	1 CONSONANT	2 CONSONANT	3 CONSONANT	DOMINANT E	NEXT DOMINANT	1 CONSONANT	2 CONSONANT	3 CONSONANT
	E	b	c	d		I	f	g	h

Fig. 10. The dominant-consonant positional system of letters using *quipus*, implementing RdS hypothesis. The links can be changed using context grammars, for instance, to select to jump to the following dominant or to one of the consonants.

We can validate the logic behind *quipus* by comparison with notation systems and code not only from Greece and Rome, but also from medieval Hindu mathematicians and scholars, like the musical charts of *Melakarta*.

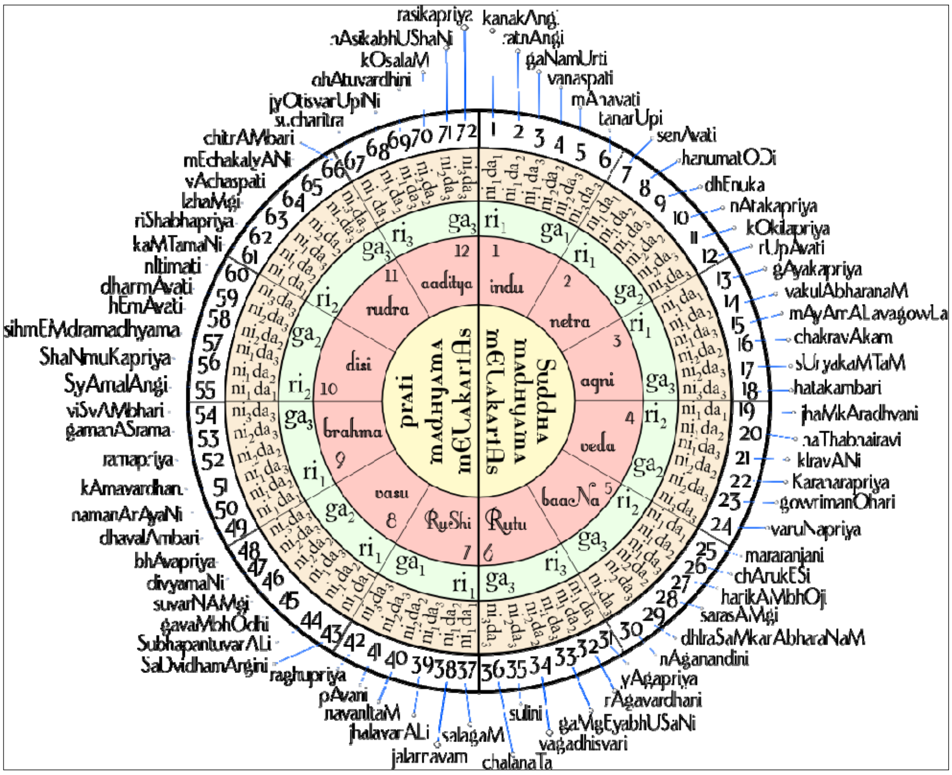


Fig. 11. *Melakarta* diagram.

Quipus and generative grammars

However, in the scope of programming and generative art, the work of di Sangro is a lot more interesting. For instance, his system can help to improve the representation of the structure of classes, methods and properties in object -oriented programming languages, such as ULM. Very often code is too difficult to understand, and this is especially true in the case of generative software.

[18] A linked List is a sequence of links, which contains items. Each link contains a connection to another link. Linked list is the second most-used data structure after array.

Besides, di Sangro's notation could help to generate coherent rule systems, to make substitution processes simpler and, at the same time, with more complex results. We all know that Shape Grammars and L-Systems are essentially based on rules. Therefore, the complexity and inventiveness of generative designs depends strongly on rules' logic and the tools to edit, change and interact with the rule system [14]. In addition, we must not overlook the problem of the interface, since complex and original sets of rules could make the programming of recursive systems very difficult. In this paragraph I will enumerate some of *quipus*' computational possibilities and advantages.

Substitution of groups of symbols in parameterized L-Systems

In L-Systems, symbols are usually substituted one by one. But following di Sangro's notation, groups of letters provide an alternative notation to single character substitution. Rules can be applied to groups of symbols, and this makes also possible to reduce the quantity of rules: for instance, we could create a large single rule (that acts as primary word) and select parts of it using context, grammars, predecessors and successors (previous and following symbols). We could select a rule reading a predecessor of distance 1, distance 2 or distance n from the starting symbol of the selected primary word. This distance is obviously a parameter. Complex forms can be subdivided in smaller parts using different symbols, and the selecting the part that correspond to a specific distance in the primary word. This improves the control of self-similarity of forms. The technique is pretty simple. Suppose to write a complex rule for symbol a using 3 symbols, a, b, c (it does not matter what the rule actually means):

a = ***bbbP<bbYcccccXddd***

This rule can be divided into 3 parts, like a primary word of di Sangro:

Part 1: ***bbbP<bb*** Part 2: ***Ycccccc*** Part 3: ***Xddd***

So if we want to use one of these parts of the rule, or all of it, we can analyze the string to be processed, or axiom "bacada" and get the predecessors of the 3 instances of symbol "a", that is "b" for the first "a", "c", for the second "a" y "d" for the third "a". The predecessor identifies which part of the rule to use:

Axiom	instance 1, pred. b	instance 2, pred. c	instance 3, pred. d
bacada	a(b)= ***bbbP<bb***	a(c)= ***Ycccccc***	a(d)= ***Xddd***

So the result will be:

b bbbP<bb c Ycccccc d Xddd

This approach has more benefits: increasing rules complexity also improves the recursive process' control and the creative possibilities of the generative grammar[19].

Quipus and generative grammars interfaces

As already said, the main problem of any recursive process is that is tricky to control and monitor along its development. Moreover, a weak interactivity causes predictability and repetition (albeit you use pseudo random numbers) and creativity is jeopardized. For this reason, shape grammars and L-Systems are not really user friendly. A new challenge is to design and edit a set of complex

[19] These improvements include new algorithms and symbolic notations for special L-Systems techniques. For more details on this subject see my contribution to the Generative Art Conference in 2016 [14].

rules that change over time and must be modified during the process.
That's why the goal of this research is to develop manipulation and editing of shape grammars and L-Systems in more flexible ways. Considering the problem of visual representation of rules and functions in L-Systems or shape grammars applications, *quipus* are interesting because its textile metaphor can be translated in GUI designs, to make the manipulation of symbols and rules more intuitive.

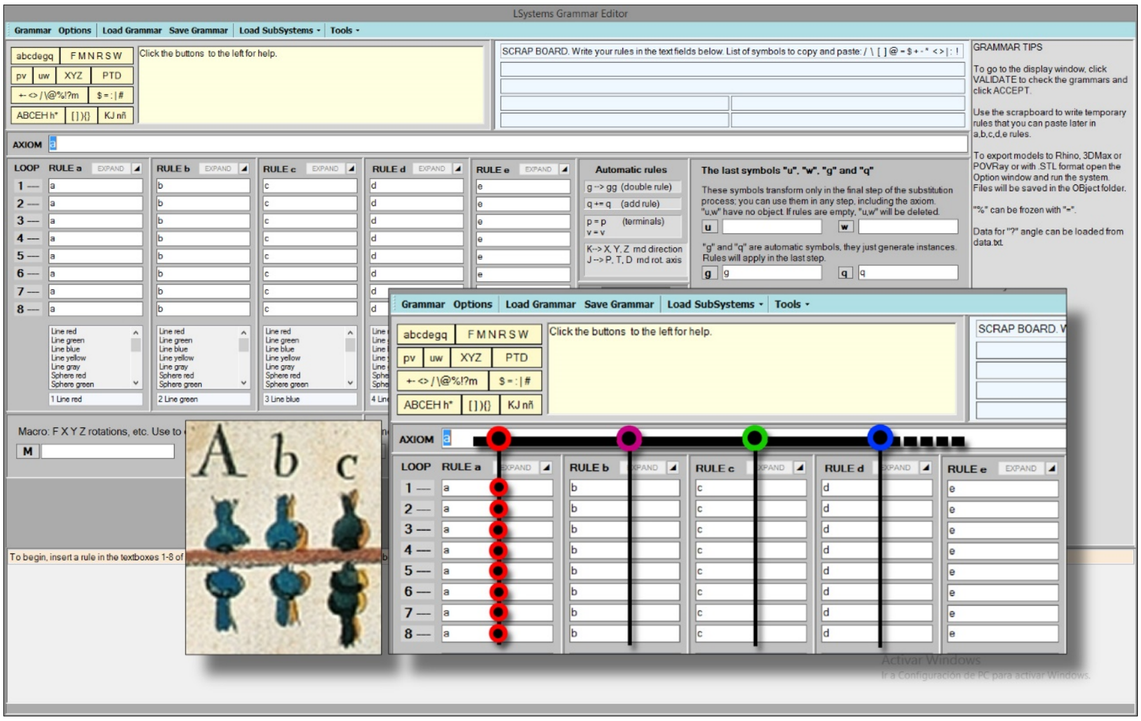


Fig. 12. Detail of di Sangro's illustration, and interface of my L-System generator (free download from http://www.digitalpoiesis.org)

As you can see in fig. 12, from symbols "a,b,c" depart sequences of rules, whose distance from the symbol (the dominant, in RdS solution) identify not only the rule, but the level of the recursive process in which it will be applied.
It is also possible to repeat a rule n times (look at the column "LOOP" to the left of fig. 12) and this is like *quipus*' knots, whose complications have a numerical meaning: 1 complication = 1 step/loop, 2 complications = 2 steps/loops, and so on (fig. 2a).

Conclusions

In this paper I made a synthesis of parts of the di Sangro's eighteenth century book *Lettera apologetica*, about the characteristics of *quipus* and its alfanumerical codification as a writing system. Di Sangro's and contemporary studies about *quipus* are still hypothesis to be confirmed by further research. In fact, the comparison between *quipus*, *mnemotechnics* and contemporary computational data structures shows that the ideas of di Sangro deserve the effort.
In this paper I tried to elucidate the analysis of di Sangro, since the book is quite complicated to read; plus, considering that no translations in English or Spanish are available, I hope that my resume could help scholars, programmers and artists comprehend how *quipus* could work or could be used for art and programming. To support this, I worked on to cases: rule design in L-Systems and interface design for Shape Grammars and L-Systems applications.
Finally, it is important to mention that other old Peruvian artifacts could be of computational interest. For instance, knots textiles [10] and *tokapus* [18], complex textile patterns that were probably a sort of communication code.

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Exploring Artistic Multi-Agents Systems
(Paper)

Topic: Computational Art

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Abstract

This paper discusses the use of multi-agent systems concept for artistic creation. While single agent systems have been explored in different artworks, the design of multi-agent systems provides some new interesting design questions. We describe the conception and development of the system used in the audio-visual performance Multiple Realities. In this artwork, images and sounds are generated in real time through dynamical systems that control and evolve virtual organisms. We discuss the issues surrounding interaction design, agency, and system feedback.

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Key words: generative art, dynamical system, virtual reality

Main References:

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Exploring Artistic Multi-Agent Systems

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Abstract

This paper discusses the use of multi-agent dynamical systems for artistic creation. While single agent systems have been explored in different ways, the design of multi-agent systems provides some new interesting design opportunities. We describe the conception and development of the system used in the audio-visual performance Multiple Realities. In this artwork, images and sounds are generated in real time through agents controlled by dynamical systems. We discuss the trade-offs related to design flexibility and emergent characteristics.

1. Introduction

Generative techniques have been used to create musical compositions, images, and other visual elements. By using them, artists give up some direct control of the final result to a system. The system itself may be seen as an agent, since it executes actions that create the artwork on behalf of the artist. Agents normally exhibit some level of autonomy and awareness of their environment; however, their level of perceived intelligence can vary.

An agent can perform complex tasks by making use of knowledge about state of the environment where the task happens. For example, a painting robot can keep track of what has already been painted to avoid painting one object over another. If more than one agent is involved in a task, not only knowledge about the environment is necessary but also shared information about goals and internal models. The lack of complete information, however, can lead to interesting opportunities for creativity. One example is the *cadavre exquis* technique, in which collaborators draw in a folded piece of paper without seeing the whole picture. The result from this method is often nonsensical drawings, that bind together parts in unexpected ways. That was viewed by surrealists as Simone Kahn and André Breton as a way to break out from an ordinary mode of thinking. As Kahn writes: “the game became a system, a method of research, a means of exaltation as well as stimulation, and even, perhaps, a kind of drug”.

In this paper, we explore how we can increase the creative potential of simple agents by combining them together to create a single artefact. We describe the system developed for the audiovisual performance Multiple Realities, which uses dynamical systems as agent models.

2. Related Work

Previous work has looked into human-robot collaboration and also into systems with multiple components. Burkovski et al. present a robotic platform for collaborative painting [1]. In this system, several users can remotely control a painting robot by moving smartphones for 10 seconds. Each user is assigned a single axis of the robot arm and the final motion is a result of the sum of the individual joint movements. In this project, the robot is just a passive tool, however, the composition step is similar to our proposition since there is no central coordination mechanism.

The Game of Life [7] is a cellular automata that takes place in a grid in which each cell can be dead or alive. From a given grid configuration, the next generation can be obtained by following two rules: 1) if a cell is alive and it has two or three adjacent neighbour cells alive, it stays alive. Otherwise it dies. 2) if a cell is dead and it has exactly three alive neighbours, it becomes alive. Cellular automata like this have been used for algorithmic composition, after a careful specification of the rules, evolution of the system, and mapping of state behaviours to music parameters [9].

Depending on how the output of the automata is used, it can be viewed either as multiple agents (each cell) coordinating through the medium, or as a single agent composed by cells. In spite of the simple rules, the game can generate complex behaviours such as oscillators and patterns that move throughout the grid. These patterns maintain their organization within the grid by self-producing their components (e.g., a glider consists of 5 live cells in a particular configuration). From a cybernetic perspective, these are characteristics that can be ascribed to living organisms [8].

The dynamical hypothesis of cognition regards it as the result of the evolution of a system in the space-state [2]. Interestingly, connectionist systems often mentioned in the context of intelligent agents, can also be viewed as a realization of a dynamical system. In this case, we view the trained network as one specific configuration of the "activation space" that leads to the problem solution [3]. Self-organization can also appear when ensembles of dynamical systems are coupled through short range interactions. This configuration has been used to investigate emergence from primordial soups of large macromolecules [10, 11] and has been linked to the origin of inference capabilities [11]. This is similar to the strategy we present here.

The connection between the agent behaviour complexity and the quality of production is more evident in the problem of music composition. An interesting music is neither completely predictable nor completely random [4, 5]. One way to ensure that a composition fits within those limits, is to evolve populations of parameters and perform selection based on how close the features of an individual are to the desired style (Differential Evolution). Kaliaktsos et al. present an analysis of the fitness of different dynamical systems to support music composition [6]. Several iterative maps were used as tone generators, fitted to rhythmic patterns of target pieces, and optimized using differential evolution. The reconstructed space-state of the target pieces (Bach, Mozart, Beethoven, and general jazz) incorporated many dimensions, indicating that dynamical systems to generate them should also have a large number of dimensions as well. In our work, instead of using a high dimensional dynamical system, we use several unidimensional ones interacting with each other as agents.

3. Exploring Multi-Agent Systems

The system developed for the Multiple Realities performance combines the ideas previously discussed to create an audio-visual experience. It consists of three components: a generative director, a visual generator, and an audio generator. The system can be configured in real-time or in the beginning of each performance (if desired) to yield unique experiences.

2.1 Generative Director

The role of the Director is to orchestrate the different visual elements of the performance and drive the corresponding musical composition. It consists of several agents controlled by independent dynamical systems running in parallel. Although it is treated as one component, each agent is independent and there is no central coordination mechanism. Each agent has a single numeric output that can be connected to a pre-defined visual parameter (for example, scale) or to an audio parameter (frequency or duration).

The agents exist and move in 3D space. In every time step, the agents move close to another agent within the visibility radius. If they get too close, they slowly move apart until a predefined separation distance is reached. Agents also grow and pulsate following the internal evolution of the dynamical system. When an agent gets in contact with another, there is a 50% chance that a cross-over will happen, effectively switching the parameters of involved dynamical systems. This causes each agent to move to a different part of the state-space and potentially initiate other exchanges. Similar to a cellular automaton, some configurations can generate stable oscillatory patterns (Figure 1).

Our system is not completely offline and was designed to be manipulated by a human performer. Using a virtual reality interface, the performer can move agents to new positions in 3D space. This changes the connection topology, allowing new patterns emerge. If an agent is placed outside the visibility radius, it will evolve without interference. Agents in close proximity will change the state more often, leading to synchronized patterns and smaller periods. Human interaction is possible but not necessary: if left alone, the system will evolve by itself. Figure *3* shows how agents can be distributed and move through space.

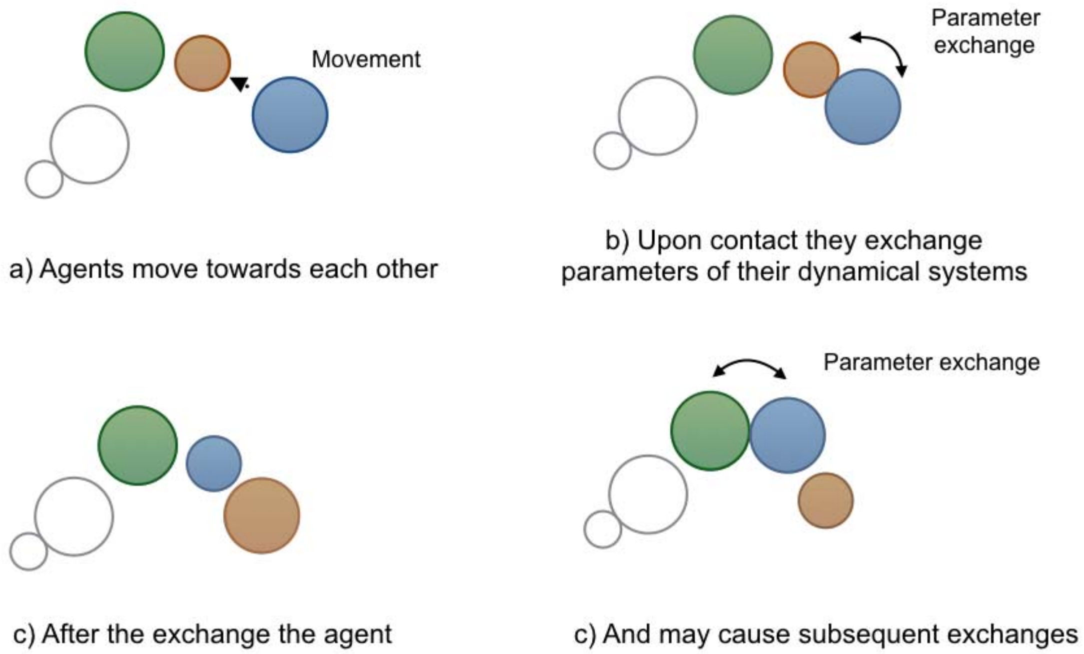

Figure 1 – How patterns that arise from the interaction among dynamical agents

Figure 3 – Left: Initial configuration of the agents in space. Right: Configuration after some time has passed. Lines indicate pairs which are moving closer.

For the inaugural performance, we chose the logistic map as the internal dynamical system for all the agents. The logistic map is a simple unidimensional quadratic function that is a discrete version of the continuous logistic equation of population growth (Equation 1).

$$x_{n+1} = rx_n\left(1 - x_n\right) \tag{1}$$

The logistic map has a single parameter which defines the behaviour of the system. For values of X within the unit interval, it reaches chaotic behaviour through a period doubling route. Chaotic behaviour starts at around r=3.5699456 and when r=4, the attractor covers the whole unitary range [12].

2.2 Visual Generator

The outputs from the Director are used to control three groups elements, each containing a few hundred copies of a geometric primitive. The groups are controlled by adjusting the distance of each element from the original position, scale of each element, and the distance among elements of the same group. Figure 4 shows the three primitives used. The leftmost and rightmost models are actually space-state trajectories of Sprott and Aizawa attractors.

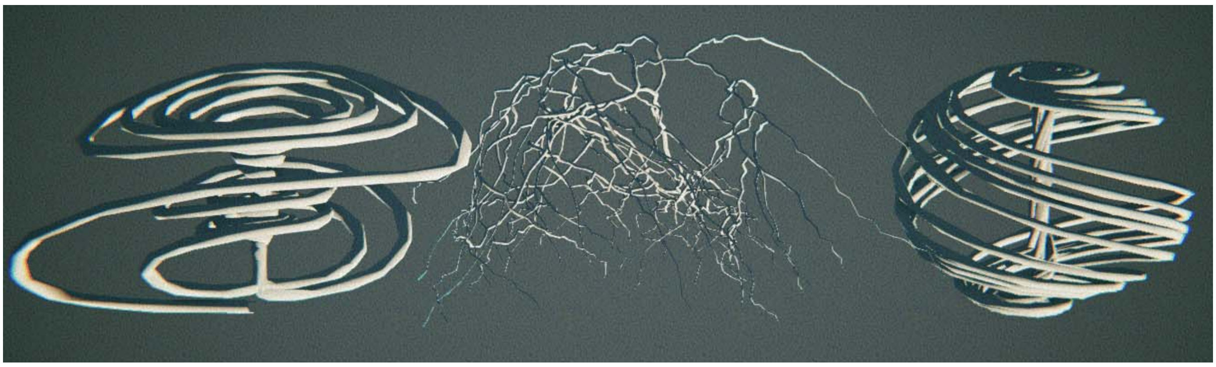

Figure 4 – Geometric primitives used in the artwork. Left: Galaxy; Middle Roots; Right: Intelligence

The artwork was inspired by cosmological theories of multiple universes, the origin of life, and consciousness as a way to navigate among realities. Figure 5 shows some generated visuals.

2.3 Audio Generator

The output from the Director is fed directly to the audio synthesis software SuperCollider using an Open Sound Control interface. The population value is used to choose a tone from the major scale. A script generates tones resembling a string synthesizer with chorus effects. Agents operating below the first bifurcation (r≈3.0) are muted to prevent distracting continuous sounds.

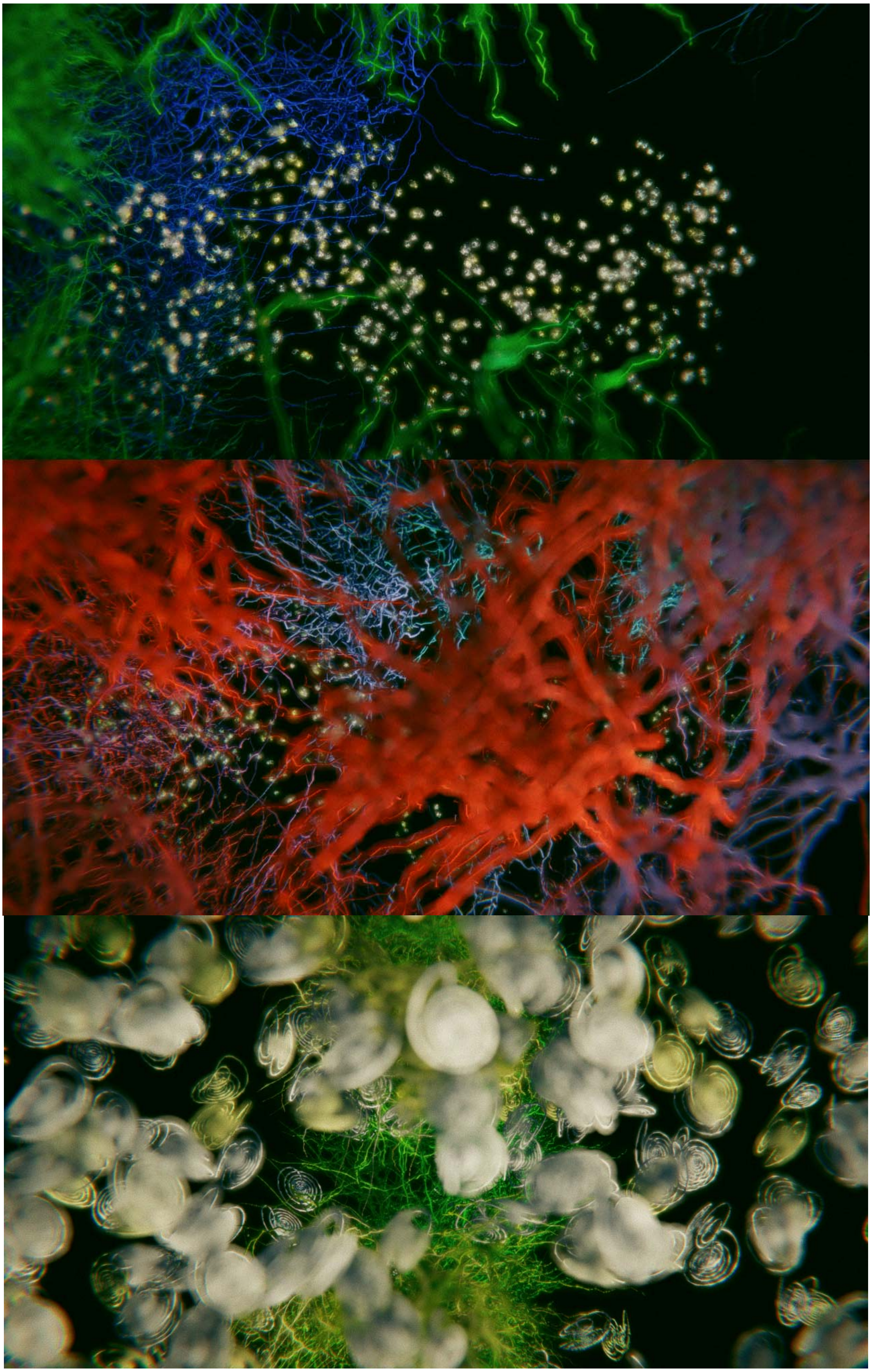

Figure 3 – Screenshots of the resulting animation

3. Conclusion and Future Work

The multi-agent model outlined in this paper was successful in creating patterns that could not be seen when the agents were isolated. The use of multiple agents also gave more freedom to select how each audio-visual element would behave, since each was tied to a single dynamical system. In a high dimensional system, all variables are coupled, effectively preventing this sort of individual adjustment.

When synchronization is desired, one possible strategy is to design separate agents with the same parameter but different initial conditions. As the system evolves they will converge in the same attractor (if outside the chaotic region). Another strategy is to use the interaction between agents to synchronize them (by matching the current state). However, if a more coherent behaviour is desired, it may be more convenient to use a single dynamical system to drive all elements simultaneously.

Finally, in this work we simply exchanged the parameter of the logistic map, while maintaining the same population. Future work may look into more complex interactions, such as duplicating, deleting, and generating new agents based on the parent's interactions. In addition, our movement strategy was very simple. More interesting behaviours may arise with more sophisticated movement patterns.

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Pisanello, St. George and the princess, 1437, St.Anastasia church, Verona. Detail.of St. George

ARTWORKS, POSTERS, INSTALLATIONS

Anna Ursyn

TITLE
Artworks: The Rider of a Horse Across Media

Topic: Art: Coding transformed:
A progression of images representing a horse with the use of various media, from a sketch, through coding, to photolitograph, photosilkscreens, and then into sculptural forms.

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Website: Ursyn.com
Artwork: https://www.mixbook.com/photo-books/interests/rider-of-a-horse-across-media-14081518?vk=mK4wXkUjgU

Abstract to GA2018, XXI Generative Art conference:
This is an electronic book exploring how computer programming can be linked, inspired by, and inspire work with digital media. The journey from sketching a horse with ink on paper, through coding of the image, transferring it to black and white plot, outputting from a code with colors to photosilkscreen, photolithograph, then merged into more cohesive image, and then a program-enhanced sculptures with the transformation of horse shape into wood and other three-dimensional forms
The title: ***The Rider of a Horse Across Media***
The type of contribution: website:
https://www.mixbook.com/photo-books/interests/rider-of-a-horse-across-media-14081518?vk=mK4wXkUjgU
The techniques presented in the book on the website:
0. Cover image Practice Makes Perfect
1. Ink drawing of a horse
2. 3-D program for a horse altered due to some transformations
3. 3-D wireframe of a horse created for a color output
4. 3-D program for a horse layered, transformed, and overlapped for a color output
5. Photosilkscreens after a black and white programmed horse
6. Photolithographs after coded image of a horse
7. Photosilkscreen after computer plot printed on a wooden plank
8. A sculpture of a horse with coded images in black and white and in color
9. A sculpture of a horse with several coded images
10. A wooden sculpture of running horses with wood cut according to codes
11. A sculpture of running horses with the photolithographs of various horses
12. Photolithograph after various coded plots.

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Artwork:
https://www.mixbook.com/photo-books/interests/rider-of-a-horse-across-media-14081518?vk=mK4wXkUjgU

Key words: drawing, 3-D program, Photosilkscreens, Photolithographs, A sculpture

Main References:
[1] Mohammad Majid al-Rifaie and Anna Ursyn, Theodor Wyeld "The Art of Coding: The Language of Drawing, Graphics, and Animation" Tayler&Francis, © 2018
[2] Anna Ursyn "Visual Approaches to Cognitive Education With Technology Integration, IGI-Global,Hershey, PA. © 2018.

Digital Craft Factory
Poster

Topic: Design

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Abstract
Digital Craft Factory wants to investigate the relationship between design and craftsmanship in the new era of digital fabrication: how this has transfigured the knowledge and workflow exchanges between designer and craftsman. The result is a new type of artisanship in which the designer's critical thinking, to plan and project any problems in a single abstract solution, is embedded with the craftmanship’s critical experience, that acts more like a step by step process. [1]
Due to the algorithms aided design is now possible to overcome any boundaries between the two disciplines and design a merging work flow, in order to transfer it in the new world of the rapid manufacturing. [2]

In particular, it was possible to develop an assisted creation system that helps guitar makers to fasten the design of the instrument morphology, according to the preference of the customers, and possible to produce easily through rapid manufacturing, in a file-to-factory optic.
It’s an algorithm-aided-design process that helps to customize the guitar according to some open inputs, generating the relative digital output.
This made possible to develop a unique shape, without losing the functionality.

This new kind of design modality emerges from a close observations of the artisan techniques and then is embedded in the design process thanks to flexible and accessible tools of generative thinking [3], in which the consciousness and creativity of the artisan work is crystallized in a responsive process, able to iterate all the possible solutions.

Alex.coppola@uniroma1.it

Key words: Algorithm-Aided-Design, Craft, Digital Fabrication

Main References:
[1] Micelli, S. (2011). *Futuro artigiano: l'innovazione nelle mani degli italiani.* Marsilio Editori spa.
[2] Hensel, M., Menges, A., & Weinstock, M. (2006). *Techniques and Technologies in Morphogenetic Design* (Architectural Design March April 2006 Vol. 76 No. 2).
[3] Tedeschi, A. (2014). *AAD Algorithms-aided design: Parametric strategies using Grasshopper*. Edizioni Le Penseur.

Moments: VR
(Installation)

Virtual Reality generative visuals, music, and sound

Artists:
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Simon Fraser University,
Vancouver, Canada
arne_e@sfu.ca

Simon Overstall
Emily Carr University,
Vancouver, Canada
simonlysander@gmail.com

Abstract
Moments is a continuously running generative artwork that explores Moment-form, a term coined by Stockhausen to describe music that avoids directed narrative curves, and instead exists within stasis. Created by ensembles of agents – musebots – that assume musical roles in both the creation and performance of each 10 minute composition, each generated work is unique, mercurial, yet compositional – rather than improvisational – in nature.

Musebots [1] are independent intelligent agents that generate both an overall musical structure, and then create the details within that structure. The musebots are "intelligent", in that they have learned about their environment, and communicate their intentions and coordinate conditions for collaborative machine composition [2].

This premiere of *Moments: VR* includes a visual world created by Simon Overstall, which reimagines the musebot messaging environment in a virtual space. Individual audio musebot's actions are interpreted visually as separate dynamic visual entities, and the structural conditions are interpreted as virtual landscapes. Although the viewer cannot influence the environment, it is possible to experience the environment in three dimensions, as individual musebot visualisations move within the space, and their audio can be tracked.

Example video: https://youtu.be/i7IP9d_KBzA
(this is a live immersive presentation that includes two dancers: the projections, sound, and music will remain the same)

Contact:
arne_e@sfu.ca

Key words: generative music, generative video, virtual reality

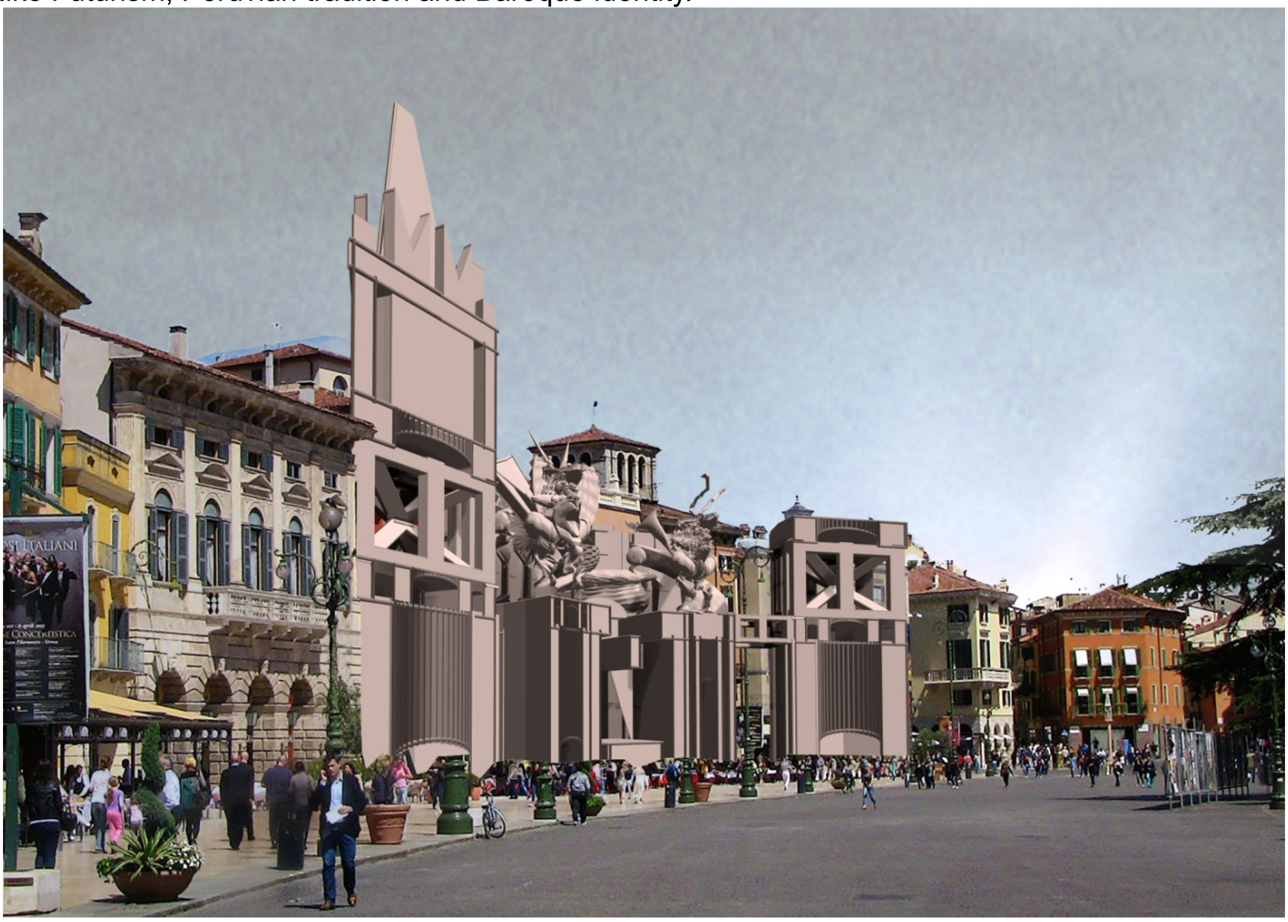
Main References:
[1] Bown, O., B. Carey, and A. Eigenfeldt. Manifesto for a Musebot Ensemble. ISEA, Vancouver, 2015.
[2] Eigenfeldt, Arne. Collaborative Composition with Creative Systems. ISEA, Durban 2018.

FUTURING VERONA. HOMAGE TO PALLADIO
(Artworks)

Topic: Architecture, Design

Author:
Celestino Soddu
Italy, Generative Design Lab, Argenia Association
www.generativedesign.com

Abstract
The architectural character of Verona belongs to the Renaissance and particularly to Palladio, that is very famous in his land and also in all world. The white house in USA is inspired by Palladio codes. I interpreted the peculiar Verona character by redesigning in generative way the Palladian paradigm getting my main reference to the study made by Wittkower. I designed some algorithms for defining the Renaissance organic harmony and the progressive sequences of increase complexity in walls, voids and roofs. This generative process works without ever re-proposing the forms of existing architecture. The results are architectures generated with a strong Veronese imprinting oversiding Palladian imprinting and reflecting my Verona interpretation. The images I present are futuristic views of Verona following my idea that in Verona preserved, in our contemporary time, the Palladio feeling of city expressed not only with his forms but also in an organic alive city vision. The 3D prints of generated architectures refer to this identity of Verona compared to others 3D prints focusing different characters that I investigated this year like Futurism, Peruvian tradition and Baroque identity.



celestino@soddu.it

Key words: generative design, Verona, Renaissance, Palladio, Baroc

Main References:

[1] Soddu Celestino, “Milan Visionary Variations. Futuristic meta-codes for Milan’s Identity”, Gangemi pub., 2005


Celestino Soddu, Verona 2018


Celestino Soddu, Verona 2018

TITLE

Palate 字觉 (Artworks)

Author(s):
Chin-En kEiTH Soo
Senior Lecturer (Visual Design)
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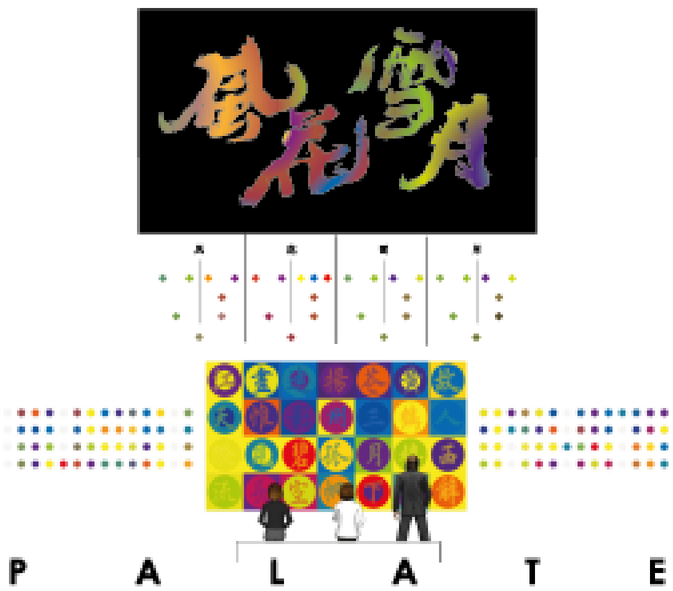
Faculty of Computing and Mathematical Science
University of Waikato

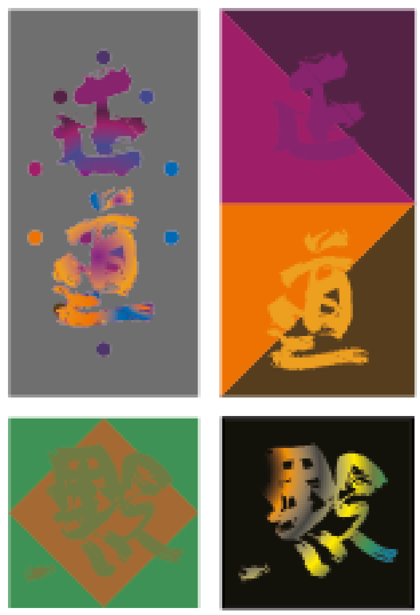
http://www.cms.waikato.ac.nz/people/ceks

Abstract

Chinese characters are a visual symbol with strong contagion. Palate uses the pronunciation and character structure of Chinese characters as the entry point to colorize the Chinese characters so as to give them the possibility of expressing colors in the design of Chinese characters. Each Chinese character has its own unique color system.

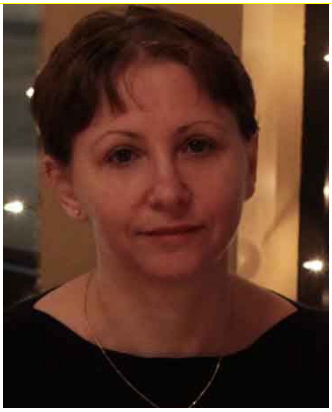
The application of the colorisation of Chinese characters can help to study the artistic charm of Chinese characters from a new perspective, improve the visual impact of Chinese characters, break the limitations of the past in the search for changes in the design of Chinese characters, and seeking a new form of modern Chinese character design.





email/address
ceks@waikato.ac.nz

Key words:
Colour Logic, generative, formula



TITLE: Generative Plant Structures – Frozen Flowers (Interactive Artwork)

Topic: computational art, evolutionary algorithms, artificial life.

Author:
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University of Lethbridge
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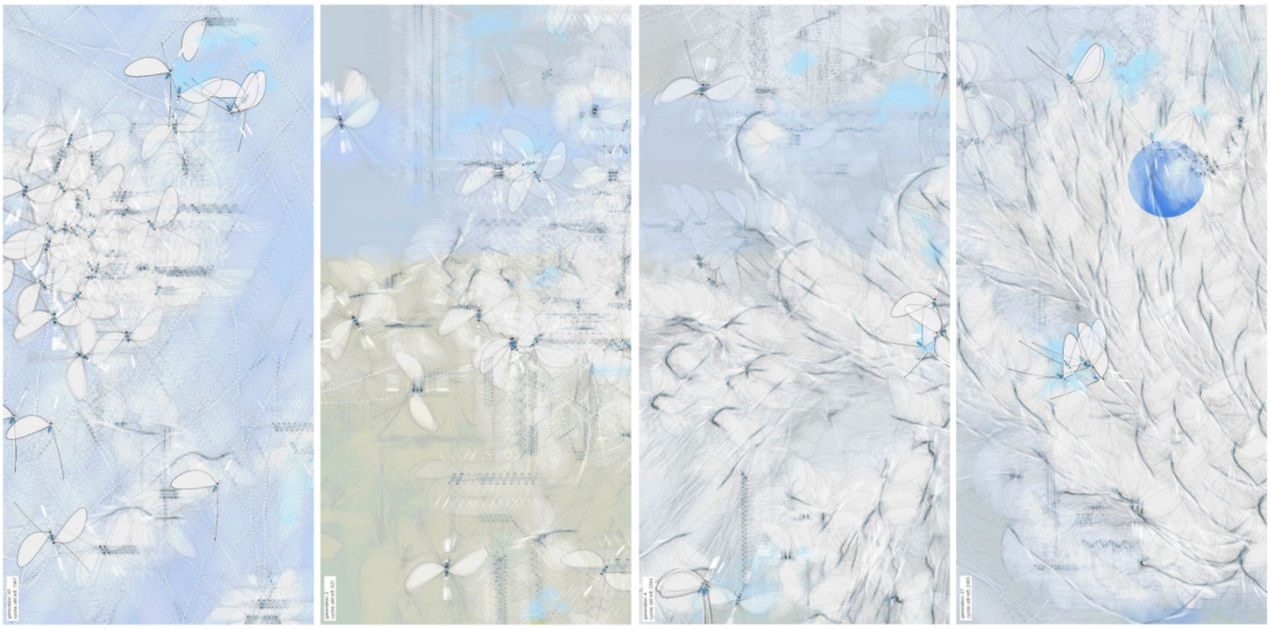
Abstract
Frozen Flowers is part of the larger series *Generative Plant Structures*. It is a computational art piece created in interaction with an artificial life system developed by the artist. When working autonomously, this system evolves agent behaviour as expressed through motion so that traces generated by the multi-agent system tends to create visual structures organized in compositions with aesthetic value. The *Frozen Flowers* series evolves new life-like forms from abstract shapes by grouping them in time through algorithms loosely based on a combination of structure creation processes that occur in nature.



Frozen Flowers. Still frames captured from artificial life system developed by Daniela Sirbu.

Email:
daniela.sirbu@uleth.ca

Key words: computational art, evolutionary algorithms, artificial life, computational creativity.

Main References:

[1] Pfeifer, Rolf and M. Lungarella, and F. Iida, “Self-organization, embodiment, and biologically inspired robotics,” *Science,* vol. 318, no. 5853, pp. 1088-1093, 2007.
[2] Reas and C. McWilliams. 2010. *Form + Code in Design, Art, and Architecture*. New York, NY: Princeton Architectural Pres..
[3] Daniela, Sirbu and I. Dumitrache. 2017. "A Conceptual Framework for Artificial Creativity in Visual Arts." IEEE IJCCC International Journal of Computers, Communications, and Control 12(3):381-392, ISSN 1841-9836, June 2017, DOI: http://dx.doi.org/10.15837/ijccc.2017.3.2759.

The language of the Athenian 'Akalyptos'
Shape Grammars for the design of Open Air cinemas in the Backyards of the Athens city block
(Poster)
Topics: Architecture, Visual Grammar, Design Approach

Author:
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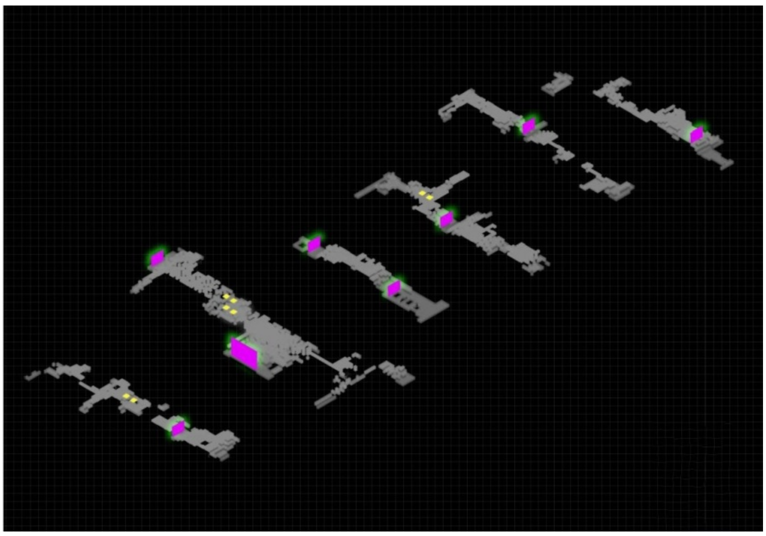
Greece, National Technical University of Athens, Department of Architecture (Masters level)
http://www.arch.ntua.gr/

Abstract

The following parametric shape grammar generates compositional forms of open air cinemas in the backyards of Athens city blocks. This idea arises on the one hand from the need to redesign the common spaces of the urban block called 'Akalyptos' and on the other hand from the existing festivals that take place every summer in many locations in the center of Athens. This project explores possible ways of analyzing these shapes in a way that can produce creative results.1 In this project cinema is used as a space production tool that shapes the interior of the building block.2 Cinemas are generated according to the urban voids of the arbitrary Athenian block. Finally, the idea-code in this generative design derives from the shape grammar where step by step we can create endless open air- cinemas like hypertrophic parasites that can eventually destroy the problematic structure of the city.

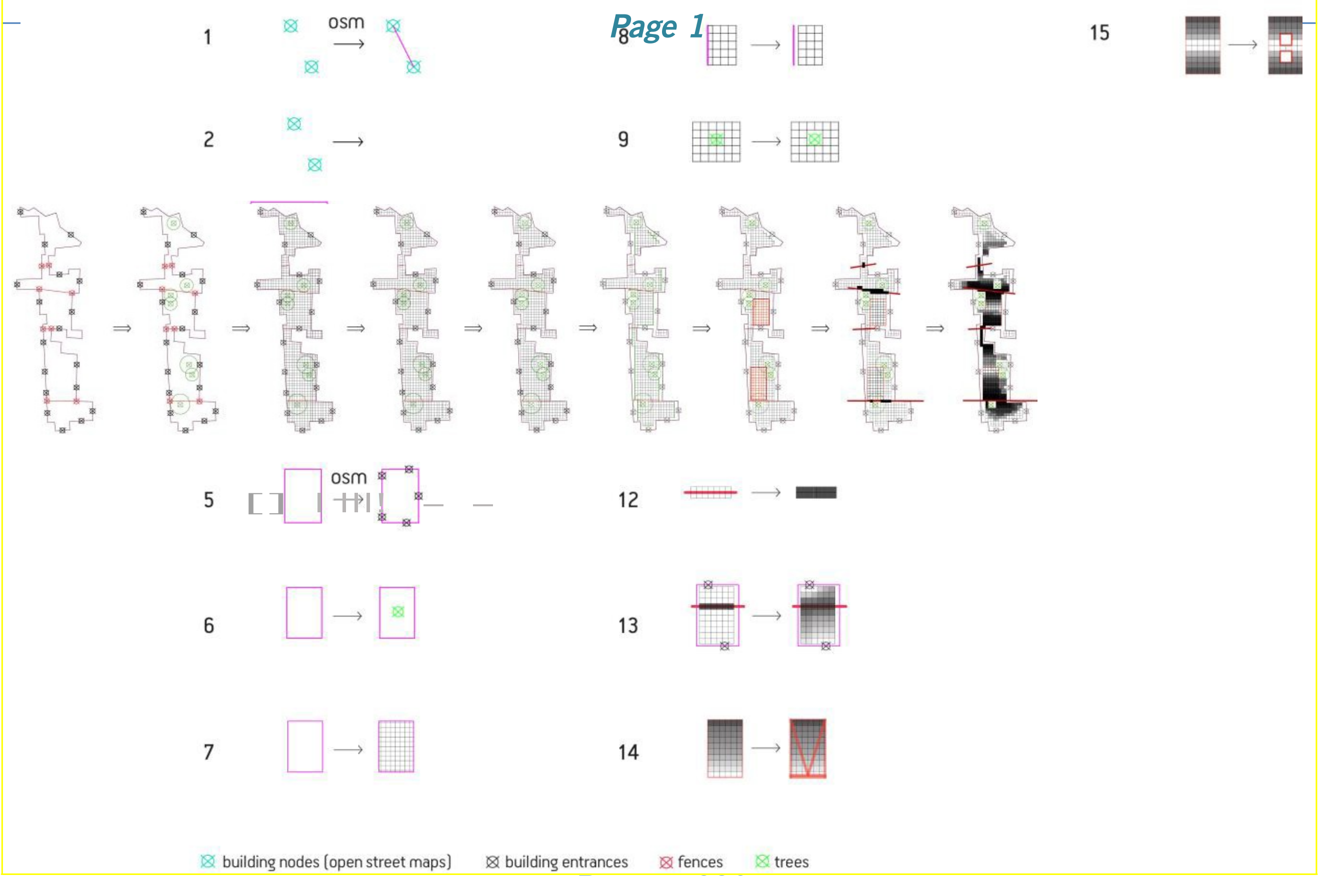


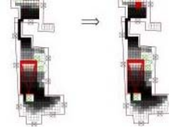
magdalinipetroleka@gmail.com

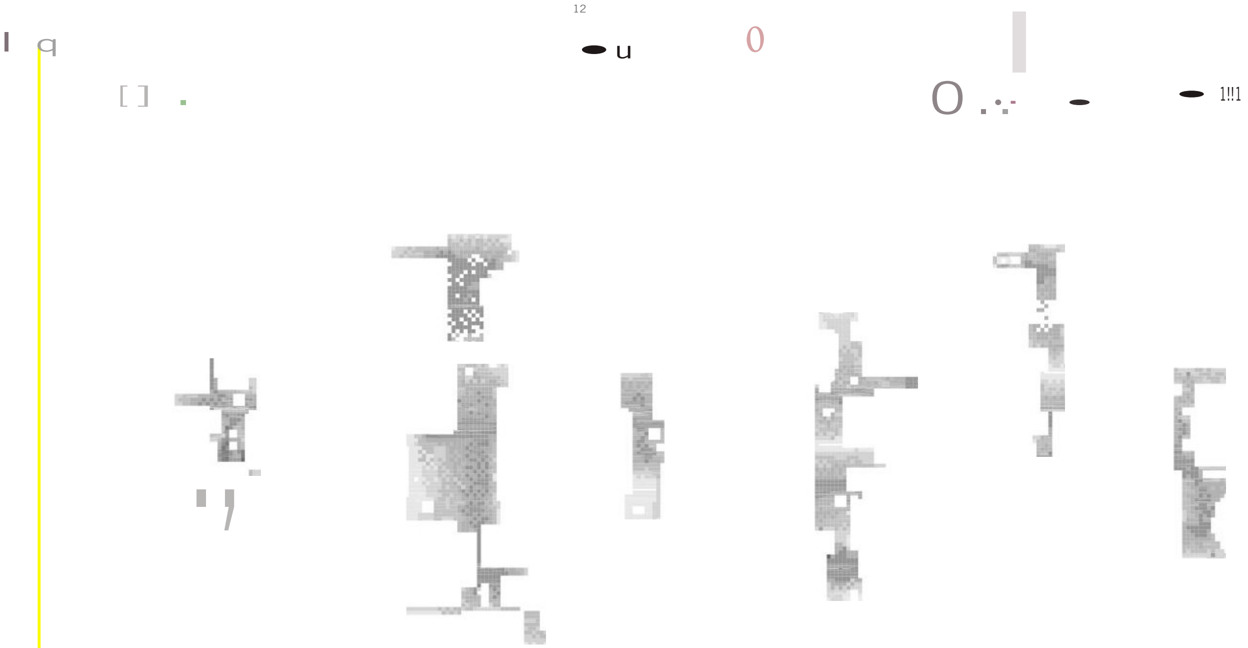
Key words: open-air cinema, Athenian akalyptos, parametric design, shape grammars, algorithmic design

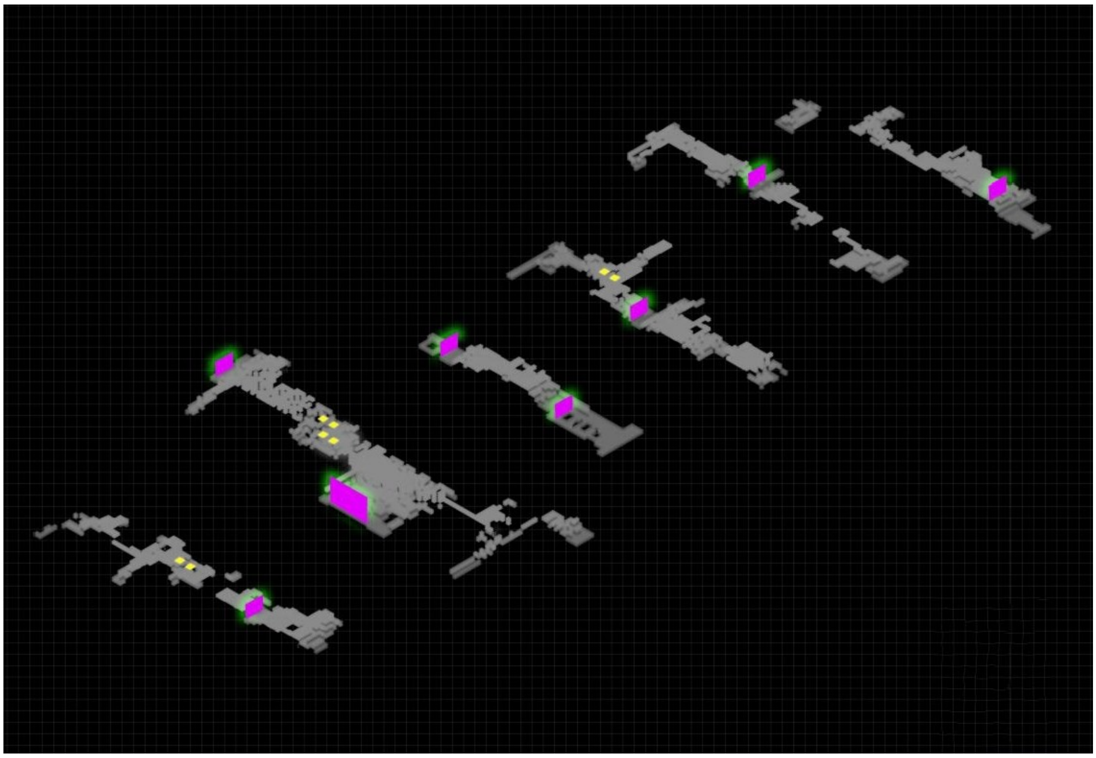
[1] Stiny G, "The algebras of design", Research in Engineering Design
[2] Bernard Cache, Earth Moves : The furnishing of Territories, USA, MITpress, 1995

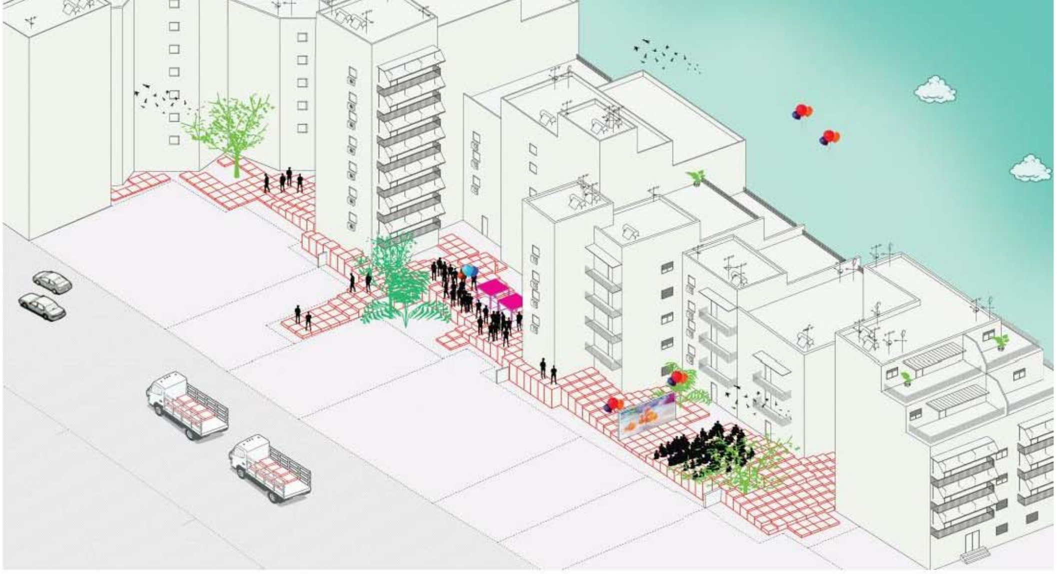
shape rules shemata :

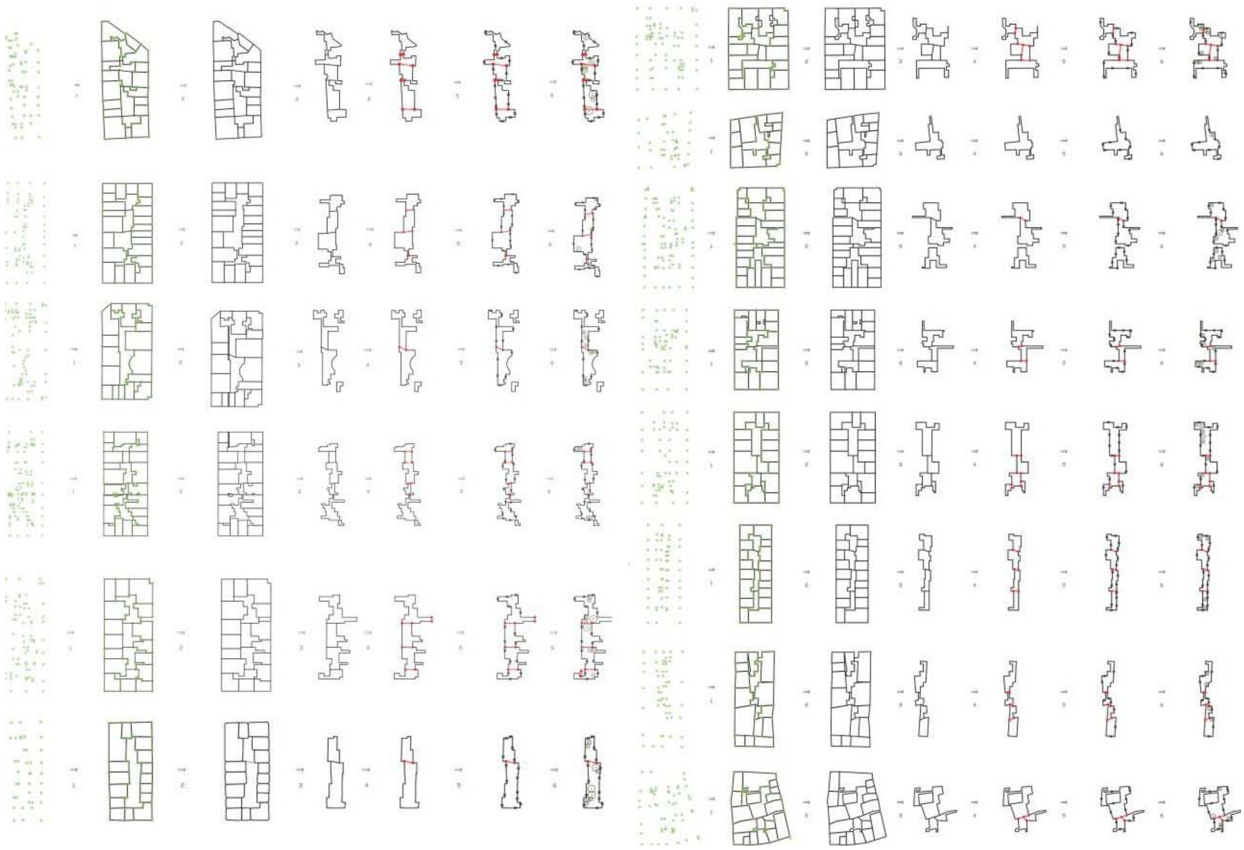


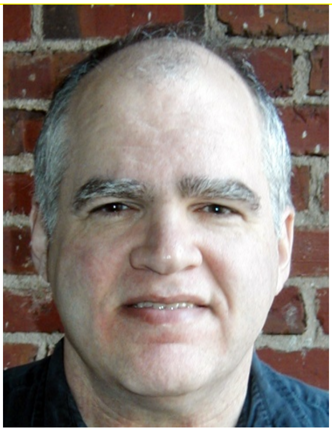












evoColorBox
(Artwork)

Topic: Fine Art

Author:
Philip Galanter
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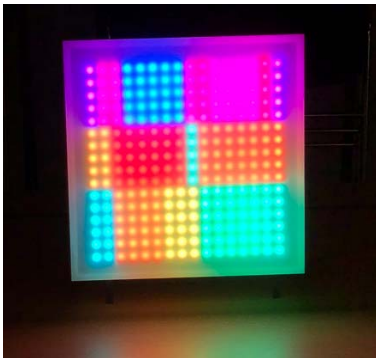
www.tamu.edu

Abstract
Human artists typically work within a feedback cycle of creation, critical evaluation, more creation, more evaluation, and so on. Generative art for the most part ignores the evaluation aspect of human artistic practice. In particular, evolutionary computation, genetic algorithms, etc. have been hobbled by the lack of fitness functions that measure aesthetic quality. Because aesthetic fitness has yet to be automated, putting an artist in the evolutionary cycle as a manual fitness function creates the so-called "fitness bottleneck."

evoColorBox is a small light sculpture that visually evolves color palettes using standard color theory rules for color harmony as a fitness function. Each performance starts with entirely random genes and usually takes about 10 to 20 seconds to evolve, and then a new performance begins.

evoColorBox displays 16 color palette chromosomes shown as 16 columns that are in genetic competition with their nearest neighbors. If a neighbor has a higher fitness score, then one of its color genes will be substituted in the chromosome in question. If the chromosome in question is more fit than either neighbor it will attempt to improve itself via mutation.



<u>Note Regarding Installation:</u> This work requires one wall socket for power, and can be mounted on the wall with small wood screws. I will also have a stand for table top use, but the wall is better.

galanter@tamu.edu

Key words: Artificial intelligence, color theory, computational aesthetic evaluation, evolutionary computing

Main References:
[1] Philip Galanter, "*Computational Aesthetic Evaluation: Past and Future." in "Computers and Creativity.*", Springer, Berlin, 2012
[2] Philip Galanter, "*Mini-XEPA: an installation of collaborating intelligent light and sound sculptures.* in *Proceedings of the conference on Electronic Visualisation and the Arts.",* BCS Learning & Development Ltd, London, 2017

Ferhan KIZILTEPE- Şaha ASLAN

DESING OF THE SENSES
(Poster)

Topic: The Samples of Conceptual Design Based on Senses in Education of Interior Architecture.

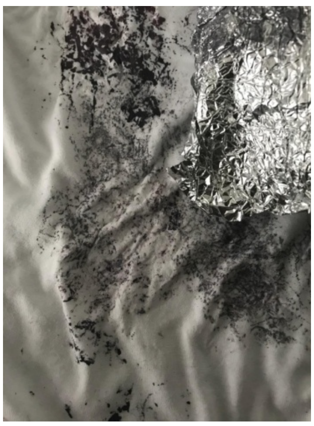
Şaha ASLAN
Turkey, TOBB ETÜ- Faculty of Architecture and Design , Interior Architecture and Environmental Design
www.etu.edu.tr

Ferhan KIZILTEPE
Turkey, Eskişehir Technical University- Faculty of Architecture and Design,
www.eskisehir.edu.tr/en

Abstract

Space is not only a means to counter to a merely pragmatic function through its indicators but also acts as a means of producing emotions. While emotion and emotion production which can be considered as the area of interest of plastic arts, it has been seen that the conceptual studies started to be designed together with function within the last century. Nowadays, people want to consume more of the products that have a similar approach in parallel with their own lifestyle. This shift in people's understanding of consumption has necessitated the designers to consider the conceptual expectations of consumers while seeking answers to be functional questions.

In this section, the results of the conceptual studies of the first year students of interior architecture by considering the issues mentioned above will be shared. This study, which discusses the perception through sensory and sensory mechanisms, was carried out with the first year students of TOBB University, Faculty of Architecture and Design Department of Interior Architecture in the 2017-18 academic year. The students studying on the basic design concepts in the first semester of the study period, which was spread over two semesters, were asked to determine a flower for the conceptual study. Through these flowers, it is aimed to produce sensation by focusing on different sensory mechanisms in each time and to plasticise these sensations in different ways. As a result, these conceptual designs will be presented to the audience in the poster section of the GA2018 Verona meeting.



saslan@etu.edu.tr
aser@ferhankiziltepe.com

Key words: Basic Design, Concept, Perception, Sensation, Emotion, Generative

Design of the Senses

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saslan@etu.edu.tr

F. Kızıltepe, B.Sc., B.Soc.Sc., A.A., M.A.,
Architecture and Design Faculty, Eskişehir Technical University, Eskişehir, Turkey

Abstract

Space is not only a means to counter to a merely pragmatic function through its indicators but also acts as a means of producing emotions. While emotion and emotion production which can be considered as the area of interest of Plastic Arts, it has been seen that the conceptual studies started to be designed together with function within the last century. Nowadays, people want to consume more of the products that have a similar approach in parallel with their own lifestyle. This shift in people's understanding of consumption has necessitated the designers to consider the conceptual expectations of consumers while seeking answers to be functional questions.

Space is the interest of PHILISOPHY, AESTETICS and SCIENCE, as an expression of the idea it is carrying [SEMANTICS], the form it is being used for [PRAGMATIC] & the technology it is made of [SENTACTICS]. It Space can be perceived by EXPERIENCE and experience can be regarded as a transformation problem where OBJECTIVE REALITY is transferred into the SUBJECTIVE REALITY [1].

This study, discusses the perception through sense & sensory mechanisms, was carried out with the 1st year students of TOBB ETU, Department of Interior Architecture & Environmental Design in the 2017-2018 Academic year, under the Basic Design course

1. The Path of Sensation, Emotion and Perception

PERCEPTION that can be defined as a high-level mental performance occurs within the layered structure of the brain called cortex. Different types of receptors [eye, ears, touch, etc,] sensitized to their own different types of stimuli progress [sight, sound, touch, etc.] through the lower layer called The First Sensory Field to the upper layers. Each step of the process transfers the data to a higher layer, each transfer enables the conversion of data into information [2].

The information can also provide feedback from the upper layers to the lower layers. The reason for the bi-directional movement is the ability of the cortex to make predictions. The brain has to send information back to the first sensory field so that a comparison can be made between what is available and what is expected to happen through foresight. Therefore, the data from a source can be transformed from its own source to a different source [3].

2. The Samples of Conceptual Design Based on Senses in Education of Interior Architecture & Environmental Design.

The study was designed with reference to the mechanism of transformation of information in the mind. The study aimed to enable the students to select a flower of objective reality, to analyze it, and to get the design knowledge in the focus of different sensory mechanisms each time through flower.

2.1 Posters

Four posters related to the subject are as follows.

References

[1] L.L.Avant, H. Helson, *"Algı Kuramları" (Theories of Perception)* (Y. Topsever Trans.). Ege Üniversitesi Basımevi, 1990, İzmir, Türkiye.

[2] Ş. Aslan, "*An Approximation Towards the Sense Criteria in Basic Design Education".* Ankara: Hacettepe University, Ph.D. Dissertation in Interior Architecture Programme., 2012. Ankara, Türkiye.

[3] J. Hawkins, "*Zeka: Beyin Nasıl Çalışır? Nasıl Düşünür? (On Intelligence*) (Z. Duman Trans.). Yakamoz Yayınları, 2010, İstanul, Türkiye.

Design of the Senses

Şaha ASLAN, Ferhan KIZILTEPE

Space is not only a means to counter to a merely pragmatic function through its indicators but also acts as a means of producing emotions. While emotion and emotion production which can be considered as the area of interest of plastic arts, it has been seen that the conceptual studies started to be designed together with function within the last century. Nowadays, people want to consume more of the products that have a similar approach in parallel with their own lifestyle. This shift in people's understanding of consumption has necessitated the designers to consider the conceptual expectations of consumers while seeking answers to be functional questions.

WHAT?

HOW ?

WHY ?

Space is the interest of **PHILISOPHY**, **AESTETICS** and **SCIENCE**, as an expression of the idea it is carrying [SEMANTICS], the form it is being used for [PRAGMATIC] & the technology it is made of [SENTACTICS].

Space can be perceived by EXPERIENCE. Experience can be regarded as a transformation problem where *OBJECTIVE REALITY* is transferred into the *SUBJECTIVE REALITY.*

SENSE & SENSATION

PERCEPTION

EMOTION

For this reason, space is an EMOTION producer for each user, giving hints on how the world is PERCEIVED.

This study, discusses the perception through sense & sensory mechanizms, was carried out with the 1st year students of TOBB ETU, Department of ***Interior Architecture & Environmental Design*** in the 2017-2018 Academic year, under the ***Basic Design course***,

The Path of Sensation, Emotion and Perception

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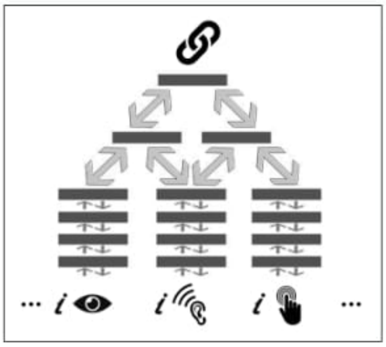

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The brain has to send information back to the first sensory field so that a comparison can be made between what is avaible and what is expected to happen through foresight. Therefore, the data from a source can be transformed from its own source to a different source.

The Samples of Conceptual Design Based on Senses in Education of Interior Architecture & Environmental Design.

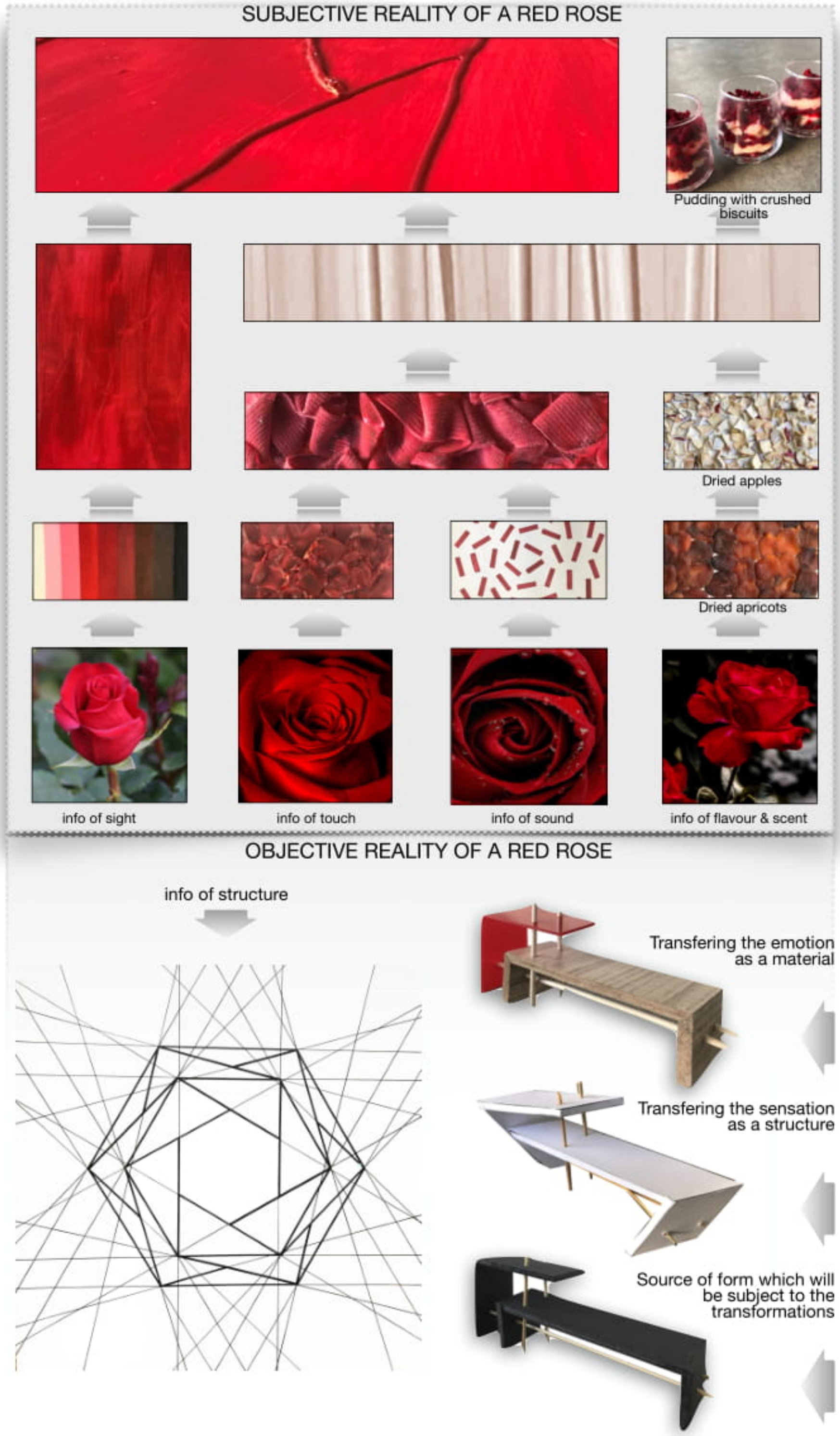
The study was designed with reference to the mechanism of transformation of information in the mind. The study aimed to enable the students to select a flower of *objective reality*, to analyze it, and toget the design knowledge in the focus of different sensory mechanisms each time through flower.

1/4

XXI Generative Art Conference | GA2018

Design of the Senses

Şaha ASLAN, Ferhan KIZILTEPE



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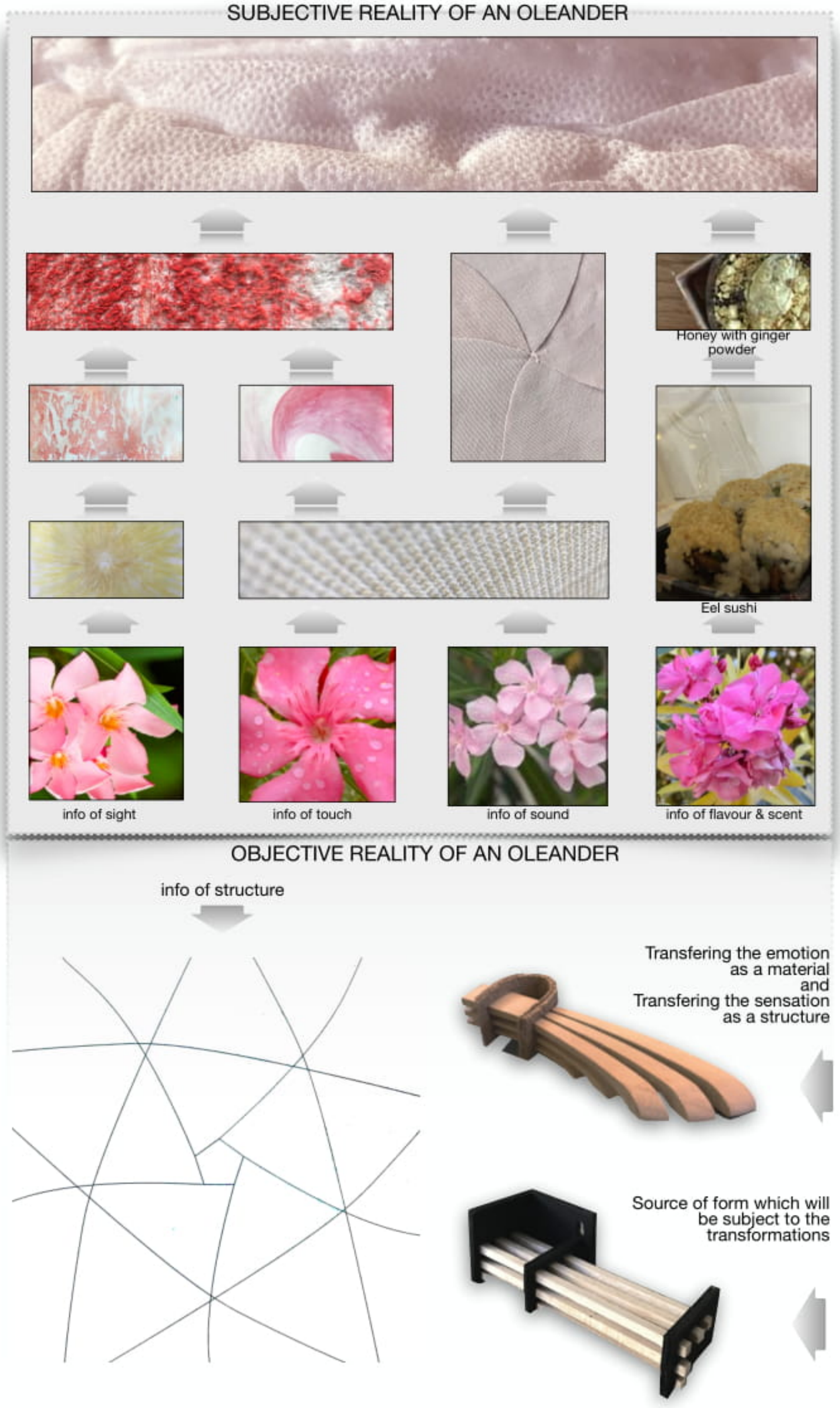
2/4

XXI Generative Art Conference | GA2018

Design of the Senses

Şaha ASLAN, Ferhan KIZILTEPE



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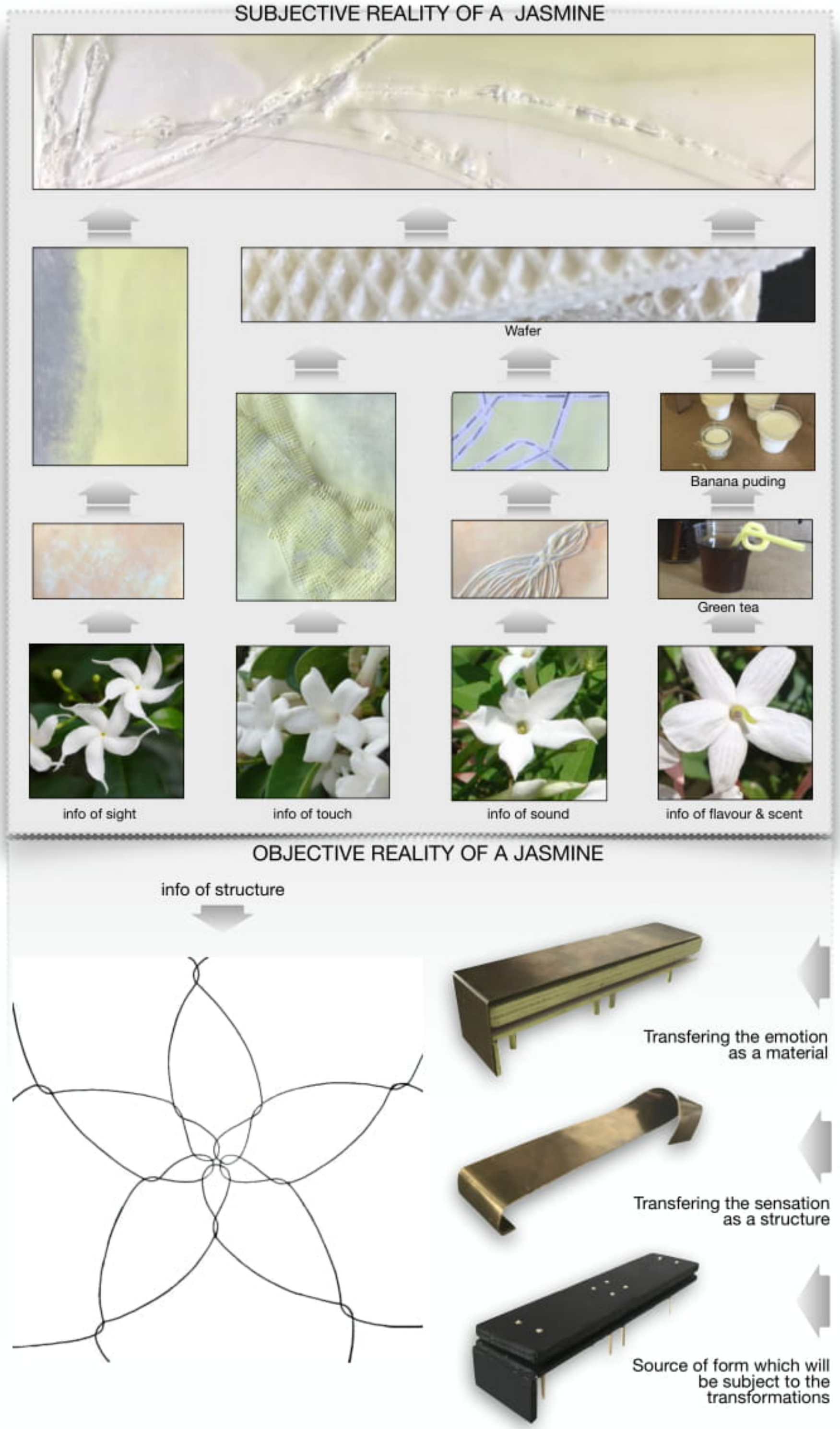
3/4

XXI Generative Art Conference | GA2018

Design of the Senses

Şaha ASLAN, Ferhan KIZILTEPE



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4/4

Latvian Garden of Destiny – the Place for Inspiration to Implement Dreams

Topic: Architecture

Author: Silvija Ozola

Latvia, Riga Technical University

Abstract

On an island in Koknese on the Daugava there is a place where the past, the present and the future of the people as well as the nation merge to give solace to the past, strength to the present and inspiration to follow your dream in the future. Landscape artist Shunmyō Masuno from Japan has visualised the Garden of Destiny, which is an architectural ensemble of monumental landscapes and has been shaped as the metamorphosis of the choir suite – it consists of the prelude and six parts, which are divided in three zones. Each zone relates to its own time and space, but all-in-all it symbolizes eternity. Latvian architects Andris Kronbergs and Raimonds Saulitis along with the "Design Bureau ARHIS" and the people of Latvia are all helping to implement this dream. The Garden of Destiny was created for the memory of all the inhabitants of Latvia whom Latvia lost during the 20th century, the ones who perished in wars, the repressed one, the ones who were forced to go to exile or suffered any other way due to their political views. Almost in every family there is a victim. The Garden of Destiny is a symbol of nation's continuous growth and development, as well as a place, which tells us in a symbolical way what the cost for Latvian national freedom and independent state was, simultaneously confirming independence and power of Latvian nation, which has enabled it to endure and anticipate better future. The Garden of Destiny, founded on August 11, 2018, gives us not only joy with the blue waters of the Daugava and changeable gradations of the sky, but also cheers us up with the saturated green shades.

What inspires the human nowadays to find strength and implement intentions? How to reveal completely the architectonically organized environmentally emotional qualities so that they would address the human? Where is the power of symbols hidden?

Latvian architect Andris Kronbergs, landscape artist Shunmyō Masuno from Japan, the Garden of Destiny (photo by Jānis Brencis and Gatis Balodis)

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ozola.silvija@inbox.lv

Key words: Andris Kronbergs, architectural ensemble, Latvian Garden of Destiny, symbol, Shunmyo Masuno

Main References: http://latvia360.com/tour-resources/koknese/apskates_objekti/liktendarzs/5/tour.jpg

Latvian Garden of Destiny as Place for Inspiration to Implement Dreams

Silvija Ozola, Assist. Prof. of Architectural Designing, dipl. ing. arch.
Riga Technical University, Latvia
e-mail: ozola.silvija@inbox.lv

Abstract

On an island in Koknese on the Daugava there is a place where the past, the present and the future of the people as well as the nation merge to give solace to the past, strength to the present and inspiration to follow your dream in the future. Landscape artist Shunmyō Masuno from Japan has visualised the Garden of Destiny, which is an architectural ensemble of monumental landscapes and has been shaped as the metamorphosis of the choir suite – it consists of the prelude and six parts, which are divided in three zones. Each zone relates to its own time and space, but all-in-all it symbolizes eternity. Latvian architects Andris Kronbergs (*Fig. 4*) and Raimonds Saulītis along with the "Design Bureau ARHIS" and the people of Latvia are all helping to implement this dream. The Garden of Destiny was created for the memory of all the inhabitants of Latvia whom Latvia lost during the 20th century, the ones who perished in wars, the repressed one, the ones who were forced to go to exile or suffered any other way due to their political views. Almost in every family there is a victim. The Garden of Destiny is a symbol of nation's continuous growth and development, as well as a place, which tells us in a symbolical way what the cost for Latvian national freedom and independent state was, simultaneously confirming independence and power of Latvian nation, which has enabled it to endure and anticipate better future. The Garden of Destiny, opened on August 11, 2018, gives us not only joy with the blue waters of the Daugava and changeable gradations of the sky, but also cheers us up with the saturated green shades.

What inspires the human nowadays to find strength and implement intentions?

How to reveal completely the architectonically organized environmentally emotional qualities so that they would address the human?

Where is the power of symbols hidden?

Key words: Andris Kronbergs, architectural ensemble, Latvian Garden of Destiny, symbol, Shunmyo Masuno

Introduction

In the middle of the River Daugava on the Island Krievkalns, which was formed in 1966 when the Pļaviņas Hydroelectric Power Station was built near the Koknese Castle ruins, till the 100th Anniversary of the Proclamation of Independence of Latvia the monumental landscape architectural ensemble was created. During the Soviet era, this territory was used for agriculture and an aerodrome. In 2005, Koknese municipality renamed 'Krievkalns' as Koknese Island (*Fig. 1*). In 2008, this island became a part of the Garden of Destiny.

There is archaeological evidence of wars including World War One, 1914, which has left its mark of trenches in the garden territory. It is a place, which tells us symbolically how much the freedom and independent state cost the Latvian nation, at the same time also confirming independence and power of the Latvian nation, which has enabled them to endure and look with hopes into the future (*Fig. 2*).

Fig. 1 The Island Krievkalns in the middle of the River Daugava (source: http://liktendarzs.lv/f/images_list/1500w/071fec2d554ecf755e730ccb4c761315.jpg)

Fig. 2 The island gives us not only joy with the blue waters of the Daugava and changeable gradations of the sky, but also cheers us up with the saturated green shades (source: http://www.designblog.lv/wp-content/uploads/2010/03/Picture-945-475x315.png)

Almost in every Latvian family there are the victims – somebody who perished during the wars, somebody who was repressed or was forced to go to exile due to their political views. In order to commemorate all people who Latvia lost in the 20th century, in 2005, Marta and Vilis Vītols (*Fig. 3*) founded the "Koknese Foundation" and they started to form a symbol of the nation's continuous growth and development – Latvian Garden of Destiny, which unites different generations and is also the victims' memorial of the Latvian occupation and Nazi occupation regime. Demography experts of Latvia, taking account the whole time people worked in Siberia and somewhere else in exile, lived there, the harm to their health, affect on the birth and other factors, estimate that the loss created by the USSR occupation regime can be measured as about 10 million man-years. It is known for sure that the number of the killed, deported, imprisoned in the concentration camps and the forced ones to go to exile exceeds 600 000 lives, apart from the unborn children. According to the national census, the number of Latvians living in the territory of Latvia from 1 467 035 (77% of the total population) in 1935 decreased up to 1 387 757 in 1989.

Fig. 3 Founder of the "Koknese Foundation" Vilis Vītols and Valda Auziņa (source: https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcROj6TJs4Uf3JHKfgbmxEw3tRSIlm5YDqt-dMjeEfbj_H0dkrn1)

Fig. 4 Latvian architects Andris Kronbergs and landscape artist Shunmyō Masuno during the opening enterprise of the Garden of Destiny on August 11, 2018 (photo by Jānis Brencis)

In 2006, an open international tender was organized for the Garden of Destiny artistic and philosophical concept solution. 207 applications of ideas were received: 112 were submitted from Latvia, but 95 from other countries (18 from Italy, 13 from France, 7 from Switzerland, 5 from the USA, Chile and Spain, but 4 from Belgium and Lithuania, 3 from Brazil, Denmark and Sweden, 2 from Croatia, China, Great Britain, Poland, Germany and Turkey and 1 application of ideas from Australia, Bosnia and Hercegovina, Indonesia, Israel, Japan, Qatar , Lebanon, Macedonia, the Netherlands, Norway, Portugal, Slovakia and Finland). Applications were assessed by a Commission of International Jury, which on March 23, 2006 made a decision and announced results. The first prize was awarded to the project “Meisō” (meditation) by the world-recognized Japanese landscape architect, manager of the design company "Japan Landscape Consultants” Ltd., Professor of Tama Art University Shunmyō Masuno. The second prize was awarded to Andis Blūms from Latvia, but Claudio Zappia and Rosanna Law from Great Britain received the third prize. Lauma Garkalne, Ligita Tomiņa, Loreta Erele and Gunta Rozenberga from Latvia obtained the Incentive Bonus. Out-of-competition regulation the jury awarded a special award to four-year-old Christopher Rubin from Latvia.

What inspires a human being nowadays to find strength and implement intentions?

Chief Priest of the Sōtō Zen Temple Kenkō-ji, guest lecturer at Harvard, British Columbia and other universities, author of lots of publications and books, landscape artist Shunmyō Masuno (*Fig. 4*) has created gardens in Berlin, Stuttgart, Frankfurt, Bergen, Ottawa, Singapore, Hong Kong and elsewhere. He has been motivated to take part in the project competition by the fact that also Japan has lost about 600 000 people in the Gulag camps. Before designing a garden, Masuno first meditates and establishes a dialogue with the space. This requires emptying of the self in order to "hear" elements of the garden speak. He explained his perspective on the ethics of gardening, saying that gardening brings about gentleness in the designer, builder, and caretakers. The garden teaches suchness or the intrinsic value of each thing, connectedness, harmony, tranquillity, and sacredness of the everyday. Developing a sense of respect for all things is no small step in becoming an ethical human being, both with respect to other humans and the environment at large.

In 2006, Shunmyō Masuno arrived in Latvia for the first time and in cooperation with “Japan Landscape Consultants” Ltd. He made the sketch project of the Garden of Destiny (*Fig. 5*). The monumental landscape architectural ensemble has been created as a metaphor of a musical piece, which includes the prelude and six parts. Each part is divided into three zones, but each zone is related to its time and space. The Garden of Destiny as a whole is like a symphony in seven parts, which symbolizes harmony and eternity of nature and the human being (*Fig. 6*). The first is the “Zone of Memory,” which is orientated towards the past and consists symbolically of two parts. The first part “Promise” or “Silver Sunset” starts with a stone paving, followed by a water canal which symbolizes victims’ tears, and it is closed by a monument hill made of 600 000 grey stones. The sunset is not in the usual colour, but rather grey – as a tragedy and emotional experience about what has happened. A path through this part and over the bridge takes to the sacred place at the Daugava – the memorial amphitheatre. The second part is the “Prayer” or “Light of Soul.” In the place, where we pray so that what happened to us would never ever repeat again, one can watch the sunset in the evening, but on November 18, the Proclamation day of the Republic of Latvia solemn national celebrations take place. The second one is the “Healing Zone” dedicated to the future. The third zone is the “Destination – Latvian’s Heart.” The Garden of Destiny is a symbol, created in nature for a constant renewal and growth of the nation – here the past, present and future of both the human and the state meet. An outstanding environmental architecture with nature of the island and beauty of the Daugava’s flow have been combined.

Fig. 5 The sketch project of the Garden of Destiny (architect Shunmyō Masuno)

Fig. 6 The model of the Garden of Destiny (architect Shunmyō Masuno in cooperation with "Japan Landscape Consultants" Ltd., source: http://liktendarzs.lv/f/features/300w/slide_29538.png)

Where is the power of symbols hidden?

A garden is not so much a place for pleasure, recreation or socializing, as a way to achieve a certain state of human spirit, peace of mind and balance of consciousness. In the garden preparation for it begins. In the Japanese garden, elements for landscape design are secondary to invisible philosophical, religious, and symbolic elements – water, stone islands, plants, and traditional small forms. Any element of the Japanese garden very rarely carries any additional, symbolic load, but then especially high aesthetic requirements are placed on it. The refined simplicity of things has the strongest artistic impact on the audience. Aesthetic characteristics are naturalness, refined elegance, the use of hints of information transfer. A state when "there is nothing", but still it is not emptiness. The concept of "not exist", "not have", "absent" in practice can be expressed in an extensive gravel field. An exceptionally positive quality – endurance, ripeness, juiciness, as well as naturalness as opposed to artificiality and violence. This principle prohibits the use of complex, intricate, decorating design and does not welcome too small elaboration of details. In the garden, it implies the active use of darkness and in general dark colours as a background for the lighter part of the garden and welcomes monochrome as opposed to colour. Aesthetic principles are quite universal and applicable in any Japanese garden, be it small, or a garden for walking, consisting of changing species and therefore requiring constant movement of the viewer, or a static landscape designed for equally motionless contemplation form. Japanese landscape designer is guided by a suggestive design approach. What the viewer sees should indirectly express thoughts of the creator, not to depict and not to explain, but to offer, hint, direct to certain reflections. Some aspects of the garden can be hidden from the viewer for the time being, other things can be made so that they cannot be seen at all, but one could guess about their presence. The desire to show an expensive (in the literal and figurative sense) object should be suppressed in all its glory, just as bright colours should give way to a restrained and natural one. It is necessary to ensure that everything that can be re-read, was in odd quantities. In Japan, Time is always considered the co-author of the garden and the assistant designer. Develop a garden so that its beauty responds to the place and course of time, as leaves respond with a breath of breeze, so that there is nothing bulky and coarse in it. Instead of absolute dimensions, the consciousness and the subconsciousness are completely affected by the "three forces": horizontal, vertical and inclined planes. We react to each of them in a completely different way: the horizontal is associated with the earthly expanse or a water mirror, with a calm, slow motion and, consequently, spiritual tranquillity. The vertical is the tension and energy needed to move up to the sky, but a clean, accented vertical is quite rare in a Japanese garden. The diagonal, or inclined plane, most often in form of an old tree, bent under the weight of years, or slopes with stone debris and bistro running streams causes dynamic associations. Art and man-made should not bulge compared to the natural. The result of creative and hard work should look easy and at ease as a result of the work of the genius of nature, and not of human hands [2].

How to reveal fully the informatively emotional qualities of the architecturally organized environment in order to address a human being?

Design of Japanese gardens accompanies aesthetic_and philosophical ideas, avoids artificial ornamentation and highlights the natural landscape. Worn, aged materials and plants are generally used to suggest an ancient and faraway natural landscape and to express the fragility of existence and time's unstoppable advance. It was considered good to use in the Japanese garden local plant species – those that are accessible and feel better than the exotic ones brought from afar. In the middle climatic zone, only a few Japanese plants are able to pass the winter. Many of them are quite adequate replacement [2].

The Japanese garden with winding paths is never revealed to the viewer immediately. The speed of movement, the rhythm of the pitch and the perception of the garden depend on how they are arranged. The location of stones on the track is made to move relatively slowly, looking down at one's feet. Uneven steps avoid attention from unwanted views or will help to see something important. Stones not only create the look of the garden, but also dictate its perception. At the junction of the diverse medium, stones indicate that a completely different story begins. In the garden we do not walk, but travel along roads, do not wander without a goal, but move from Place to Place, from Discovery to Discovery. A garden should occupy a large area in which we travel through time and space. The central part has a bizarre-shaped pond with islands, surrounded by man-made hills and valleys, along which travel routes are laid. In gardens hills and the pond are recreated landscapes in miniature in order to make imaginary journeys along paths for walks, which should evoke feeling of going on a long, mysterious journey. Routes for walks should lead uncharted spaces and spheres out of the garden to external to it – to distant places and even, perhaps, to far times. Garden views should be revealed to visitors as successive frames of a film that has never been seen before, and the design of tracks prompts the viewer where to look and where to stop. In the garden, depending on its size and mastery of execution, such pictures can be from two or three to several dozens, in order not only to depict the deep purpose of the garden for walking, how to interpret and find the essence of beauty, to explain the reason for the attractiveness of the garden [2].

Implementation of the Garden of Destiny

The place, where the Garden of Destiny has been implemented, could tell us lots of interesting facts, as during the course of time it has experienced unique things. In 1935, in Koknese the Harvest Festival took place the first and only time, in which President of the Republic of Latvia Kārlis Ulmanis also participated. Anyone could take part in the Garden of Destiny development with their work, time, good thoughts and means. The "Silurs" Ltd. Carried out the engineering geological research, "JMI Birojs" Ltd. Made the project for the Daugava's bank reinforcement in the Amphitheatre's 402eighbourhood, but the "Polyroad" Ltd. Prepared technical projects for construction of the Perimeter Road and the Amphitheatre. Architects Andris Kronbergs and Raimonds Saulītis form the design office "ARHIS" Ltd. Developed the project for the multifunctional public building and its adjoining territory.

Implementation of the Garden of Destiny was divided into 10 stages, and in 2008, the Garden of Destiny was opened with the planting of the Apple-tree Alley. In April a hundred apple-trees were planted, and every apple-tree has got the planter's message to someone close person or group of people. Romantic apple-trees surrounded the life artery of the Garden of Destiny and it takes to the central part of the garden – the Amphitheatre at the Daugava (*Fig. 7*). President (1993–1999) of the Republic of Latvia Guntis Ulmanis together with his grandson planted one of the first apple-trees. Since December 11, 2008 President (2007–2011) of the Republic of Latvia Valdis Zatlers has been the guardian of the Garden of Destiny.

Fig. 7 The central part of the garden – the Amphitheatre at the Daugava (source: http://i9.tiesraides.lv/1200x0s/pictures/2016-07-25/2016-07-25_liktendars_ugis_nastevics.jpg)

Fig. 8 On both sides of the Apple-tree Alley or the Friends Road of the Garden of Destiny the land was levelled in about 10 ha and grassland was planted (source: https://www.celojumubode.lv/uploads/country/500x_image-liktendarzs-liktendarz.png)

In 2009, Koknese farm "Roplaiņi," managed by Aivars Dambītis, carried out bulky earthworks with a great precision for the Amphitheatre's building site preparation. The location of the Amphitheatre was outlined in nature, footpaths, envisaged in the project, were created, the territory of the gravel-pit was cultivated, opposite Koknese Evangelic Lutheran Church the bank of the Daugava was cleaned up and a carpark for visitors' cars was made. With the helpers and local entrepreneurs' from Koknese support on both sides of the Apple-tree Alley (2008) or the Friends Road of the Garden of Destiny, the land was levelled in about 10 ha and grassland was planted (*Fig. 8*).

In the late summer and autumn about 30 individual joint work activities took place, in which 2 000 people from whole Latvia took part. Shunmyō Masuno had sketched the View Terrace in his project, therefore in 2009 the "Koknese Foundation" organized the project tender for students of the Art Academy of Latvia and Riga Technical University. The jury evaluated 24 applications. The prospective architects from Riga Technical University Laura Laudere and Didzis Jaunzems together with their cooperation partner architecture office "Jaunromāns un Ābele" won. During the Forest Days, President of the Republic of Latvia Valdis Zatlers with his spouse Lilita Zatlere planted an oak-tree.

In spring 2010, a temporary information building, where to meet visitors and introduce them with the project, was made in the Garden of Destiny. The main event of the year in the Garden of Destiny was the beginning of the Amphitheatre construction on April 15. More than 500 stones from different parts of Latvia were delivered for the stone layer "Silver Sunset". In 2010, Didzis Jaunzems and Laura Laudere in cooperation with architects from the architecture office "Jaunromāns and Ābele" Mārtiņš Jaunromāns and Māra Ābele developed the technical project for the boat marina with the View Terrace in the riverside grove of the Daugava. The jury marked the pavilion's successful blending with the landscape of the Daugava and its intimate link to the nature. "JMI Birojs" Ltd. and Juris Marnauza offered their solution for the river bank reinforcement as a donation. In the summer, using the material, excavated in the part of the Amphitheatre, the "Little Mountain" (*Fig. 8*) was made. According to Shunmyō Masuno's plan, on the hill a spiral memorial house will be built, in which visitors will be able to climb the spiral stairs in order to look at 60 000 perished for Latvia people’s names engraved on the walls. The technical project for the House of Silence, which will be a place for contemplation and memories, was developed by students of Riga Building College, who intended their work as a donation to the Garden of Destiny [1]. Several lists of the politically repressed people have been made, but the information has not been collated yet to show anybody an available and clear list. On November 18, 2010 a presentation of the work accomplished during that year was demonstrated. The founder of the “Koknese Foundation” Marta Vītola was awarded the title of the Honorary Citizen of Koknese.

On January 20, 2011 a bonfire was kindled in the Garden of Destiny to commemorate the ones who were killed during the barricades in January, 1991. In 2011, it was planned to develop the five zones designed by landscape architects and planting of trees on the prepared relief was continued. Plants are the flesh of any garden. In Japanese gardens the main material is a stone in a form of gravel and pieces of rock of different sizes. In rock gardens there are plants – grassy plants and moss or groups of trees. In a single Japanese garden, a rather limited set of plants is usually used, although the wild flora of Japan is by no means poor. Many species that are often used in the world’s horticulture originate from the Japanese archipelago. Usually in the garden several plant species are repeated many times, which in the best way affects the colour unity, general integrity and rhythm of the composition. In the Japanese garden, little attention is paid to plant diversity and overseas, rare or valuable species. Preference is always given to native species of trees, shrubs and grasses. The main structural tree is a pine – a symbol of happiness and longevity. The base of the Japanese garden is most often coniferous, including “black pine” and “red pine”. Plants are often used as carriers of a symbolic load, closely related to spiritual and physical life.

In 2012, the first 1 000 stones were cobbled in the path of the Apple-tree Alley. The path was covered with grey pavement (*Fig. 9*), applying boulders, which were searched for all over Latvia. Mostly the dark grey ones were necessary, which were envisaged in the design of the Garden of Destiny (*Fig. 10*). First of all, they were looked for in the nearest neighbourhood, as transportation of big stones is expensive.


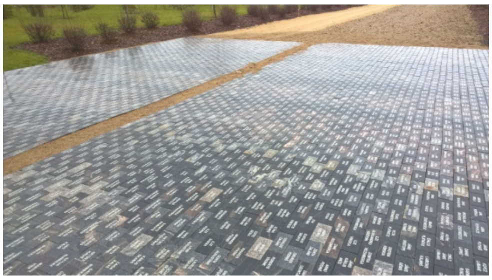

Fig. 9 The first stones, cobbled in the path of the Apple-tree Alley (source: [http://laikraksts.com/raksti/foto/LL258/Liktendarzs_394.jpg)](http://laikraksts.com/raksti/foto/LL258/Liktendarzs_394.jpg)

Fig. 10 The path was covered with grey pavement (source: https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQtm8eUObMZ533QfKEtvsQBly5zGbgxoBRvbPt5cuiB8Q05HYAiVQ)

In 2012, all pupils from comprehensive and vocational schools of Latvia were invited to prepare little plates of wishes for the Anniversary of Latvia. Five best ones from every school of Latvia were sent to the “Koknese Foundation”, which received in total 334 dispatches with 1 739 plates that on November 9 were placed in the Garden of Destiny. Next year everybody was invited to proceed with the tradition, started by pupils, and leave their wish to Latvia (*Fig. 11*).

Fig. 11 Everybody was leave their wish to Latvia (source: http://www.ovg.lv/sites/default/files/Liktendarzaa3.JPG)

In August, “Dreamway” Ltd. under Andris Ozoliņš’s guidance started to build the View Terrace (*Fig. 12*), architecturally conforming to the forest relief of the Garden of Destiny, which is the result of lots of people and countries’ good will and cooperation, where one can feel the flow of time and find their strength.

Fig. 12 The roof of the View Terrace for looking at the River Daugava (source: https://www.designboom.com/wp-content/uploads/2014/02/DJA-view-terrace-+-pavilion-designboom03.jpg)

When looking at the river of destiny from the terrace, it is possible to see a picturesque view over the Daugava. The View Terrace, which is one of the most with love replete objects (*Fig. 13*), is an often-chosen venue for wedding ceremonies by new couples.

Fig. 13 Interior view of the View Terrace (source: [https://images.adsttc.com/media/images/534b/740f/c07a/8005/6100/0097/large_jpg/View-Terrace-13.jpg?1397453823)](https://images.adsttc.com/media/images/534b/740f/c07a/8005/6100/0097/large_jpg/View-Terrace-13.jpg?1397453823)

Two paths take to the terrace (*Fig. 14, 15*), which wind on two levels – one of them reaches the Daugava, but the other one merges with the building and takes to the roof of the View Terrace. The first permanent building of the Garden of Destiny – the View Terrace (*Fig. 16*), which was opened for public on November 9, received the Latvian Architecture Award. The greenery of the terrace was made by Romāns Streļčūns, the specialist from Dendroflora Department of the National Botanical Garden of Latvia and project manager Bruno Cīrulis. The photo of the View Terrace was published in the international landscape magazine "International New Landscape" in the autumn, 2015.

Fig. 14 Two levels of the View Terrace (source: http://travelnews.lv/gallery/5672/mid_129345.jpg)

Fig. 15 Two paths take to the terrace (source: https://inhabitat.com/wp-content/blogs.dir/1/files/2014/03/View-terrace-and-Pavilion-DJA-2.jpg)

Fig. 16 The Garden of Destiny and the View Terrace in wintertime (source: http://www.fold.lv/uploads/2013/05/LAS-Liktendarza-paviljons1-1007x706.jpg)

Not far from the View Terrace, the Hiroshima Peace Stone (*Fig. 17*), presented to the patron of the Garden of Destiny, President of the Republic of Latvia Valdis Zatlers, was placed on May 25, 2010, which is calling for peace all over the world. The unique heart-shape boulder, chosen by sculptor Ojārs Feldbergs – the Heart Stone (*Fig. 18*), has become the symbol of love of the Garden of Destiny and beloved place for wedding ceremonies. It calls you to feel the energy of stones accumulated through centuries and enjoy the picturesque landscape. Not far from there the Wedding Grove has been created, where newly-weds plant threes on their special day.

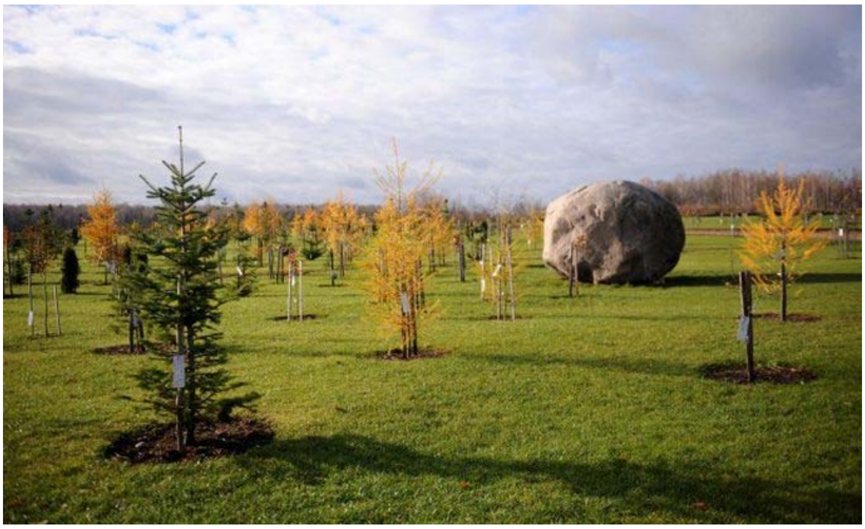

Fig. 17 the Hiroshima Peace Stone (source: https://f8.pmo.ee/linKunoCAtkiZ6deTwrtYAbJhzY=/685x410/smart/nginx/o/2018/07/04/7998401t1h64d6.jpg)

Fig. 18 Architects Shunmyō Masuno and Andris Kronbergs and he Heart Stone (photo by Jānis Brencis)

The apple trees of the Destiny Garden's Friends Alley, which stretch their branches over the cobbled path, are overseen by the leading specialist of Institute of Horticulture, Doctor of agronomy Māra Skrīvele, and in the autumn 2011, the first fruits was harvested. On November 18, the path of the Apple Alley towards the Amphitheatre was illuminated for the first time by the initiative and support of the "Dreamway" Ltd.

In 2013, paving of the Apple-tree Alley, planting of the Destiny Garden's Grove, construction of the car parking and the Amphitheatre, in whose centre Shunmyō Masuno placed ten big boulders from Latvia, were continued. In the Japanese garden, stones are used to imitate wildlife and they are designed to evoke associations with natural landscapes. The garden creator must be able to see the beauty of nature and in an ideal way to create it in the garden space. Abstract compositions that have nothing in common with the natural landscape are endowed with powerful symbolism that leads the mind far beyond the limits of the garden fence to philosophical depths and spiritual heights. Large stones can be a visual obstacle – to divide, complicate the space, close unwanted species, protect from the wind or someone else's gaze. Stones can be a neutral background (*Fig. 19*) for other elements of the garden, serve to fix the shore or slope, hold and mark turns of the water channel, mark and make more natural changes in the direction of paths and adjust the speed of movement, on the stairs and ramps prevent soil flushing.

The stone, located separately from the others, must be with character, so that one would like to look at it. Raw and processed stones are used for paving and bridges. From 2013 till 2017, the Latvian Association of the Politically Repressed Persons together with 72 members of Latvia municipalities planted 40 oak-trees. In order to commemorate the politically repressed ones from their towns and regions they formed the guard of honour around the Amphitheatre (2010–2018), which concentrates in itself the blooming love of the Apple-tree Alley, eternal peace of the stone layer and power of the donated stones and separates symbolically the past and future part of the garden. The grey stone layer "Silver Sunset" around the Amphitheatre consists of more than 50 000 boulders (*Fig. 20*), which were taken there by inhabitants of Latvia for their relatives and family remembrance. The River of Tears (*Fig. 19*) flows along the external side of the stone layer (*Fig. 21, 22*) and symbolizes victims' tears and faith that what happened in the past will never ever recur. To arrive in the heart of the Garden of Destiny, one has to let the river with its eternal and soothing water flow to find consolation.

Fig. 19 The model of the Amphitheatre (source: [http://www.alausa.org/media/files/infogram-sep-2015/liktendarzs.jpg)](http://www.alausa.org/media/files/infogram-sep-2015/liktendarzs.jpg)

Fig. 20 Stones can be a neutral background (source:

http://visitkoknese.lv/sites/default/files/tourism_object_images/004_Liktendarzs_Ainars_004.jpg)

Fig. 21 Amphitheatre consists of more than 50 000 boulders (source: www.lv/liktendarzs)

Fig. 22 The stone layer (source: https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQTIwBd8AUHBGRUabJVH_m3XmZVpiXa94Og5FyCaj3So70MiFqV5w)

In the Garden of Destiny not far from the Apple-tree Alley, in order to honour the most outstanding athletes' of Latvia remembrance, a special memorial was made with the Latvian Veterans & Seniors Sports Association and Latvian Sport Museum's initiative and support. On July 13, 2013, the memorial "For Athletes of Latvia – Victims of Different Repressions" was consecrated by Priest of Koknese Evangelic Lutheran Church Valdis Baltruks. "The Garden of Destiny is necessary for the small Latvia in order to commemorate the victims having suffered from superpowers. I have also suffered – my father was shot by a Russian soldier already after the capitulation on May 14, 1945. I have planted an apple-tree for my dad in the alley," said the outstanding Latvian sportsman, Olympic Champion (1968) in the javelin Jānis Lūsis. The "stone gardener" Ojārs Feldbergs felt honoured after being invited to create the memorial, which consists of eight boulders particularly chosen and placed by the sculptor. The words written by Latvian poetess Ārija Elksne (1928–1984) on the memorial plate in the sculptural group "From them inextinguishable foot of light" can also be read in the title of the book dedicated to Latvian sports workers and athletes having suffered from repressions. “The goal of the publication is confirmation of dignity to the hundreds of people who represented Latvian sport in different historical conditions. Today we are proud of 1 331 medals which in the Olympic Games, World and European Championships and Cups during 1912 to 2012 have been won by Latvians and athletes of Latvian origin. We are proud of 537 Olympians, 27 Paralympians, who during 30 years have won 30 gold, 50 silver, 28 bronze medals,” the opening address, written by President of the Latvian Veterans & Seniors Sports Association Daumants Znatnajs, was read by experienced sports journalist and commentator Gunārs Jākobsons.

In 2014, strengthening of the Daugava bank was implemented and the Central Entrance of the Garden of Destiny was opened. The physical distance between stones and groups of plants not only divides, but also connects them, provides an ensemble perception, because it should not be too small – then it turns into a gap, and also should not be too large, because in this case it loses the connection between objects. To make the journey seem long, the small space between the Central Entrance Gate and the main object includes not only the winding path itself, but also a system of symbolic thresholds, each of which is intended to raise and sharpen the feeling of distance and penetration into more and more internal circles of the world. The first threshold coincides with the entrance to the garden and separates the garden from the outside world. Guests are given time to finally bring the spirit and thoughts in a reliable state in order to achieve inner harmony and tune in to peaceful perception of spiritual realms. Particular attention is paid to aesthetic qualities and the device of the road leading to the main object. The symbolic threshold beyond which the sense of unity between those is added to the transcendental purity of the spirit – is an expectation. Guests participating in the ceremony, halfway between the Central Entrance to the garden and the Amphitheatre, will pass from the external garden through the next, middle threshold, and enter the internal space. Having gone all the way with his real and symbolic thresholds, ablutions and bows, the guest enters the Amphitheatre as a completely different person – not who he was outside the garden gate a few minutes ago. His spirit is calm, and his senses are refined and tuned to the perception of matter, inexpressible in words.

In 2015, the campaign of earth collection for the 12,5 m high Big Mountain was started in order to create it between the Friends Alley and the Grove. The shape of the Big Mountain will reflect the passage of time and nature – its southern slope will be adorned with a mixedwood forest, but the northern slope will be covered with a meadow of wild flowers from Latvia. In winter the flower field will symbolize the past, but in spring – the life energy and courage to unfold for the future. In 2015, reinforcement of the Daugava bank and construction of the car parking for visitors were completed. On the 100th Anniversary of Latvian Rifle Regiment Establishment, sculptor Ojārs Feldbergs with the support of the Ministry of Defence of the Republic of Latvia and the Art Academy of Latvia, creating the memorial for riflemen in the Grove of the Garden of Destiny, in the trenches, which still have remained next to the road as a reminder of World War One, placed boulders from Latvia, which symbolize Latvian riflemen. The memorial has two parts: a composition of Latvian boulders, symbolizing the ones who stayed at home, and a line of boulders placed in trenches symbolizing Latvian riflemen. The memorial was opened by Minister of Defence of the Republic of Latvia Raimonds Bergmanis on August 8, 2015. In the Garden of Destiny (*Fig. 23*) oak-trees were planted by presidents of the Republic of Latvia Andris Bērziņš and Raimonds Vējonis with his spouse Iveta Vējone.

Fig. 23 Overview of the Garden of Destiny in 2015 (photo by Gatis Balodis)

An asphalted road section of the historical Riga-Moscow highway takes to the Friends Alley of the Garden of Destiny, and it gets "interrupted" in front of the entrance into the Daugava Bay opposite the church. In the 1960s before the Pļaviņas Hydroelectric Power Station construction it took further up the hill past Koknese Castle Ruins. In 2016, according to the project developed by the design office "ARHIS," construction of the multifunctional public building (2016–2018) on the side of the highway opposite the church was started with the support of the parliament of the Republic of Latvia. This building has been made like a hill or beginning of a bridge (*Fig. 24, 25*) and it symbolically expresses the idea of the Garden of Destiny – the national path from the past to the future. The building's roof will be a place for walking and an viewing platform overlooking the garden and the Daugava. In the public building there are planned two conference and event halls, a café and restaurant, which will provide an opportunity to organize concerts and other activities all through the year. Natural ventilation, application of the earth heat and solar energy has been envisaged in the engineering solutions. The local material – dolomite will be used for the wall finish on the north side of the building, but the south façade will be put in glass. At the façade turned towards the garden, the Wall of Wishes with more than 2 000 plates of wishes to Latvia has been created. Here everyone can leave a wish to Latvia and Latvian nation. Good wishes in exchange of donations are added to the wall and closely next to each other are waiting for a better tomorrow.

Fig. 24 Construction of the multifunctional public building (source: https://pbs.twimg.com/media/Da44HK0X4AEBk9B.jpg)

Fig. 25 The multifunctional public building (source: http://www.staburags.lv/uploads/thumbnails/680x455/articles/2016/11/142663__581f44f2b2f7b.jpg.jpg)

Formation of the Big Mountain was commenced by the help of the Latvian Environmental Protection Fund and the Ministry of Environmental Protection and Regional Development of Latvia. The top will be a place where everyone can observe the Daugava and surrounding landscape of a garden. For the mountain formation 169 160 m^3 soil of different structure was necessary. In 2016, supporters of the Garden of Destiny delivered about one third of the necessary soil. Every soil charge was registered. The Big Mountain will be decorated with flowers from the Latvian meadows and a grove. The garden, in spite of the lasting draught in 2016, gave us joy not only with the clear blue waters of the Daugava and changeable gradations of the sky. It also gave us joy with its saturated green shades. When looking from above at photos taken by the Japanese language teacher, translator, an active supporter of the Destiny Garden's development Uģis Nastevičs, one can see small oak-trees, apple-trees, fir-trees, rowan-trees, maple-trees and other trees, which remind us of pins in the green grassy plaid and after warm spring winds and mild sunshine grow vivacious. The Big Mountain of Meadow is waiting for its turn to become mightier. However, the biggest pleasure was for the 14 128 paved grey cobblestones, sawed from Latvian boulders, that decorated the Apple-tree Alley, creating an original belt of patterns. The path of cobblestones symbolizes the national community in the past, present and future. Engraving took the most of time, thus, starting from July 1, all notified cobblestones were handed over to masters, thus supplementing the road to the Amphitheatre (*Fig. 26*). Using 18 265 cobblestones, one fifth of the path was paved in 2016. However, more than 114 000 grey cobblestones with donators, their relatives and friends' names were necessary for the profoundly symbolical eight-metre-wide and more than 200-metre-long Friends Alley. Board member of the "Koknese Foundation" Bruno Cīrulis: "The Garden of Destiny is a place where we can find consolation to the past, obtain strength for the present and inspiration for our future dreams. It is a place which we are creating for next generations – the future of Latvia. The Path of Friends, in which we have a chance to incorporate cobblestones with people's names, will give the Garden of Destiny a special value. Each cobblestone is like a message, in which we will feel who we were yesterday even after several years. We are glad about every family, sports team and work group, who contribute to the sense of community and thoughts about Latvia in the Path of Friends."

Fig. 26 Overview of the Garden of Destiny in spring 2016. An outstanding environmental architecture with nature of the island and beauty of the Daugava's flow have been combined (source: http://g1.delphi.lv/images/pix/659x380/XNBs0IPxjhI/liktendarzs-2016-gada-pavasari-3-47440561.jpg)

During March 24 till April 2017, the campaign "Record Your Name in Latvia!" took place, and cobblestones with all presidents of the Republic of Latvia and their spouses' names were added to the Friends Alley. A special event was the opening of the Pedestrian Bridge on the right side of the Amphitheatre. Thanks to the funding of the Riga International Rotary Club and Jurijs Šteinbuks's initiative, the Pedestrian Bridge was made, so that it would be easier for visitors to reach the View Terrace. The central object of the "Memorial Zone" is the digital exposition Liktens Gāte or the Patyh of Destiny, which consists of 12 symbolical informative stops, and each of them is dedicated to a turn in the 20th century destiny of Latvia. Each historical event is supplemented with people's life stories. The exposition has been made in cooperation with philosopher Artis Svece, Head of Latvia National Library Information Service Sector Ginta Zalcmane and "DD Studio" Ltd. The Patyh of Destiny was opened on the day of the donation campaign "Let there be the Latvian Garden of Destiny! Tell Us about Your Grandfathers" by Latvian Television on June 17, 2017. The digital path takes to the memorial site dedicated to the people lost for Latvia and having suffered in repressions in the 20th century. The exposition will be placed in the environment. However, broader information will be available on the mobile gadgets. The content will be available only on the spot, it will not be possible to study it sitting at home, – you will have to go to the Garden of Destiny. At the moment the visitor, when walking, will come to the virtual House of Silence. Nevertheless, it is planned to build a real house according to the Garden of Destiny architect's intention. In the House of Silence there will be a list of the people's names: we commemorate all who have perished for Latvia during the 20th century – the ones who suffered from repressions, perished in the war conditions, were forced to leave their fatherland and became refugees or died, resisting the violent totalitarian regimes. On November 18, in the Friends Alley it was possible to see all till September 24, 2017 registered cobblestones, on which donators' names are engraved.

In spring 2018, the registered cobblestones during the campaign "Warm up Latvia" were added to the Friends Alley. In the society beloved musicians Kārlis Kazāks, Jolanta Gulbe, Aija Andrejeva, Jānis Holšteins Upmanis, conductor Ints Tetarovksis, athletes Raimonds Bergmanis, Aigars Apinis and their coach Aldis Šūpulnieks, the Dukurs Family and the Lūsis Family. The team of ice-hockey Club Dinamo Riga have manifested their support to one of the most beautiful and extensive projects of the Garden of Destiny with their cobblestone. "The personalized cobblestone can be a great form how to thank to people who have supported us or helped altruistically to others. It can be a sincere Christmas present to friends, relatives and colleagues or an opportunity to create own family's message for the future generations. We would like to believe that supporters' names, which will be paved in the road of the Friends Alley, will be able to create an impression about the today's value of Latvia, its inhabitants – strong families, beloved athletes, creative personalities and unselfish people," thinks Zita Siliņa, head of the trade centre "Galerija Centrs". In 2018, construction of the multifunctional public building, the virtual House of Silence with the digital path, the Amphitheatre, the Big Mountain of Meadow and the Friends Alley were completed. The Garden of Destiny was opened on August 11, 2018.

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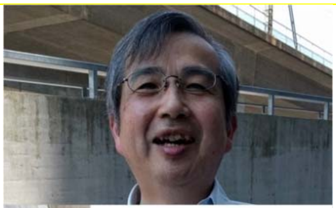


2D Generative Faces for Evolutionary Social Simulation (Installation)

Topic: (Art)

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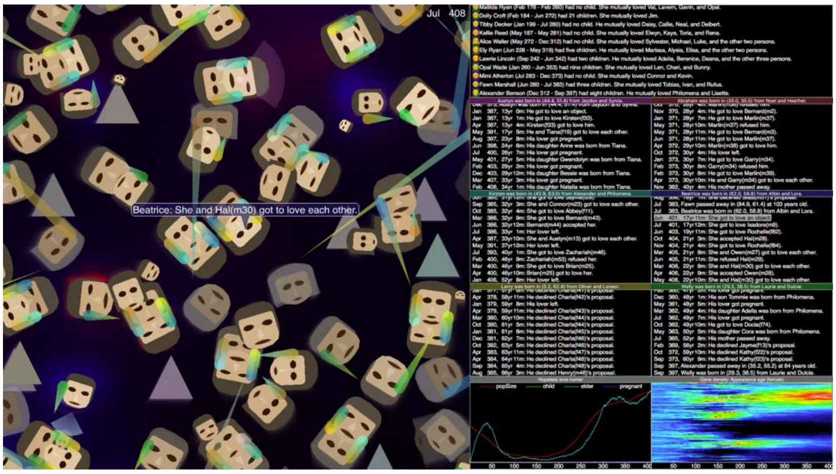
Abstract

The simulation of crowds constitutes a useful technique for improving the appearance of CG animations in films and computer games. Since it would look weird if the faces of all the simulated people look exactly the same, there is a need to develop generative algorithms that can automatically generate a wide variety of individual faces. Such algorithms are not only useful for the purpose of interacting with simulated characters such as in computer games but also for observing and understanding activities and events in social simulations.

In our previous work about a simulated evolutionary human society [1], each person was drawn as a simple two dimensional polygon with two colors. In this revised version, the visualization renders each person as a simple face. Similarly to the previous simulation, each person's face is drawn in such a way that a human observer can easily deduce the underlaying hereditary traits coded within the genome of the corresponding person.

While the number of parameters for drawing a visual representation of a human face is potentially enormous, our simulation employs a highly simplified visualization method that requires only five genetically encoded scalar values for drawing a face. Four of these parameters are mapped to the deformation of the face shape, and the fifth parameter affects the tanning of the skin color. The age of the simulated people also affects the shape and color of their faces.

The computational cost for rendering these faces is sufficiently low on a PC that is equipped with a recent GPU to allow the display of more than six thousands agents during each simulation step while preserving a smooth frame rate.



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Key words: face generation, evolutionary society, 2D CG

Main References:

[1] T. Unemi and D. Bisig, "*Rapid Biography in a Society of Evolutionary Lovers*," in Proceedings of the 20th Generative Art Conference, Ravenna, Italy, 2017.

2D Generative Faces for Evolutionary Social Simulation

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Premise

The simulation of crowds constitutes a useful technique for improving the appearance of CG animations in films and computer games. Since it would look weird if the faces of all the simulated people look exactly the same, there is a need to develop generative algorithms that can automatically generate a wide variety of individual faces. Such algorithms are not only useful for the purpose of interacting with simulated characters such as in computer games but also for observing and understanding activities and events in social simulations.

In our previous work about a simulated evolutionary human society [1], each person was drawn as a simple two dimensional polygon with two colors. The shape of the polygon represents the sex of the person and the colors form part of a system of hereditary traits for appearance and aesthetic preferences. In this revised version of the social simulation, the visualization renders each person as a simple face. Similarly to the previous simulation, each person's face is drawn in such a way that a human observer can easily deduce the underlaying hereditary traits coded within the genome of the corresponding person.

The following sections describe the mapping between genetic information and rendering parameters, efficiency of rendering process, effects of visualization, and alternative drawings not by polygons but pixel-based images.

1. Parametric face shapes

In a real living organism, its physical appearance emerges through a complex morphological process of growth during which the underlaying genetic code only plays an indirect role. In our simulation, we omit this complicated process and employ a direct mapping between the genetic code and the drawing parameters of the face. While the number of parameters for drawing a visual representation of a human face is potentially enormous, our simulation employs a highly simplified visualization method that requires only five genetically encoded scalar values. Four of these parameters are mapped to the deformation of the face's shape. The left-hand side of figure 1 shows the variation of adult male faces with respect to concentration and spread. A face at the center in this figure is created from mean values of these parameters. Facial elements are represented by polygons that possess a fixed number of vertices. In order to realize the deformation, the following function f is applied to the original x and y coordinates of each vertex to reposition them.

$$f(x) = \frac{\alpha x}{1+(\alpha-1)|x|}, \alpha = \beta^{g}(g \in [-1,1], \beta = 2) \qquad (1)$$

The origin of the coordinate system is assumed to be at the center. The coordinate range of the drawing area is [–1, 1] in each axis. The parameter g controls the amount of concentration. For a g value of –1, the face is mostly spread. For a g value of 1, the face is mostly concentrated. The coefficient β adjusts the maximum deformation rate in the range of [1, ∞].

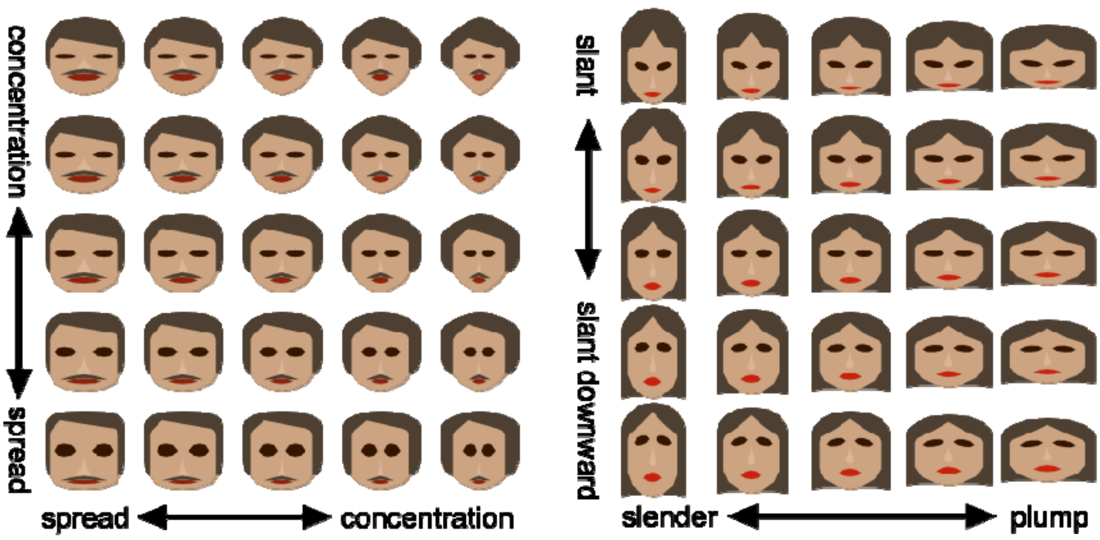

Fig 1. Left: Variation of male adult faces with respect to concentration / spread in the horizontal and vertical direction. Right: Variation of female adult faces with respect to plumpness and slant.

The right-hand side of figure 1 shows the variation of adult female faces with respect to plumpness and slant. The former variation is realized by simply adding a linear offset to each vertex coordinate according to the following equations.

$$\Delta x = \eta k, \Delta y = -\eta k, (k \in [-1,1], \eta = 0.2) \qquad (2)$$

The parameter k controls the amount of plumpness. For a k value of -1, the face is mostly slender. For a k value of 1, the face is mostly plump. The coefficient η adjusts the maximum deformation in the range of [0, 1]. The latter deformation is achieved by shifting the vertical coordinate y according to the following equation.

$$\Delta y = \gamma h max\left(0,1-(x^2+y^2)\right), (h \in [-1,1], \gamma = 0.25) \quad (3)$$

The parameter h controls the amount of slant. For a h value of -1, the face is mostly slanted downward. For a h value of 1, the face is mostly slanted upward. The coefficient γ adjusts the maximum deformation rate in the range of [0, 1].

The fifth parameter affects the tanning of the skin color. The age of the simulated people also affects the shape and color of their faces. The position of the eyes and the top vertex of the nose are lower during childhood. With increasing age, the left and right edges of a face shift downwards. The color of the hair gradually becomes gray and finally white once a simulated person reaches a senior age. To increase the visual difference among the sexes, we added a mustache to the face of an adult male older than 16 years. Figure 2 shows a variation of male faces with respect to aging and tanning.

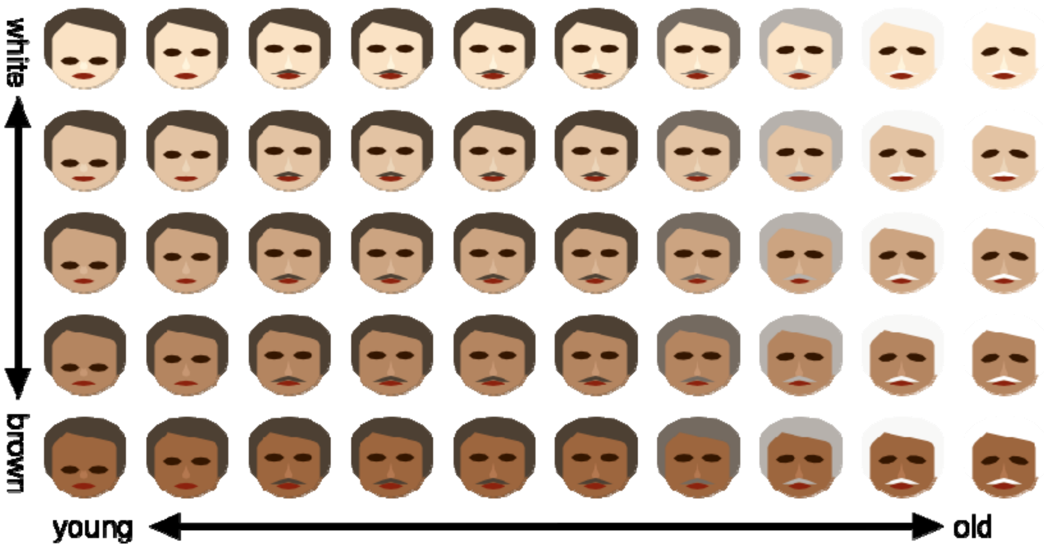

Fig 2. Variation of male faces with respect to aging and tanning.

2. Rendering efficiency

The computational cost for rendering these faces is sufficiently low on a regular personal computer that is equipped with a recent graphic processing unit. Such a computer allows the display of more than six thousands agents at each simulation step while preserving a smooth frame rate. However, it can be useful to further decrease the computational cost for example in order to achieve a smooth animation also on a low cost machine, or to reduce energy consumption, and so on. An effective method to increase drawing efficiency involves a reduction of the number of vertices for facial elements that are drawn at a small scale. For this purpose, we have prepared alternative polygon shapes whose number of vertices is almost half of the original ones. The original shapes contain a total of 146 vertices for a male face and 150 vertices for a female face. For the reduced versions, the number of vertices was decreased to 78 and 74 for male and female faces, respectively. The number of vertices differ between the sexes due to the addition of a mustache for the male face and distinct hair shapes. As described in [1], the visualization possesses the capability to render the 2D animation at an arbitrary zoom factor. When zoomed out, it is effective to show the reduced face versions, whereas the normal versions are shown when zoomed in. Figure 3 illustrates the differences between normal and reduced shapes for male and female faces.

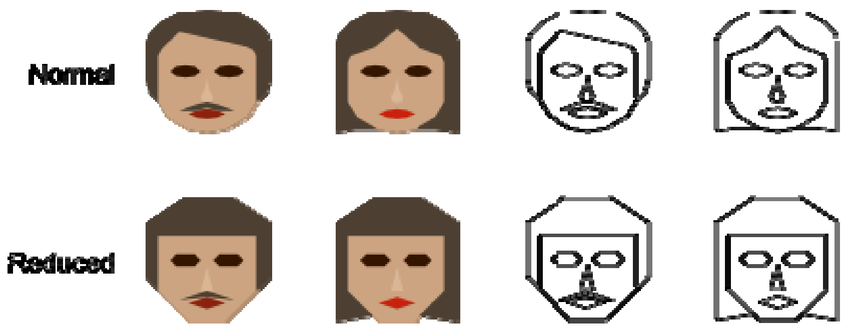

Fig 3. Normal and reduced shapes for male and female faces.

3. Effects of visualization

As has already been demonstrated in [1], the separation of appearances between different sexes is promoted through an evolutionary process that exhibits a selection pressure based on the reproductive advantage of heterosexual couples. This phenomenon becomes apparent in the simulation when observing the differences between facial characteristics of men and women drawn on the screen, even if these characteristics don't appear as particularly natural when compared to real humans. The visualization also reveals a racial separation that becomes apparent as an uneven distribution of colors when observing the entire population. Figure 4 shows an example of a population after 2,000 years of evolution. In this simulation, the parameters that specify face shapes are sex-influenced, but the skin color is not. We can observe a spatial separation of the skin colors. A comparison of two different magnified regions within the simulation (see figure 4) highlights that the different characteristics of male and female faces are race dependent. In the middle image, men appear slender and with slightly slanted eyes whereas women appear plump and vertically concentrated. In the right imaged, men appear with thin eyes and women possess bigger eyes. The size of the eyes is not directly controlled by a genetic parameter but results as a consequence of the vertical spread / concentration of a face.

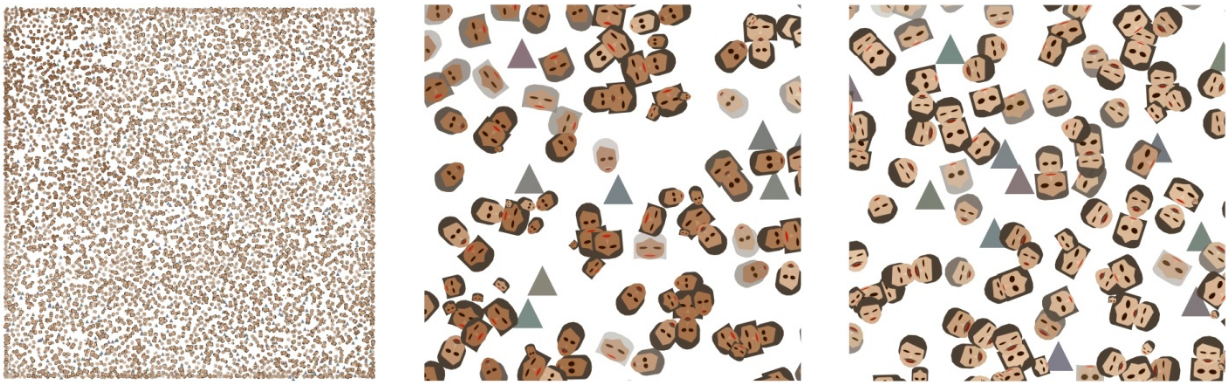

Fig 4. A sample population after 2,000 years of simulation. From left to right: view of the entire population consisting of approx. 6,000 people, magnified view of the top left area, and magnified view of the middle bottom area. Gray triangles represent objects.

4. Utilizing pixel-based images

In general, there exist two distinct methods for drawing 2D visuals by a digital computers. One method employs numerical vectors for representing positions and colors. The other method employs a 2D grid of colored pixels. A vector representation offers the advantage that visuals can be drawn at an arbitrary scale without introducing visual artifacts such as jagged lines. On the other hand, a pixel representation permits the rendering of detailed textures and smooth color gradations both of which are essential for displaying digital photographs and sophisticated paintings.

To examine the possibility of an alternative visualization method, we introduced a pixel-based face representation. The previously described equations for face deformation are still applicable. For this type of visualization, the equations modify the position at which color values are sampled within the pixel array of the original face image. The coordinate values of the sampling positions are calculated using the inverse function of each equation. The higher computational costs for calculating the inverse functions can be alleviated by running the calculations within a shader program on a graphics processing unit. Following this approach, it is possible to render each frame at a frame rate that is sufficient for a smooth animation.

For our first trial, the face images in Emoji characters were examined. Figure 5 shows examples of deformed face images for adult males and females. Apple's Emoji character set includes seven faces for different ages and genders; that is, baby, boy, girl, adult man, adult woman, elderly man, and elderly woman. The Emoji characters also exist in five different skin colors. To realize a continuous variation of skin colors, a face is rendered as a composite image of white and brown skins whose respective appearance is controlled by a blending factor. Unfortunately, there currently exists no method for continuously changing a face with respect to age. As a consequence, a face shape changes suddenly at the boundary of each age span.

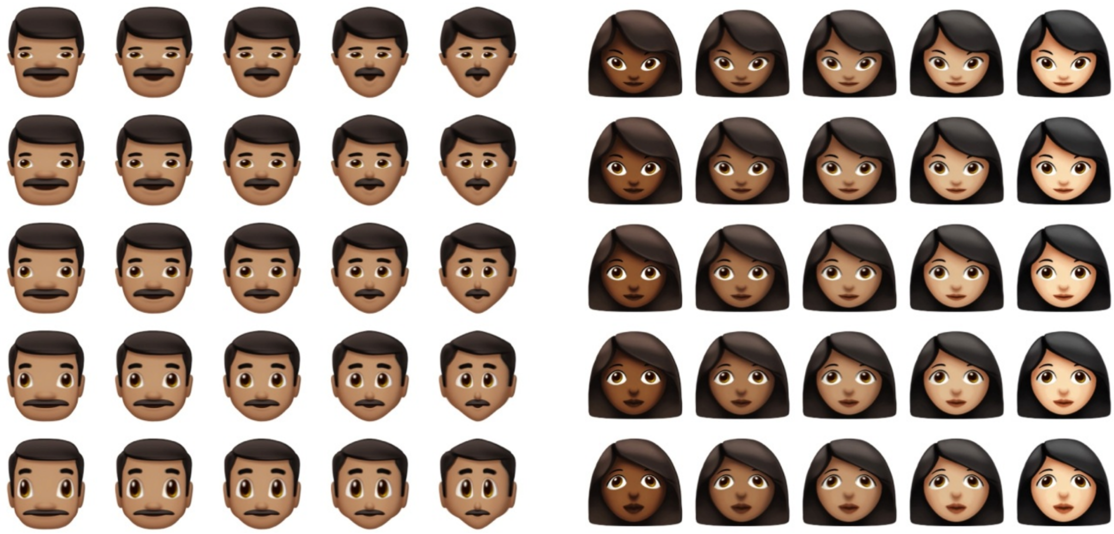

Fig 5. Face variation using pixel-based images extracted from the Emoji character set of Apple's macOS 10.12.

5. Related works

Research on parametric representations of human faces has been conducted within several fields and with different objectives. Chernoff's 2D face [2] provides a useful and intuitive method for clustering by expressing vector data as parametric 2D face shapes. This method can be used to express a maximum of 18 parameters. Typical examples described in [2] include the representation of fossil data (8 parameters), nummulite specimen (6 parameters), and mineral content (12 parameters). The currently most active research field deals with the animation and variation of facial expressions in 3D. One of the most canonical publications that describes this approach can be found in [3]. Due to recent improvements in computational power and machine learning techniques, it has become possible to generate realistic facial animations from a few training examples [4]. While the issue of drawing efficiency is generally considered to be important, the criteria of what constitutes an acceptable computational cost varies greatly between different applications. When a computer that offers higher computational performance becomes available for us, it might become feasible to extend our visualization by rendering each agent as 3D figure with full body and garments.

6. Concluding remarks

In this publication, we described an extension to our simulation that allows to render each agent with a face shape. The current version uses only six parameters to alternate the appearance a face. For future versions, it might be interesting to expand the diversity of face shapes for instance by including parameters for controlling the ratio between a face top and bottom width, and the scales for each individual face elements. By increasing the diversity of face shapes, it would become feasible to display emotional expressions. These expressions could appear in response to the occurrence of important events in the simulated society such as birth, proposal, acceptance, rejection, separation, and death. Though these extension would also make it possible to render the faces in a more realistic manner, an increase in realism is not necessarily our main aim since it likely less effective in provoking the imagination of the audience. Rather, we are hoping to improve the uniqueness and artistic value of our installation.

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Pisanello, St. George and the princess, 1437, St.Anastasia church, Verona. Detail of the Princess.

LIVE PERFORMANCES

Moments: Monochromatic
(Performance)

Live cello and generative music system (musebots) Artists:

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Nicola Baroni University of Bologna, Bologna, Italy nicola.baroni@fastwebnet.it

Abstract
Moments is a generative artwork that explores Moment-form, a term coined by Stockhausen to describe music that avoids directed narrative curves, and instead exists within stasis. Created by ensembles of musical agents – musebots – that assume musical roles in both the creation and performance of each 10 minute composition, each generated work is unique, mercurial, yet compositional – rather than improvisational – in nature.

Moments : Monochromatic explores how virtual musical agents can interact with a live musician, as well as each other, to explore a unique structure generated for the musical performance. Because the structure is generated at the beginning of the performance, musebot actions can be considered more compositional, rather than improvisational, as structural goals are known beforehand.

Important aspects (sectional points, harmonies, states) are communicated visually to the performer via standard musical notation. Additionally, the performer's live audio is analyzed by a ListenerBot, and translated for the virtual musebots, who can, in turn, attempt to avoid the performer's spectral regions, or become attracted to them.

Example video: https://youtu.be/Z8b8en-_VIY

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Key words: generative music, human-computer interaction

Quantum Chromodynamics Gadgety Simulation Performance

Algorithmic Live Music

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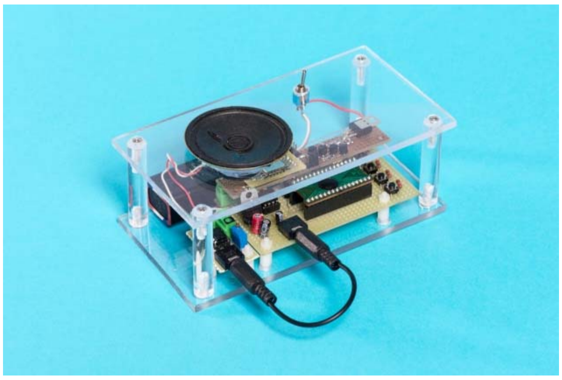
Gadgety Sound System (GSS) is a distributed system of musical modules for algorithmic live concerts. Instead of relying on a monolithic set of speakers and a single source of sounds, ***GSS*** synchronizes multiple autonomous inputs and analogue devices. Each loudspeaker is provided with its peculiar set of sounds: ADSR envelope generators, analogue filters, amplified electro mechanic devices...

Nodes behave on two different levels: on one they engage in a dialogue among themselves, propagating information throughout the system; on the other, they interact with humans, which by various means can alter their musical trajectory. ***GSS*** is a format for live algorithmical music which pushes the idea of *Algoraves* towards an explorative and participative version of *Networked Music Performances*.



Since the system is still under development, a simulation will be presented at ***GA2018***, using a series of oscillators based on the concept of *triolectics* (as opposed to *dialectics*). The idea, the paternity of which is shared by artist Asgern Jorn and psychologist Oscar Ichazo, led us to the creation of automata-like sequencers and effects, to build an emergent multi-scale composition, ***Quantum Chromodynamics Gadgety Simulation***, that will be performable in the Gadgety platform when it will be ready.

Quantum Chromodynamics Gadgety Simulation makes use of Pure Data, the FOSS real-time graphical programming environment for audio and video synthesis.

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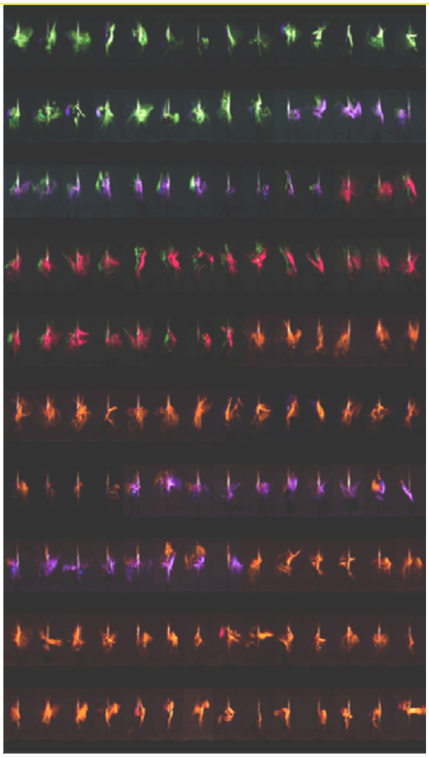
Key words: distributed systems, generative music



ALCHEMEDIA: FLOW-SONORITIES
(Live Performance)

Topic: (Art - Poetry)

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Abstract
This work aims to present an authorial creation method: the File Theatre, essentially derived from "practice-led-research"-"research-led-practice" process, at Digital Humanities Lab (Lhudi) - Mackenzie Presbyterian University. Lhudi is a result of more than 15 years of intellectual collaboration, mediated by technological devices for academic, artistic, cultural and scientific production. The lab (Lhudi) is part of Mackenzie Stricto Sensu Program in Education, Art and Culture History and aims to provide technologic and theoretical infrastructure to produce knowledge concerning the intersection areas between digital languages and the humanities studies. The File Theatre concept, in general, is about an algorithmic scene composition mediated by software using a previous file database in different languages (verbal, visual, sound) and from different artists. In this way, the File Theatre performance composition elements become algorithm variables, which will only compose a real scene in a "here-now" space-time. "Alchemedia: Flow sonorities" is a live performance derived from this algorithmic concept, in which different artists with their own perspectives and files, in different languages, compound a new scene complex resulting from collaborative perceptions and expressions.

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Key words: file theater, performance, algorithm, sound.

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EMBODIED SOUND INTERACTION
(Live Performance)

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Live performance of body-movement interaction with digital and generated sound. An increasing understanding from various research fields shows that body-movement affects the way we perceive and evaluate ourselves and the environment. Which raises new and challenging questions regarding embodiment, perception and interaction; in digital technological environments, virtual reality (VR), data-live and sound environments. This informs the aesthetic and technical design of embodied interactive audio visuals which is interdisciplinary and useful to digital research and human-computer-interaction (HCI). Full-body-motion tracking of x, y, z, co-ordinates of 22 body parts in the physical performance space; raw, pitch and roll data of all body parts tracked in motion, are utilized in simultaneous-interaction with 3-D motion-graphs and sound.

A theory of embodied interactive audio-visual data-live environments developed from analysis of user experience. Research found users' perception oscillated between proprioceptive and movement-vision, modes of perception and interaction. It was found that for these enhanced modes of perception during interaction, that proprioception was challenged and consciousness transformed. A series of software tools were developed for body-interactive 3-D visuals and analogue synthesizer modulation. The research expands existing knowledge in the fields of human-computer-interaction (HCI): digital media, augmented and virtual realities, embodied interaction, interactive audio-visuals, and new media theory.

artresearch@interactionalmedia.com

Key words: Interactive sound, embodiment, sensory, body-movement perception, body-active perception.

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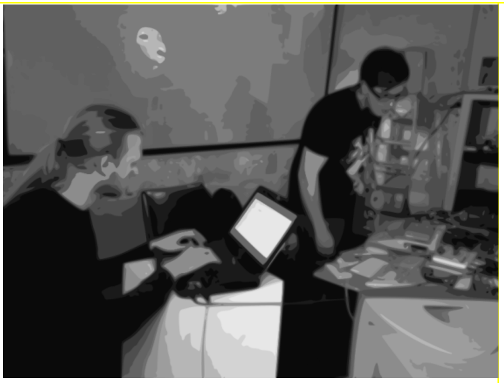


generative radio station
(Live Performance)

Topic: Art, Music

Author(s):

labora media
Germany

www.labora.media

Abstract
"labora media" is a group of artists and their mobile laboratory to create interactive media in real time with their own developed instruments, as independent as possible.

The "generative radio station" is a device that generates endless music and streams it local over a fm transmitter.
It is small, sensible and portable to react to different environments.
Listeners can connect to it and influence the style of music indirectly.

We use the generative radio station as a part of our invention called "radio caching" :
- Create a radio channel
- Stream it over a legal fm transmitter
- Let your audience know, how to listen to

info@labora.media

Key words: generative music, radio caching

TITLE: Transcape Disturbances

Topic: audiovisual live performance

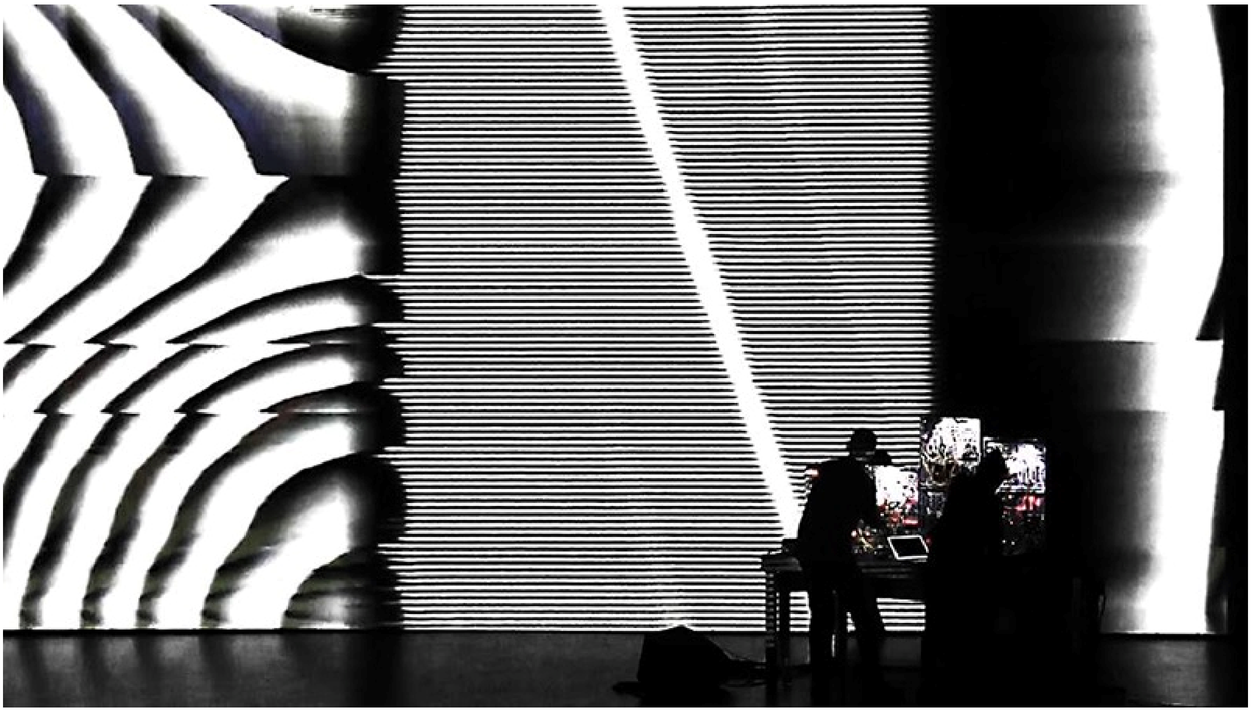
Authors:
Inire

Krzysztof Pawlik
Małgorzata Dancewicz
www.inire.net

Inire is a duo that focuses on formal explorations from the border of traditional composing, sound art, field recording, music collage and widely understood electroacoustics. They explore sound and image interactions and convergence.

Audiovisual performance *Transcape Disturbances* is built entirely from the sounds and images generated by voltage-controlled audio and video modular systems. Live composing creates here a structures in which music and pictures are subjected to mutual deconstruction. The range of what is visible affects what is audible, and vice versa. Intense structures, interacting and permeating each other explore here human and non-human acting in terms of music and video.

Interchanges of analogue audio and video harmonies brings human recipient aware of the constant immersion in the network of electromagnetic dependencies.



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Key words: audiovisual performance, voltage controlled audio and video

Main References:
https://culture.pl/en/artist/inire
https://vimeo.com/inirevideo/videos

TITLE : Apoptosis. The intersection of drawings, painting and animation. Live Performance, art exhibition

Topic: Art, Painting, Animation

Author:
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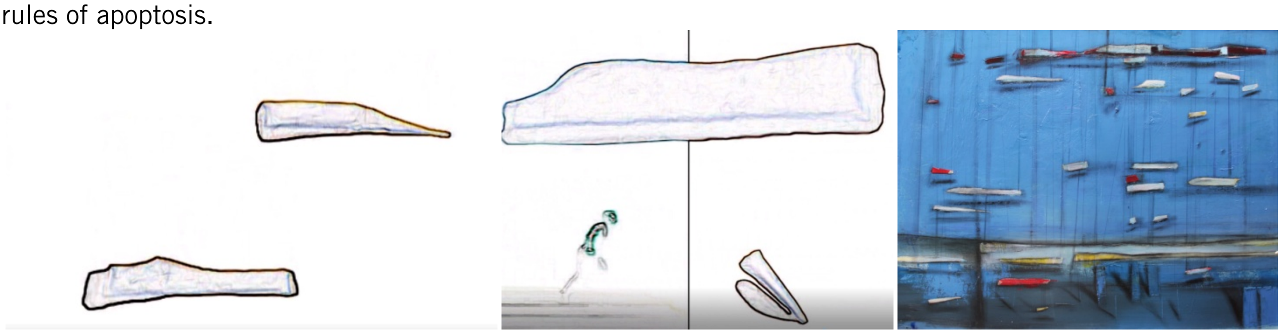
Abstract
Generative art as a direction of creativity uses tools that allow discovering new layers of expression of form and emotions influencing the recipient. The innovation of the technology in generating shapes and forms with the use of computer techniques gives new possibilities to interpret the structure of the artwork. Generative structures of the artwork can be also translated into its semantic features. Paradoxically, the used generative technique in forming art to become the main idea in the meaning of the artwork. Presented short etude called Apoptosis is such an attempt. The title refers to concepts known from biology. Apoptosis (Greek in the literal translation of leaf fall) is a natural process of programmed cell death in a multicellular organism. Apoptosis is a highly regulated and controlled process that confers advantages during an organism's lifecycle. Thanks to this mechanism from the organism worn or damaged cells are removed. Apoptosis can be compared to a planned, controlled cell suicide aimed at the development and evolution of the organism. The average adult human loses between 50 and 70 billion cells each day due to apoptosis. The term medical "apoptosis" itself refers to the evolutionary processes in biology is therefore close to the interpretation of the principles of generative art.
The performance created with the use of the generative software is a multimedia interpretation of the works of my easel painting. When I am painting in a traditional way, I define the rules of the composition based on single, autonomic shapes. Multiplying them in the painting space defines a whole set of rules and dependencies in the space of the canvas. In addition, I introduce a semantic factor and force the viewer to interpret the artwork. According to the definition of apoptosis term, the coded cell death, generates more life forms. The process known in biology illustrates the generative construction of the natural world. In my work, I revive elements of images in the form of animations. I try to show the death factor in a progressive, monotonous cycle of moving simple forms and sound. In certain sequences of animation, running human forms are introduced. Dehumanizing them and reducing them to simple forms, anonymous, devoid of identity, is to provoke statements that human life is subjected to the rules of apoptosis.



The artworks, live performance and article was carried out as part of statutory research no. S / WBiIŚ / 2/16 at Białystok University of Technology

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Key words: apoptosis, generative art, semantic art

Main References:

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TITLE
Live Performance

Topic: Music (Live Coding)

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Abstract
We are in a technological shift to deeply question the structural and formal boundaries of music through all the definitions it entails. Considering the possibilities that the rapidly developing technology provides to the contemporary artists in the field of creativity, the conceptual and functional definition of the musician must be reconsidered with the contribution of the technological developments. Musicians who can adapt themselves to current climate of rapid changing conditions, tend to expose performances that are focused on more audio and visual materials than in the past. In the hands of technology, sound which is formally the basic building block of music, can easily be transformed into various forms while the image brings itself forward to exist with it at every opportunity, and the musician can play a vital role in this change.

While the musician's journey of becoming him/herself is traditionally based on focusing academic theories and conceptions, today it is also shaped by the individual contribution of experimentation following the widespread possibilities of technological opportunities. The musician can easily access many musical instruments in the virtual environment while he/she is able to produce various compositions at the same time and can incorporate different production methods such as composing music with algorithm, live music coding, sound synthesis, sound sampling and sound synchronization with image. In an era where variety of contemporary musical forms exist, how should we depict sound and image components as being the main arteries of musical performances? How should we define the role of a musician who is utilizing technological instruments to constitute sound and image focused art pieces in terms of artistic performances?

RAW is an Istanbul based live coding duo creating Audio Visual Performances. Performances are composed of improvisational sonic structures accompanied with pre-programmed interactive visual materials. Visuals have been developed with core programming environments and various generative visual manipulations occur with data received from sound to interact with. Furthermore, RAW invites the audience to immerse into the performance visually with using additional top cameras, and code views projected on large displays. Sonically the audial experience moves into the fields of noise, electronic, techno, minimal and ambient genres with improvisational forms.

Video Links: http://vimeo.com/rawlivecoding
Web Site: http://rawlivecoding.com/

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Key words: Live Coding, Generative Visuals, Creative Coding, Music, Sound and Image

TITLE: Evolving Landscapes - Winterscapes (Live Performance)

Topic: adaptive animation, experimental animation.

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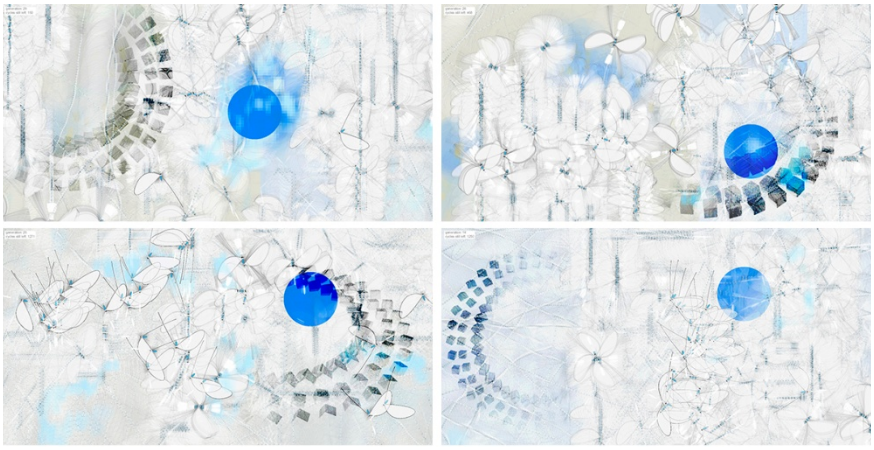
Abstract

Evolving Lanscapes-Winterscapes is an artificial live system that evolves winter-like visual structures and environments based on loosely emulating processes that underlie form generation in the natural world. Visual abstract narratives are developed through the integration of these forms with pre-rendered animation and through live interaction with the system. An adaptive form of animation painting is developed in the process.



Frozen Flowers. Still frames captured from artificial life system developed by Daniela Sirbu.

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Key words: 3D animation, 2D animation, GA, EA, computational art.

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TITLE

The Ode to Christus Hypercubus

Topic: Music

Author:
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Paulo Ronqui
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Abstract

The performance of the Ode involves a process aided by the computer that connects music, images, and poetry, a multimodal performance fulfilling the sound space with alliterations of sacred music. It consists of images and music that interacts with a live trumpet player and a virtual choir played by the computer in real time.

The Ode reconstructs the Medieval Organum in a sound metaphor of an imaginary echo that still has persisted in the walls of Cathedrals. Along the performance, there is an interactive animation produced with fragments of the Dali's Christus.

The idea is to simulate fourth-dimensional hypercubus using the audio signal to produce real-time geometrical transformations in the image cropped set. The program extracts pitch and intensity from the audio played by the musician and animates a set of four cubes, therefore, images are generated along the sounds iteratively.

A video synopsis of the electroacoustic and visual interaction can be found in https://youtu.be/Ks3X8OTZkMs.

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Key words: multimodal, Salvador Dali, Music, Visual Arts

Main References:

[1] Manzolli, J. "*Multimodal Generative Installations and the Creation of New Art form based on Interactive Narratives*", Proc. 18th Generative Arts Conference, 2015, pg 32-44.

Multiple Realities
(Live Performance)

Topic: Computational Art

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Abstract

The performer wears a virtual reality headset and moves around interacting with tri-dimensional elements in the space. The audience, by means of a mapped projection, sees how the elements, react to the gestures and touch of the performer. All images and sounds are generated in real time through dynamical systems which control and evolve the virtual organisms. The performer can adjust the point of view of the audience, but that is always incomplete, prompting them to create their own interpretation of what they see. Approximate time: 15 minutes.

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Key words: generative art, dynamical system, virtual reality

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www.generativeart.com
www.gasathj.com

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