GENERATIVE ART 2015

proceedings of XVIII Generative Art conference

edited by
Celestino Soddu and Enrica Colabella

in memory of Valeria Solesin
Young Venetian PhD student at Sorbona, Paris
Victim of terrorism, Friday 13 November 2015
"Godiam la pace, trionfi l'amore", Mozart, Idomeneo

"Venice more Venice than before". In the cover *Futuring Past* "Generated Venice from *Canaletto*", a study on the Venetian Identity. All the architectures, palaces, cathedrals, bridges and fashion dresses are generated with Argenia software by Celestino Soddu, designing a visionary Venetian artificial DNA. It's an homage to the wonderful city of Venice that hosts us in this XVIII Generative Art event.

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GENERATIVE ART 2015

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Fondazione Bevilacqua La Masa
Palazzetto Tito

Proceedings

Edited by Celestino Soddu and Enrica Colabella
Generative Design Lab
Politecnico di Milano University, Italy

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An unique gift for each GA participant.

OPENING

Our welcome to all participants at GA2015. We are in Venice, one of the most important Italian site of cultural interchanging from centuries.
We have reached the eighteenth appointment of Generative Art and all seems changed.
In the beginning, Generative Art was one of the so many ways to call digital art. Now, that everything is digital, Generative Art is finally finding its own identity that appears strongly recognizable. At the beginning was not so clear the difference among the generative approach and the other parallel fields like genetic or evolutionary approach. Now the philosophy of GA becomes fundamental and clearly perceived specially from people working in creative fields.
The main character of Generative Art is not in a peculiar technique or technology but it is in the possibility of discovering a way of working as basic structure of creativeness.
We can identify this working way as the art of connections. This art is very ancient but still alive. It is: poetic logic.
With creative acts performed between vision, imagination and memory, poetic logic is able to connect:
Art, considered as the ability of creating and performing, and Science, as logical speculation able to discover the rules subtended in the world that surrounds us.
These two essential components have been so well interpreted by the Renaissance artists by discovering their poetic logics in Nature and in the artificial world. By this quality of studying they were able to rediscover the Past time by generating new incredible fascinating masterpieces. The father of Renaissance is Piero della Francesca. All artists of Renaissance, in primis Leonardo, gained by Piero's great art and science a deep source of knowledge. The art by Piero is an endless font of poetic logics, still today undiscovered, for generative artists.
Generative art can find a peculiar space for discovering unexpressed realities for better identifying the world in which we live. Therefore it finds an irreplaceable role as link among knowing and creating, from past and future. FUTURING PAST. This is the core of a GA process.
As always in our annual appointment, we have had preferences for proposals that seemed us more open in crossing different fields. Only this open approach can allow us to perform our point of view toward the multiplicity of possible visions and interpretations. As GA 2015 organizers, we strongly work for a meeting not fixed in peculiar sectors and opened not only to technical discussions. GA conference is in fact always oriented, above all, to exchanges and discussions among experiences of various disciplines, also not yet performed. The main aim of this meeting is to find new "logics" and "operational" points of view for understanding and creating a possible poetic vision about our time. GA conference works toward a collective aim by turning possible interpretations into moments of interchange and communication. We surely will do that by "generatively" discovering and exalting the aspects that we more care.
This year the proposals have been numerous and performed by different generations, coming from people that few decades ago approached the creativity using the first computers and young people experimenting new possible points of view in our digital civilization. We are all together in this fascinating city, Venice, that we hope we would represent in our future generative artworks.

Celestino Soddu and Enrica Colabella
Chairs of Generative Art conference

Venice 9 December 2015

Greetings from Bevilacqua La Masa Foundation

We are very glad to host and collaborate for the realisation of this symposium focused on the Generative Art.
Bevilacqua La Masa, Institution of the Municipality of Venice, has always been interested in contemporary artistic experimentations, also in relation to the developments of digital technologies.
The project “Tomorrow Now. Contemporary artistic practices in the Digital Culture”, conceived in 2005 and later developed with lectures, exhibitions and live performances, has been the tool to explore this field.
Generative artists do not draw, they rather calculate algorithms, providing systems the information to draw; we are dealing with an artistic practice that through technical and mathematical skills instructs an artificial intelligence to produce visive materials: creativity + artificial intelligence + technical knowledge; the second term is the focus, the change in comparison to the traditional approach to the medium in Art
Today we describe this entity as “smart”, considering we are immersed in and enclosed by smart devices; this artificial intelligence is still one of the most interesting issues to investigate, from the rationalism of Hall in 2001:A space Odyssey, to the visions of allo-worlds of Marcos Novak, for example, who has exhibited here at Bevilacqua La Masa.
I hope this emotional appeal to this “alterity” will accompany this symposium

Stefano Coletto
Curator at Bevilacqua La Masa Foundation, Municipality of Venice

XVIII Generative Art papers

Piero della Francesca, Ideal City

Celestino Soddu

Generative Design Futuring Past

Topic: Art, Architecture, Design

Author:

Celestino Soddu

Generative Design Lab., Politecnico di Milano University, Italy.

generativedesign.com

Main References:

[1] Soddu Celestino, "*Citta' Aleatorie*", Masson ed, Milan, 1989

[2] Soddu Celestino, "*L'immagine non Euclidea*", Gangemi, Rome, 1986

[3] Soddu Celestino, "*Milan Visionary Variations*", Gangemi, Rome, 2005

www.generativeart.com

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Abstract:

Generative Art is inspired to Nature. It proposes the logics proper of the natural events, from the generation to the species, from the oneness and un-repeatability of every event to the multiplicity of the variations belonging to a same species.

But there is an aspect that appears really interesting and essential. The possibility, for Generative Art, to be a tool to communicate the passage from the past to the future. The memory of the past doesn't exist if it doesn't happen, contemporarily, a logical interpretation of the same past and its re-thinking in terms of progressive structure able to be used for the construction of the future.

The "magnificent fates and progressive" (Giacomo Leopardi) of the man, in other terms the construction of our future has always been connected with the ability of the memory and, progressively, with the ability to create artificial events based on the interpretation of the memory of our past as engine to trace the future. The logical interpretation of the own references, of the artworks to which we are inspired, can be at the base of the generative structure, of the algorithms that progressively operate for producing future scenarios.

Generative Art founds on this structure of continuous progressive transformation.

Generative Design was born as "Art" to design a progressive path of transformation from the initial idea to the final result. Then all inside a creative run. But also as "Art" to activate this progressive path from the past to the future.

If, as it appears clear, the design and every other creative activity of the man is a progressive run of transformation, as in nature, it cannot be born from an equilibrium but it needs an initial disequilibrium. Also the final result, as in nature, cannot be a static final result, optimized, perfect in the sense of non modifiable result because the changes would remove the aura of perfection. Also the result belongs to the progressive path: it is perfectible, is dynamically connected to the progressive path that traces the future from the past.

Generative Art opened, very expressly, this possibility: to be able to represent the progressive dynamics of the past toward the future. It can work rereading the artworks of the past by identifying the harmonic structures of them. Better it could run by logically interpreting, through peculiar creative subjectivity, the structures of harmonic transformation identifiable in these masterpieces. And transcribing them in algorithms.

C.Soddu, Generated Venetian Cities, 2015

Contact:celestino.soddu@generativeart.com

Keywords:

Generative Art, Futuring, Generative design, Identity, Recognizable

Generative Design Futuring Past

Celestino Soddu

Professor at Master School of Design

Director of Generative Design Lab, Politecnico di Milano University

www.generativedesign.com

celestino.soddu @ generativedesign.com

Introduction

Generative Art is inspired to Nature. It proposes the logics proper of the natural events, from the creation of unique and un-repeatable events to the multiplicity of variations belonging to the same species.

But there is an aspect that appears really interesting and essential, and I should like to enlighten it with this paper: *Generative Art can perform the passage from Past to Fut*ure. The memory of the past time doesn't exist if a past logical interpretation doesn't happen contemporarily. We need to re-thinking it in terms of progressive structures able to be used for the construction of future.

The human "*magnificent fates and progressive*" (Giacomo Leopardi), in other terms the construction of our future has always been connected with the ability of our memory and, progressively, with the ability to create artificial events based on our interpretation of the memory of our past as engine to trace a possible future. The logical interpretation of artworks to which we are inspired, can be at the base of a generative structure, of the algorithms that progressively operate for producing future scenarios.

Generative Art is based on this structure of continuous progressive transformations.

Generative Design was born as "Art" to design a progressive path of transformation from the initial idea to multiple final results. Then all inside a creative running as "Art" to activate a progressive path toward the future.

Generation and Genetic Evolution

Just considering this peculiar aspect of Generative Art, we must appraise that a deep difference exists among the different souls of Digital and Algorithmic Art. Particularly interesting is the difference among the Generative approach to Art and Design and other approaches founded on the Evolutionary and Genetic structures.

The creative process of Generative Art starts from an idea still not expressed in events. We can identify this "*starting idea*" as a structure in *disequilibrium*. It is *an idea of "species"* defined only focusing some characters and references, but not already focusing a form.

The result, the "Generative Artwork", is the generative engine. This is as an artificial code, that we can identify as the progressive procedure of designing for increasing complexity. We can automatically manage this progression through algorithms able to control the subsequent transformations.

Still reporting this process to Nature, the starting point of generative processes is an embryo of which we build, through algorithms, its "artificial Dna": as a set of codes able to check and perform the progressive transformations toward a growing individual.

As we identified in 1992, (Enrica Colabella and I), in our book "Environmental Design of Morphogenesis" with the sub-title "Genetic Codes of Artificial Ware", the Artificial DNA has the ability to produce a nearly endless series of events, recognizable as an identified "species", by a generative idea, through a progressive path controlled by algorithms. The possible variations, that might be produced, are performed following too the interaction with the "environment", in which this process is performed. In my projects, for instance, the extemporaneous impact with the "environment" is concretized by a set of variables that are always *naturally* different: the date and the time when the generative process starts.

All happens in different ways, by using genetic algorithms or evolutionary algorithms. The starting point is not an idea but a series of finished events, that operate like "parents" in the creation of "children", and so on. There is not a progressive increase of complexity but the starting points and the ending points are events with *comparable* complexity. In other terms a generative structure of increasing complexity doesn't exist inside the genetic path; but the possibility to identify the best solution in a set of parallel alternatives exists.

The existence of a *"simulated time of growth*" appears as the difference among these two approaches. My opinion is that the "simulated time" could produce complex results; in absence of this "time", we could only generate stochastic results. The generative approach proposes the use of the creative time following what happens in all the design activities: today I am interested in one possibility, tomorrow I can change idea and I am fascinated by another aspect. At the end the design result answers to manifold different requests, sometime in opposition. And the complexity was born.

The main aims of the generative approach are the progression and the multiplicity. The aim of genetic approach is the optimization toward perfection. Completely different also if both are useful. If we apply these different approaches to re-thinking the past for shaping the future, with Generative approach we can trace progressive and increasing complexity possibilities; with Evolutionary approach we can define an optimized possibility by managing the already done.

The first uses poetic logics, the second uses analytical logics

Equilibrium and disequilibrium

As every other creative activity, design is a progressive run of transformations. it cannot born from an equilibrium but it needs an initial disequilibrium.

My opinion is that the results too cannot be static results, optimized, perfect in the sense of un-modifiable, because possible changes might remove the aura of perfection. Also the result belongs to the progressive path: it is perfectible, dynamically connected to a progression toward future.

In Generative Design the result is never univocal. It is manifold as the variations are manifold in the fugues of Bach. Variations doesn't deny the possibility to perform events extremely harmonic and dynamically perfect. In Generative Design nothing is "statically perfect", optimized; but every event is unique and un-repeatable, belonging to a species in which all the individuals represent together an "idea". They have in common characters and identity of a well identified and recognizable "species".

No individual is perfect. But every individual, in their uniqueness, following their progressive disequilibrium, gives an essential contribution to the "*dynamic perfection"* of the species. We can identify the species perfection with an idea of progressive transformation from past to future.

If perfection means that the project cannot be modifiable, it will not be able to gain the increasing complexity of our time, stopping its time toward future. In practice it might not allow the designer to go ahead. As final results, the generations of a series of variations open toward future, build results through the multiplicity of possible facets of a same design vision. These will give an essential contribution to the next generation of variations, that are progressive creative reality, as in Nature.

Beauty and Harmony in *futuring past*

Very expressly, Generative Art opens the possibility to represent the progressive dynamics of past-future. It can work re-reading the past artworks by identifying their harmonic structures. Better it could run by logically interpreting, *through a peculiar creative subjectivity*, the structures of harmonic transformations identifiable in the past masterpieces, by transcribing them in algorithms.

It is not a novelty. This act has always been effected by artists of all times. This ability of Art gave an essential contribution to communicate the progressive evolving from past in future. What could appear as static perfection of a masterpiece will be transformed in progressive harmony. Only quoting some of these "***futuring past***" actions, Picasso has done it, following Velasquez or Francis Bacon with Van Gogh. This is the main condition for tracing the innovation for the future.

My main aim was always to give my possible contribution inside this way of working. I pursued it starting from my first generative work, the "artificial DNA" of Italian medieval cities in 1987. I constructed a generative code by interpreting Giotto and Simone Martini paintings.

I followed always this approach until my last generative work: "*Futuring Canaletto",* made by interpreting Canaletto for generating possible Venetian cities, that, in the appreciation of this marvellous city, try to break every residual concept of stillness. Venice as a city, that is not (statically) perfect but it is always able to fascinate us in multiple and parallel visions of its dynamic harmony. We cannot only relate this strong fascinating identity to peculiar repeated forms, colours or presence of particular events. This identity works through the multiple possible interpretations by progressive logics.

In my generative experiments on the past artworks identities, a constant has always been the consideration of their "*patina of time*", more than their formal characters. This aspect concerns what appears "transformed by time" more than what appears "perfect", as just finished. I must admit that this approach to the masterpieces of Art, Architecture and Cities could be considered as a "very" Italian approach. Piranesi, in his engraves on the Roman ruins, identified and interpreted this "time patina" in exemplary way.

Obviously different approaches exist. The meticulous reconstruction of the past as perfection, as it is pursued above all in systematic way by Chinese and by some other oriental cultures, is proper of a particular concept of beauty-perfection that doesn't find comparison in the Italian approach. It would be interesting to appraise, in these cultural approaches, how Art supports the maintenance of these cultural identities in the progression from past to future.

Identification and Construction of Generative codes.

For doing that we have to follow the subsequent steps:

1. Interpreting the past masterpieces for defining the geometrical structure and spatial relationship with the aim of performing a topology of these past events (cities, artworks, music).

2. Finding Disequilibrium. We must identify a point of view able to help us to interpret with algorithmic dynamic structures the past events, also if they seem, at the first sight, to be static.

3. Designing a not-linear structure with generative algorithms able to represent our interpretation.

4. Generating manifold variations able to represent, from different points of view, our complex vision of the past events. And verifying that their identity and our design vision remain well identifiable in their difference, also if interconnected in the generated scenarios.

Futuring Past projects

I would like to shortly re-run some of these experiences of mine about *futuring past* working with generative algorithms.

Medieval city and castles. At the beginning of the eighties, when I was wondering how to build the first generative project able to produce 3D models of Italian medieval city, I had made a real important choice. I had available a lot of Italian medieval cities enough well preserved and with an abundant analytical and historical documentation. But I have preferred to use, as reference, the artworks of artists like Giotto and Simone Martini where they represented these cities in their paintings and frescos following their visionaries feelings. I have also had a preference for the "perspective distortions" present in these artworks. According to my logical geometrical interpretation (my book: The image not Euclidean, C.Soddu 1986) it didn't deal with distortions but with the creation of a disequilibrium able to transform these artworks in "a visionary dynamic visits" to these cities. These virtual tours shown the subjective interpretations of these artists by clarifying and communicating, in a logical geometrical way, the characters of their medieval towns. So, the faster and best way to approach the complexity of medieval towns was finding a possible logical interpretation of these artists and operating, on this discovery, my progressive interpretative logic. This excluded any possible simplification, always connected to analytical evaluations of the existing environment. I succeed in directly considering the complexity of the events and, specifically, their disequilibrium as powerful engine for the progression toward my future vision.

Fig. Generated Medieval cities. "C.Soddu, Citta' Aleatorie, Masson Pub. 1989

The first results have convinced me that medieval identity was not based on specific forms but on specific topologies, on dynamics of progression and on harmonies of relationship. The forms easily appeared interchangeable. The relationships were essential to the appreciation and to the possibility of recognizing the identity I was looking for. And I have pursued this choice in the following generative experimentations: the interchangeable structure of the forms and the pregnancy of the topology.

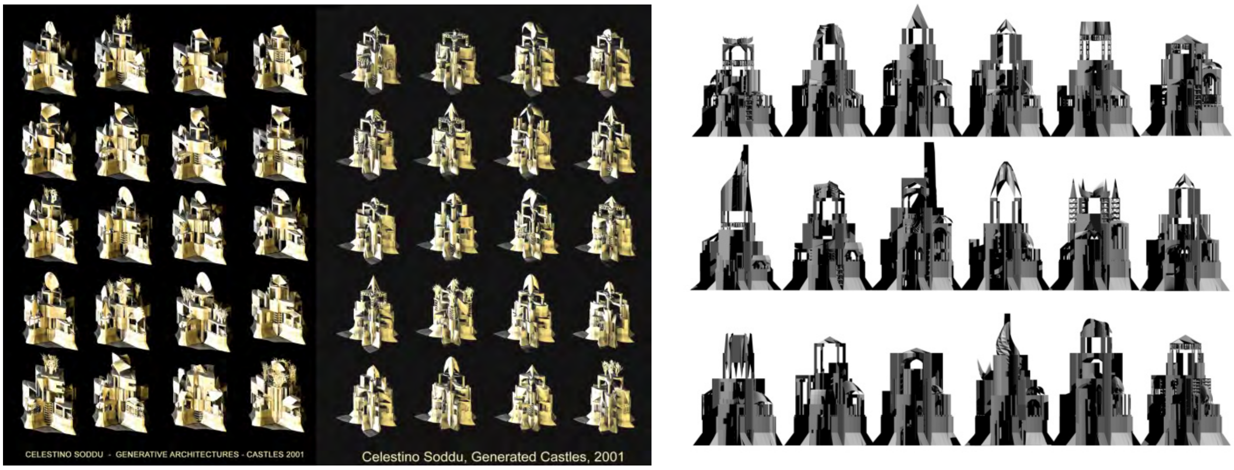

Fig. Generated Medieval Castles 2001 and 2003. Forms are completely different and are changing from a generation to the subsequent, but the character and topology performs the Medieval identity.

The main role of topology emerged also in the following experimentations on some American cities, New York City and Chicago, of which I looked for the structure of the identity through generative codes. But not only. I was discovering too the importance of their characters, able to consolidate the strong dynamic image of a city living its time and looking to the future. So I tried to identify the Identity of these city, pursuing concepts of "ideal city", that each inhabitant has of his "loved" city, as "*a way to look at the future*". This identity process was clear from Hong Kong to NYC, from Washington D.C. to Los Angeles. And, obviously, also when I tried to generatively approach the identity of Rome, Venice and other European cities "so loved" by their inhabitants.

Fig. Generated New York City, generated architecture in Chicago and Los Angeles (2002, 2003) trying to fit the Identity of these fascinating US cities.

Fig. Futuring Past with generated architectures in Hong King waterfront (2009), Brussels (2013) and Jerusalem (2011), looking for their identity codes.

Constructing the algorithms for managing these so different city identities, I discovered the strength of the small details and of specific progressive geometries, practically of small variations in the parameters used in the generative algorithms. Small variations were able to identify some characters of specific cultural identities. For example, the attempt that I made for generating an architectural event in Delhi, done on the occasion of my visit in India. Increasing just a bit the parameter of control of the possible fractal event repetitions had brought to a meaningful increase of the "Indian" identity in my generated events.

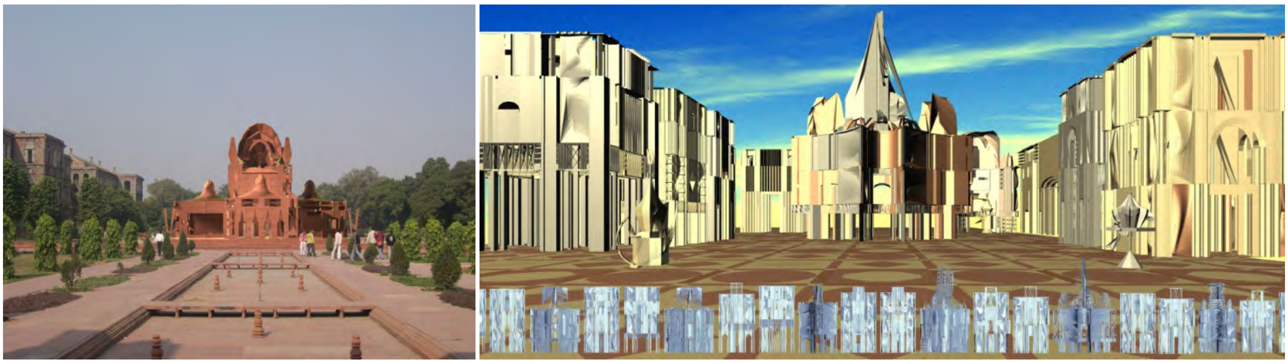

Fig. Futuring Past generating architecture in Delhi, 2006, and referring to the topology of the Ideal City by Piero della Francesca, 2004.

Going ahead, I have constructed the "Dna" of the city of Lucca in the same way. I operated on the topological structure and managed, with small variations, the previous "medieval" algorithms. I have generated a series of variations of possible Lucca cities that I have used for personalizing the covers of the proceedings of GA2012.

Fig. Futuring Past of Lucca by generating city variations, 2012.

My experimentation of Generative Futuring of the work of Gaudi, that is one of my masters, was longer and more hard. Operational references to the catenary curve as geometry able to build the structures proper of Gaudi, appeared too much obvious and too much simplified: not able to bring to the complexity that is one of the characters of this architecture. So I have re-read some aspects of his work through progressive disequilibrium due to progressive variations of the verticality but, in the same time, by maintaining the topological structure of the connections among events. A hardly predictable generative structure was born, but full of charm. A charm that was not due to random, that I don't like in my works, but was due to the unpredictable emerging of formalized relationships among parts when these were transformed changing their progressive order. The results are recognizable architectural variations as interpretations of Gaudi, as homage to this great master. But also as pushing his works to Future

Fig. Futuring Past Gaudi (2003) and a generated architecture for a museum in Milan used for the cover of Blueprint magazine (1999)

For Milan, in 2004 when, in Hong Kong, has been asked me to prepare an exhibition on Futuring Milan, I have decided to undertake an experience that can seem different but, for many reasons, it is not different from the previous ones. I decided to give back to Milan what Milan had lost as essential component of its own identity. Milan has been the home of Futurism, but Milan has subsequently forgotten this component of its history and, today, few events remember this cultural past. I proposed this lost identity in about thirty new architectures generated for Milan; grafting on the consolidated components of Milan Identity the seeds of the Futurism. A "new DNA" of Milan was born, able to rediscover the potentialities of Futurist fever but, in the same moment, finding again, in a possible future, the progression of this lost identity. My aim was to bait a new futurist disequilibrium for the future in Milan; but it is not easy. (C.Soddu, Milan Visionary Variations. Futuristic Meta-Codes for Milan's Identity 2005)

Fig. Futuring Milan, Futurism museum variations, 2004

Visual Artworks are certainly a field in which the ability of Generative Art to communicate the progressive passage from past to future seems to be immediate and extremely strong. I experimented that by interpreting the portraits by Picasso and Francis Bacon. These artists were experimenters of the Futuring Past too, working by interpreting Velasquez and Van Gogh.

Doing that I had a very important advantage. My main interest and acquired knowledge is the three-dimensional space. The main logical geometrical interpretation that I adopted has been the passage through different dimensions. In fact I interpreted the works of Picasso and Francis Bacon reading them as 3D models. With this approach I succeed in activating in the space some topological structures and relationships that I had identified as interesting in their bi-dimensional paintings. Moving from 2-dimensional events to those in 3D has meant to have to insert my own vision because, as it clear appears, it is not possible to increase the dimension from 2 to 3 without operating a subjective interpretation, without inserting further relationships among events and building new geometries. Therefore the results have been 3D artworks, sculptures that I directly printed with the first 3D printers.

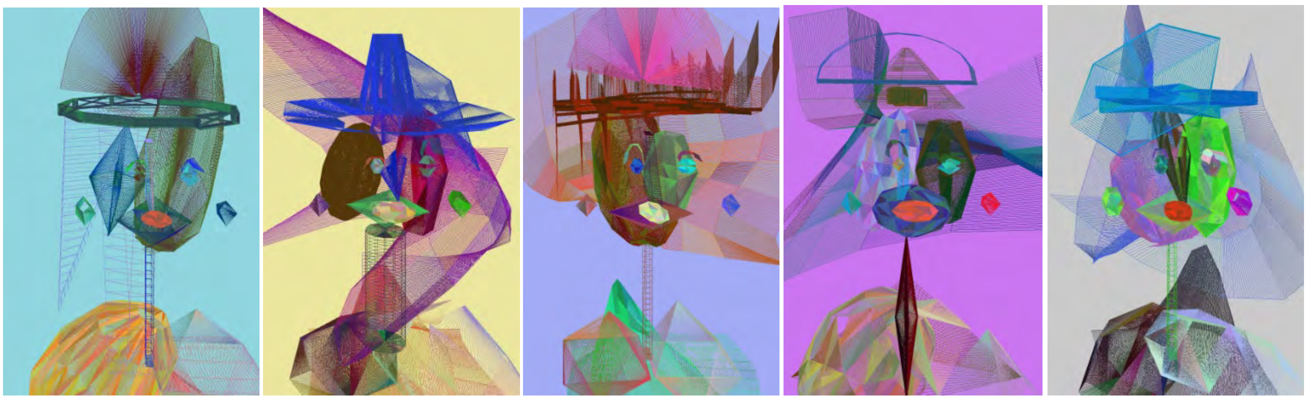

Fig. Futuring Picasso, Generated woman portraits, 1997.

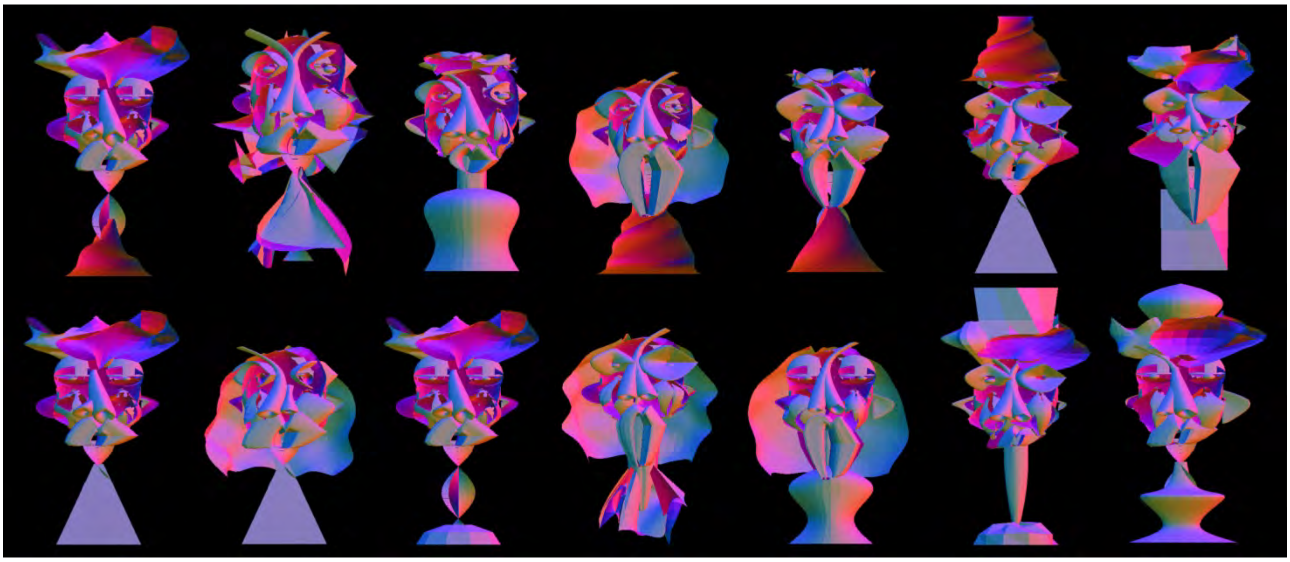

Fig. Futuring Francis Bacon, 2013

The most interesting discovery has been the practical verification that different identities don't annihilate one each other. The possibility to recognize past and future persists and it's stratified in the complexity of the results. The artworks still have two different identities: not only Picasso or Bacon but they have also assumed a clear possibility to recognize them as my artworks. The bridge between past and future has been created without copying the past but only with the increase of significance due to the interpretation. As it happens when in a strongly characterized city a new architecture is built. If the new architecture is not a copy but a subjective interpretation of the existing city made by a good architect, the identity of the city grows through this new facet of sense. This is the charm of ancient cities, but also of cities, like NYC or Hong Kong where the love to own city is strong and each possible interpretation is full of sense.

In all these works the starting point of creative acts is gathering the disequilibrium of the past. That is considering the past as alive. This is a generative approach: identifying the character of the "species" and increasing it with subsequent possible interpretations for performing further possible qualities. In fact the results are variations, nearly endless, of three-dimensional portraits. Them, in my intentions, could increase the complexity of the memory and appreciation of the works by building further disequilibrium for a "progressive memory", consolidating a bridge between past and future.

In the engraves of Piranesi, especially in those representing the ancient Rome, the progression is explicit. The progressive disequilibrium is appreciable both in the content (Rome with an explicit "time patina") than in its structure. Piranesi operated in the time with progressive incisions on the plate, one after the other. Besides, in these progressive stratifications of contents, the perspective structure was slightly varied so that the vision of the work was "dynamic", asking to the observer to virtually move himself when he considers a detail of the work. In 2008 I have tried "to continue" one of the works of Piranesi following this process of progressive stratification. I have in fact inserted in one engrave of Piranesi a series of variations of an architecture generated by me, a "Babel Tower". The result has been a series of prints that I have used as different unique covers for the proceedings of Generative Art conference of that year, dedicating every cover to one of the participants. Just this multiplicity of variations shaped a further and explicit disequilibrium dynamically connecting the past with the future.

Fig. Futuring Piranesi: Generating Babel Towers, 2008

Always using the engraves of Piranesi as environment for my new architectures in Rome, I have tried to find again the contemporary sense of the Baroque architecture. More specifically of the architecture of Francesco Borromini. Here the generative approach has been focused on the geometries trying to dynamically read the complex geometries of the Baroc. In other terms I have tried to read the geometries as generative geometries (V. paper GA2014). The most difficult moment has been when I needed to make dynamic the "perfection" of Sant'Ivo alla Sapienza, based on the equilateral triangles. It strongly appeared as static in its "perfection" as if it were impossible to push this geometry inside a progressive path able to produce variations. The attempt has been done by performing the possible dynamics of this geometry through an interactive transposition of the topological relationships among different geometric models. Following this approach I succeeded in finding again a lost disequilibrium in the apparent fixity of the equilateral triangle (v. my paper GA2013).

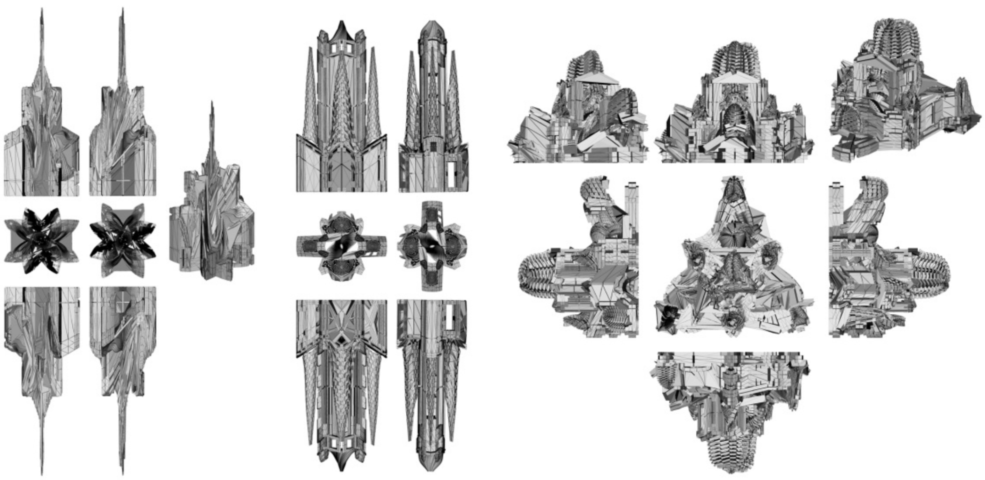

Fig. Generated Baroque Architectures, redefining baroque identity with generative geometric systems

Fig. Futuring Baroc and Rome Identity. Generated baroque architectures interpreting Borromini in Piranesi engraves, 2013.

Finally the experimentation that I have done for Venice on the occasion of this conference. I would want to call it "Futuring Canaletto" for the reason why, as I have always done when I designed virtual Dna of cities, I didn't used as reference the physical city, analyzing single parts and aspects of it, but I have "progressively" interpreted the works of an artist that represented Venice by interpreting this "Ideal City": Canaletto. I have not only abducted from Canaletto the progressive geometric structure of the architectural and urban events but I have also interpreted his so important feeling for this city, that is a way to look at the future. More, Decio Gioseffi, the great expert of geometries and art history, said me twenty-five years ago, that my artworks remember him Canaletto. I always asked myself why and, finally, I assumed that it was because of continuous progressive perspective, from the whole city to details. And I followed his indication. The architectures that I generated for these Venetian variations, as the urban orders, the bridges and so on, are not present in Venice. No copy or repetition of existing events, and not even a formal or deconstructive analysis. I also inserted, like Canaletto with daily Venetian events, a fashion generation for showing a typical contemporary event. The results would like to be, in my intentions, as expression of the identity in progress of Venice, of its recognizable Dna. Breaking, in this way, the static approach to Venice and giving back to this city a small engine to glimpse its Venetian future and the pride of a city that it is not only the static analysis of what is present, not only a museum, but a way to think progressive, a way to think generative.

Fig. Futuring Canaletto, variations #1 and #2

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Jônatas Manzolli

Multimodal generative installations and the creation of new Art form based on interactivity narratives

Topic: (Multimodal Installation, Music)

Author: Jônatas Manzolli

Music Department,
Interdisciplinary Nucleus for Sound Studies (NICS),
University of Campinas Brazil

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Abstract:

We present the development of generative installations and interactive narratives as an interdisciplinary research methodology. The key points introduced here are: investigation of new paradigms on human cognition mediated by interactive technologies that attempt to describe how the creativity operates [1]; development of new technologies that incorporate interactive techniques based on the integration of multimodal signals [2]; the creation of new Art forms based on interactivity narratives, digital music instruments, virtual soundscapes and synthetic visualization [3]. These systems can be evaluated from the perspective of the interaction between agents and devices generating sounds, video and 3D graphics. Therefore, the unfolding concept is: the behavior of agents in an immersive space, interacting with various devices, could indicate how this space affect their actions and how meaning is constructed in the course of their interaction [2]. Our research project is anchored in a multimodal laboratory where we study human cognition and music creativity supported by digital interfaces, computer graphics and motion capture. It is an interactive environment with a large 3D screen and an eight channel sound diffusion system. In order to describe interaction and the generative design in such environment, we present two works: "**Danças do Vento**", a interactive multimodal soundscape and "**Eólia**", a virtual harp played with a mobile phone. Moreover, immersion in such systems might induce a unified implicit and explicit experience, facilitating creativity, discovery and understanding by both expert and novice users.

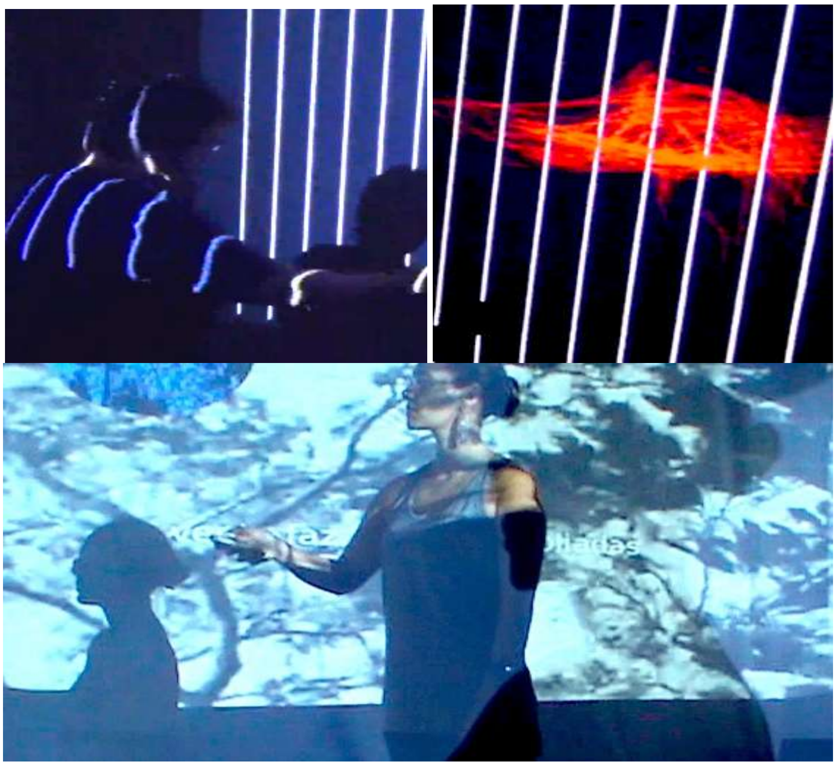


Figure 1: the virtual harp (top), performance of "Danças do Vento" (bottom).

Contact:
jonatas@nics.unicamp.br

Keywords:

multimodal, installation, interactive, music, creativity

Multimodal Generative Installations and the Creation of New Art form based on Interactive Narratives

Prof. Jônatas Manzolli, BMath, BMus, MMath, PhD

Interdisciplinary Nucleus for Sound Studies (NICS)

Music Department, Art Institute, University of Campinas (UNICAMP)

www.nics.unicamp.br

e-mail: jonatas@nics.unicamp.br

– Abstract

We present a recent study on multimodal generative installations that can be described as immersive and interactive infrastructures in which is possible to generate, interact, analyse and storage multimodal information (audio, video, images, human movement and bio-signals). The article starts with a theoretical viewpoint based on the motion of Presence followed by the description of the computer environment implemented in our study. The aim is to discuss a unified experience where data and users are merged in space and evolve coherent in time. Our approach is based on two kinds of interactions implicit and explicit one and on expansions of the local virtual experience to a ubiquitous one, using the Internet. Shortly, we discuss how the implicit and explicit interactions, local and remote agencies are used to digitally synthesize images and sounds in real time and to furnish the man-machine interplay within immersive environments. Finally, four multimodal installations are presented to exemplify the interactive and generative design used in these artistic works.

– 1. Introduction

– Firstly, this paper describes compositional processes and generative design of four recent multimodal works where integrated theoretical and technological framework was deployed in the search of delivering novel ways of technologically mediated perception and interaction with immersive digital media [18-20]. Complementary, our research is anchored in a series of artworks described as interactivity narratives and supported by digital music instruments, virtual soundscapes and synthetic visualization [14-16]. We also have studied how virtual spaces, furnished with interactive soundscapes, digitally generated sounds and 3D animations and interactive video-clips contribute in understanding creativity [17].

– On the other hand, recent research has attempted to study human cognition and understand how the creativity operates in different contexts [1-6]. It has been developed research on interactive techniques based on the integration of multimodal signals and the analysis and storage of audio, video, images, human movement and bio-signals in virtual reality spaces [7-9]. There are viewpoints concerning to the analysis of body motion and emotional contains when apply to the design of intelligent user interfaces and to enhance the man-machine interplay [10-12]. There is also research in the perception and interpretation of complex intentional movement patterns using neuroimage techniques [13].

– Dialoguing with these recent studies, this paper reports recent developments obtained at the

NICS/Unicamp and the eXperience Induction Machine (XIM) at University Pompeu Fabra, Barcelona. The XIM laboratory is an immersive room equipped with a number of sensors and effectors that has been constructed to study human cognition [8, 9,19].

– In the following section a theoretical viewpoint anchored on the motion of Presence is presented. It follows a section on an interactive environment model that is based on implicit and explicit interaction, performance with digital musical instruments (DMI) and the boids algorithm used as core computer engine. Last section elucidates the previous ones describing four different multimodal installations: "Danças do Vento" Portuguese for wind dances, "Eólia" for Aeolean, "Pássaros de Papel" for paperbirds, and CromaCrono≈ for chroma-chronos.

– 2. Theoretical Perspective

Next sub-sections introduce a set of definitions related to the terminology used in the study followed by a brief discussion on the concept of Presence that furnishes most of our assumptions on the immersive rule of multimodal interactions.

2.1 Starting Points

Our study aims to a) create a unified experience where data and users are merged in space (i.e. a true mixed reality experience) and b) evolve coherent in time (i.e. narrative progression); c) explore and exploit both implicit and explicit cues from users in their individual and collective interaction with the system; d) use novel multi-modal sensing and effector systems to boost interaction with and understanding of the dataflow generated during man-machine interplay.

We also acquire that in these processes the computer acts as an autonomous adaptive sentient guide that assists humans to explore creative spaces and discover novel patterns driven by both their implicit and explicit (re)actions.

Moreover, the user parametrical control on the computer GUI and agent's movements captured by tracking systems are called here as *explicit interactions*, complementary, *implicit interactions* are related to capture of bio-signals to infer affective states and subliminal perception, and *ubiquitous interaction* is remote agent interaction over the Internet. Figure 1 presents the general schema of the study. It illustrates a) two kinds of interaction within a mixed reality space (implicit and explicit), and b) the expansion of the local virtual experience to ubiquitous interaction using mobile devices (see also Figure 2).

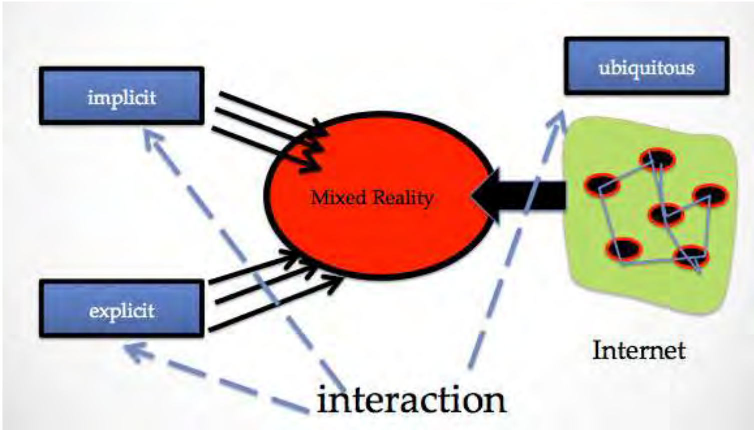


Figure 1: *Diagram of the general schema of the research reported here. It is based on implicit, explicit interaction on a mixed reality environment and ubiquitous interaction over the Internet.*

2.2 Presence & Virtual Reality

In order to study the constructions of meaningful relationship between agents and environmental stimuli in a virtual space and explore their interaction with animations and sound-generative processes in real time, our research is anchored on the motion that interactive media within mixed/virtual reality environments induces a agent coupling with the space. It is defined as the *sensing of Presence* [7].

The theoretical viewpoint is that the delivery of Presence is closely tied to an understanding of consciousness and, in particular, of the interplay of implicit and explicit factors in the construction of human behaviour. Presence has long been a key concept in tele-operation and virtual reality (VR) and has been defined as the "*sense of being in a virtual environment*" [18]. It is not clear, however, how this "sense" is generated and it is not uncommon to see it explained with the notion of "the suspension of disbelieve" coined by in the early 19th century by the poet and philosopher Coleridge.

– It is also found in recent literature that the notion of Presence results from the interplay of both central and peripheral factors and that it should be assessed through a number of convergent measures that include measures of the subjective, physiological and the behavioural state of the user [20]. Therefore, Presence, induced by virtual and/or physical sources of stimulation, is governed by a number of principles that underlie human experience, creativity and discovery.

In our approach the notion of Presence indicates that there are essential inputs for the construction of self-referral agencies. Thus we deploy methodological efforts focusing on interactive media within mixed reality environments in order to study the constructions of meaningful relationships between agents and environmental stimuli in virtual spaces [19].

The assumption is that the interaction of an agent or group of agents with an immersive space, using various interactive devices, indicates how these processes affect their behaviour and the meaning that is constructed by them. Therefore we explore human accessible mixed reality systems where the information about the users' explicit (e.g. actions, gestures, vocalizations, etc.) and implicit (e.g. affective states, subliminal perception, action tendencies, cognitive states, etc.) interactions within the environment dynamically shape the data's presentation to the user and thus the user's Presence in the data space [17].

– 3. Interactive Environment Model

– Our objective is to test the environment capacities and functionalities to produce audio-visuals as stimuli (effectors) and motion tracking and biosignals caption to evaluate agents' responses (sensing). We search for correlation between implicit and explicit interaction related to real time transformations on audio and video. We are using audio descriptors analysis [21] and movement descriptors analysis to study the interactive control of music based on body expressions [10,11]. Within this analytical perspective, our aim is to test generation of audio, video and the system capacity to integrate bodily expressed movements and their correlation to emotional contains.

– For controlling the dataflow, we are using digital musical instruments (DMIs) [22]. DMIs differ from their acoustic counterparts by using computer technology for sound generation and electronic instrumentation techniques for the acquisition of performer movements, allowing for unprecedented control of sound and media synthesis; performer actions are mapped to the control of sound synthesis parameters and computer graphics generation using either explicitly-designed associations or intermediate transformations or machine learning systems [23].

– Our model also dialogues with the mathematical notion of dynamic system. We conceive that man-machine interaction can be described by concepts such as stability, instability, and disturbance and it is capable of producing self-organized behaviour when implicit and explicit interactions are coupled. Moreover, we started your modelling, searching for a simulation of dynamic system to be the core of the machine counterpart behaviour. Thus, we chose the boids algorithm to be our intrinsic machine generative engine, for its characteristic of simulating in computer software the collective organization of bird flocking.

– Created by Reynolds [24-25], the boids algorithm is a computer model of a dynamic system that simulates bird flocking controlled by a set of simple rules to determine their flights, collective organization and trajectories in space. Reynolds declares that procedural models simulating complex natural phenomenon can aid scientific understanding of them. Further, the computer simulations help to recreate the phenomenon and control it and they can be also used in computer animation, games and the arts.

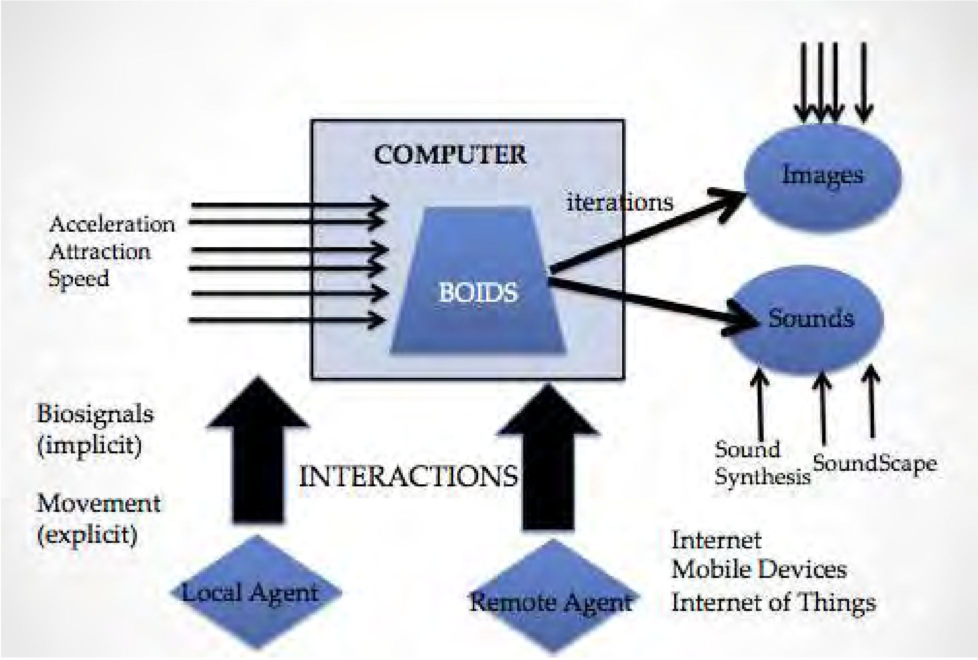


Figure 2: *The diagram synthesizes all aspects of the model discussed until now. The explicit interaction based on body movement and the GUI control, the implicit interaction based on capture of bio-signals, the boids algorithm generating images and sounds in real time, and remote agent interaction over the Internet.*

– 4. Multimodal Installations

Shortly, in the context of creating computer systems for aiding generative composition and interactive performance with multimodal content, this article presents a research on implementation of computational resources for controlling immersive digital processes and managing and sharing via Internet, a multimodal interactive process.

In the next sub-sections we presented the room infrastructure used in our research followed by brief descriptions of four multimedia installations: "Danças do Vento", inspired by the dynamic behaviour of wind, "Eólea", a virtual Aeolian harp, "Pássaros de Papel", a parallel between migrating birds and people, and "CromaCrono≈, a system for audio-visual improvisation in real time.

The reported works are based on a) physical spaces and infrastructure for interaction and digital immersion; b) development of computational models for interacting with digital devices producing sensory multimodal signals; c) computer simulations to test the systems behaviour and d) interactive performances with local and remotes agents.

The rule of these installations can roughly be classified in three main purposes: a) performer-interaction (single or group performances); b) interactive sound installations, typically group performances where performers interact with objects in a space creating/modifying sound or media events; c) dance-music works, group performances typically involving dancers and musicians, where dancer movements can influence the music being performed.

4.1 Infrastructure

The interactive room used to create the installations is a multiuser mixed-reality space covering a surface area of 7x7m (Figure 3, left) equipped with a set of sensors and effectors. The effectors include computer graphics projected in 4 complementary walls and an octophonic sound system. The sensors are: system for capturing and analyse human motion and a system for capturing bio-signals. Two microphones and a video camera are placed as audio-visual sensors and recording devices.

The infrastructure provides physical space and audio-visuals to experiment with sonification and visualization and to interact with synthetic devices such as soundscapes, interactive video, animation and 3D-graphics. It is also possible to the agents to perform music, dance and acting.

All these are linked to the concept of mixed reality where agents in the physical world and avatars are exchange information in real-time. The data-flow of the environment is presented in (Figure3, right). There are three systems working together: Effector System: produces visual and audio stimuli and receive information from the sensing system and from a Database; Sensing System: produces multimodal signals to be used as controller of the effector system and storage information; Storage System: storages all information that circulate from sensing and effector systems.

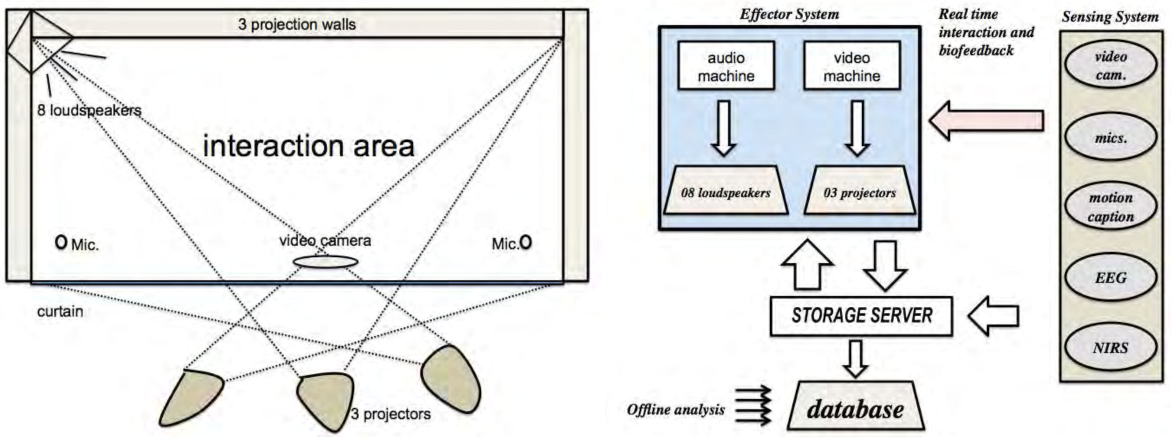


Figure 3: *Interactive room basic infrastructure (left). Dataflow of the processes in the environment (right)*

4.2 Two wind Installations: Danças do Vento & Eólea

In these two installations we search for relating performers' movements with sounds and images resembling dynamics and rhythmic behaviour of the wind. In "Danças do Vento", the concept is to build an interactive performance environment organized in four different "wind dances". It proposes an interaction with sights and soundscapes described as "emotional states of the wind": Breeze: wind softness, Chimes: wind chants, Wind-works: products of wind energy, and Storms: wild wind rumblings. This work can be accessed in:

http://estudio.nics.unicamp.br/watch_video.php?v=9HMYYHGRO54H

In "Eólia", the concept was to build a virtual Aeolian harp. We simulate the wind behaviour using the numerical orbit produced by the boids algorithm. Similar to the blowing of the wind in open air, the boids are used to interact with a 23-strings virtual harp. The string sound is synthetized in real time by the Karplus Strong algorithm [26]. Performer's movement with a mobile phone disturb, disperse and/or attract the boids what provoke collisions between the boids and the virtual strings, and than sounds are generated. This work can be accessed in:

http://estudio.nics.unicamp.br/watch_video.php?v=5WX6U6HU8R27

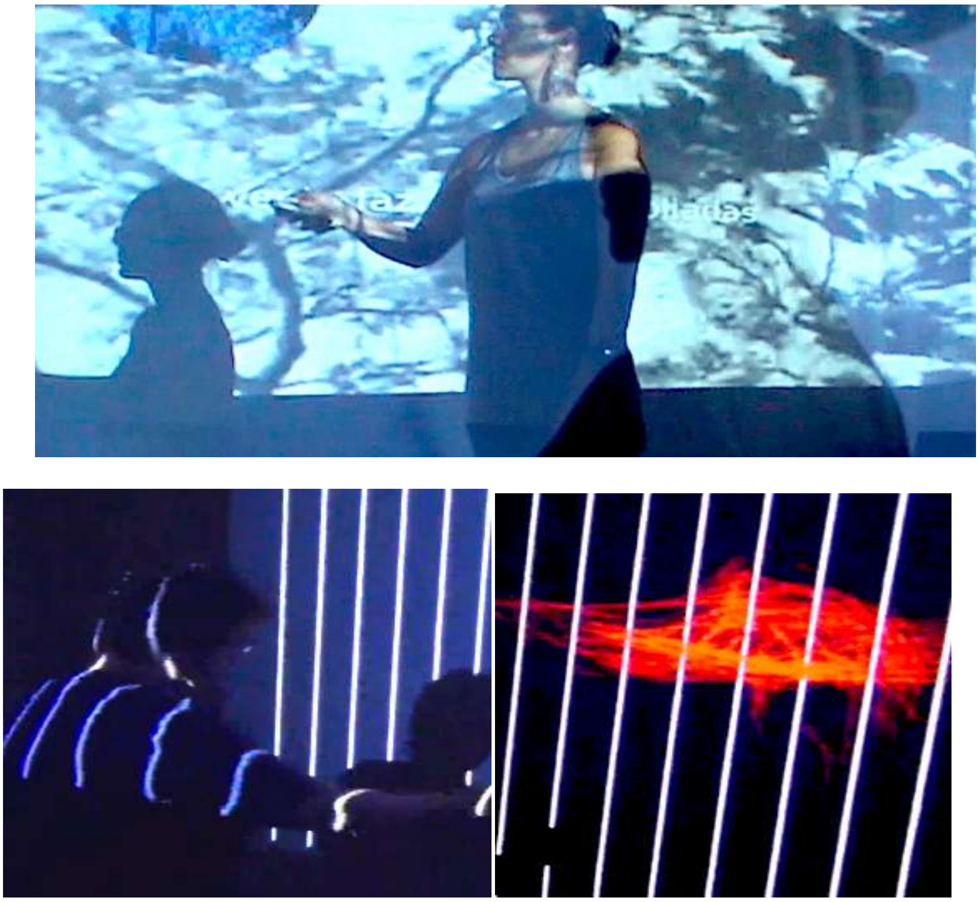


Figure 4: *Image of “Danças do Vento” (top). Image of a performance with the virtual harp “Eólia” (bottom)*

4.3 Pássaros de Papel

This multimodal installation addresses two concepts: a) human ability to extract data from natural and artificial phenomena in different scientific disciplines which by far exceeds our ability to understand them, and b) since many of these natural and artificial phenomena we don't comprehend, migration of birds and people are not yet fully understood. Probably because limitations on our ability to represent and experiencing migratory phenomena and live together with others.

“Pássaros de Papel” establishes a parallel between birds and people migrations. It stats that *when birds fluttering their way south in their wrinkled V-shaped flocks comes to mind, often along their path, between breeding and wintering grounds, comes an spontaneous sensation: they are not only flying wings in the sky. They are spreading ideas, producing colours in dark storms and many times expressing people’s behaviour.*

“Pássaros de Papel” structural elements are: large screen projection, soundscape in a quadriphonic sound diffusion system and local network to interact with mobile phones. It is presented in a semi-darkened room, the graphic animation and the quadriphonic soundscape that features birdsongs, people’s voice and environment sounds, are modified and mutated by the visitors.

The interactive soundscape consisted of samples from three sound database: a) birdsongs and environment sounds related to migration of birds, b) people's song, voice, sound of crowed squares, celebrations, football games, etc. and c) pre-composed low frequency drones.

The boids algorithm is applied to generate large digital birds. Differently from the previous installations, the boids numerical trajectories are used to generate colourful wings. In other to obtain these wing like shapes, a two-dimensional bicubic interpolation is applied to the boids sequence of (x,y) points. Interactions with human agents modify attraction, velocity and acceleration of the boids that in turning are used to mould shapes, dispersion in space, number of wings and fluttering behaviour.

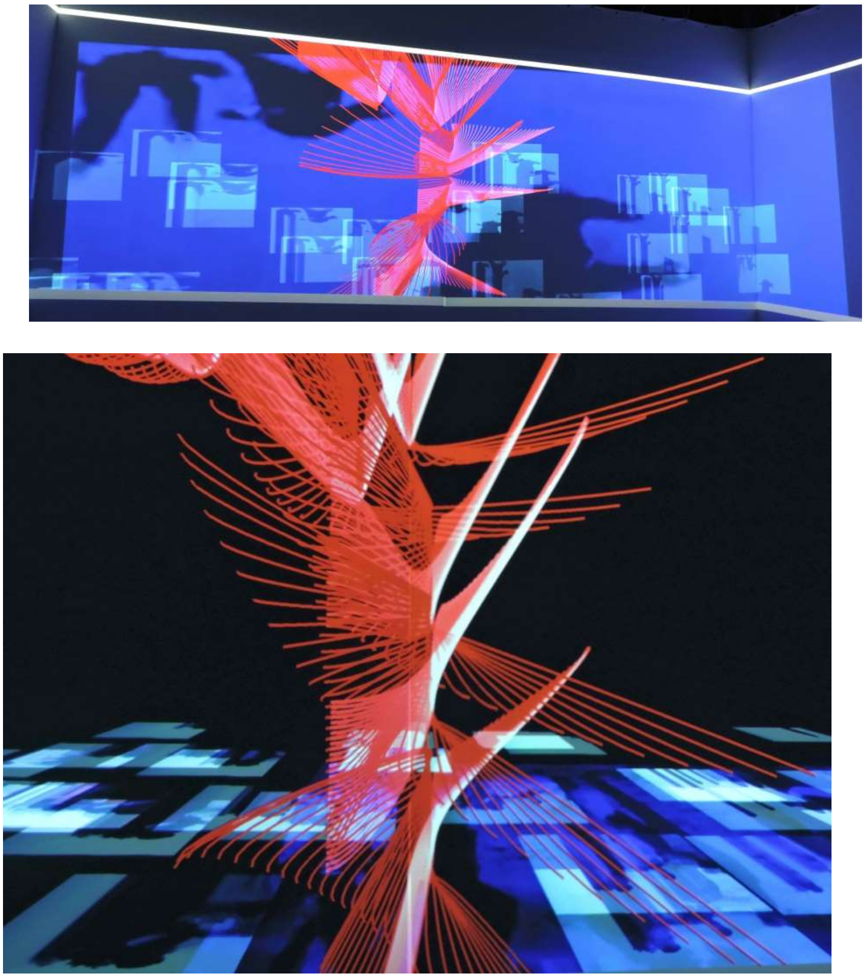


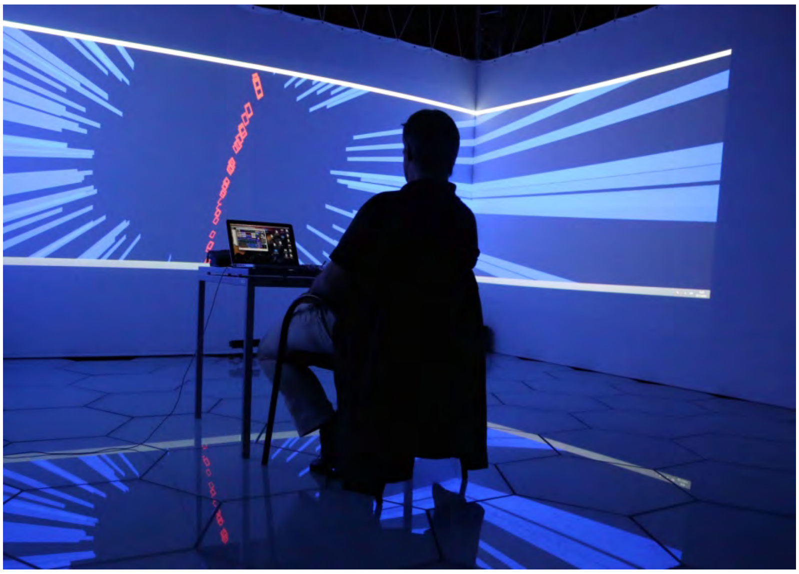
Figure 5: *Photos of "Pássaros de Papel" featuring the large screen projection and the wing-shapes generated with the BOIDS algorithm and bicubic interpolation curves.*

4.4 CromaCrono≈

This is a system for audio-visual improvisation that produces digitally synthesized sounds and images in real time. Departing from observations on the way sensory processes are integrated with the environment, CromaCrono≈ paradigm exploits the interaction of space and time from the human agent perspective.

It expands the notion of texture: from physical and tactile sensations to the cloud of events that are perceived surrounding the subject. Than, texture is conceived as a mass with a density of interwoven processes, which increases as much the processes are interconnected.

In CromaCrono≈, Simple geometric shapes and computer-synthesized sounds support that textural architecture (see figure 6). The boids are used to control several parallel processes generating an animated audio-visual in real time. Boids trajectories are used to display hundreds of primitive geometric shapes varying in shape, colour, speed and dispersion in space. All this variations produce a visual texture that is coupled with generative rules for controlling sounds and interactions with local and remote agents.



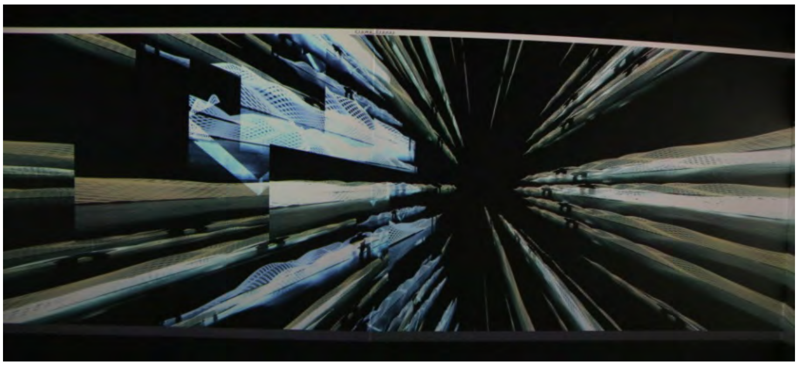


Figure 6: *Photos of the CromaCrono≈ environment illustrating the complex animated texture produced by the system in real time. It is an audio-visual texture of interwoven processes which density increases as much they are interconnected.*

Sounds are generated in real time by four different standard synthesis methods: additive synthesis, FM, wave-shapping, and Karplus and Strong algorith. A granular synthesis engine post-process is applied to the initial synthesis signal according to spatial projection of two colour-voices: the bluish and reddish ones. In other to emphasize the visual discrimination of two independent interwoven textures, the opposition in the colour spectrum defined these starting colours.

The shapes in the complex visual textures (see figure 6) are associated to sound synthesis engines: <u>spheres</u> to additive synthesis, <u>squared frames</u> to FM, <u>planes</u> to waveshapping and <u>triangular frames</u> to Karplus Strong. Colour shades are changed in real time by audio inputs. The colour RGB vector representation is coupled to variations on audio features extracted from microphone inputs, and from the sounds produced by the systems. Audio features extracted from the audio are: variations on the fundamental frequency, variations on the audio intensity and the spectral Chroma.

Therefore, the whole system works as a unified generative process that digitally synthesize sounds and images, receive GUI and remote control from the Internet, and in turning generate audio and image outputs (see figure 7, top).

Despite of many processes controlled simultaneously, the system is design to operate in a loop of 14 parameters. They are organized in a “Composition Curve” with 10 iterated-sections, 140 parameters in total (see figure 7, bottom). That economical representation allows fast transmission and communication peer to peer over the Internet.

Genetic Algorithms operate over the whole generative engine. Mutation, crossover, insertion, selection are applied to the 14 control-parameters and structural operations shift (left/right), transposition (up/down), new-curve, square-curve and undone are applied to the whole curve.

Economic set of parameters and small set of compositional operations, make possible to evolve and share in real time compositions/improvisations via Internet. Local and remote agents control together the generative process of CromaCrono≈. Sound and images are synthesized in local machines while agents exchange parameters that produce a “texture of times”.

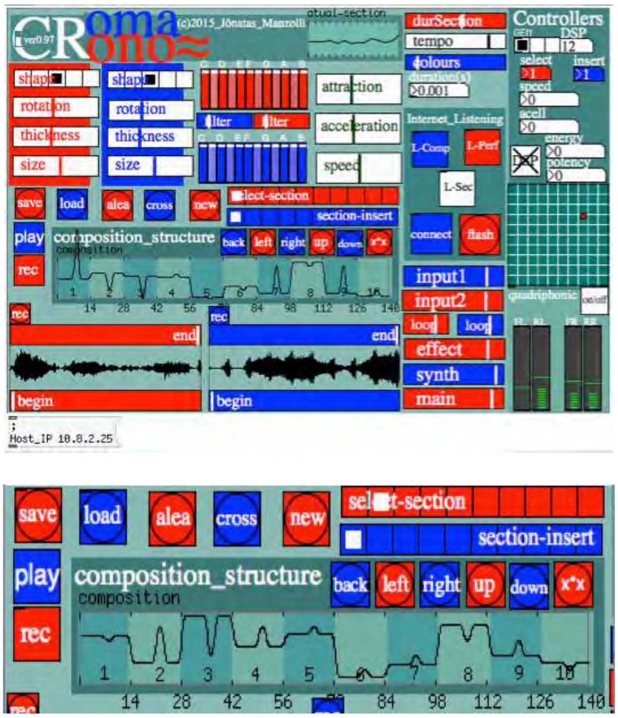


Figure 7: *GUI of CromaCrono≈ showing all the integrated control parameters of the system (top), and in detail the “Composition Curve” and the buttons to apply genetic and structural operations over the curve. A remote user can also “press” the buttons using a mirror program in a location via a VPN connection.*

– 5. Discussion and Conclusion

We presented a paper on the development of multimodal installations based on a methodology anchored in interactive mixed reality spaces. Starting upon the concept of Presence, a computer model to interact with local and remote agents affording implicit and explicit information was discussed. Four examples described mechanism for generating sound and images via computational mechanisms. Generative processes instantiated on the computer use the boids algorithm in both images and sounds generation and than the system generate animations, control soundscapes and digitally synthesized sounds.

Each installation has specific characteristics, different aspects in which their interactive narratives are constructed. “Danças do Vento” departs from the dynamic behaviour of the wind to create visuals and soundscapes featuring four different “wind dances”. “Eólia” simulates a virtual Aeolian harp. The trajectory of boids, modified by performers using mobile devices, produce sounds when the boids collide with the virtual strings as the wind plays strings in an outdoor space. “Pássaros de Papel”, draws a parallel between migrating birds and people and its generative algorithm is based on bi-cubic interpolations of the points generated by the boids. CromaCrono≈ is a system for audio-visual improvisation in real time. In this case, the boids are used to control parallel processes generating a complex audio-visual texture composed by four primitive geometric shapes, colours and digitally synthetized sounds. A small set of parameters controlled by genetic algorithms makes possible to share a real time improvisation via Internet controlled by local and remote agents. Despite of each installation has a specific design they all preserve an aesthetic unit aligned to principles of interaction discussed in the paper.

Finally, we would like to point out that Art, in particular generative and digital Arts, play an essential component in the study of creativity. Whereas Science is by necessity bound by the state of the art and the opinion of peers, Art can boldly leap beyond the shackles of collective expectations and norms elaborating and validating new principles.

– Acknowledgements

I wish to thank the research team of SPECS of the Centre for Neuro-Robotics and Autonomous Systems (N-RAS) for hosting me at the Pompeu Fabra University during these last few months. I thank also my students from the Interdisciplinary Nucleus for Sound Studies of the State University of Campinas (NICS), Unicamp, Brazil for supporting this research and help me in different aspects. This research is supported by the Foundation for the Research in São Paulo State (FAPESP) project 2015/07084-0, and by the National Council for Scientific and Technological Development (CNPq) projects 305065/2014-9 and 470358/2014-9.

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Ben Baruch Blich

The logic of curatorship: Between displaying and representing as a matter of selection. *(Paper)*

Topic: Curating Art, Design, Architecture

Author:

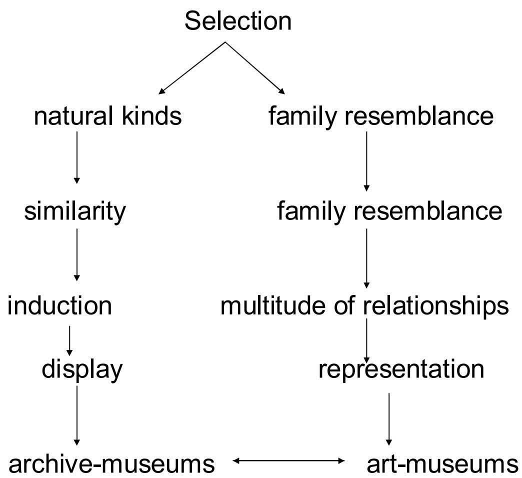
Ben Baruch Blich

Bezalel Academy of Arts and Design, Jerusalem

Abstract:

The ideas I intend to put forward in this paper are intuitively known and practiced by each and every one of us, even without a title of a curator. After all, we all decorate our houses by hanging paintings, posters, photographs, by placing statues and all sorts of furniture – chairs, tables, cabinets, cupboards, as well as lamps, stereo sets, telephones, computers, etc. to make our private intimate surroundings agreeable, pleasant and cozy.

Unknowingly, we all act as curators facing by each and every choice we make a dilemma of selection - should we use all or most of our collection of paintings, posters, furniture we own and display them in our private homes, or should we choose and pick those we consider important, representing taste, autobiography, political inclinations, etc., and put emphasis on those articles we find significant. In short, should we display whatever is available, or exhibit those pieces which represent an idea, an inclination, an ideology.



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Keywords: Representation, display, natural kinds, family resemblance, curators, art, design, architecture.

COURCHIA Jean-Paul

Johannes Vermeer : A generative artist ? So What ?

Topic: art and science

Courchia Jean Paul

Saint Joseph's Hospital, Dpt of Ophthalmology. Marseille. France

Sarah Guigui MD

Department of Internal Medicine, North Shore LIJ at Forest Hills Hospital.

Benjamin Courchia MD

Department of Pediatrics, Mount Sinai School of Medicine at Elmhurst Hospital.

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[1] Secret Knowledge: Rediscovering the Lost Techniques of the Old Masters. David Hockney

[2] Vermeer's Camera: Uncovering the Truth behind the Masterpieces

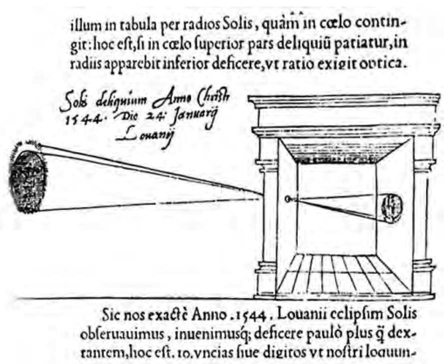
Philip Steadman

[3] Tim's Vermeer

Film (2013)

Courchia@numericable.fr

Johannes Vermeer van Delft was born in 1632 in Delft, where he would spend his entire life. He is one of the greatest artists of the seventeenth century Dutch painting. He was nicknamed the "master of Dutch light" giving to his compositions bright colors, always working on textures patterns and light contrasts. He really painted with light. Few paintings will be made by the artist, 35 or maybe 37, small size, most portray figures in interiors, intimate scenes. A large number of Vermeer paintings, by their photographic aspect, suggest that he used a camera obscura ("dark room"). It is a device that makes use of an optical phenomenon. It is almost like a photographic camera without the light-sensitive film. If light rays pass through a very small hole (a pinhole) of a wall of a darkened room, the image of the outside scene will be recreated on the opposite wall. The projected image will be upside down and laterally reversed. In this presentation we will show examples that strongly suggest that J. Vermeer use this device. After David Hockney [1], revealing the tools of the old master, Philip Steadman [2] noted that many of Vermeer's paintings had been painted in the same room, with the right size as if they had been painted from inside a camera obscura. In Tim's Vermeer documentary film [3], directed by Teller, the inventor Tim Jenison duplicate *The Music Lesson* with the camera obscura's technique.



Gemma Frisius observing the solar eclipse in 1544

The Music Lesson

Keywords: generative art, camera obscura.

Johannes Vermeer : A generative artist ? So What ?

Courchia Jean Paul, MD

Saint Joseph's Hospital, Dpt of Ophthalmology. Marseille. France

e-mail : courchia@numericable.fr

Guigui Sarah

Department of Internal Medicine, North Shore LIJ at Forest Hills Hospital.

Courchia Emmanuel

Department of Psychology, Queens College at CUNY.

Johannes Vermeer was a Dutch artist born in Delft (the Netherlands) on October 31th 1632, and died on December 16th 1675 at the age of 43 years old. Over the course of his life he was a successful painter locally around Delft and The Hague, but this modest celebrity was soon forgotten after his death.

He painted only few paintings of which only 36 are known to date. His paintings are often thought to be small but in reality are of varying sizes from 160 cm to 20 cm in greatest dimension. What is interesting is that they are sometimes at the same (or almost) dimensions. Especially in the series of interiors with the light coming through a window on the left, it is possible that the size's choice is not only linked to the fact that Vermeer use standard sizes.

It is not until 1866 that Vermeer becomes familiar with global fame. Thanks to Theophile Thore-Burger, a French journalist, whose art critic column propelled Vermeer onto the international scene. In 1842 when he saw the View of Delft in the Mauritshuis of The Hague and became an instant fan of the duct painter. He helped Vermeer's notoriety by publishing an essay attributing 66 works to the painter although 34 are universally attributed to him.

This notoriety coincides with the advent of photography. This parallel will lead many critics to blame Vermeer for his "photographic" style.

"It has been suggested more than once that the renascence in the reputation of Vermeer in the second half of the 19th century may not have been unconnected with the invention and spread of photography." Will say Arthur K. Wheelock Jr., the author of Vermeer and the art of painting.

The likeness of Vermeer's paintings to photographs comes from the perfect illusion of space and depth, perspective, geometry and the importance of details. For example in the Music lesson, the front flap of the virginal can be compared to the original paper type and we can see that all the details of the pattern are present even if they are quite small. Also, in the Lacemaker, the threads of the lace she is shown working on are represented with an extreme delicacy, while the threads on the side are blurred with color spots.

An extreme truth of tonal value and respect of dark and light in the subject make his paintings close to some photographic work.

In 2001 David Hockney, the English painter, wrote a book called “Secret Knowledge: Rediscovering the Lost Techniques of the Old Masters”, besides the well known fact that linear perspective appears around the time of the Renaissance, Hockney affirms that the history of the renaissance parallels the history of optics. He will create what he called “the Wall” in his studio with images of great realistic art from 1400 until 1900. Observing a sudden rise in precision and realism around 1420, to which he associates with the birth of optics around this time.

With Charles Falco, professor of Optical Sciences at the University of Arizona, he postulates that concave mirrors could have been used in that period to project images.

For Hockney there are three parts to the story of art: the pre-optics period (awkwardness), the optics period (disappearance of awkwardness), and the post-optics (the return of awkwardness).

In 2002, an architect, Philip Steadman, wrote “Vermeer's Camera: Uncovering the Truth behind the Masterpieces” where he brings up the possibility that Vermeer was in fact using a camera obscura.

The camera obscura, precursor to the modern photographic camera, works similarly to the human eye. This device was well known for centuries and documented by Ibn al-Haitham in his Book of Optics in 1011–1021. Gemma Frisius in 1544, during a solar eclipse, drew the first representation of a camera obscura.

The theory that Vermeer used such technique can be founded in several ways:

Reflection: there are reflections on the lion's head motifs that adorn his chairs in several paintings that cannot be seen by naked eye.

In the “Officer and Laughing Girl”, there is a distortion in the perspective, “a photographic perspective”. The officer's head is about twice as wide as that of the smiling girl, while there are quite close.

There are no lines drawn beneath the painting. Vermeer do not make any drawing underneath his painting.

Philip Steadman finds common features in several paintings about the same size: the windows, the ceiling, the back wall and the floor. For example there is the same ceiling in the ”The Music lesson”, the “Allegory of Faith”, the “The Art of Painting”; the same floor in ”The Music lesson”, the “Allegory of Faith”, “The concert”, the “The Art of Painting”, the “Lady Writing a Letter with her Maid” and “The love letter”; We find the same type of window in height paintings.

Using reconstruction for the rooms in 3D and 2D, Philip Steadman, found the viewpoint, where Vermeer put his lenses if he uses the camera obscura. He will reproduce a model of Vermeer's studio, with dolls and furniture, and took pictures with photographic plate camera.

Tim Jenison, NewTek Founder and inventor, will bring light to two questions left by Philip Steadman. Using a classic camera obscura, how come the image is not mirrored? And inside a booth in semi darkness, how can Vermeer paint in color? "The problem with the camera obscura as Hockney described it, is that it could really only be used for drawing, tracing the projected image. You can't paint under a projection because the light being projected affects the color and value of the paint being applied. It is only accurate over a white surface."

Tim Jenison will perfect the classic Camera obscura by adding a concave mirror that will resolve the two problems left by Philip Steadman.

In his documentary Tim's Vermeer, Tim Jenson builds a room with the same dimensions as the one showed in "The Music Lesson". He will be able to repaint « the music lesson ». Jenison's project took more than four years. His painstaking results are impressive for an amateur.

So what?

Well, this discussion brings up the eternal question asked about art. Does technique matter more than content?

Clearly, we will never know for sure whether Vermeer did or did not use the technology of his time to achieve the best possible result. What is clear however is that Vermeer's technique does not affect the content of his work. It provides a glimpse into a time period that is remote to ours and establishes a connection between our ancestors and us that only art can achieve.

Whether our Homo sapiens ancestors used stencils to paint the walls of the Lascaux cave does not seem to affect our perception of their works.

The only question, or blame, that could be brought up to Vermeer's door is whether or not he was forefront with his use of techniques such as a camera obscura to achieve the results he wanted.

In conclusion, it is fascinating to think of Johannes Vermeer as a geek who was at the cutting edge of technology in 17th century Holland. It seems unlikely that Vermeer's possible use of optics to achieve a high level of details will impact how the public views his work. It reemphasizes, however, Vermeer's commitment to the essence and the emotions of a scene rather more than anything else.

(1) Secret Knowledge: Rediscovering the Lost Techniques of the Old Masters. David Hockney

(2) Vermeer's Camera: Uncovering the Truth behind the Masterpieces. Philip Steadman

(3) Tim's Vermeer - Film (2013)

Daniel Bisig
Philippe Kocher

DRIFT – Virtual Sand in augmented Space

Topic: Audiovisual Installation

Authors:

Daniel Bisig

Zurich University of the Arts

Institute for Computer Music and Sound Technology

Switzerland

http://www.icst.net/

Philippe Kocher

Zurich University of the Arts

Institute for Computer Music and Sound Technology

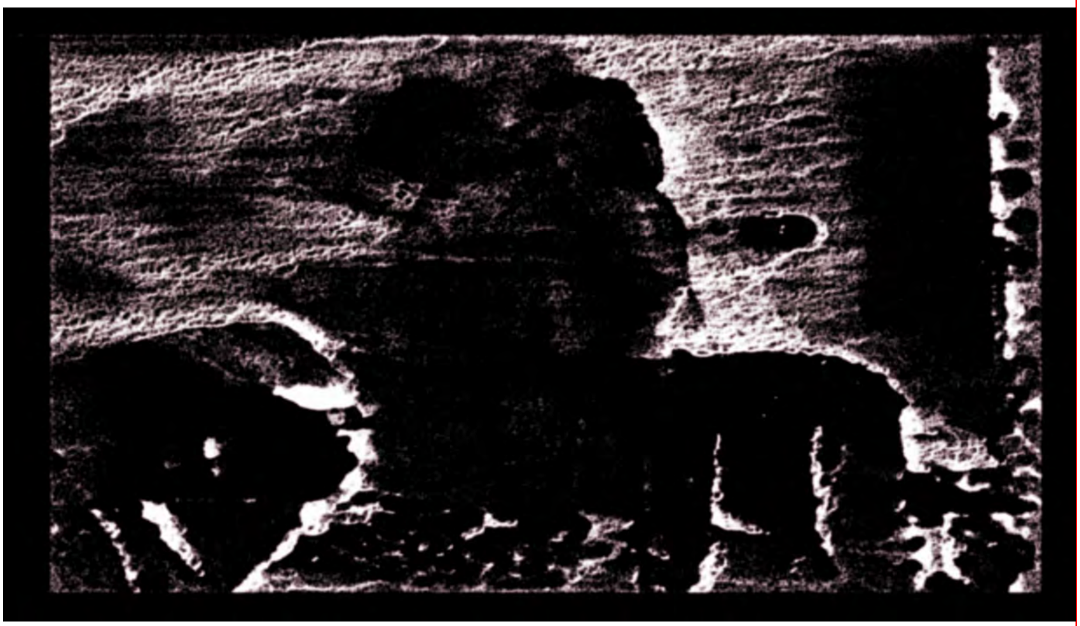
Switzerland

http://www.icst.net/

Abstract:

Drift is an interactive audiovisual installation that overlays the appearance and behaviour of a generative mechanism with the properties of a surrounding physical space. This installation forms part of a series of works in which the authors experiment with generative approaches to augmented reality. These works place a particular focus on merging simulation-based and natural systems not only of the level their respective appearance but also with respect to their underlying physical and behavioural properties.

In this installation, the generative system is based on simulated sand grains that move across a virtual relief. The relief is derived from a combination of the physical properties of the exhibition space and a geometrical representation of an imaginary space. The installation itself consists of a rotating platform that houses a camera, a video projector and two directional loudspeakers. As the platform turns, the camera and projection scan across the surrounding space. The virtual relief to which the simulated sand grains respond to changes in accordance to the scanned space. At the same time, the behaviour and distribution of sand grains becomes perceivable as an acoustic and visual projection that is aligned and superimposed with the physical appearance of the scanned space. Visitors who are present in the exhibition space automatically become part of the generative processes. Their presence alters the space perceived by the scanning mechanism and their appearance also becomes subject to the process of audiovisual superposition.



Screenshot depicting virtual sand grains drifting past physical obstacles

Contact: daniel.bisig@zhdk.ch

Keywords: Audiovisual Installation, Augmented Reality, Particle Simulation

DRIFT – Virtual Sand in Augmented Space

Dr. Daniel Bisig

Zurich University of the Arts

Institute for Computer Music and Sound Technology

Switzerland

http://www.icst.net

e-mail: daniel.bisig@zhdk.ch

Philippe Kocher

Zurich University of the Arts

Institute for Computer Music and Sound Technology

Switzerland

http://www.icst.net

e-mail: philippe.kocher@zhdk.ch

Abstract

Drift is an interactive audiovisual installation that overlays the appearance and behaviour of a generative mechanism with the properties of a surrounding physical space. This installation forms part of a series of works in which the authors experiment with generative approaches to augmented reality. The generative system of Drift is based on simulated sand grains that move across a virtual relief. The relief is derived from a combination of the physical properties of the exhibition space and a geometrical representation of an imaginary space. The installation itself consists of a rotating platform that houses a camera, a video projector and two hyper-directional loudspeakers. As the platform turns, the camera scans across the surrounding space and provides the data on which the virtual relief is based. At the same time, the output of the simulation becomes perceivable as an acoustic and visual projection that is aligned and superimposed with the physical appearance of the scanned space. Visitors who are present in the exhibition space automatically become part of the generative processes. Their presence alters the space perceived by the scanning mechanism and their appearance also becomes subject to the process of audiovisual superposition.

– 1. Introduction

Drift is a generative artwork that creates synthetic audio and video based on an analysis of its surrounding space. Its consists of a motorized rotating platform that carries a distance sensing camera, a video projector and two ultrasonic loudspeakers. As the platform moves, the camera traces the surface of the space. The trace serves as a common ground for two otherwise independent processes: the generation of a visual and acoustic output. These two outputs are projected on the same surface region that has been traced by the camera. As a result, the characteristics of the physical space gives rise to dynamic and intangible processes that transform the formerly static appearance of the space into a fluid and malleable environment.

The realisation of this artwork is motivated by the authors long standing interest to employ generative systems to extend and augment physical objects and environments (see for example [1, 2]). The artistic format of an installation offers the opportunity to develop generative processes that mirror in a literal or metaphorical sense the close relationship between the structural and perceptual characteristics of a natural space. The challenge and prospect of this approach consists in the design of a generative system that maintains an intimate relationship between space, light and sound but at the same time renders this relationship amenable to creative experimentation beyond the natural constraints of a physical space.

The approach of extending and transforming an existing physical space by artistic means constitutes an interest that is shared by several artists. This interest is often motivated by a desire to transcend the physicality, solidity and permanence of a space. In many of the resulting installation artworks, light plays a particularly important role as a medium for the transformation of space. The following section provides a cursory overview of some of the works that have been realised in this context. A particularly rich artistic outcome has emerged from the Californian art movement *Light and Space* [3]. Pioneering members of this movement such as James Turrell or Doug Wheeler employ light in order to transform the perception of a space and to provoke a liminal experience [4, 5]. Among their works feature installation series such as the neon light spaces by James Turrell and the light walls by Doug Wheeler. A similarly classical series of installations named *Lichtballett* have been realised in Germany by the artist Otto Piene [6]. These light-based installations are realised as kinetic sculptures that create shifting light patterns across surrounding walls of the exhibition space. Among younger generations, artists such as Barbara Kasten [7] or the London bases art collective *United Visual Artists* continue this tradition of manipulating space via the medium of light. For instance in her piece *Axis,* Barbara Kasten employs shadow, colour and lighting effects as a means to render a space ambiguous and fluid. The work *Momentum* by the United Visual Artists [8] turns the space of the Barbican Centre's Curve gallery into a spatial instrument, that consists of a sequence of pendulum-like elements. These swinging pendulums emit sound and light which they project across the six metre high walls and curved floor of the space.

– 2. Concept

Drift has been realised as the most recent incarnation of two general concepts that have informed many of the authors collaborative artworks so far. The first general concept has already been mentioned and refers to the augmentation of natural objects via the application of algorithmic principles. In a simulation-based approach, the algorithms are designed to model some of the structural and behavioural aspects on which the appearance of these objects is based. The creative experimentation with these algorithms leads to a perceivable output that preserves some of the characteristics of a natural object's appearance.

The second general concept is related to the fact that the creative experimentation with algorithmic principles has important implications for works that incorporate multiple media. If each of the individual media is created through the activity of a common set of algorithmic rules, then these rules imprint across these media a formal relatedness that becomes perceivable as a consistency of appearances. This consistency is inherent to the creation process of each of medium and therefore doesn't require any form of coordination among the media in their creative design.

In the specific case of Drift, the object to be augmented is the exhibition space. The incorporation of the physical and perceptual characteristics of this space is the core principle of this artwork. The simplified representation of the space as three dimensional surface relief forms the basis for the operation of the generative algorithms and the rendering of the installation's visual and acoustic output. Just as these surfaces serve as live input for the generative algorithms they become subject to manipulation by the installation's synthetic audio and imagery. By creating and projecting a synthetic audiovisual output from generative processes that respond to the surface characteristics of the surrounding space in a very dynamic way, the permanence and tangibility of the space's original appearance is partially superseded by the fluidity and intangibility of computer generated audiovisual material.

The surface of the real physical space is complemented by additional synthetic surfaces, which are also used as input for the generative processes. These synthetic surfaces represent virtual spaces whose properties can significantly deviate from a physical space. By combining the inputs from a physical space and one or several imaginary spaces, the response of the generative processes and the resulting audiovisual projection originates from the presence of a hybrid space. It is this combination of dynamic generative processes and virtual spaces that imbue the physical space with aspects of intangibility and dissociation from local reality. The extent of this augmentation and its ephemerality is emphasised by the fact that the installation kinetic activity. As the installation rotates, the surface regions (both physical and virtual) that serve as input for the generative algorithm continuously change. As a result, the augmentation manifests via a narrow but dynamic audiovisual projection that briefly supersedes the local characteristics of a region of physical space after which this region return to its former natural appearance.

Due to the fact that the installation operates with life input, the augmentation process is part of a mutually dependent feedback loop between physical space, generative processes and audiovisual superposition. The existence of this feedback loop becomes apparent in the installation's site-specificity and the interaction possibilities of visitors. The real-time characteristics of the installation allow the generative processes to respond differently to the varied surface configuration of different spaces. As a result, each exhibition setup provides a unique situation within which the augmentation feedback loop unfolds. With respect to interactivity, visitors of the installation become automatically part of the augmentation feedback loop: their body surfaces serve as input for the generative algorithms and in turn becomes subject to a superposition with the installation's synthetic audio and video.

– 3. Implementation

– 3.1 Hardware

The hardware setup and the cabling among the different devices is shown in Figure 1. The housing of the installation is divided into two compartments. A closed stationary lower compartment contains a hall effect sensor, a DC Gearmotor with integrated rotary encoder, a motor driver, a motor controller and a microcontroller. An open upper compartment which rotates around a central axis carries a video projector, two hyper-directional loudspeakers each with its own audio amplifier, a distance sensing camera and two computers. A small magnet is attached underneath the bottom platform of the upper compartment. This magnet is sensed by the hall effect sensor and thereby indicates a reliable reference orientation. The upper compartment is supported by four ball bearing wheels that are attached to the top plane of the lower compartment. The motor transmits its torque via a belt to the axis of the upper compartment. The axis contains a three pole sliding contact through which electrical power from the lower to the upper compartment is transmitted. Control and sensing data concerning the motor's position and speed is sent wirelessly via a point to point connection between two Xbee modules. Among the equipment placed on the rotating platform, the loudspeakers deserve a more thorough description. Each of them consists of a disk-like arrangement of multiple ultrasound emitting capsules which together form a highly directional audio beam. This inaudible ultrasonic beam acts as carrier wave for a sound signal which becomes audible only when the beam hits an obstacle. In this situation, the obstacle becomes perceivable as source from which the sound signal originates.

3.2 Software

An overview of the software components that control the installation as well as their communication protocols is given in Figure 2. The microcontroller runs a motor control and communication software. The first computer runs a motor control and communication software, the main installation application that comprises functionality for video tracking, simulation and visual rendering, and a watchdog program for job monitoring and program scheduling. The second computer runs the sound synthesis software and another watchdog program. These individual software components are described in more detail throughout the remainder of this section.

3.2.1 Motor Control and Communication (Microcontroller)

This software controls the position and speed of the motor. The software communicates with the first computer by receiving control settings for the motor's target position and speed and by sending the motor's current position and speed. This software also maintains a stable reference orientation with respect to which the motor target position is defined.

3.2.2 Motor Control and Communication (Computer 1)

This software acts as an interface between the microcontroller software, the simulation software, and the sound synthesis software. It communicates with the first software according to the Xbee API v2 protocol, with the latter two programs via OSC. This software passes on information about the motor's current position and speed to the installation software and sound synthesis program. From the simulation software it receives information about the motor's target position and speed. This information is divided into multiple motor control settings that are then scheduled and sent sequentially to the microcontroller in order to guarantee a safe accelerate or deaccelerate of the rotating platform.

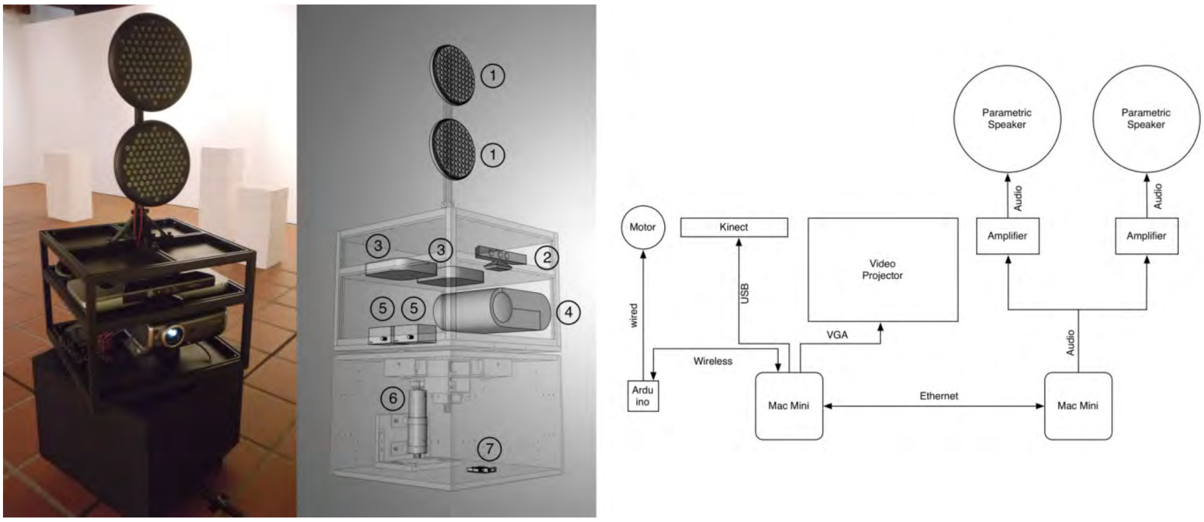


Figure 1. Installation hardware. From left to right: a photograph of the installation within the exhibition space, a schematic depiction of the installation hardware, a schematic depiction of the individual devices and their cabling. The numbering in the middle image refers to the following devices: 1) parametric loudspeakers, 2) distance sensing camera 3) computers 4) video projector 5) audio amplifiers 6) motor 7) microcontrollers. For the sake of simplicity, the motor driver, motor controller, hall effect sensor, magnet, and sliding contact are not shown in this image.

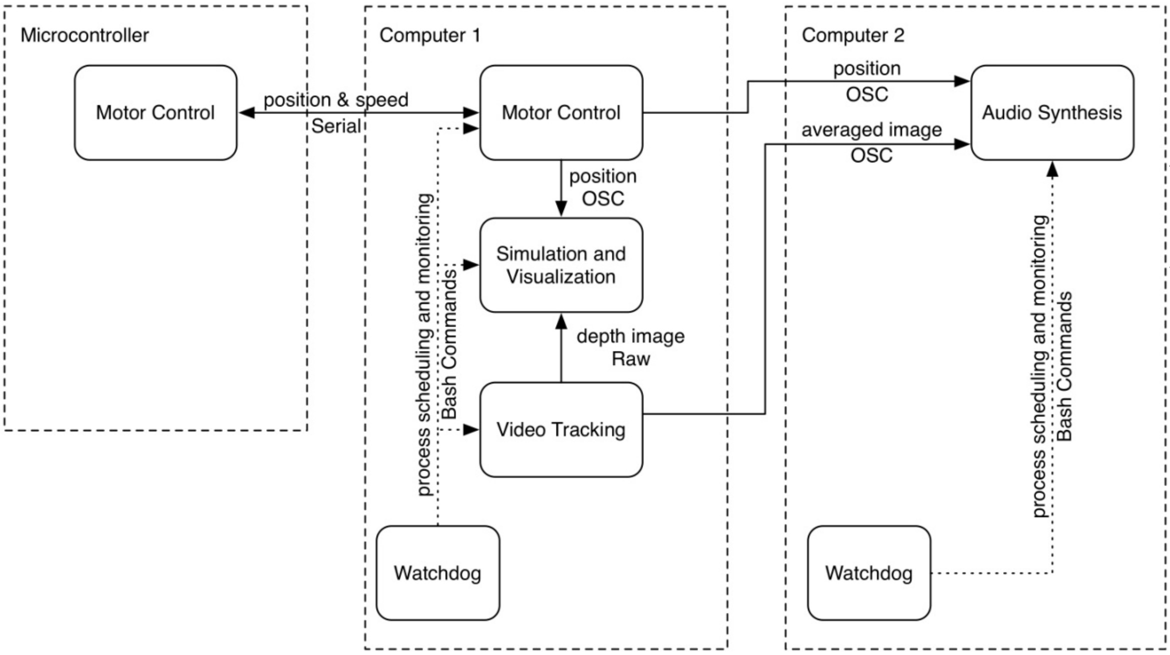


Figure 2. Software and protocols. The image depicts the software components that run on the microcontroller and the two computers. Most of these components represent individual applications with the exception of the "simulation and visualization" and "video tracking" component which are part of the same software. Solid lines indicate communication channels among software components. Dashed lines indicate the scheduling and monitoring activity of the watchdog software. The line labels describe the type of data that is being exchanged and the protocol used.

– **3.2.3 Video Tracking (Computer 1)**

The sequential processing steps of the video tracking software are depicted in Figure 3. The software retrieves a distance image based on the current point of view of the tracking camera. It also retrieves a second distance image by extracting a section from one of several previously stored panoramic distance images that represent virtual spaces. The location of this section within the panoramic distance image is controlled by the current position of the motor. These two distance images are averaged into a merged image. The merged image is then subjected to two different post-processing pathways. One calculates a horizontal and vertical gradient to be directly passed to the simulation software. The other calculates averaged values of 24 columns located in the centre region of the merged distance image. These values are sent via OSC to the sound synthesis software.

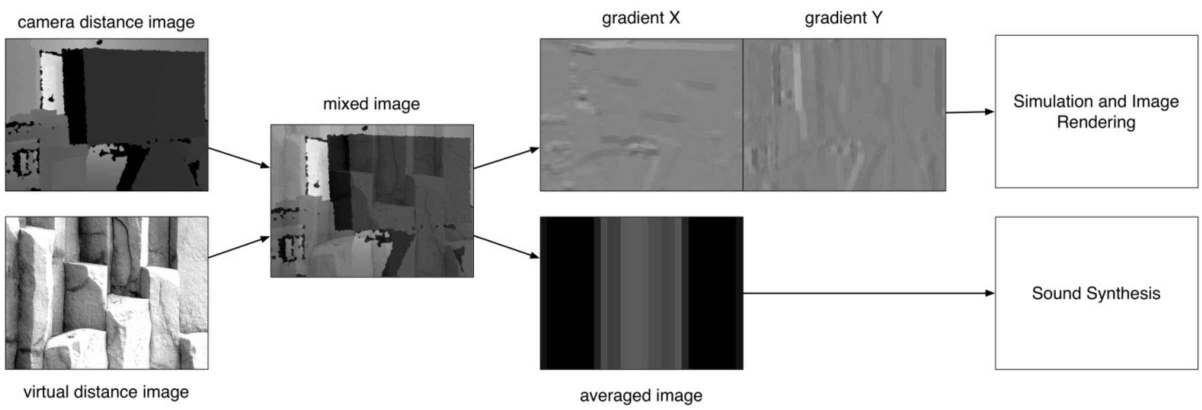


Figure 3. Image processing. A schematic representation of the image processing steps that are applied to the two distance images prior to their usage as inputs for the simulation, image rendering, and sound synthesis routines.

– **3.2.4 Simulation and Visual Rendering (Computer 1)**

This software forms the core part of the installation. Its controls the simulation algorithm, the visual rendering, and the kinetic movements of the installation. It also controls the global states of the simulation, each of which is associated with a particular image of a "virtual space" as well as a certain set of parameters for the simulation and visual rendering. State changes are always triggered at a predefined angle. In addition, some parameters are variable depending on the direction and speed of the motor's rotation and on whether visitors are present within the view of the tracking camera.

The simulation implements a particle system in which each particle possesses the following properties and behaviours: a mass, a preferred velocity, and a preferred speed. The particles experience drag and perturbations effects. They can sense the horizontal and vertical gradients derived from the distance image as slopes that oppose or propel their movement. By laying down virtual pheromone marks, the particles can sense neighbouring particles and either be attracted to them or evade them. As a result, the particles are able to move on their own or as groups with a limited degree of autonomy. Yet this autonomy is influenced and possibly superseded by the effects that the gradients exert on the particles' movements. These effects typically lead to an accumulation of particles in front of an inclination, a scattering of particles along a decline, or a splitting of a groups of particles at a corner of an inclination. The particles' sensitivity to image gradients can be adjusted in such a way that they respond either to only very steep gradients or to both steep and shallow gradients. A high responsivity to steep gradients accentuates the effect of sharp corners and edges which are predominantly present in the surfaces of the walls of the exhibition space (see Figure 5 top left image). A high responsivity to shallow gradients strengthens the influence of smoother surfaces such as the ones being provided by the visitors (see Figure 5 bottom left image). In order to be able to run the simulation with several hundred thousand particles, all the behaviours and simulation routines have been implemented as OpenCL kernels that are being executed on the GPU.

The simulation and visual rendering of the particles are tightly related. Each particle is rendered as a filled circle whose only customisable attributes are its diameter, colour, and transparency. Accordingly, the characteristics of the resulting visual rendering is predominantly determined by the spatial arrangement of the particles. This arrangement is controlled by a combination of the particles own behaviours and the geometrical structures of the physical surfaces of the surrounding space (see Figure 5 for some visual renderings of the particle system).

– **3.2.5 Sound Synthesis (Computer 2)**

The sound synthesis is realized in the programming environment *SuperCollider.* There is a total of nine different sound-producing modules (instruments). Some of these modules consist of an array of oscillators and generate dense sonic textures or tone clusters. These textures are static in their overall appearance, but detailed and granular in their microstructure. Other modules play audible patterns of bell-like chords and single tones.

In every module, some of the sound synthesis parameters (pitch, volume, timbre etc.) are subjected to external control. The data received via OSC from the video tracking software, is mapped onto these parameters. According to the number of columns taken from the distance image, the data consists of an array of 24 ever-changing values. In some modules, these values are applied in parallel, i.e. to control the parameters of 24 oscillators at the same time. In other modules, the values are used in sequence, to form a pattern perceivable as a repetitive texture or even a cyclic melody. As a second external control some of the modules employ also the angle of the rotating platform to regulate their sound synthesis parameters.

While the installation runs, there are always two modules sounding at the same time. Whenever the rotating platform reaches one of four predefined angles, one of the modules is replaced while the other continues, which results in a slowly paced variation of the sound characteristics.

– 3.2.6 Watchdog (Both Computers)

The watchdog software consists of a small python script that constantly monitors whether all the software applications are running. If an application has unexpectedly quit, the watchdog might kill additional applications if they are related to the crashed application according to an interdependency map. It then tries to restart these applications in the predefined sequence given by the interdependency map. If the restarting fails, the watchdog program reboots the computer. The watchdog program also maintains an exhibition schedule according to which it stops all applications after the exhibition's closing hours and starts them before the exhibition opens again.

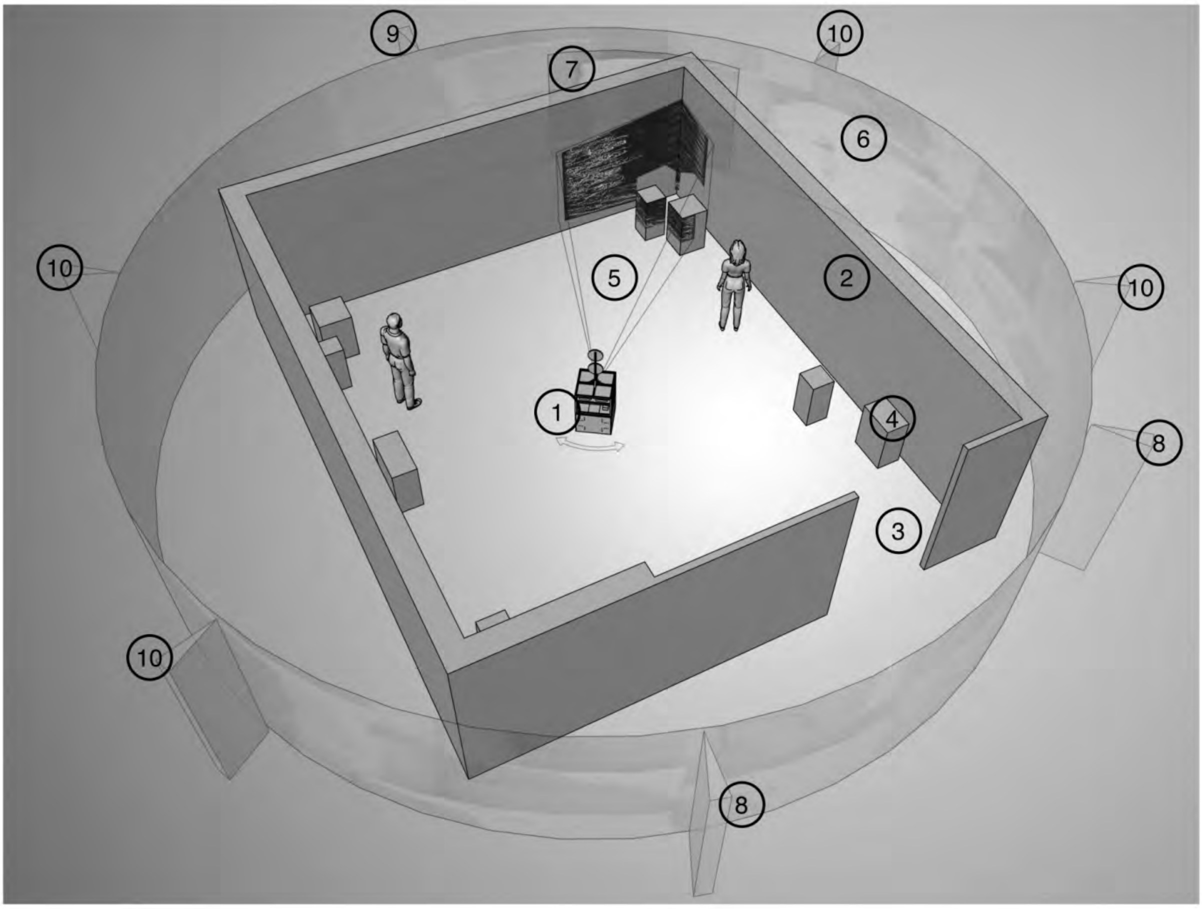


Figure 4. Installation setup. A schematic representation of the exhibition space and a surrounding virtual space. The numbering refers to the following elements: 1) the rotating platform 2) the walls of the exhibition space 3) the entrance 4) one of several pedestals 5) a frustrum representing the camera view, video projection, and audio beam 6) the distance image of a virtual space 7) a subregion of the virtual space that is aligned with the orientation of the installation 8) limit orientations for the installation rotation 9) state change trigger position for the simulation and visual rendering 10) state change trigger positions for sound synthesis.

– 4. Results

Drift has been exhibited from October 23 to December 6 2015 in the gallery *Zimmermannhaus* in Brugg, Switzerland. The schematics of the exhibition space are shown in Figure 4. Some impressions of the exhibition situation are shown in Figure 6. The gallery permitted us to setup the installation one week in advance of the opening in order to allow us to adapt and fine tune the installation to the specifics of the space.

– 4.1 Space, Movement and Interaction

Concerning the placement and kinetic movement of the installation, the following adaptation were made in order to take into account the layout of the exhibition space. The rotating platform was placed in the middle of the exhibition space. The central reference orientation for the motor was assigned in such a way that the installation’s audiovisual output is projected onto the main wall opposite of the entrance. Due to the fact that the entrance section of the exhibition space consists of a series of glass windows, we decided to concede our plan to let the installation rotate through multiple full revolutions. Rather, we introduced limit orientations at locations beyond which the video image would be projected though the glass window (see Figure 4). Accordingly, the kinetic movement of the installation operates as follows: starting from the central reference orientation, the installation rotates either clockwise or counterclockwise. It maintains this rotation direction until it reaches a limit orientation at which it reverses direction. Whenever the installation reaches the reference orientation, the software triggers a scene change. This scene change starts as a widening of the projected image in order to cover as much of the rear exhibition wall as possible. Subsequently, a different virtual space is selected and the simulation and visualisation transitions gradually to a new parameter set. With a brief delay, the projected image narrows down again to a narrow vertical strip and the rotation resumes.

The installation’s response to the presence of visitors was implemented in such a way that it causes a slowing down of the kinetic movement. This calmer mode of operation is meant to facilitate the observation of and interaction with the audiovisual superposition that manifests on the exhibition wall and the visitors’ bodies. As soon as the camera view is again free of visitors, the speed of the rotation gradually increases to its original higher value. Finally, we decided to modify the exhibition space itself in order to increase the diversity of its otherwise extremely uniform and regular wall surfaces. This small intervention involved the placement of white exhibition pedestals in front of the wall at more or less random locations. This disarrangement of the physical space led to a greater heterogeneity in the captured distance images which in turn caused the generative simulation, visualisation and sonification routines to respond in a more diversified manner.

– 4.2 Simulation and Visual Rendering

The principal functionality of the simulation and visual rendering software had largely been implemented and tested prior to the working phase that took place directly in the exhibition space. The first site-specific adaptation was the implementation of a mechanism that relates the values of certain simulation settings to the rotation direction and speed of the kinetic movement. This change was considered necessary in order to establish a behavioural and aesthetic correspondence with the frequent directional changes in the kinetic movement. In the end, the main simulation parameters that were controlled by the motor’s movement were the velocity and directionality of the movement of the simulated particles as well as their sensitivity to the presence of image gradients. The relation between kinetic movement and particle movement caused the particles to move in synchronicity with the surfaces of the exhibition walls and to become almost stationary during moments when the kinetic movement stopped.

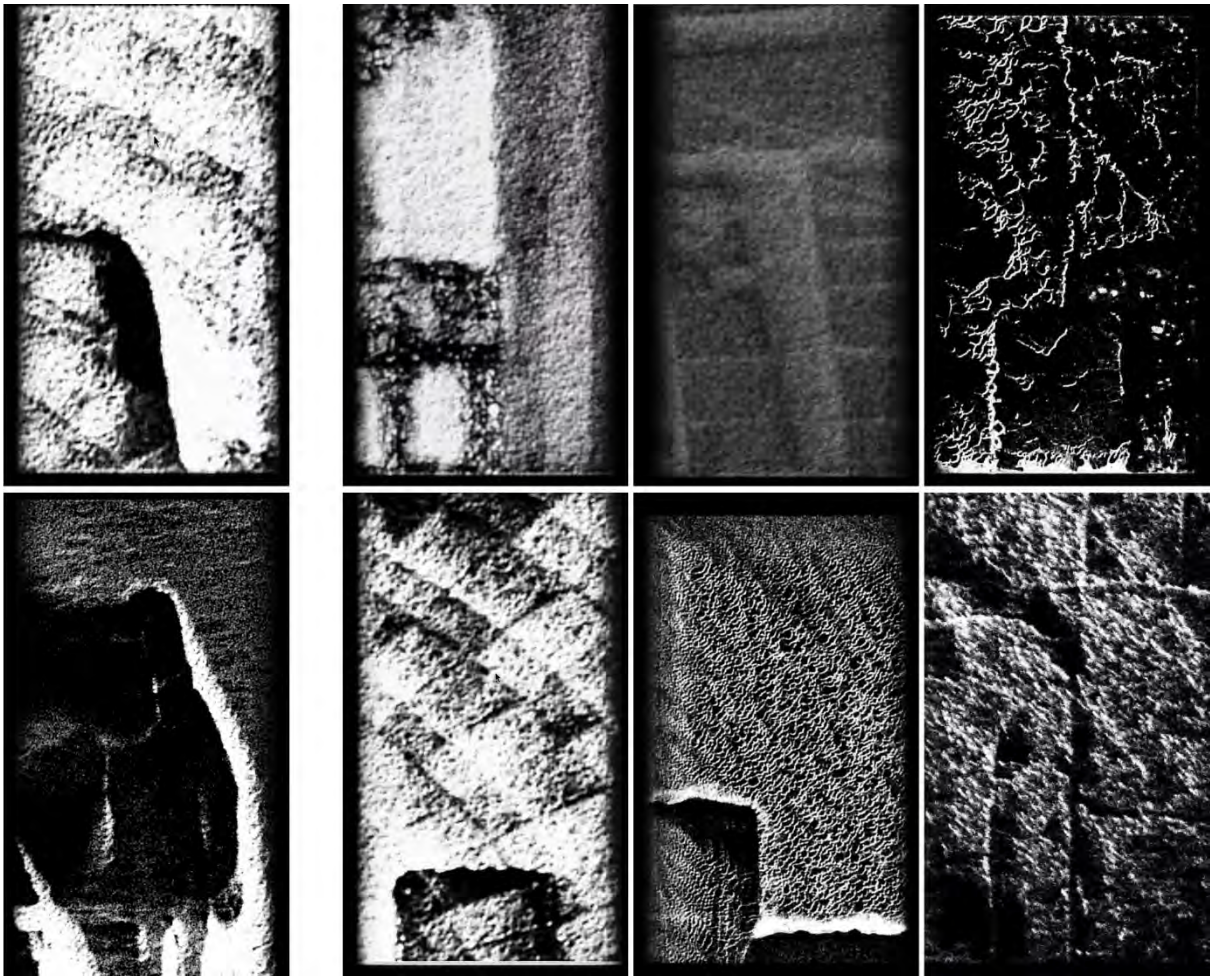


Figure 5. Visual renderings of the particle simulation. The column on the left side depicts visual renderings of the particles' response to gradient images. The three columns on the right side depict visual renderings of simulation settings that differ with respect to the strength of the effects of the physical space, the virtual space, and the particle's autonomous behaviours. Left side top image: Particle responding to the steep gradients obtained from tracked objects. Left side bottom image: Particles responding to the shallow gradients retrieved from tracked visitors. Right side top left image: strong physical space, weak virtual space, weak particle autonomy. Right side top middle image: weak physical space, strong virtual space, weak particle autonomy. Right side top right image: weak physical space, weak virtual space, strong particle autonomy. Right side bottom left image: strong physical space, strong virtual space, weak particle autonomy. Right side bottom middle image: strong physical space, weak virtual space, strong particle autonomy. Right side bottom left image: weak physical space, strong virtual space, strong particle autonomy.

The second site-specific adaptation concentrated on finding combinations of simulation parameter settings that balance the strengths of the influences of the physical space, the virtual space, and autonomous particle behaviours on the visual superposition effect. Each of these combinations of parameter settings defines a scene. In the end, the variety of scenes that were created for the exhibition space represent permutations of the following parameter combinations: strong or weak influence of image gradients derived from the physical space, strong or weak influence of image gradients derived from virtual space, strong or weak autonomous behaviours that are independent of any image gradients. The images on the right side of Figure 5 depict visual renderings that correspond to some of these permutations.

Concerning the configuration of the visual rendering, it was decided early on that all particles would be rendered as small black and white circles. The only variety among the scenes that concern the visual settings are the transparency levels of these particles and small modifications of the circle radius. This decision was made in order avoid that the projected video image would deviate visually too much from the normal appearance of the white exhibition walls. Rather, the purpose of the video projection was to create a situation of superposition in which both the visual rendering and the normal wall appearance intermix with each other without any of the two dominating and superseding the other one.

– 4.3 Sound Synthesis

This installation was primarily conceived on the basis of a visual concept. Hence we had to come up with strategies to adapt this concept to the acoustic modality. We tried to establish relations between video and audio in common characteristics of the hardware, in similar generative algorithms and in the choice of a specific sound design.

A hyper-directional speaker emits the sound in a focussed beam analogue to the way a video projector emits light. It produces a virtual sound source that appears at the point where the sound beam hits an obstacle. Having the speaker and the projector aligned, image and sound, both being projected, are made perceivable to the visitor in a very similar fashion. But there was an even more subtle effect: As the walls reflected the sound beam, a second virtual sound source could be perceived at the opposite side of the room, depending on the listeners position. This effect nicely went in line with our intention to superimpose the output of a generative mechanism with the given physical properties of a surrounding environment.

The strategy to use the same data – the depth image of the distance sensing camera – as common basis for the visual rendering and the sound synthesis enabled us to establish perceivable link between the two media on a structural level. However, as this data is inherently visual, it required a certain amount of translation in order to be applied to sound synthesis parameters. As a matter of fact, image deals with space and music with time; a recognisable gestalt in music is primarily a temporal phenomenon. Therefore, some of the sound-producing modules read the data in succession, i.e. one value at a time in a cyclic pattern in order to generate a kind of melody and hence transform space into time. Furthermore, it was necessary to reduce the amount of data since the pixels of the depth image in full resolution provide too large an amount of data to be handled in a meaningful way in the realm of sound synthesis. This led to the decision to employ only the averaged value of 24 rows from the middle of the depth image.

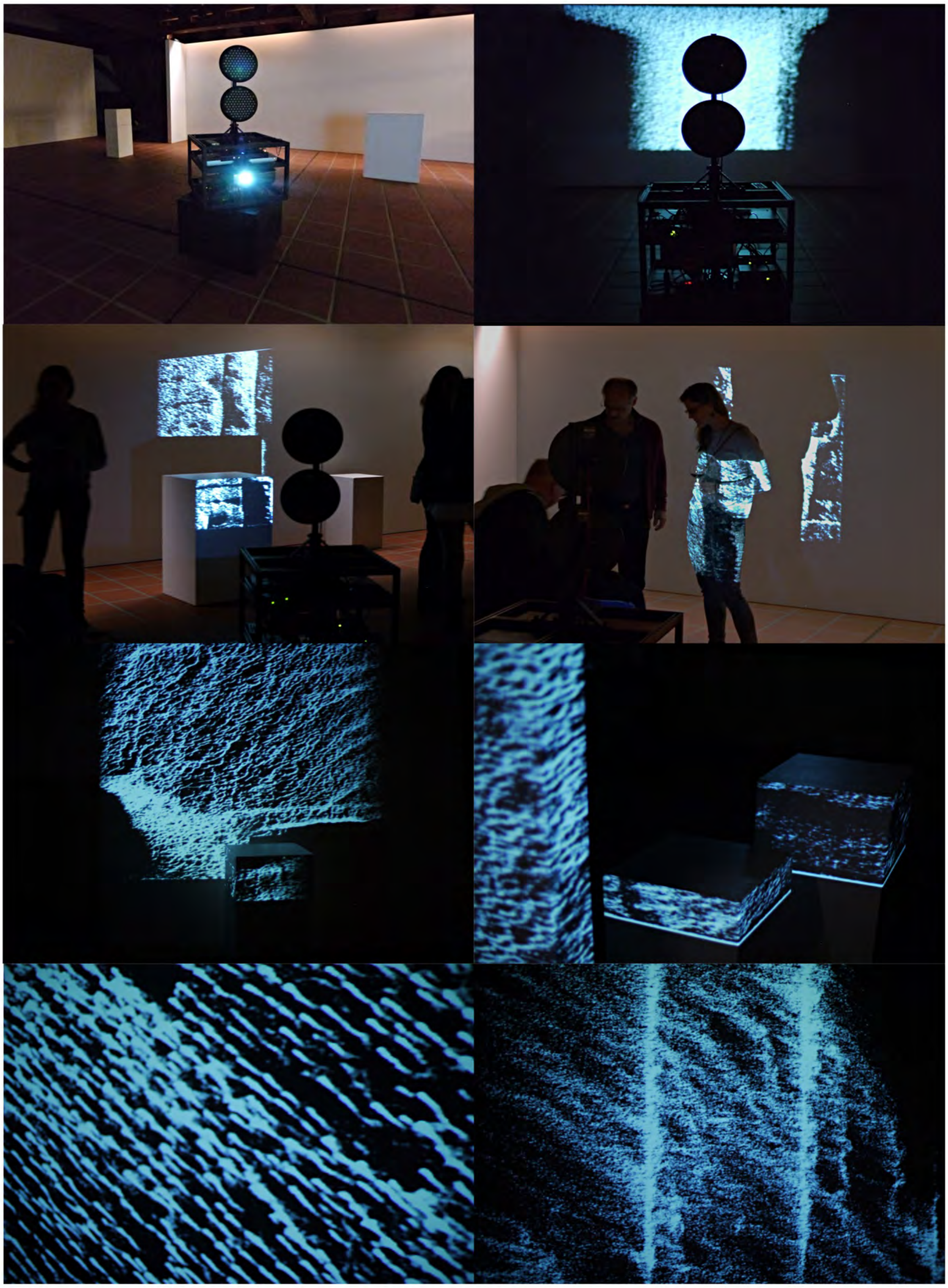


Figure 6. Exhibition impressions. The photographs were taken during the opening of the exhibition.

Due to the site-specifity of this installation much of the work had to be done on the premises. The selection of sound-producing modules and the actual mapping and scaling of the camera data required the installation to be up and running. Apart from establishing a structural relationship between imagery and sound via the utilization of the same sensor data, another kind of relationship had to be made up at this point. The choice and development of sound synthesis techniques and methods was influenced to a large extent by the aesthetics of the material generated by the visualisation software. The huge number of particles and their specific way of moving about found their counterparts for instance in the technique of granular synthesis or in the design of sound textures with subtle microstructures. By these decisions a relationship between the two media could also be established on a metaphorical level.

– 5. Conclusion

The process that started with the specification of the installation concept and ended with the actual installation taking place in an exhibition space was highly interesting for us. In particular, the final week before the opening proved to be crucial for realising a tight and site-specific relationship between the installation's capability to sense and respond to the peculiarities of a physical space and the physical space's susceptibility to accommodate the synthetic audiovisual output into its appearance. Despite the fact that surface reliefs were the only physical characteristics of the space that were used as input for the generative processes, a clear and very specific correspondence between the space, its visitors, and the synthetic audiovisual output could be achieved. The fact that this correspondence became perceivable as a superposition on the surfaces of the physical space (a space that most visitors were very familiar with because of their previous exhibition visits) strongly conveyed the concept of merging artificial and physical aspects of a space. For this reason, we believe that the installation has been successful in realising and conveying our generative approach to augmented reality.

Based on this outcome, we are interested to further proceed along this line. First and foremost, it would be interesting to setup the same installation in different spatial situations such as larger rooms, and/or rooms with more diversity with respect to their surfaces, and/or rooms that are partially open to external influences such as daylight changes or acoustic emissions. On a slightly longer timeline, it seems worthwhile to try to improve and expand the characteristics of the relationships between a physical space and its virtual augmentation. For instance, in its current version, the correspondence between the installation's kinetic movement, the surrounding space, and interacting visitors is very simplistic. The former correspondence is static and based on a few manually determined orientation key points. The latter one is a binary rotation speed change based on a distance threshold. It would be more interesting to capture and translate in the kinetic movements of the installation more distinguished and continuous aspects of the physical space and the interacting visitors.

An expansion of the relationship between a room's characteristics and generative processes can also be achieved by capturing and analysing a wider range of physical qualities. With the addition of a simple infrared camera, the light situation in the room could be taken into account. Changes in the light situation, whether caused by sunlight that enters the space or by visitors manipulating light switches, could be used as explicit inputs for the simulation and rendering processes. The acoustic properties of the space could also be taking considered, for instance by conducting impulse or frequency response measurements in order to acquire information about the room's acoustic characteristics. This information could then be used to change the sound synthesis methods and thereby produce a specific sonic result. The same acoustic information could also be used to control the visual rendering. This would again involve a translation of data between the modalities, which could lead to interesting results.

To conclude, we would like to express our conviction that generative approaches to augmented reality provide an exciting avenue for artistic creation. This artistic activity provides an opportunity for practitioners in generative art, installation art, and augmented reality to base their collaboration on a common ground of interests.

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Enrica Colabella

Poetic Logic

Topic: Generative Art

Author:
Enrica Colabella
Generative Design Lab, Politecnico di Milano University - Italy
www.generativedesign.com

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www.generativeart.com

enrica.colabella@polimi.it

Abstract:

Poetic logic is the generative art of connection between a past and a future time. In logical terms, we need a structure of connection, not deductive or inductive, but *abductive*: the only one able to perform a not linearity following an interpretation. The main topics of the generative process are:
Vision as the ability of delineating characters as *concrete* AI aims to gain;
Imagination as the construction of an idea/code *executable* during the GA process;
Memory as the possibility to gain *recognizable* variations as results. of the same ideas/code. Concrete, executable, recognizable are the main characters of each GA process. The generative process performs a double resonance between:
1 – ***Sounds / Words***
2 – ***Numbering / Shapes***
These structures are open to an interchanging between themselves.
G.B. Vico, "*La Nuova Scienza*", 1725 – G. Leopardi, *Il fanciullo e L'Antico, 1832*
E.v. Glasersfeld, "*The incommensurability of scientific and poetic Knowledge*" 1970
Exempla for:
1 – **Painting/ Word**:
Piero della Francesca, "*FLAGELLAZIONE*", 1460
P.Bruegel,"*12 PROVERBS*",1558 - "*NETHERLANDISH PROVERBS*",*1559*
Tiziano Vecellio, *"ALLEGORY OF PRUDENCE",* 1565
2 – **Word/Sound/Live-Painting:** Pasolini "*LA RICOTTA*":
Proximity: investigation about Piero della Francesca self-portraits – *Character/Feature*

Piero Della Francesca, 5 *self- portraits* + 1

Keywords: poetic, logic, abduction, proverbs, variations, character/feature

Poetic Logic

Prof. Enrica Colabella

Generative Design Lab – Politecnico di Milano University

www.generativedesign.com

enrica.colabella@polimi.it

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Poetic logic is the generative art of connection between a past and a future time. In logical terms, we need a structure of connection, not deductive or inductive, but abductive: the only one able to perform a not linearity following an interpretation. The main topics of the generative process are:
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1 – Abduction

Poetic logic is a process able to work by following the term of abduction coined by *Charles Sanders Pierce* in his work *"The logic of science".* As he said*, "[a]bduction is the process of forming explanatory hypotheses. It is the only logical operation which introduces any new idea" ….*abduction encompasses *"all the operations by which theories and conceptions are engendered".* [1] The proper place of Pierce concept of abduction is in ***the contest of discovery***. For a long time, there were several discussion from *Harry Frankfurt, (1958) to Schurz (2008)* and so many others still today, about how it is possible to control the entailment of the *idea* in the logical abductive process.
We can define the acting of *idea* as the ability in connecting in a new *vision* the past toward an *imaginative* future following a poetic structure as words, sounds, figures, architecture fragments, pictures, smells, movies segments as impressions, performed on our *memory*.
The new art generation is always a memory product.
Following my passion for poetry, I tried to define the character of the *idea* as a *poetical* structure, performing the methodology of a GA process in "*The environmental design of morphogenesis"* written by *C. Soddu* and me, (1992)

2 - Generative Logics

We can define art as a discovering process where we try to tale our *impressions* of world, defining some *characters,* as our creative logic *expressions.* Already Plato, after all, said that the whole philosophy starts with *the wonder*. The definition of a poetic logic is a process of our mind following step by step:

1 Vision
2 Memory
3 Imagination

The sequence 1, 2, 3 are not linear. This means that the starting point of the process may be memory or imagination or vision and so on in all their combinatorics.
By a side, the process run between two structure: ***significant*** (philology/orthography) and ***significance*** (philosophy/sound voice), for defining *characters*, also in opposite in significance, by the other side for gaining an *interpretative idea*, *open, adaptive and flexible*.
In fact, if we perform *our vision* as a point running on a *circle* and going toward the centre, we know that the distance is always the same. If we put our point of view on a generative *ellipse*, running on, the distances between two centres ***changes***, The first distance between the point of view and the first ellipse centre, as a *memory* point, outlines a site of ***significant*** data, as a storage of our *vision*; the second centre becomes the *imagination* site, as ***significance*** for gaining new visions between reality and visionary action. When in our life the 2 polarity, memory and imagination, come back to only one, we gain *panic*.Sa

3 - Poetic logic definition

Still to-day, in our digital civilization we associate the word poetic only to the literature world. In reality, poetic logic is the main structure of every scientific artwork.
Poetic logic works as a generative art of discovering by a process from past toward future; following an interpretation as a new ideas able to gain characters fixed as a starting point of the generation as first **aims** of the process
We can call this generative process:
Futuring past, as a poetic challenge for building a quality in continuum of our artificial ware. Each culture in the world rises from the art of orality by performing languages as results of an open **generative** process**.** This complex structure of so different human sounds is the main Humanity identity.

Ong defined our digital civilization as a second orality. Tools changed for that literature is not the dominant tool of culture anymore, but poetic logic remains as indelible quality in every form of communication. We immediately recognize it in every media expression; in fact, our attention rises steeply when we discover it in every digital communication. The art of poetry had problems of surveying for new defined concepts connected mainly to the configurations of art as a random anonymous result. This performed a losing process of its main character of authorship, following in each university of western world the grid: *"Art and author are dead!"*

The main difference is possible to identify in the strong passage from relations in art mainly of quality (poetic) into relations based only on quantity, that are very easy to control with industrial devices, following designed ad hoc structures.
Poetic logic is the **underground structure** of any artwork: a text, a painting, a sculpture, a building, a town, a landscape etc.
For discovering this structure it is necessary **an interpretation** of the reference contest in which our idea is performing.
In music the structure is *lo spartito* (the score), where for playing are fixed the characters of *how* to interpret the musical text in playing, by following words/adjectives in Italian, the most adaptive significance language for sounds. In similar way, we design transformations rules as algorithms connected from our poetic idea in a double connected process.

4 - *Poetic logic and ALGORITHMS*

To make exercises with algorithms can be amusing, but it is unable to define any poetic result, able to produce emotional impressions.
For innovating, we need to discover connective procedures from the past time. This seems to be the principal condition of generative art: ***futuring past.***
The GA methodology connect dynamically by a side the complex world of *vision, imagination* and *memory*; by the other side the perspective art discovered in *Renaissance* defined by a point of view, a ground line and an horizon, connected by a direction as significance.
This imaginative and scientific art was expressed, with a deep complexity, still to-day to discover, especially by *Piero Della Francesca*.

5 – Gian Battista Vico, "*La Nuova Scienza"*

In "*La Scienza Nova", 172*5, GianBattista Vico termed for the first time *Poetic Logic* as the ability of human mind to create metaphors. This process allows us to make connections between elements that would be otherwise unrelated.

In fact, Vico defined with the *poetic logic* expression the way with which in the heroic age men interpreted the world, because their knowledge was not only *rational*, performed by intellect, on the contrary *fantastic* because effected with *imagination*. Human beings start in expressing their imagination by tales song.

Vico performed a strong connection between the world of tales and reality as *a double system* between imagination and science, by delaying the poetic knowledge in its autonomy, in totally contrast with the tendency of his time. For this reason, we can call Vico as t*he beginner of the modern aesthetic* and as the founder of an *autonomous* vision of art.

The origin of words are imaginative word, in contrast with the porous words of our time, as fast sponges.

In fact, Vico affirms that the words have some original stamps that characterize them and with that to pay count, if we want to think.

To think is not possible if not through the language. I cannot have an idea if not by language. At the "*New Science"* origin, there is the barbarity that can always return. "*Word is not everything, it postpones to the grid, to the sound and it cannot exhaust its native origin".*

*"Logic derives from the word **logos,** that in primis and prompter becomes in Italian **tale**. Greeks and Latins had called logos as **mutus**; that in mutable times becomes **mental**. So logic from logos means and **idea** and **word**."*

Word is able to foresee *with the courses and the recourses of history.*

It is unfathomable for its nature as history.

Word is born not for defining, but **for expressing** and it always has a relationship problem list with the thing. In the word, the thing can appear only as *phenomenon*.

For understanding the word the philology, the etymology are not sufficient, **imagination** is necessary for performing the imprinting of the words sounds by Dante, Virgilio… as an exercise of *mobility* between proximity and distance.

Immediately we say: **proximity** is in *a thinking* that puts toward the centre the dimension of *poiesis*, and it is in a *looking* for its roots and its ways in the ancient time.

6 - Proximity: *"The child shining" from Vico/ Leopardi until Kubrick*

There are places of the search of Vico - from *"Six Orationes"* to *"De antiquissima Italorum sapienti",* to "*The New Science* "- in which a weaving of questions shapes him, that will be also for Leopardi substance of a thinking and of a poetic aging.
In Vico there is a recognition of a knowledge, in the ancient time, founded upon the poetic perception, that inventive and creative of the world is. The appeal of a mutual implication relationship between *philology and philosophy*, around certain and true: from where it grows the attention to the language as precious universe *for all the forms of knowledge*. The recognition that exists a sort of ***"mental dictionary of the sociable human things",*** felt by everybody, and inside this to feel universal there is *the unfolding of languages*, *of their variety, plurality and dissemination.*

In contrast, the hidden power of our time transforms this mental social concept in a reality of people connected by adding their singular names in structures as social net etc. in which every singular identity disappears, emerging only the quantity of connections. There words run free without any deep significance, consumed only in fast way.

We discover in Vico the point related to the ancient wisdom. It is founded "… inside the fables, in which, as in embryos or matrixes, it is discovered to have been rough all the secret knowledge". There is a young humanity from the strong imagination, manufacturing of knowledge. There is the wonder, the senses, the effects "of the natural appearances" that blind the minds with the bright images: "the sturdiness of the senses handed liveliness of imagination".

The ancient poetry not as disguise aware of truth but as aurora of a wisdom.

For Leopardi too, the poetry of the ancient times does not hide truth, it is direct proximity to the nature, listening of its voice, mimesis of a physics.

In Vico and Leopardi we discover a knowledge, also religious, founded upon a metaphor: "… the world and the whole nature are a big intelligent body… ". This is able to perform a relationship between poetry and philosophy and a tension between the two ways of knowledge (comparative disposition, faculty to gather the relationships hidden among the most distant things, imaginative attitude). This is a search of a new time - an over-philosophy - in which the knowledge of the "whole and of the intimate of the things" produces a regeneration as the exercise of a thought in poetic acting.

Poetic wisdom is the genealogical representation of the ancient time, or better of the origin, of the passage after the mute language and the language of heroes to the language of men.

In poetry, they defined in first aim what it is trace of the origin, that is of the song, of the voice, of the rhythm, of the musical element, of the orality that precedes the writing and for this is poetry intended by popular people.

"The poetry was lost from the popular people through the writing", (Zibaldone).

About metaphor (*"The New Science*", book II, II section) Vico says that: *"It is more praised, when to the foolish things it gives sense and passion. The first poets gave bodies to animate substances, only of so much of what they were able, that is of sense and of passion, and in this way they did the fables of it; for this reason every metaphor made in this way becomes to be a short tale."*

About *dignity*, XXXVII of the first book of *The New Science* : *"The most sublime job of poetry is give sense and passion to the foolish things and it is ownership of children of taking not animated things among their hands and, amusing themselves, to speak them as if they were alive . This philological-philosophical dignity demonstrates that men of the young world, for nature, were sublime poets".*

"In children it is vigorous memory: then vivid it is to access to imagination, that is memory or dilated or composed. This dignity is the principle of the evidence of the poetic imagines that owed to form the first child world."

Now we live an inverse procedure.

If men at the beginning were all poets, now men escaped totally to any vision of Nature beauty, also if this continues daily in generating endless beauties. We lose more and more to discover and to love them. This is our reality. We do not have any tools, that allows us to transcend the pseudo limit of reality for discovering the underground sonority that it is anywhere around us. Today we succeed in listening only to the artificial voice of the translated things. We are in totally habit of this **passive** sound.
If feeling is the language of truth, without imagination, the language does not draw the poetic threshold, in whose vibrations and resonances there are the trace, if not the presence, of the natural word.

This is a picture of the masterpiece *Shining* by S. Kubrick as a great example in our cultural time of the child ability in performing an *imaginative voice*, connected to our complex human identity.
"Nature cries because it is deprived of language" **(*Sprachelose*)",**
W. Benjamin. The poet resounds in his language - human language - this lament, a lament that is *rustling, murmuring, crying*.

7 - **- Translation from past toward future**

"Incipit is there where we arrive"
Hans Urs von Balthasar

A translation from the industrial era to our new digital civilization strongly marks the building of past equal artefacts toward a progressive rediscovering of unique unrepeatable objects, designed as in Nature.
Uniqueness is the main character of poetry and of the human life for the simple reason that until now we are born in two people and we die alone, and if we are a result of a love act, and if we are an artificial genetic result.
Moreover, this is forever, incontrovertible.
The passage from a technological into a digital language chanced in deep all the communication shapes. Processing art in our times puts the main question: "Can the digital innovation change the whole procedures and rules of the creative process? Obviously, in total way.

In fact, today, the poetic tools characterize an unstable paradigm in all media from press to cinema, from poetry to digital art and architecture, being only a result of precariousness. *Evolution?* Certainly, with the disappearing in poetry of the character of words as stones in our memory. Old words deconstruct their structures in young generations, running toward a weed assumed with explosive strength, as lightings in full day. All new words seem generated in a false new of changing*, because are connected to past in simplified way. So we say good-by to our lost poets in continuous research of the literature "un-perfect knowledge".*

Now digital innovative evidence is in the availability of data: these are available immediately in open continuous number.

The processes of selections are analytical and they are able to identify only the same equal without any hidden significance in an undertone similarity toward new open connections. The internet research about a word works only on the same significant correspondent to the researching word. Naturally, in this selective criterion, *significant* and open peculiar *significance* became very distant, unattainable. For this reason, the necessity to define new selective criterions is evident, being this relationship the basic structure of each creative process.

8 – Tenores song, a generative process in performing words

Tenores from Sardinia are able to perform the rhythm of playing in *discontinuous way*, following *different characters* in the same sound sequence.

They sing an ancestral sound for performing words, *following the wind*.

This performing song belongs to one most ancient structure of music, declared by Unesco patrimony of Humanity.

The double structure works:

1; 2- 2b; 1a

1 - 1a = Tenor and Falsetto

2 – 2 b = Bass and contra, toward *harmony*

This is a structure of morphogenesis: incipit, performing syllables in imitations of animals sound toward *Harmony*, falsetto.

The song follows in spiral way, *ad continuum*.

9 – Exempla of poetic logic as complex art of connections

1 – **Painting/ Word**: *Piero della Francesca, “FLAGELLAZIONE”,* 1460

This is one of the most enigmatic painting by *Piero della Francesca*, font of endless interpretation. For many centuries, the painting was abandoned. It was rediscovered by *Johann David Passavant* only in 1839 in the sacristy of the *Duomo of Urbino*, In his rediscovery script, Passavant declared to have found Piero signature and the writing "*Convenerunt in unum*, "nearby" to the group of the three figures (may be on the frame) .These are then ***disappeared.***
The sentence is drawn by the Salm II, that belongs to the service of holy Friday, reported to the Passion of Christ. This becomes the secret key for any *congruency* interpretation of this so mysterious artwork, that after the rediscover was and is object of many possible interpretations:
Roberto Longhi that defined Piero*”The poet of shapes”*, Carlo Ludovico Ragghianti, Alfredo Venturi, Eugenio Battisti, Henri Focillon, Kenneth Clark, (1951), that called The Flagellation by Piero *'the greatest small painting in the world'***.** Marilyn Aronberg Lavin, that wrote *Piero della Francesca: The Flagellation*. David King**,** Sir John Pope-Hennessy in *The Piero della Francesca Trail, Carlo Ginzburg, (1985) in The Enigma of Piero. Aldous Huxle and so on.*
The interpretations of Piero artworks are exercises of poetic logic, for gaining results in very different ways, but all possible interpretations are congruent to Piero’s artwork. Interpretations may be too much realistic or simplified, but true. On the author's traces for unveiling the logical connections, also those unexpressed for pure aesthetical pleasure of discovering.

2 - **P. Bruegel the Elder “***12 Proverbs”*-*"Netherlandish Proverbs",1558/59*

 

According to the Columbia Encyclopedia, a proverb is a short statement of wisdom or advice that has passed into general use. More homely than aphorisms, proverbs generally refer to common experience and are often expressed in metaphors, alliteration, or rhyme. Pieter Bruegel the Elder completed a series of "Twelve Proverbs"(1) on individual panels. Then he also made "Netherlandish Proverbs"(2), that is thought to be the first large scale representations of this genre in Flemish painting. These proverbs are of two types: those which were demonstrating the absurdity of much of our behaviour; and more serious proverbs illustrating the dangers of folly. The scene is on humans and animals and objects, W. Fraenger (Der Bauernbruegel und das deutsche Sprichworl, 1923) studied and therefore translated in relationship to the general northern folklore (3).
The poetic structure of these paintings is comparable to the treats awaiting foreigners in Alice in Wonderland and Gulliver's Travels. Their basis of fantasy is the presentation of *an assortment of familiar things in an unexpected way*
He poked fun at human life and folly by translating into visual images *ordinary, everyday expressions* that would strike home immediately to his Flemish audience.

3 - Tiziano Vecellio, *“ALLEGORY OF PRUDENCE”,* 1565

The three heads allude to the three ages of man: *youth, maturity and old age*. The inscription is performed in three sections, associated with the respective heads underneath.
The left head resembles Tiziano himself in old age; the bearded central man has been thought to represent his son *Orazio*, while the youth may depict his cousin and heir, *Marco Vecellio*.
The triple-headed beast - wolf, lion and dog - is *a symbol of prudence*.
The painting has acquired its present name suggested by a barely visible inscription, *EX PRAETERITO/PRAESENS PRUDENTER AGIT/NE FUTURA ACTIONẼ DETURPET* ("From the experience of the past, the present acts prudently, let it spoil future actions").

10 - *Pasolini, La Ricotta*, diacronicity in vision and in sound

P.P.Pasolini on "La Ricotta set"

"The poetry language is an outside language. Its inside and permanent characteristic is the diachronic structure. The poetry time is the remote, the imperfect or the future time. The next past is impossible (as it is typical in the today's use of Italian): the present is possible as dramatization of the past, or rather as historical present. The present of the diary too, is not but a fiction: in reality, the same poet soul is in revocation. Shortly, poetry has to gain itself on the time myth: to stretch a veil of time on the things said, or past or future. In such diachronic structure, its tendentious meta-historicity can be conceived, otherwise as of a type ambiguously spiritualistic. You understand that its irrationality (what it is concretized in the time myth), such it is only apparently: it is not but a revocation or ***a logical elliptic prediction****. The intuition is not but some jump of logical thought. That is why every poetic action or generically intuitive is always referable to a rational ideology.*

"*The RICOTTA"* is one of the most complex expression of poetic logic gained in art. There are contemporaneously: *cinema, painting, music and literature*. This is a medium-length film by *Pier Paul Pasolini,* 1963, inserted inside the episodes film *Rogopag - Let's Wash our brain*.

The core of Pasolini investigation stars from these 2 paintings:

1 - **Giovan Battista di Jacopo di Gasparre,** known as *Rosso Fiorentino*, *Deposizione*, 1521 - Volterra, Pinacoteca Civica

2 - Pontormo, *Deposizione*, 1525 - Firenze, Santa Felicita

In both paintings, it prevails ***complexity, innovation, uniqueness.***

These painting are an ancient example of GA

In Pontormo (2), the complexity is expounded through an ascending movement, as a "*inexplicable knot*", (L. Venturi, *History of the Italian art*, Milan, 1932) of very light figures, without weight . In fact, the arrangement of the plans makes fulcrum and raises itself entirely leaning on the young placed in low. All is behind an unnatural background, that it is indefinite, made exception for ***the only grey cloud.***

As for the composite elements of the painting by *Rosso*, the linear articulation is as many complex, making not lever on its "lightness" but on one "*net from the sweaters firmly hooked*" (Kusenberg, "*Rosso Fiorentino*", Paris, 1931). Ciardi about the intention has spoken in "*The Rosso Fiorentino. Reality and Vision*", Volterra. In both the paintings a meticulous attention it is noticed for the dresses of the characters (especially *Maddalena* in the picture by Rosso) and above all their postures, that individualize ***horizontal, diagonal and vertical lines*** in which to divide the representations.

It is on the intense dramatization of the event and on the spiritual share that it implicates, that the two authors assemble their own attention.

In the painting by *Pontormo*, ***the man with the green hat***, almost imperceptible on background ***is the same artist***. With the fixed look toward the outside of the painting, as he seems to go out of the painting space, he risks himself, to evidently voice the proper one strong emotional share.

In the other painting, ***the young man with the red hair*** in closed-up, that ***hides the face among his hands*** for the desperation. This act has been defined by Ciardi a "***denied self-portrait"*** of the artist: also in this case the painter has opted for a personal involvement in the represented event, with the purpose to underline his own intense emotional share. This was a very important interpretative key for performing the interpretative gen-system by Pasolini.

2 *Live variations in La Ricotta of the 2 original paintings*

Pasolini was in Bologna a student of *Roberto Longhi* and especially in this film, he demonstrated to have very well understood his lesson. The double process of his abduction on the two paintings gains in his mind an incredible fascinating *idea*: to use *live* the actors voices and his own director voice too, filming the reconstructions performing of the 2 paintings. It is an explosion! Pure generative art. For these scenes, he had great problems with Justitia and terrible critics on newspapers

Starting from this *chaos*, he arrived in the film sequences to a perfect *order*. His movie translation of these 2 painting masterpieces gained its maximum with the voice of Mary, declaiming an ode by *Jacopone da Todi*, accompanied by *Domenico Scarlatti* music. Sublime! It is really a great expression of generative art from past to future.

8 - Film sequences

11 - The art of discovering: ***Piero della Francesca,*** the poet of shapes

A friend in need is a friend indeed.

Piero Della Francesca, 5 self-portraits

Vasari, Biographies [3]: *Piero makes to know us in this obscurity how much it is important to imitate the true things, and the working in removing them from the really. Which having done very well, he has given cause to modern age to follow him and to arrive at that highest degree, where are seeing the things of our times. In this same history, he effectively expressed in a battle the fear, the animosity, the dexterity, the strength and all the other affections that in those people it is possible to be considered that they fight, and likewise the accidents with an almost unbelievable massacre of wounded, of fallen and of dead people…*

Flute Player in the "The battle of Eraclio e Cosroe"

Homage to Piero della Francesca, the father of all generative artists

Following "*all the other affections* ***that in those people it is possible*** *to be considered", (Vasari);* and some traces of investigations made by me from many years, I discovered some poetic logics on *Piero 5 self-portraits*, by my impressions of characters: *imprinted, lonely and sympathetic*, performed in his five self- portraits. So I read the Piero face as a new his self-portrait, in "*The battle of Eraclio e Cosroe" inside The History of the True Cross*", ***in the face of the musician playing the flute with a Byzantine hat***. This process follows two parallel structures one objective connected to features, and a second connected to characters. These lines perform the idea, but we need new extra elements for demonstrate in deep the hypothesis.

The attribute Byzantine made my mind running in Orient. My vision connected in my memory the song of Phoenix and my imagination was able in this generative process to identify the face of Piero. He is imitating the song of Phoenix for dispersing the hate and the horror with his melody, following his great heart so full of love and science to design rules and procedures of *"La pittura Chiara*", the great art and science gained by a human being.

This discovery is not only a tale, it is true. The second step of demonstration is just configured by me. In this generative process, I followed two parallel structures: one objective connected to *features*, and a second connected to *characters.* These lines perform the idea, but we need new extra elements for demonstrate in deep this hypothesis. But this is another paper!

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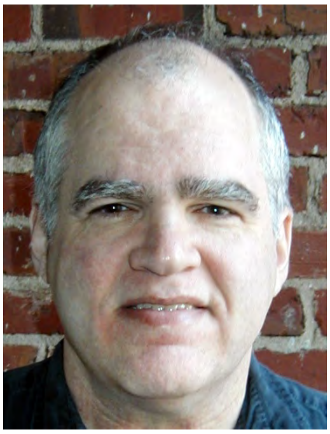
Philip Galanter

Paper: **Complexism and Generative Network Theory in the Arts and Humanities**



Topic: Art and Cultural Theory

Author:

Philip Galanter

Texas A&M University
Department of Visualization

USA

http://www.viz.tamu.edu/

Main References:

[1] Galanter P:, "*What is Complexism? Generative Art and the Cultures of Science and the Humanities*", International Conference on Generative Art, Milan, Italy, Generative Design Lab, Milan Polytechnic; 2008.

[2] Galanter P:, "*Complexism and the Role of Evolutionary Art*" in *"The art of artificial evolution : a handbook on evolutionary art and music",* Springer, Berlin, 2008.

Abstract:
In previous writing I've traced how the systems-based nature of generative art leads to the application of complexity science, and how in turn that leads to the theory of complexism. Complexism is, in a sense, the projection of the world-view and attitude suggested by complexity theory into the problem space of the arts and humanities.

This paper extends the discussion of complexism with particular attention to generative networks, authorship, and the cultural circulation of ideas. Modern notions of heroic authorship, and postmodern notions such as the death of the author and deconstruction, are reconciled using modern network theory.

Brought into this speculative discussion are notions from network theory such as topology, metrics, preferential attachment, random attachment, node density, directed flow, order and disorder in small world networks, power laws, and emergent and scale-free networks.

Contact: email

Keywords: Complexism, generative networks, art theory, cultural theory,

Complexism and Generative Network Theory in the Arts and Humanities

Philip Galanter, MFA, BA

Department of Visualization, Texas A&M University, College Station Texas, USA

philipgalanter.com

e-mail: galanter@tamu.edu

Abstract

In previous writing I've traced how the systems-based nature of generative art leads to the application of complexity science, and how in turn that leads to the theory of complexism. Complexism is, in a sense, the projection of the world-view and attitude suggested by complexity theory into the problem space of the arts and humanities.

This paper extends the discussion of complexism with particular attention to generative networks, authorship, and the cultural circulation of ideas. Modern notions of heroic authorship, and postmodern notions such as the death of the author and deconstruction, are reconciled in the context of modern network theory.

A critique of the failure of postmodern network theory, including the myth of the rhizome, is offered. In addition, a suggestion is made as to how a network-based view can help assign authorship to the programmer versus the computer in the case of digital generative art.

1. Introduction

In this paper I want to share some speculative thoughts regarding notions of authorship within the context of a philosophic and aesthetic view I've termed "complexism." While these ideas are somewhat tentative, they seem to be a natural extension of ideas leading up to this point, and provide an interesting frontier for further work.

Those encountering computer-based generative art for the first time often ask artists "who is the artist, the computer or you?" More sophisticated discussions of authorship are held captive by the faulty paradigms of the heroic modernist artist or the dead post-structural artist. The first question will be tentatively answered at the end of this paper, but first requires a discussion of network theory in the context of complexism. The latter question is first addressed in an on going attempt to subsume these incomplete contradictory models in an inclusive synthesis.

1.1 Background - Generative Art Theory and Complexism

In earlier writing I've offered a complexity-influenced theory of generative art that begins with the following definition:

> 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. [1]

Given that the key element in generative art is the use of an external system, an understanding of system theory can illuminate generative art theory. The strongest contemporary body of system theory is that found in the interdisciplinary field of complexity science. In particular in previous writing I've leveraged the notion of "effective complexity" in sorting out various approaches to generative art. [2]

Previous notions of complexity, such as that in Shannon's information theory, have tended to equate complexity with disorder. For example, for the analysis of data delivered by an information channel, Shannon attributes the greatest complexity to random data. This follows from the notion that information that is difficult to compress is complex, and random data cannot be losslessly compressed at all. [3]

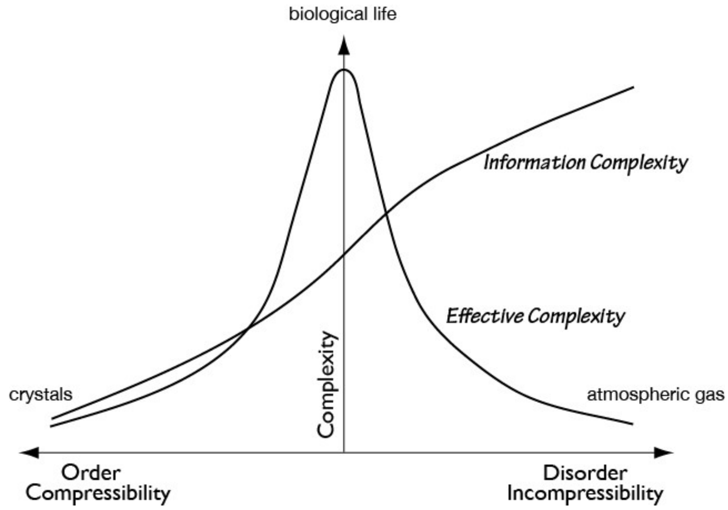


Figure 1 – A mix of order and disorder maximizes effective system complexity

Effective complexity attempts to capture and formalize a more intuitive sense of complexity. In nature we tend to associate maximal complexity with the realm of biology and living things. Simple systems seem to be of two kinds. First, first there are highly ordered systems such as the strict lattice structures of crystals. Second, and at the other extreme, there are highly disordered systems such as the molecules exhibiting Brownian motion in atmospheric gas. Both are, in their own way, relatively simple. Living things, however, exhibit both order and disorder. Order is required to maintain a degree of organic integrity, but a degree of disorder is required to allow for variation and adaptation. These two notions of complexity are illustrated in Figure 1.

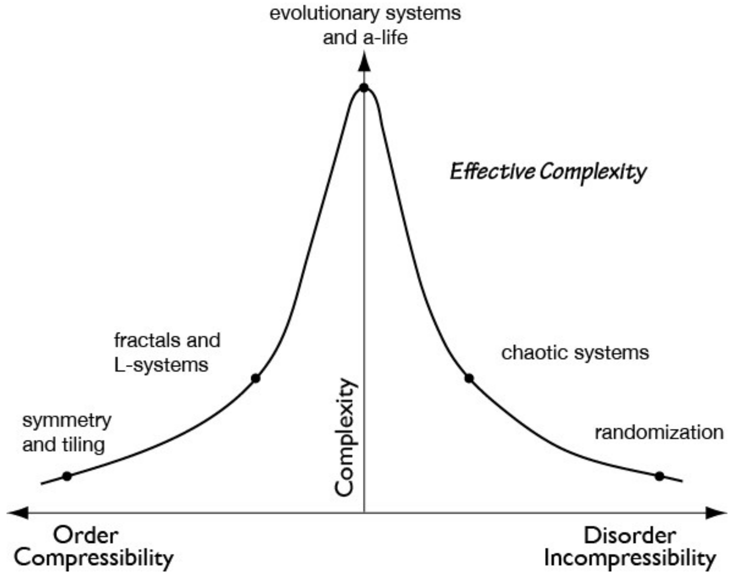


Figure 2 – Generative systems organized by effective complexity

In terms of a rough history of generative art progress tended to follow the general understanding of systems in the given culture. Simple highly ordered systems, such as grids, tiles, and symmetry, were the first systems exploited in the making of generative art. It wasn't until the 20th century that highly disordered systems were significantly used by generative artists such as John Cage and William Burroughs. However, in contemporary generative art it is primarily nature-inspired complex systems that are of greatest interest in the generative art community. This is illustrated above in Figure 2.

It's beyond the scope of this paper to provide an in depth presentation of complexism. However, complexism can be summarized in the table shown as Figure 3.

Modernism	Postmodernism	Complexism
Absolute	Relative	Distributed
Progress	Circulation	Emergence and Coevolution
Fixed	Random	Chaotic
Hierarchy	Collapse	Connectionist Networks
Authority	Contention	Feedback
Truth	No Truth	Statistical Truth Known to be Incomplete
The Author	The Reader	The Generative Network
Pro Formalism	Anti Formalism	Form as a Public Process Not Privilege

Figure 3 – Complexism as a thesis / antithesis / synthesis generated theory

The key idea is an extension of an idea first credited to C. P. Snow, and exercised with vigor in the so called "science wars" of the 1990's. [4, 5] I've previously described this conflict as a paradigmatic contradiction found when one compares the modern culture of science versus the postmodern culture of the humanities. Where the sciences posit real progress towards absolute knowledge, the humanities celebrate the circulation of ideas and relative knowledge. Where in science we find an impulse towards the fixed and hierarchical, in the humanities there is the collapse of existing structures into arbitrary or “random” relations.

Complexism proposes to reconcile these apparent contradictions, and the various notions from complexity science shown in the chart hint how this is done. This paper focuses on the second to the last row dealing with theories of authorship.

1.2 Complex Systems as Networks and Process-based Ontology

Complex systems are those where a large number of agents or components have local interactions that result in emergent behavior at a higher level and larger scale. Traditional science proceeds in a reductionist manner. It is assumed that iteratively breaking phenomena down into component parts will provide insight. And indeed this is often the case. But what are lost are the holistic and emergent properties generated by mechanisms such as feedback, chaos, and self-organization. The lack of bottom-up models leaves much unexplained in pre-complexity traditional science.

In a sense complexity science encourages a move away from nouns and towards the greater inclusion of verbs. Rather than simplistically breaking big nouns into many little nouns, a new emphasis is placed on verbs as the interactions between those little nouns. This is made clearer if complex systems are modeled as networks. A network in this context is where components, the nodes, have local interactions that serve as links. (In standard graph theory nodes are called vertices and links are called edges.) The nodes are the nouns and the links are the verbs. So in the brain there are neurons viewed as nodes, and signaling viewed links. In an economy the entities possessing wealth are nodes, and the exchange of money, goods, and services are links. In an ant colony individual ants are nodes, and their use of pheromones serving as messages serve as links. And so on.

Ultimately networks only make sense as a fusion of nodes and links. Without links nodes cease being nodes. And without nodes there can be no links. This suggests an ontology based on process philosophy. Unlike the substance-oriented ontologies of the early Greeks, and the related traditional concepts carried forward in most western philosophy, being can instead be viewed as becoming or process. Networks exist as process where substance and activity, i.e. node and link, cannot be separated without both disappearing.

The interpretation of networks from a process philosophy point-of-view provides an ontological aspect to complexism.

1.3 Complexism and Theories of Authorship

In the conflict between the modern culture of science and the postmodern culture of the humanities I’ve noted that both tend to err towards oversimplification representative of their kind. Traditional reductionist science embraces highly ordered systems to a fault, just as the postmodern humanities embrace highly disordered systems to a fault. This can be seen in the modern and postmodern theories of authorship, and is especially apparent in 20th century art because it notably transitioned from modernity to postmodernity.

In modern art the focus is on the author working from a position of privilege in the heroic pursuit of totalizing masterworks. In modern art the audience receives the work as is and contributes little. But in the postmodern art world the post-structural take after Barthes is that “the author is dead.” What this means is that the work, the “text,” has its own independent existence. In fact the text has a kind of multiple existence in that it is instable and multivalent, and the audience creates meaning through deconstruction.

The view of authorship from the vantage point of complexism is closer to a “common sense” view of communication, but then builds from there to add new insights. A common view of authorship is that three components are required; an author, a reader, and a text. What complexism adds is the observation that an author in one situation is a reader in another. This creates a network where reader/authors are the nodes and the texts are the links.

Once authorship is situated in a network-based model, the full range of network theory concepts can be brought into play.

2. The Failure of Postmodern / Post-structural Network Theory

Prior to the Copernican Revolution the dominant Ptolemaic geocentric model held that all heavenly bodies circled around the Earth. But the retrograde motion of some planets, i.e. their apparent occasional backwards motion, was difficult to square with the Ptolemaic paradigm. Those immersed in the Ptolemaic tradition, however, exhibited their own retrograde tendencies returning again and again to their comfort zone with increasingly arcane nested systems of epicycles within epicycles. It was complicated brilliant work. It was also incorrect. This intellectual retrograde delayed the ascension of the new Copernican heliocentric paradigm.

Today a new retrograde tendency is at work in the arts and humanities. For decades the comfortable models of postmodernism and post-structuralism have dominated the scene with a Ptolemaic-like presence. And too many humanists, having now been exposed to a potential Copernican Revolution of networks, complexity, and emergence, keep returning to their comfortable postmodern post-structural paradigm to retrofit these new ideas as epicycles within epicycles.

The philosopher Paul Cilliers is one of these. His book “Complexity and Postmodernism” offers an interpretation of neural connectionism as something already implicit in Derrida’s notions of traces and differences. But doing so exacts a great cost. In his view mental representation becomes recursive and unanchored, and our ability to create meaningful abstractions from empirical evidence is fatally eroded. Ultimately he questions the very practice of any network science when he says: “If something is really complex, it cannot be adequately described by means of a simple theory. Engaging with complexity entails engaging with specific complex systems.” [6]

Alexander R. Galloway in “Protocol: How Control Exists After Decentralization,” and with Eugene Thacker in “The Exploit: A Theory of Networks” offer a fundamentally political critique of computer networks. He points out that while the Internet is popularly viewed as a new decentralized and highly democratic medium, in fact it is a new form of highly efficient control by means of the technological protocols required. [7, 8]

Citing numerous philosophers, but most notably Foucault on power relations and Deleuze and his notion of control society, Galloway attempts to capture the new science of networks with the standard tropes of contemporary critical theory. But one must beware of those who ultimately only claim word games, lest they become caught in the epicycles within epicycles. Galloway seems all too comfortable rhetorically eliding from the control of checksums and packet routing to the implication of social control. And his worries about the social implications of object-oriented code encapsulation, and the need for political critique to be applied to algorithms, seem at best to be a form of what philosopher Gilbert Ryle has termed a category mistake.

This is not the first time that critical theorists in the humanities have sought to subsume science. As noted earlier the clash of the modernist-enlightenment values of science with the postmodern-skeptical values of the humanities came to a dramatic height with the Sokol Hoax and so called “science wars” of the 1990’s. Time has not been kind to the humanities field of science studies. And as even Cilliers notes, the entire postmodern post-structural enterprise is susceptible to the criticism that its highly corrosive skepticism and relativism undercuts its own ability to make any claims at all. This is what Jurgen Habermas has called a performative fallacy.

The application of science-based network paradigms, in their own Copernican right, is leading to novel and important findings in linguistics, literature, art history, anthropology, social behavior, and criticism. It is the humanists who insist on retrograde motion back to postmodern post-structural thinking that stand to miss out on the numerous theoretical, empirical, and mathematical insights afforded by the new science of complex networks.

2.1 The Myth of the Rhizome and Rise of Scale Free Networks

In it's original use the term "rhizome" refers to a plant structure. As a kind of horizontal shoot, rhizomes are sent out by a plant's root system. They will then terminate and create another rootstock, and with it a new vertical plant structure. Rhizomes provide an efficient way for plants to reproduce and spread.

In the realm of the arts and humanities the rhizome has become a popular metaphor for networks. This can be traced to Deleuze and Guattari's use in "A Thousand Plateaus: Capitalism and Schizophrenia." [9] It was intended to contrast with arboreal or treelike hierarchical structures, and also to offer a subversive structure that can infiltrate and overcome those same hierarchies.

It is this subversive nature of the rhizome that attracts the attention of the postmodern humanities. The possibility of destabilizing highly ordered structures resonates with the deconstruction of fixed meanings, and the radical equality of nodes supports the urge to collapse hierarchies and undermine authority.

With the introduction of the Internet, and especially the World Wide Web, into the culture of the humanities, there was an immediate identification of a "new" powerful communication technology with this socio-political agenda.

Translated into the kinds of topology found in network engineering and graph theory, trees are typically called star networks. They consist of a central node that branches off into secondary nodes, and these in turn branch off into tertiary nodes, and so on.

The precise topology of Deleuze and Guattari's rhizome is difficult to pin down because it is described in different, somewhat inconsistent, ways. It is most like what is known as a random graph in graph theory. A random graph is essentially a random network is created by iteratively linking randomly selected homogeneous nodes. The nodes are radically similar, and the links arbitrary and unpredictable. Investigated in depth by the prolific mathematician Paul Erdős with Alfréd Rényi, random graphs were once considered a natural stand-in for real world networks such as economies, the brain, metabolic and genetic biology, and so on.

But what scientists and mathematicians now know, and what has mostly been ignored in the humanities, is that random graph networks are rarely found in real world complex systems. In fact random graphs are now used as a kind of null hypothesis in network analysis. The network topology that is emergent in all manner of complex systems is called a "scale-free" network. Scale-free networks shorten the average distance between any two nodes by using central hubs, secondary hubs, and further lower-level hubs to create shortcuts. In a random graph such a journey requires visiting many intervening nodes. This is why airlines, for example, utilize hub airports for long flights, and then shorter legs to smaller local airports. [10, 11]

The number of links a given node has is called the "degree" of the node. In a random graph the distribution of node degrees is a Gaussian "bell curve." This shouldn't be terribly surprising given the random nature of its construction. The distribution of node degrees in the scale-free networks found in complex systems follow a power law curve.

Scale-free networks are found in complex systems such as social networks for friendship, collaboration, business, and notably co-authorship. Both the underlying physical and logical structures of the Internet, as well as the link structure of the World Wide Web, are scale-free networks. All manner of economic networks self-organize into scale-free topologies, and the entire realm of biological networks, from large-scale ecologies to genetic, metabolic, and protein interaction networks are scale free.

In summary, the complex networks we refer to as being scale-free exist between the high order of hierarchical star networks and the high disorder of random networks. And the rhizome, once intended as an allegory, turns out to be mostly a myth.

3. Authorship in Generative Art

In a chapter in an upcoming volume I've described a number of problems in generative art theory. [12] These are not problems that require a single correct solution per se, but are questions artists, critics, and insightful audience members will want to consider.

> "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 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."

One of these questions was noted earlier, that concerning the problem of authorship in generative art. In traditional works literal authorship is trivial in that it is either a historical fact or at least a well-defined question for historical research. For many the insertion of the generative system between the artist and the artwork problematizes this simple relationship, and causes some to wonder whether the proximate cause, i.e. the computer or other system, should be credited with authorship.

Meanwhile, as was noted above, the model of authorship itself is also disputed. There is a conflict between the heroic author of modernity and the dead author of postmodern post-structuralism. Here it is suggested that the network model of authorship can illuminate both issues.

3.1 The Challenge of Inceptionism

Research software engineers at Google Inc. have created an image classification system using a very large database of over one million images and neural networks with unusually deep structures of 10-30 layers. The system delivers state-of-the-art computer vision capability in terms of being able to identify the content of previously unseen photographs. [13]

Of interest to this discussion however, and what caused an overnight sensation in social networking spaces inhabited by computer art practitioners, was a technique the Google team has termed "inceptionism."

Inceptionism uses a trained image recognition neural network to generate images. An initial image is presented to the neural network and it attempts to use pattern recognition to identify objects in the image. The neural network doesn't identify objects in a strictly binary found/not-found manner, but rather identifies areas with fuzzy probabilities, with lower layers identifying simple components like edges and shadows, and higher layers identifying more complex, composite, and abstract semantic features. Just as children might identify circus animals while looking at clouds, this system can "see" objects that aren't really there.

The trick is then to feed back the identified shapes into the original image by amplifying or modifying the given pixels in the direction of even stronger recognition. This is then done iteratively and with each step the image becomes more and more altered, and what the neural net "sees" visibly emerges in the image. If low levels of the neural network are used, then simple features like lines or patterns become exaggerated turning a photo into a kind of abstract art. If higher levels of the neural network are used actual objects appear like phantoms out of the ether. If, for example, the neural network learned how to identify different kinds of animals, the technique of inceptionism will add dream-like animals to the image. These animals can take on a surreal look because the neural network will combine partial matches creating creatures like, for example, a bird with the head of a cat.

As an Internet meme the technology was first heralded as a breakthrough in artificial intelligence. The software was then made available to the public, and with its very specific look, it became something more like a new Photoshop filter. The challenge that interests us here, however, is how inceptionism can make us question our notions of authorship in the context of generative art.

3.2 Towards a Network Model of Authorship

Complexism suggests that authorship takes place in the context of a network of reader/authors passing texts back and forth. As noted previously this not only reconciles the modern and postmodern conflict regarding authorship, it also finds affirmation in studies of scale-free social networks for collaboration and attribution relationships.

Looking at a single author in such a network one can note the numerous incoming links for texts the author has read. These can be considered the influences the author draws from. Most generative art practice can be depicted in the network by inserting a computer between the author and reader. The generative artist/author creates a text that happens to be a computer program. The program is then used by the computer to generate the artwork sent on to the reader. The author has a large number of incoming links as influences. But the computer has a single incoming link, that being for the computer program that is an expression of the programmer’s creativity and point of view.

But would such a diagram be an accurate depiction of inceptionism? After all the programmers created no code about animals, drawing, rules of composition, and so on. They created a system capable of learning patterns, but it was the neural network itself that learned from a million images what the world looks like. An honest network diagram would then show the computer as not having a single incoming link, but rather thousands and thousands of links for the images that were its influences.

What is suggested is that it is the attachment of links, rather than the ordering of nodes, that assigns authorship. Where many links lead to the programmer, and a single link leads to the computer, authorship of the generated artwork belongs to the programmer. But where many links lead to the computer, and the programmer is merely one of them, then authorship of the generated artwork belongs to the computer.

This need not seem strange. By analogy, we might credit Picasso’s parents as being the “authors” of the young Pablo Picasso, but we would only credit Picasso himself as being the author of his works. The works are, in part, the result of the uncountable influences on Picasso offered by the world. In a similar way we might view the Google programmers as being the parents of the neural network system. The resulting artworks, however, are the results of the million and more images that served as the computer’s influences.

It should finally be noted that this suggestion speaks to authorship but not creativity. An author can be creative to a greater or lesser extent. An author who merely compiles a phone book for a small town might be deemed to be entirely lacking in creativity. If we use the degree of incoming links to determine authorship, the analysis of creativity is a distinct and separate consideration.

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Fiammetta terlizzi	**The golden Library. A not linear system from past to futureTYPE of proposal**

Topic: Generative processes from Ancient Books

Authos:

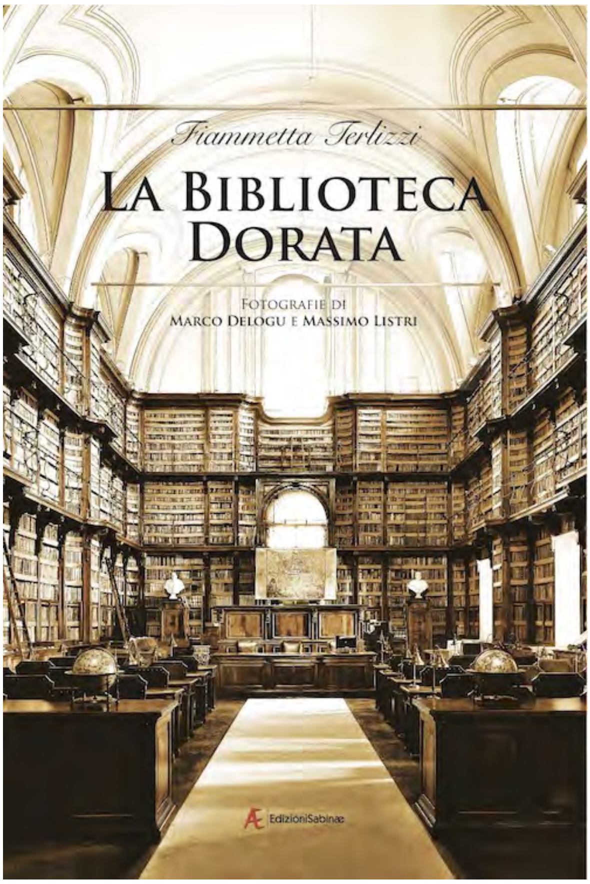
Fiammetta Terlizzi

Director of Angelica Library, Rome, Italy

Abstract:

This new published project is dedicated to the Angelica Library as another important *tessera* of the mosaic of the library activities. These are focused in discovering the bibliographic, architectonic and historical inheritance kept by this Institution. During four centuries, The Angelica Library has been so important for Roman and European cultural life. It is a great opportunity for people expert and also for students in human science to have the possibility to look up in an illustrated catalogue. This can reach everybody, following an impressive selection made by author, as a deep knowledge of the so very complex material by discovering. Four centuries ago the Angelica was founded by the Augustinian bishop Angelo Rocca for Rome's and Europe's *"public benefit"* but it is still nowadays an important cultural attraction, not only because of its bibliographic collection, but also because of its peculiar and exceptional *fondi.*

The novelty of being the first library of the modern era opened to "public use" is an example of non-linearity , a breakthrough in the European system. This freedom for culture creates an unique and unrepeatable configuration for opening minds of young people..



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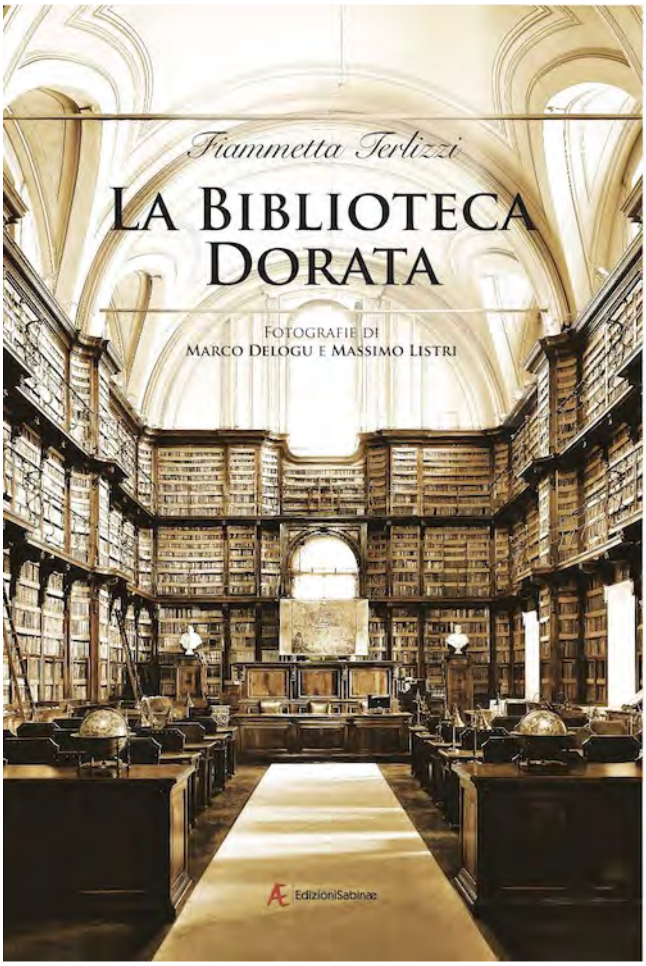
Keywords: Library, Generative, Not linear system

Non-linearity of a Library

Fiammetta Terlizzi

Director of Biblioteca Angelica, Rome



To understand the innovation represented by the Biblioteca Angelica it's interesting to briefly analyze the historical evolution of the different models that have characterized the library at various times, to track the real purpose that this institution has taken in different moments in history, through the analysis the cultural significance of each model and the factors that have contributed to its appearance and its disappearance.

The library is a system of organization and supply of knowledge, so every historical period changes its shape in a different way according to a cultural model based on past experience following different factors that interact each other forming a real cultural project.

The cultural objective of the library is defined by the selection of the material to be preserved, and by the development and conservation of the collection.

THE LIBRARY OF ALEXANDRIA

The most important library of the ancient world was that of Alexandria, established at the beginning of the third century BC, which is thought to have contained over 500,000 books.

Catalog, glossary, dictionary, edition, commentary - all of these tools today so widespread - were the result of the creative mind of the Alexandrian scholars who - in relation to such a huge amount of material - had to provide to create such intellectual tricks like selection, synthesis, categorization, textual segmentation.

The arrangement of the texts, their treatment and the work of translation and of editing is the epicenter of this monumental project, unique model that integrates two ideas almost antithetical:

a storage container from side to side, a giant hypertext that was created as additional texts, examples and other variations came in this center of knowledge.

But the Alexandria library was a cathedral of knowledge, a library of state without public: its role was not the education and dissemination of knowledge in society, but the "deposit" of all the works of the known world to preserve them in only one place.

MEDIEVAL LIBRARY

The deposition of the last Roman emperor Romulus Augustus in 476. C. conventionally marks the beginning of the Medieval Age. The end of the ancient world led to the decay of the cities that were the basis for the development of libraries. For the first time, the crisis of public storage was compensated by the creation of libraries by great patrician families. Later with the spread of monasticism, this task was taken from monasteries.

Like the other structures within the monastery, the library was completely self-sufficient, able to produce everything necessary for its "life". The practice of reading moved from the open places, squares, to closed monasteries, churches, cloisters. It was a collective reading during the liturgical celebrations, during meals or during a retirement, or it was an individual reading. Slowly the custody of the books became almost exclusive task of the monastic institutions. The disappearance of the Roman administrative organizations, in fact, left a vacuum that was quickly filled by new ecclesiastical structures. Quite inadvertently, the Church became the only guardian of the entire classical cultural heritage. This monopoly of knowledge allowed the Church to decide what to keep alive and what to give up, influencing the history of culture.

The monastic library was a library of mere preservation: there were no users, and the only people having advantage were the monks of that particular community. The Medieval Age books, so big, heavy, awkward to carry, tells us about their immobility; its large letters, the text lying comfortably on the page, the indexing and miniatures, are elements that tell us how it was just a beautiful object to display and to carefully store.

The MODERN AGE

Starting from the second half of the fifteenth century, the invention of printing was the answer do the new request of knowledge coming from universities and from the development of the schools. It was the event that shocked the world of intellectuals and consequently that of libraries.

In 1455, Johann Gutenberg printed the first Bible through a process of printing with movable type, opening the way for a new approach in spreading culture. The printing facilitated scholars in their interests and it made accessible the world of culture also to a different and enlarged audience that before was far from it, especially because of the cost of the manuscript book. Even the religious leaders, both Christian and Protestant, identified in the press an important resource in the struggle for ideological supremacy, and both sensed the importance of libraries as repositories of possible dangerous weapons. But these were still preservation libraries and rarely library "of use"; in these libraries the books were kept as valuable assets and shown sparingly also to scholars: the books, in other words, were an important part of the heritage of God. An example of library preservation is the Malatesta of Cesena, established in XV century, where the manuscripts are linked to the reading benches (plutei) by chains.

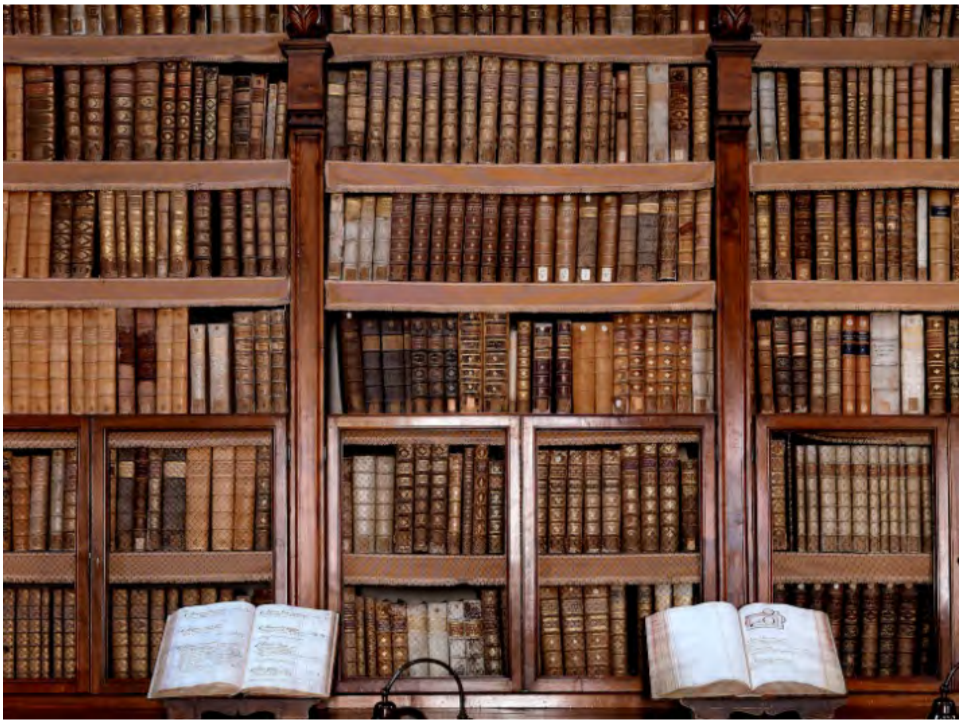
Keeping books, however, means organizing in a more organic way. In the sixteenth century the need to guide the reader on his reading path arose. It was really difficult because of the birth and evolution of new sciences. A key of knowledge was offer by the creation of catalogs. They were divided according to different disciplines and subjects.

With the Lutheran Reformation the monasteries were suppressed and the libraries of these monasteries supported the performing of a new type of library, a public library, useful for the whole community. Luther thought that libraries and books in general, should be used for the education of the people, in the religious, political and commercial field. His aim was to bring together and make available the necessary books to the community.

Generally the 'public' library was not widespread and certainly not as we understand it:

Typically humanists put available their collections for friends, creating 'open private' libraries. The birth of a public library is an idea of a 'Renaissance mind': thanks to the spread of literacy and new cultural needs carried out by the humanists, the huge change derived from the press led to a greater number of books than never was available before. The books return to be both objects to be preserved but also to be exhibited: the baroque halls of libraries seem designed more to surprise the visitor than for the study. It's a "museum-library", usually with a central plan with the furniture itself as a part of the architecture and the volumes arranged around the perimeter of the room, often in full-height shelves, accessible through galleries; the reader has a central location: is a library where container and contents are identified and almost merged together.

The monumental hall lives by the richness of its furnishings, and the ornate shelving for books .Among the Roman libraries, the Biblioteca Angelica is a symbol of this cultural model.

THE ANGELICA LIBRARY - It's the oldest public library in Rome and Europe and owes its name to the augustinian bishop Angelo Rocca (1546-1620), who in the last years of the XVI (sixteenth century), entrusted his collection of books to the friars of the convent of St. Augustine in Rome. Angelo Rocca, a passionate collector of precious editions, head of the Vatican Press during the pontificate of Sixtus V (fifth), gave to the library an suitable site, own income, a regulation and wanted it to be open to everyone.

"… omni artium et scientiarum genere refertissimam … comparatam coenobio Sancti Augustini Urbis … non solum religiosorum, sed etiam clericorum, et laicorum commoditati". So it was that Rocca wanted to clarify the public function of the Angelica Library which since 1604 (one thousand six hundred and four) opened its doors to those who, researchers or not, without limitations of status and wealth, had the pleasure, the usefulness or the simple curiosity to discover its library treasures. Sure it was a daring and pioneering idea, considering the historical times and the social dynamics of the moment. The intellectual foresight of this choice is obvious and is the principle of knowledge, art and culture sharing, and of goods produced by them, which could never exist without placing the focus on the "public", undisputed protagonist in any process of safeguard and valorization.

The Generative Art, by the use of specific generative software of high quality, has the aim to perform projects of "species" starting from an idea and the ability to create with transforming algorithms, structures ever more complex and different but extraordinary for their "uniqueness". The innovative element, therefore, is to refer not to the final product (as it may be a book, a painting or a photography) but to the "process", therefore to the methodology of work. In this key operates a chain process in which art is created not only by creations-mother, but also from the many works that these creations can give birth.

The generative project carried forward by the Polytechnic of Milan, thanks to the leadership of Prof. Celestino Soddu, borns from the will to explore and expand the fields of human creativity not achievable nowadays without the use of computer tools. Generative Art has as its purpose the search of beauty, the produce a reflection on form and on art as a cognitive process; it is a way to make art that has a complicated relationship with the traditional artistic currents, because everything is experimental and tied to new media in a completely unconventional way.

The Generative Art, understood as modus operandi, is akin to the vision that the Golden Library has of the "cultural heritage". From the beginning the Angelica was an example of "non-linearity", of non-conventional approach to the system, considering the Know as a not private but as a "common heritage", believing every opportunity of meeting not only as an opportunity of growth and of personal and collective knowledge, but also as a precious opportunity to generate new ideas and, therefore, new cultural experiences. For this purpose, diversifying wisely its offer and relating to a ever wider public, it has tried to bring users to the art and to its various manifestations, considering it as an essential principle to ensure its survival in the present and in the future.

What has been said shows the enhancement and promotion of the site, and the preserved heritage, through events such as exhibitions, theatrical performances and artistic performances of various kinds. For this meritorious work extra institutional, it adds the output in the past few months of the volume, the golden library (Edizioni Sabinae) that highlights - through an agile description of the major bibliographic treasures preserved, and not only that, the enormous cultural and social potentiality of a Library projected into the future. A future which, I repeat, this is only possible through innovation and new opportunities for the dissemination.


IN
PRINCIPIO
CREAVIT
DS
CELVM
ET TERRAM


BIBLIA
SACRA
VVLGATAE
EDITIONIS
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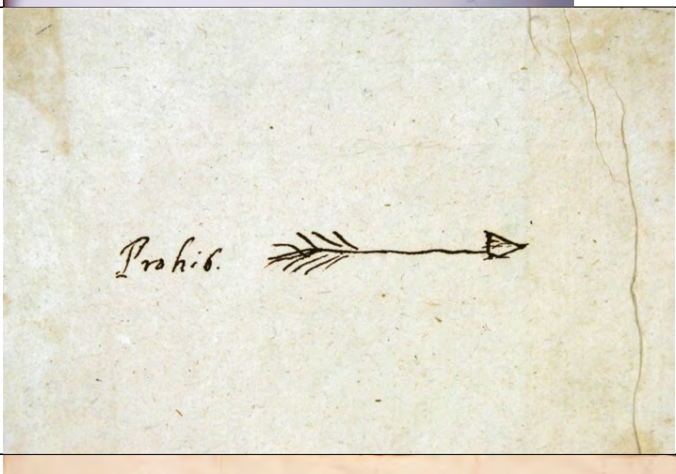
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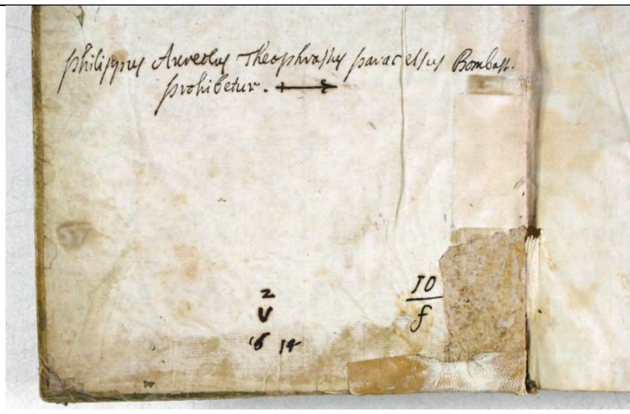
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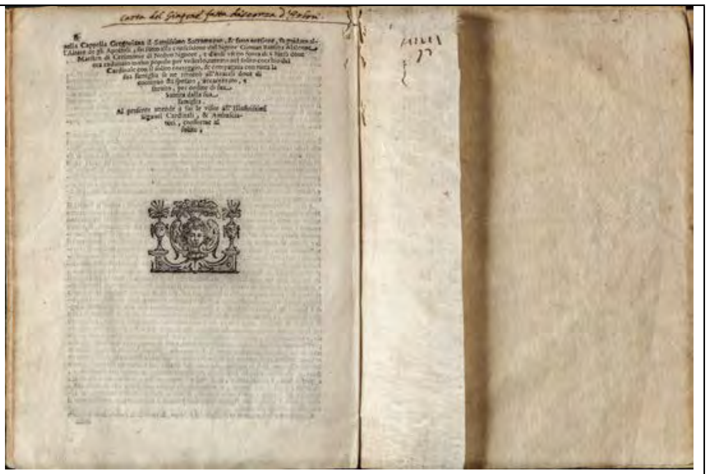

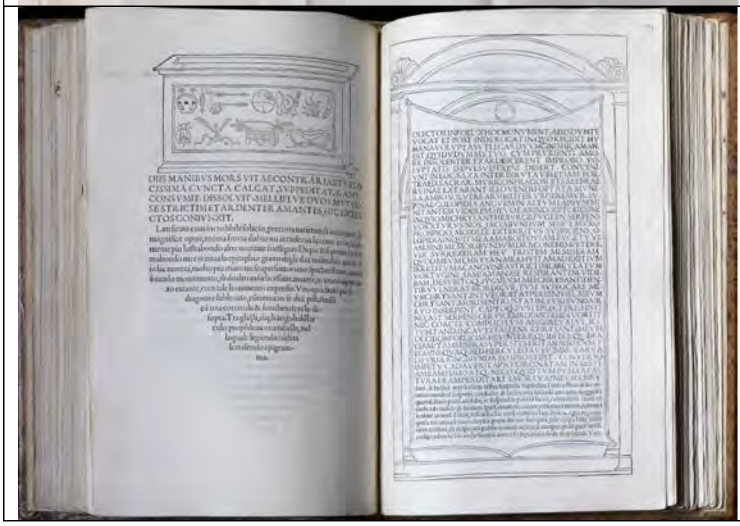

Designing 3D-Printable Generative Art by 3D Turtle Graphics and Assembly-and-Deformation

Yasusi Kanada

Topic: 3D design, 3D printing

Authors:

Yasusi Kanada

Dasyn.com
Tokyo, Japan

Main References:

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[2] Yasusi Kanada, “*Support-less Horizontal Filament-stacking by Layer-less FDM”*, International SFF Symposium 2015, August 2015.

Abstract:

3D models are usually designed by 3D modelling tools, which are not suited for generative art. This presentation proposes two methods for designing and printing generative 3D objects.

First, by using a turtle-graphics-based method, the designer decides self-motion (self-centered motion) of a turtle and print a trajectory of the turtle as a 3D object (Fig. A). The trajectory is printed using a fused-deposition-modelling (FDM) 3D printer, which is the most popular type of 3D printer.

Second, by using the assembly-and-deformation method, the designer assembles parts in a palette, each of which represents stacked filaments, applies deformations to the assembled model, and prints the resulting object by an FDM 3D printer. The designer can also map textures, characters, or pictures on the surface of the object. Various shapes can be generated by using the assembly-and-deformation method. If the initial model is a thin helix with a very low cylinder (*i.e.*, an empty cylinder with a bottom), shapes like cups, dishes, or pods with attractive brilliance can be generated, and a globe and other shapes can be generated from a helix (Fig. B).

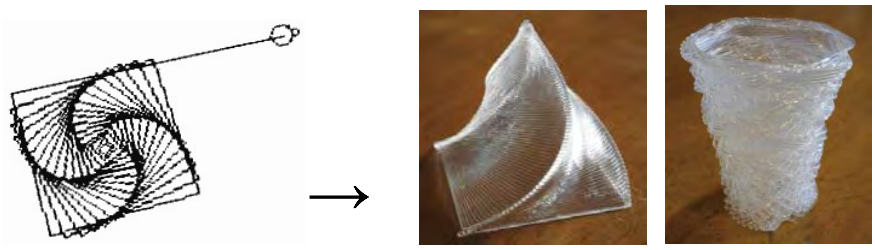


Fig. A Turtle-graphics-based prints

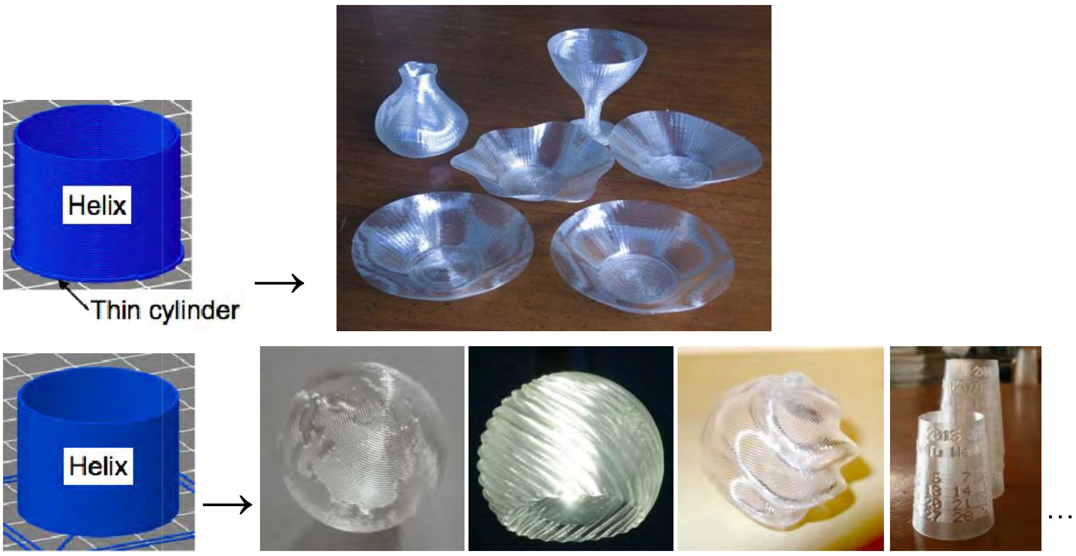


Fig. B Assembly-and-deformation (and texture-mapping) based prints

Videos:

Turtle-graphics-based method: http://youtu.be/7H5-acxQ_RE (skewed pyramid)
Assembly-and-deformation method:
http://youtu.be/5P1vaahzW98 (dish)*, http://youtu.be/YWx1vqig2-o* (globe)

Contact: *yasusi@kanadas.com*

Keywords: Design, Directed 3D printing, Fused deposition modelling (FDM)

Designing 3D-Printable Generative Art by 3D Turtle Graphics and Assembly-and-Deformation

Yasusi Kanada, Ph.D.

Dasyn.com
Tokyo, Japan

e-mail: yasusi@kanadas.com

Abstract

3D models are usually designed by 3D modelling tools, which are not suited for generative art. This presentation proposes two methods for designing and printing generative 3D objects. First, by using a 3D turtle-graphics-based method, the designer decides self-motion (self-centered motion) of a turtle and print a trajectory of the turtle as a 3D object. The trajectory is printed using a fused-deposition-modelling (FDM) 3D printer, which is the most popular type of 3D printer. Second, by using the assembly-and-deformation method, the designer assembles parts on a palette, each of which represents stacked filaments, applies deformations to the assembled model, and prints the resulting object by an FDM 3D printer. The designer can also map textures, characters, or pictures on the surface of the object. Various shapes can be generated by using the assembly-and-deformation method. If the initial model is a thin helix with a very low cylinder (*i.e.*, an empty cylinder with a bottom), shapes like cups, dishes, or pods with attractive brilliance can be generated, and a globe and other shapes can be generated from a helix. Python APIs for these methods have been publicly available.

1. Introduction

2D generative objects (artwork) can be generated by using Processing [Pea 11], which is a procedural programming language. Generated objects can be shown by a computer display or realized by a printer. However, the generation process can be observed only in the virtual world. The generation process can be embodied in the real world by turtle graphics (and by Logo programming language, which was designed for children), which was developed in 1960s by Seymore Papart and his group [Pap 80]. 3D graphical generative art can be generated by the 3D functions (P3D) of Processing or by 3D turtle graphics [Ver][Tip 10]. They can create various 3D graphical shapes; however, they cannot create real-world shapes.

This study aims generatively forming real-world 3D generative design by using 3D printers; thus, 3D generative design is first explained. There are two types of 3D design tools, *i.e.*, manual-design tools and generative (or algorithmic) design tools, and they can be used for both free-form design and design by parts assembly. Manual-design tools are used for specifying parts and models. They are used for top-down design. Many commercial and free manual-design tools, which are called 3D computer-aided design (CAD) tools, such as AutoCAD, SolidWorks, or Blender, are available. Models can be created as free-form models, *i.e.*, freely designed by drawing lines or other shapes by using manual-design tools by pointing devices, or created by assembling predefined parts and specifying parameters manually. In contrast, generative-design tools draw graphics, generate models, or specify parts algorithmically using a declarative or procedural language. They can be used for bottom-up design. The users of the tools, *i.e.*, the programmers, write programs to generate models. For example, 3D graphics can be generated by using Processing [Pea 11] (P3D), and 3D models can be generated by using OpenSCAD [Wik].

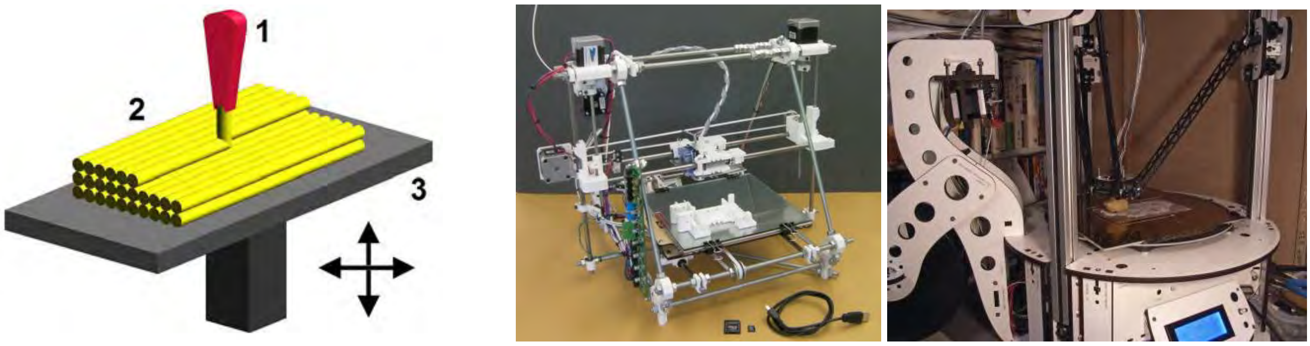
This study aims not only designing artwork by a generative method but also printing the design in a generative method. A conventional 3D-printing method can be used for printing a generative objects; that is, the design can be expressed by a static (declarative) language, *i.e.*, STL (Standard Triangulation Language or Stereo-Lithography), and the expression, *i.e.*, an STL file, can be "sliced" to layers by a so-called "slicer", and can be printed layer-by-layer by a 3D printer. However, this complicated process may spoil the generative-ness of the original design. The author intend to print the design in a more straightforward method that reflects the generative-ness of the original design.

The rest of this paper is organized as follows. This paper first introduces popular conventional 3D printing method called FDM (fused deposition modeling) in Section 2, and then describes two methods that are suited for creating generative objects by using 3D printers. The first method, which is based on 3D turtle graphics, is described in Section 3. Designers (programmers) can directly and intuitively create 3D shapes by this method in a similar way to Processing. However, unfortunately, it is necessary for the designer to be very much careful about supporting printed filaments, otherwise they are easily drop down and the shape can easily become unprintable. In contrast, the second method described in Section 4, which is based on deformation of assembled 3D parts, can more easily managing printability. Section 5 concludes this paper.

2. Conventional 3D Printing

When creating solids by using a 3D printer, conventionally, a model designed by a three-dimensional computer-aided design (3D CAD) system is horizontally sliced by using a program called a "slicer" and the resulting file is sent to the printer. Although there are various output formats for 3D design data outputted by CAD systems, the slicer usually accepts a file described by STL, which is a declarative language. STL approximates the surface shape of the model by a collection of triangles. (It cannot express the inner structure of 3D shapes.)

Although the model outputted from a CAD system is static (declarative), computer-aided manufacturing (CAM) programs for 3D printers are dynamic (procedural) because they create products operationally. There are various types of 3D printers; however, most of cheaper printers belong to the FDM type (**Fig. 1**(b)). FDM-type printers extrude melted filament (plastic) from a tip of a nozzle and solidify it (Fig. 1(a)). When using an FDM-type printer, the object to be printed is sliced horizontally and represented by G-code [Kra 00], which is a language for computer-aided manufacturing (CAM) and originally used for conventional machining tools such as milling machines. The model outputted from a CAD system in STL or other format is static (declarative). In contrast, because G-code originally expresses motion of machine tools, it is intrinsically dynamic (procedural/operational). The motion of a print head and the velocity of plastic extrusion can be specified by G-code.



(a) Principle of FDM-type 3D printing (b) Examples of FDM-type printers
("FDM by Zureks" by Zureks - Wikimedia Commons)

Fig. 1 FDM-type 3D printers

The print head of an FDM-type printer only moves to restricted directions in conventional 3D printing; however, it can actually move freely. Because an FDM-type printer conventionally prints sliced object layer by layer, the print head does not move vertically except when transition between layers. However, by using G-code directly or by using software that generates G-code, it can be moved to arbitrary direction. Although many 3D printers are not designed to move the head toward vertical direction quickly, Delta-type printers, such as Rostock MAX (see the right photo of Fig. 1(b)), are suited for this purpose.

3. 3D Turtle Graphics Based Method

Because the head of a 3D printer can move freely to any direction, it can draw lines and curves that can be drawn by Processing. It is more similar to turtle graphics because the head moves in a similar way as turtle. A 3D printer can thus embody 3D turtle graphics exactly if there are no mechanical constraints such as gravity or resilience. This section thus describes 2D and 3D turtle graphics first, and describes the method of 3D printing based on 3D turtle graphics, which is constrained by mechanics.

3.1 2D and 3D turtle graphics

As described in Section 1, turtle graphics was introduced by Papert in 1960s, and he also proposed a programming language called Logo. By using Logo, 2D line-art can be drawn by a trajectory of a “turtle”. This is called “turtle graphics”. The basic drawing commands of turtle graphics are the following three.

- *Forward d.* This command moves the turtle forward by distance d.
- *Turn left a.* This command turns the turtle to the left by angle a° (degrees).
- *Turn right a.* This command turns the turtle to the right by angle a°. By using these commands, the turtle can be moved to any location in the 2D space, and the trajectory can be displayed as shown in **Fig. 2**.

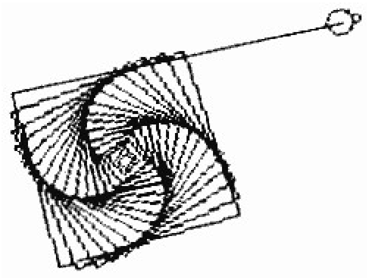


Fig. 2 2D turtle graphics

As described in the previous subsection, turtle graphics is originally two-dimensional; however, similar methods called “3D turtle graphics” were developed to draw 3D shapes (e.g., [Ver][Tip 10]). To extend turtle graphics to 3D, commands for moving up/down or for turning up/down must be added. Moreover, Bernd Paysan proposed “Dragon Graphics” [Pay 09], which is an extended 3D turtle graphics that can generate complex 3D shapes easily. However, all of them are graphics for displaying shapes by a 2D display. They cannot show the 3D trajectory of turtle.

3.2 Printing method

This subsection discusses on a method of 3D printing, which is based on 3D turtle graphics and describes a design and implementation of this method. This method is called the turtle 3D printing method.

The semantics of 3D drawing commands and G-code are similar, so the former can be translated to the latter. Because G-code is procedural, commands in G-code can draw lines in a similar way to turtle-graphics commands. However, people do not usually write G-code directly, and it is not suited for human because it is similar to assembly languages or machine languages. Fortunately, it is easy to translate 3D drawing commands to G-code; it is required only to translate forward command to a corresponding G-code command (*i.e.*, G1 command). 3D printers can thus execute commands in a similar way to turtle graphics.

However, because the coordinate of a print head is usually described by using a Descartes coordinate, they must be translated to turtle-direction-based coordinates. The technical detail is described in a previous paper [Kan 15a].

There are two alternatives for turtle coordinate: polar coordinate and cylindrical coordinate. The polar coordinate system is used for flight simulators, and the direction of turtle is decided independent of the gravity direction. Unfortunately, because it is inevitable to take gravity direction into account in 3D printing, this coordinate makes guaranteeing printability difficult. That is, when using a flight simulator (and probably when flying by an airplane), it is easy to crash the airplane because it is difficult to grasp the gravity direction. A similar situation occurs in 3D printing.

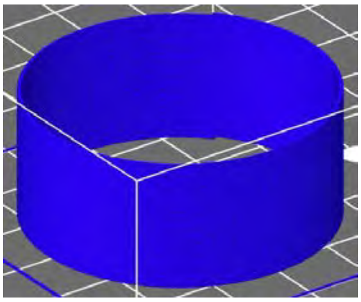
If the cylindrical coordinate system is used, the turtle always assumed to be directed horizontally. A vertical motion is described by specifying the vertical displacement, but the direction of the turtle is unchanged. Because the gravity direction is constant for the turtle, it is easier to design objects to be printed than using polar coordinate.

3.3 Examples

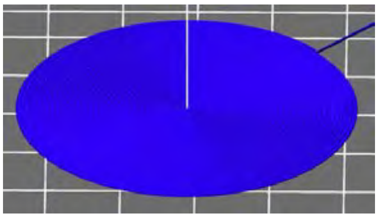
The author wrote 3D turtle graphics programs that prints shapes such as a helix, *i.e.*, thin empty cylinder, a skewed square pyramid, a 2D fractal using a program library developed by the author himself. This section first describes the program library and then describes the examples.

A program library in Python language, **`turtle.py`**, for generating G-Code for 3D printers, which is based on cylindrical coordinate system, was developed and used for describing programs to generate shapes. This library is publicly available at http://www.kanadas.com/program-e/2014/08/a_python_library_for_3d_turtle.html. This library can be used for many 3D printers, especially open-source RepRap printers [Rep]; however, unfortunately, because they are not completely compatible, the program that use the library (and maybe the library itself) has to be modified. The above programs are specialized for Rostock MAX printer.

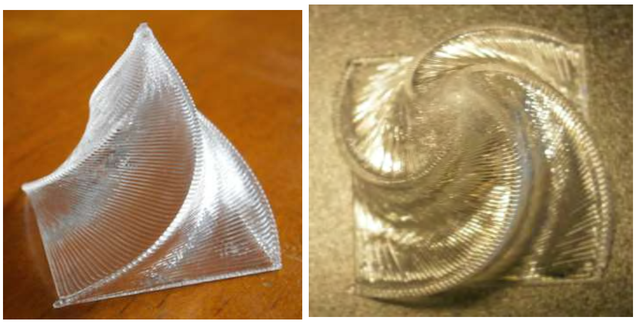
Figure 3 shows examples of shapes. Shapes such as a cylinder, disc, pyramid, and basket, shown in Fig. 3(a) to (e), were created by repeating an advance and a rotation (distance x and angle a).



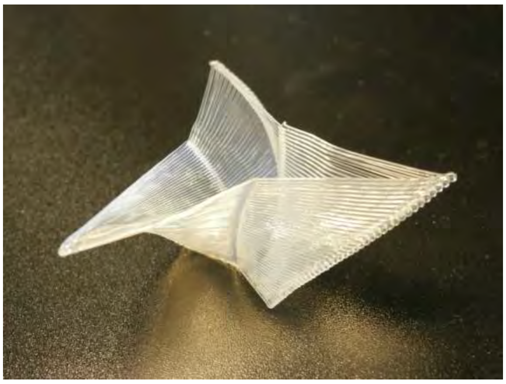
(a) Helix (Cylinder)



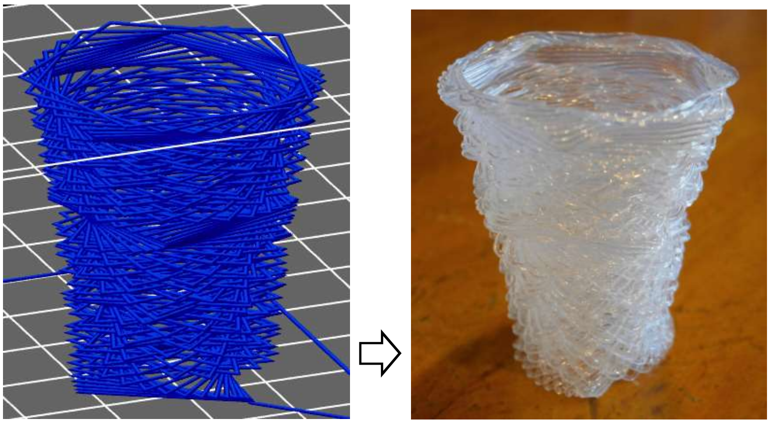
(b) Spiral (Disc)



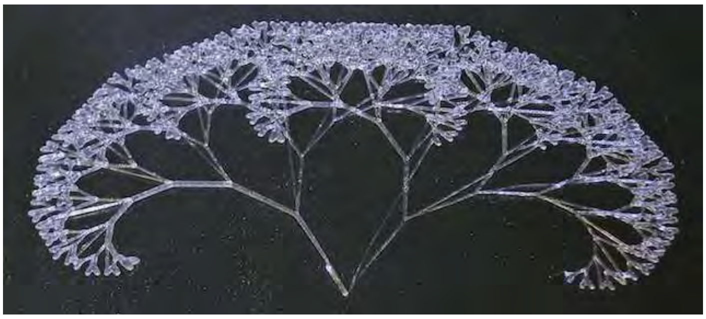
(c) Skewed square pyramid (a shrinking pattern)



(d) Example of expanding pattern



(e) A shape with less vertical overlapping of filaments



(f) 2D fractal tree

(g) 2D shape created by advances and turning expanding angles

Fig. 3 Printed results – patterns with rotation and shrinking/expanding

Figures 3(a) and (b) show models of very primitive shapes, *i.e.*, helix and disc. (These shapes are also primitives in the assembly-and-deformation method.) Figure 3(a) shows a model of an approximated helix (or cylinder). This model, which is expressed by a Python program or a G-code (which is generated by executing the Python program), is visualized by a 3D-printing software tool called Repetier Host. The approximated helix in Fig. 3(a) consists of short straight lines drawn by the turtle (*i.e.*, print head). The direction of the lines are slightly upward, so the turtle draws a helix instead of a circle. If the amount of an advance, *d*, is decreasing or increasing, the pattern is shrinking or expanding. Figure 3(b) shows a spiral (a disc) that also consists of short lines, which is a 2D shrinking pattern. This shape also consists of short straight lines. A cone (not shown here) can be printed in the same way.

Figure 3(c) shows a skewed square pyramid, which consist of longer lines. This is a 3D shrinking pattern. The turtle moves from outer to center. This photo suggests the relationship between this shape and the 2D shape shown in Fig. 2; however, the pattern in Fig. 2 is expanding, that is, the turtle moves from center to outer. The drawing direction is reversed. The right photo in Fig. 3(c) was taken from above. A printing process was recorded as a video; it can be seen in YouTube (http://youtu.be/7H5-acxQ_RE). In contrast, an example of expanding pattern is shown in Fig. 3(d). In these patterns, filaments are stacked mostly completely, so they stay in the designed location, but never drop down.

Figure 3(e) shows a sparse pattern that the turtle does not stack filament completely, that is, there is interspace between lower and upper filaments. The left figure shows the design (drawn by Repetier Host) and the right photo shows the printed object. Originally, the vertical pitch was designed to be 0.4 mm. Limited part of the filament is supported by the filament below; however, because the pitch naturally becomes smaller in the printed result, that is, the pattern was caved in, it was redesigned to be 0.3 mm so that the macroscopic shape becomes closer to the design as shown in this figure. However, part of the filament that is not supported by the filament below still sags. If supported area is reduced, the filament sags more; however, in the case of Fig. 3(e), the print result is still close to the design. If a designed pattern is sparser, the turtle fails to shape it.

Figures 3(f) and (g) show examples of 2D patterns, which can be created in the physical space by 2D turtle graphics or drawn in a virtual space by Processing. Figure 3(d) shows a 2D fractal tree. A 2D fractal such as shown in Fig. 3(f) does not fully utilize the functions of 3D printers, *i.e.*, 3D shape generation. 3D fractal shapes are better for utilizing them; however, as far as the author knows, 3D fractal shapes require printing in the air, so they cannot be generated by turtle 3D printing; that is, no method for supporting filament in the air (without support material) is given. Figure 3(g) shows a pattern generated by multiplicatively increasing the turning angle when repeating advancing and turning.

3.4 Problems of turtle 3D printing

A supposed design and printing process for turtle 3D printing, which is described below, requires iterative design and printing process because there are many problems including dropping problem that prevent a straightforward process. A unit process consists of the following three steps: the designer (programmer) first describes the program and generating a G-code program, second verifies the G-code program by graphics, and third prints the result (sending the G-code program to a printer). However, a single iteration of this process does not usually successfully generate a correct result. The reason of failures is that there are many problems such as the following ones, which spoil the result even when the visualization of the G-code is succeeded.

Three problems are described here. An easy problem is that, because the initialization part of the G-code, **`turtle.init`**, does not initialize the printer completely, printing may fail because of incomplete initialization; however, this problem can easily be solved. Another problem is that optimum temperature may vary by the difference of filament even when the filament material is the same, e.g., it is PLA; however, the temperature can easily be optimized. The most difficult problem is caused by mechanics, especially by gravity; that is, printed filament may drop down or may cave in because the filament must be supported by previously printed filament but it fails. When it is not possible to avoid caving in, the vertical pitch may have to be changed smaller as shown in Fig. 3(e).

4. Assembly-and-Deformation Method

Because it is difficult to design objects appropriately for printing them by the 3D-turtle-graphics-based printing method as described above, the author designed one more method for designing and printing 3D objects in a generative way. This method, which is called the assembly-and-deformation method, is explained in this section.

4.1 Outline

It is easier to generate a shape, which may be complicated, by virtually deforming another (simple) shape than forming a shape by stacking a filament (or string) by turtle graphics in an ad-hoc manner. Although types of shapes that can be generated by deformation is restricted, it is easier to keep the shape printable by deformation than by turtle graphics; that is, if the original shape is printable and the deformation preserves the printability, the deformed shape is also printable. The 3D-printability concept is explained more and the preservation issues are explained in the previous paper [Kan 15b].

For example, **Fig. 4** shows examples of deformation from a virtual cup (which consists of a helix (empty cylinder) and a thin (filled) cylinder) to a variety of shapes. If a shape different from the cup is used, other types of shapes can be created by deformation. Examples of such shapes are shown in Section 4.5. The deformations are explained in the following subsections, and the technical detail is described in a previous paper [Kan 15b].

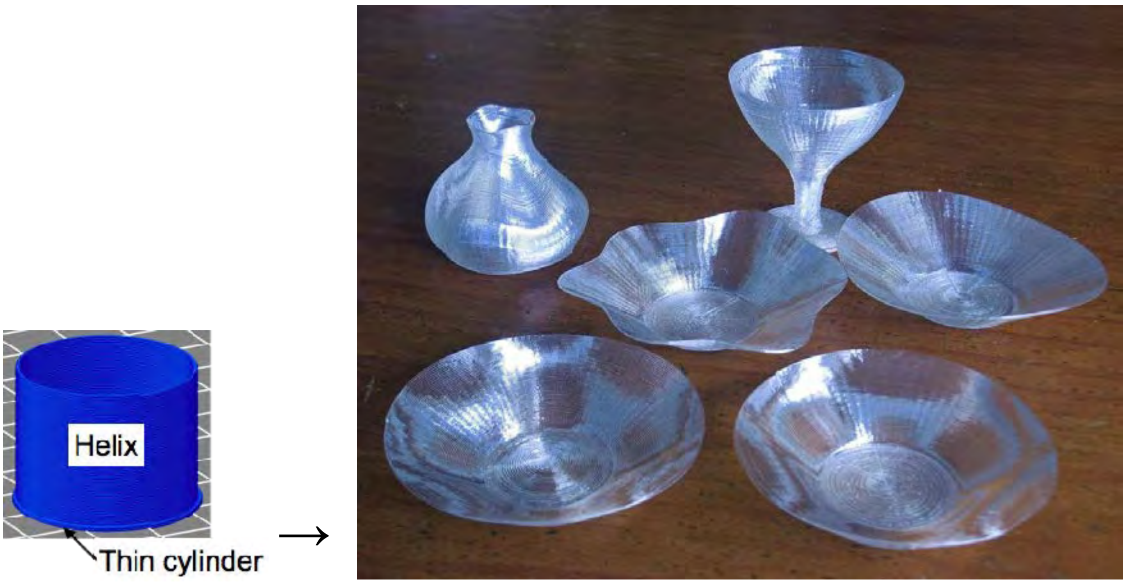


Fig. 4 Examples of shape generation by deformation

4.2 Deformation

This section briefly reviews the history of deformation in computer graphics and generative art, and describes a method of deformation for 3D printing.

4.2.1 Deformation in computer science, technology, and art

The deformation concept plays important roles in computer graphics and in generative art. In computer graphics, “free-form deformation” has been considered important for the solid modeling or surface modeling of objects with free-form surfaces [Sed 86][Coq 90], and it was used because it eases the control and rendering of 3D geometric shapes [Bar 84]. In free-form deformation, a user specifies the shape of the object using a graphical user interface (GUI).

In generative art, deformation is also an important technique and is used everywhere [Pea 11][Une 08]. However, in contrast to many other computer-graphics applications, in generative art, artistic objects are generated algorithmically, and deformations used for this purpose are also generative.

Deformation has not yet been focused on in 3D printing. Although deformation is essential in drawing graphics including generative art, and free-form deformation can be used in CAD for 3D printing, deformation is not useful in the slicing and printing steps of 3D printing. This is due to the fact that conventional 3D printing methodology does not take the attributes generated by the deformation into account because they are not (cannot be) used in slicing and printing steps. However, such attributes are important in direction-specified 3D printing.

4.2.2 Deformation method for 3D printing

This section describes a method for creating various shapes (surfaces) by using “deformation”. Basically, the shape may not have a hole on the side (unsupported part) to be printable. To preserve the printability of the object (*i.e.*, to keep the model correctly printable), deformation for 3D printing requires controlling two attributes of strings: cross section and printing velocity.

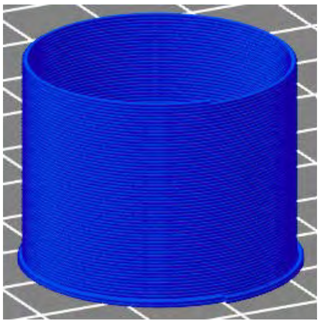
Two types of deformations are defined. One is Descartes-coordinate-based deformation and the other is cylinder-coordinate-based deformation. Both translate coordinates, cross sections, and printing speed.

A cylinder coordinate is more useful for describing a deformation, especially when axisymmetric models are deformed. The following function is defined in the library.

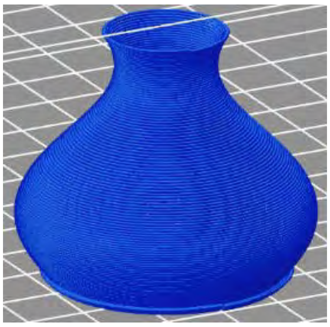
deform_cylinder(*fd*(*r*, *θ*□□*z*), *fc*(*c*, *r*, *θ*□□*z*), *fv*(*v*, *r*, *θ*□□*z*))

In this expression, function *fd*(*r*, *θ*, *z*) (*i.e.*, the first argument) maps a location (*r*, *θ*, *z*), which is expressed in cylinder coordinates, to a new location (r_1, θ_1, z_1). Function *fc*(*c*, *r*, *θ*, *z*) (*i.e.*, the second argument) maps a cross section at location (*r*, *θ*, *z*). Function *fv*(*v*, *r*, *θ*, *z*) (*i.e.*, the third argument) maps a head speed at location (*r*, *θ*, *z*) to a new speed. The same monotonicity conditions as deform_xyz exist for *fv* and *fc* for deform_cylinder, and functions *fd*, *fv*, and *fc* must be continuous and smooth. It would be better if the cross section could automatically be optimized; however, it is currently difficult. Therefore, the cross section must be manually specified in the method proposed in this paper.

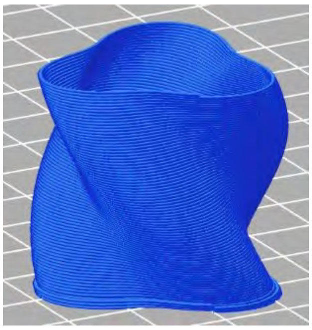
Examples of deformation are visualized in **Fig. 5**. (Repetier Host was used.) Figure 5(a) shows a cup, which consists of an empty cylinder and a disc (bottom); that is, the cup is an assembly of two direction-specified components. This cup can be transformed to a plate shown in Fig. 4. The shapes in Fig. 5(b) and (c) can be created in similar ways. Figure 5(d) shows an empty cylinder (without a bottom). This cylinder can be transformed to a sphere shown in Fig. 9(e), which preserves the filament pitch.



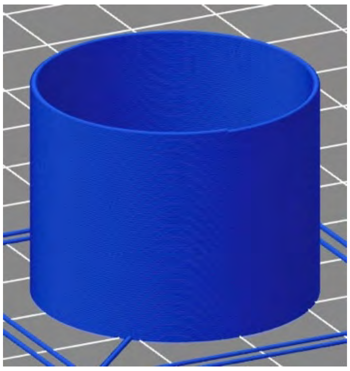
(a) Cup – original shape



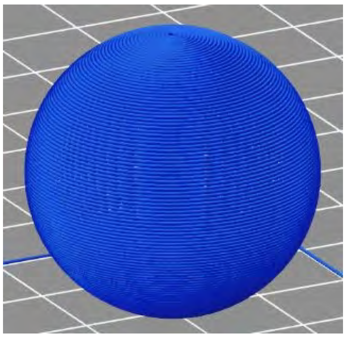
(b) Vase – symmetric deformation result



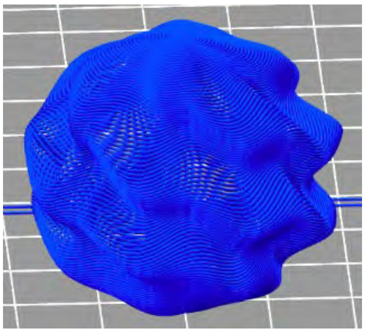
(c) Non-axisymmetric deformation results



(d) Empty cylinder – original shape



(e) Sphere – symmetric deformation result



(f) Non-axisymmetric deformation results

Fig. 5 Examples of deformation

Moreover, non-axisymmetric shapes such as those shown in Fig. 5(c) or (f), which can be generated by deforming axisymmetric shapes shown in Fig. 5(a) and (d), can be easily generated using cylinder-coordinate based deformations. Although various shapes exist in Fig. 5, all these shapes are generated only using these trigonometric functions. However, other types of functions can of course be used.

4.3 Texture-mapping technique

This section summarizes a texture-mapping method (or modulation method) used with the proposed printing method, which is described more in a previous paper [Kan 15c] (and also in another paper [Kan 15b]). Pictures, characters, or textures can be mapped to the surface of an object printed by using this method (see Fig. 8(g) and (h)).

To map textures to the surface of an object to be printed, the cross section of the filament on the surface can be controlled to express textures. This method can generate fine structures, although it is not suited for generating large and deep structures. It can be called the extrusion modulation method; that is, the process of filament extrusion is modulated by pictures, characters, or textures.

Two methods are available for extrusion modulation. The first method is to vary the extrusion speed of filament and the second method is to vary the print-head motion speed. The second method was selected because it is better in response time. In 3D printers, the delay between the motion of the extruder that extrude the filament and the motion of filament at the nozzle, *i.e.*, the tip of the print head is large. It may take several seconds. The response is, thus, slow. Print heads of 3D printers are usually heavy so they have large inertia; however, the response of the print heads are still much better than the filament response.

A method for modulating a surface of a direction-specified model of a 3D-printed object by varying the head motion (and/or the extrusion speed) is described below. The original model is assumed to consist of short lines, which is called “strings”. This method converts the original strings S*i* to new strings S*i*’ (1 ≤ *i* ≤ *N*). The original model is modulated by using a bitmap and the modulated model is generated.

Figure 6 outlines the modulation process. Each string has the cross section, c*i*, as its property and the head speed, v*i*, is also specified. These values are updated by the modulation. If the corresponding bit is zero, the value of c*i* becomes c0 and the value of v*i* becomes v0. If the corresponding bit is one, the value of c*i* becomes c1 and the value of v*i* becomes v1. If v0 = v1, the cross section is controlled only by extrusion speed. This is *not* the selected method. If c1/c0 = v1/v0, the cross section is controlled only by print-head motion speed. This method is selected because the extrusion-speed control mechanism does not respond quickly; that means, it has large latency.

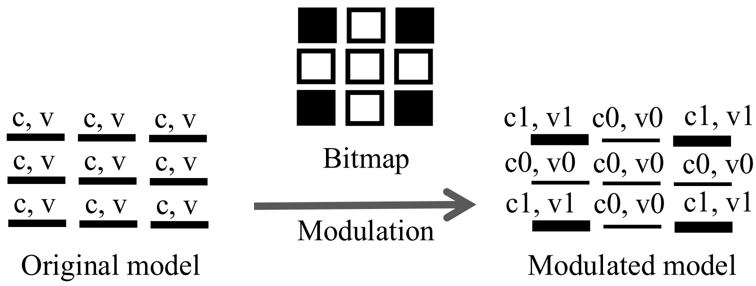
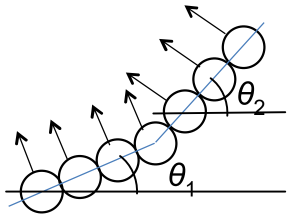


Fig. 6 Modulation by a bitmap

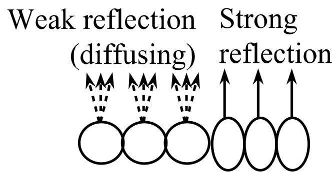
4.4 Reflection of light

Several types of filament used for FDM printers reflects light on the surface and brilliantly shines, and the amount and the direction of reflection can be controlled by certain techniques. This is an attractive attribute for artistic or visual-design purposes. For example, transparent PLA, especially pure PLA, is quite attractive in reflection (see Fig. 8, especially (a) and (b)); that is, reflection becomes strong in 3D-printed objects made of PLA because strings increase the surface area that reflects light. This attribute is caused not only by the surface, but it is also affected by the internal structure of an object. If the filament is not transparent, the brilliance disappears.

The reflection can be controlled by the angle of stacking filaments, filament density, or some other attribute of the printing method (**Fig. 7**). Figure 7(a) shows reflection controlled by the overhang angle. If the direction of the light source is varied, different portions of the object more strongly reflect the light. Figure 7(b) shows reflection controlled by the filament density. Even if the direction of the light source is varied, the diffusing part never reflects light brilliantly.



(a) Reflection controlled by the overhang angle



(b) Reflection controlled by the filament density

Fig. 7 Reflection control

4.5 Examples

The author designed and printed various examples. A program library, **`draw.py`**, for generating G-Code for 3D printers was developed and used. This library is publicly available at http://www.kanadas.com/program-e/2014/10/3d_printing_library_for_parts.html. By using this library, an object designer can write a program to select parts, such as a line, a helix, a cylinder, to specify parameters of the parts, and to combine them. In the current version, deformations can only be applied to the combined model, but it will be applied to parts or partially combined model too. Similar to **`turtle.py`**, the above library is specialized for Rostock MAX; however, the same or slightly-modified program can be used for many other 3D printers. The technical detail is available in a previous paper [Kan 15b].

Pieces designed by the proposed method and printed by Rostock Max 3D-printer are shown in **Fig. 8**(a) to (h). Various plates and vases can be created by deforming a cup, as shown in Fig. 8(a) to (d); that is, a combination of an empty cylinder and a helix. Although these objects still require non-straight-forward design and printing process that includes fine adjustments of filament cross sections and printing speeds, this process is much easier for the designer than the process required for turtle 3D printing. All the samples in this section are available from a Web site (http://store.shopping.yahoo.co.jp/dasyn/).

By using the proposed printing method (which is called the helical/spiral printing method [Kan 15b]), shallow plates such as shown in Fig. 4, 8(a), or 8(b) can be created without support material, which is required for conventional 3D printing method. Because no support sticks to the surface of the plate, surface filaments can be kept smooth (to be mirror plane) and the surface can be brilliant.

The deformation function used for the plate shown in Fig. 8(a) contains cos(4θ), which generates the 4-cycle patterns, and the light-reflection control technique[1]. The brighter (reflecting) areas move while changing the

[1] A video on the printing process (http://youtu.be/5P1vaahzW98) and samples (http://store.shopping.yahoo.co.jp/dasyn/1011-04.html) are available.

light-source direction. Figure 8(b) shows a heart-shaped plate[2]. The deformation function for this plate is based on the following function that maps a circle to a heart shape.

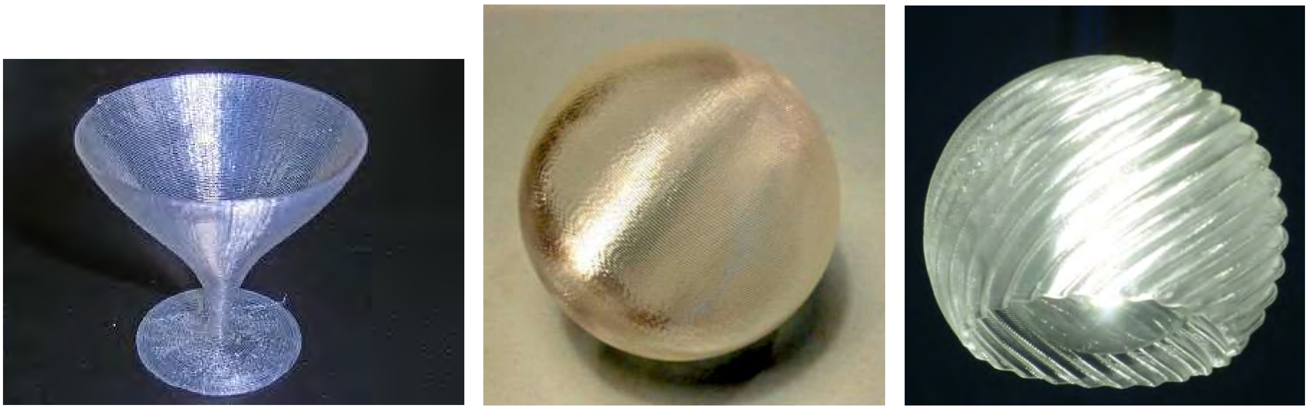
$$fdh(x, y, z) = (x + bz\,\mathrm{sqrt}(|y| / radius), y, z)$$

This function is based on a “equations for heart-shaped curve” [Yam 07]. The appropriate range of parameter b is from 0 to 1.2. This function becomes identity function when $bz = 0$ (at the bottom (center) of the plate), and it generates sharper heart shape when bz becomes larger (at the top (perimeter)).

Figure 8(c) and (d) show taller objects. Figure 8(c) shows a vertically “swinging” vase; that is, the print head slightly moves up and down (so the filament waves vertically) when printing. Such a motion never occurs in conventional 3D printing methods. It was printed with three-cycle vertical motion. They are generated from a cup as well. Figure 8(d) shows a “wine glass”. Vases and wine glasses sometimes leak water; however, by controlling the filament cross-section and the printing speed properly, most of them do not leak water.

[2] A video and samples: http://youtu.be/G9x14DZYN_8, http://store.shopping.yahoo.co.jp/dasyn/3db0f5bafe.html

(a) 4-cycle plate (b) Heart-shaped plate (c) Vertically-"swinging" vase



(d) Wine glass (e) Sphere (f) LED shade

(g) Globe (h) Calendar

Fig. 8 Printed objects generated by various deformations

Most of the shapes of the plates and pods are approximated by 72 linear lines per round trip of the head. The turning points of the head and filament can be observed in these photos, especially in Fig. 8(a) to (c). The plates will look better if they consist of finer lines, but it will take more time to print them.

Shapes in Fig. 8(e) to (h) are created by deforming a helix (drawn in Fig. 5(d)). An example of a printed sphere is shown in Fig. 8(e)[3]. A sphere can be clean, brilliant, and strong; however, it is necessary to determine the cross section of filaments and the printing speed (*i.e.*, the head motion speed) very carefully to obtain these properties. Figure 8(f) shows a shade for an LED lamp. This is the largest object in Fig. 8; however the diameter is approximately 80 mm, and the printing time is less than 20 minutes.

[3] http://youtu.be/xr6zg0Z07HA, http://store.shopping.yahoo.co.jp/dasyn/1032-10.html

The texture-mapping method is used in the object shown in Fig. 8(g) and (h). Figure 8(g) shows a globe, *i.e.*, a sphere that a world map of 300x150 pixels is mapped to; this means the sphere consists of 150 approximate circles and each circle consists of 300 strings[4]. The map by equidistant cylindrical projection method derived from NASA was taken from a web site called “Celsia Motherload” (http://www.celestiamotherlode.net/catalog/earth.php). The diameter is 50 mm and the contrast of the land and the sea is 1.3 to 1.4. If the contrast is too strong, the printing may fail. Figure 8(h) shows part of a calendar. Each cylinder contains days in two months, so a set of calendar consists of six cylinders.

5. Conclusion

This presentation proposed two methods for designing and printing generative 3D objects, *i.e.*, a 3D turtle-graphics-based method and the assembly-and-deformation method. The former is more intuitive but easy to fail, and the latter is easier to generate printable design. Although it is yet not very easy to create an object exactly as designed by a straightforward process, various shapes can be generated by applying these methods iteratively. In the second method, the designer can also map textures, characters, or pictures on the surface of the object. If the initial model is a thin helix with a very low cylinder (*i.e.*, an empty cylinder with a bottom), shapes like cups, dishes, or pods with attractive brilliance can be generated, and a globe and other shapes can be generated from a helix. Python APIs for these methods have been publicly available; however, easier ways to use these methods will be developed.

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Francesca Franco

Exploring Processes and New Constructs in Art: the missing link in the history of Generative Art

Topic: Art

Author:
Dr Francesca Franco,
Senior Research Fellow,
Institute of Creative Technologies,
3.04 Queens Building,
De Montfort University,
The Gateway, Leicester, LE1 9BH, UK
http://www.dmu.ac.uk/about-dmu/academic-staff/art-design-humanities/francesca-franco/francesca-franco.aspx
www.francescafranco.net

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Abstract:

This paper explores the history of generative interactive art and its contribution to the broader field of art history from the late 1960s to the present. The history is exemplified in the creative work of British artist Ernest Edmonds (b.1942) in which the invention of new concepts, new tools and new forms took place in parallel and operated in an interdependent way.

The paper develops the themes within Edmonds' art and shows his connections with the Systems Artists and their forebears. In particular, the paper concentrates on the encounter of Edmonds with artistic thinking about systems and process in the broad sense, as well as digital and interactive work developed from the 1970s until the present time. As my paper will demonstrate, connections between Constructivism, Systems art and Generative art have been strong and at the same time considerably overlooked. The aim of this paper is therefore to present one of the missing histories of generative art through the analysis of a specific artist and his role in re-shaping the notion of interaction well before the advent of the World Wide Web.

By combining the analysis of the computer-based art collection held at the Victoria & Albert Museum, London, and a series of interviews conducted by the author with the artist in the past two years, this article will shed light on an original aspect of generative art and its consequences in contemporary art.

Biographical note: Francesca Franco is Senior Research Fellow at De Montfort University, Leicester, where she is studying the Edmonds Archive of computational art held at the Victoria & Albert Museum, London. In 2009–10 she was Research Fellow on the AHRC funded project Computer Art and Technocultures at Birkbeck, University of London, and the V&A Museum. She holds a PhD in the History of Art and MA in Digital Art History (Birkbeck). She is an Associate Editor of *Media-N*, Journal of the New Media Caucus.

Francesca’s most recent publications include “The First Computer Art Show at the 1970 Venice Biennale. An Experiment or Product of the Bourgeois Culture?” *Relive: Media Art Histories*, Cubitt and Thomas, eds., MIT Press (2013); “Exploring Intersections: Ernest Edmonds and his time-based generative art,” *Digital Creativity*, 24:3 (2013). Her first monograph on the history of generative and interactive art is contracted with Ashgate: *Ernest Edmonds - Generative Systems Artist* (forthcoming 2016).

Contact:
ffranco@dmu.ac.uk

Keywords:

Ernest Edmonds (b.1942), Generative art, Systems art, interaction, influence, process, time-based art.

Exploring Processes and New Constructs in Art: the missing link in the history of Generative Art

Francesca Franco
De Montfort University, UK

ffranco@dmu.ac.uk

www.francescafranco.net

Abstract

This paper explores the history of generative interactive art and its contribution to the broader field of art history from the late 1960s to the present. The history is exemplified in the creative work of British artist Ernest Edmonds (b.1942) in which the invention of new concepts, new tools and new forms took place in parallel and operated in an interdependent way.

This paper first examines the artist’s background, context and key works engaged with the notions of structure, time and colour. The paper will then concentrates on two important, but often overlooked, works he created: *Fifty One & Fifty Two* (1980) and *Four Shaped Forms, Venice* (2015). The paper poses a number of questions about the origins and development of these works. How were these works created and what inspired their creation? How are they connected? Based upon an analysis of material held in Ernest Edmonds’s Archive, the National Archive of Computer Based Art and Design at the Victoria & Albert Museum, London, and a series of interviews conducted with Edmonds by the author, the paper provides answers to these questions.

In this paper, the term “time-based art” is used meaning that the artwork exists *through time*, in the same way as film and music do. The term "generative art" is used according to the definition by Margaret Boden and Edmonds in their 2009 article “What is generative art?” according to which the term indicates art “wherein the artwork results from some computer program being left to run by itself, with minimal or zero interference from a human being.”[i] This definition expands the original notion of generative art applied to architecture that Celestino Soddu proposed in his *Città Aleatorie* in 1989.[ii]

Keywords:
Ernest Edmonds (b.1942), Generative art, interaction, influence, process, time-based art.

Introduction

Today, it is almost impossible to list all the variations and nuances that have been explored in interactive art since its origins. The rapid advances in computer technology, especially from the early 1980s onwards, have accelerated exponentially the growth and ramification of such field. It is equally challenging to understand which were the roots from which it all originated. An example that helps in tracing the history – or one of the histories – of this subject is the work of British artist, Ernest Edmonds, who has been active in the field of interactive generative art since the late 1960s.

Looking at how some of Edmond's works have been created, this paper investigates how they disrupt the formal systems of art perception, particularly through interactivity and audience participation. From the late 1960s through the following two decades, most of Edmonds' work has been either concerned with the implications of the notion of computation, exemplified by his seminal work *Nineteen* (1968-9). Nonetheless, in the early 1980s, Edmonds carried out a parallel experimentation in art concerned with the organization and structure of surfaces and colours, both in terms of process and execution. The results, analyzed in this paper in detail, included two important works, *Fifty One & Fifty Two* (1980) and *Four Shaped Forms, Venice* (2015). As the paper will demonstrate, despite the thirty-five year gap that separates these works, the way they were created and similarities that connect them, help us understand one of the key developments of generative art from its very early stages as well as its evolution up to the present time.

Artist's background

Ernest Edmonds is a pioneer of computational art whose work has been engaged with the notions of colour, structure, time, and interaction from the late 1960s. As demonstrated by a number of recent studies and art exhibitions, his work has contributed to establishing a link, often overlooked, with the structural research conducted in the late nineteenth century by Paul Cézanne and the subsequent developments carried out by constructivist artists in the 20th century.[iii]

His background is in mathematics, philosophy, and logic. These studies provided opportunities for interdisciplinary exchanges that have had a strong impact on the nature of his art. They also enabled Edmonds to explore new ideas in art through the use of technology that have become a constant stimulus in his creative research.

As an artist, he has been influenced by a variety of interests, such as concrete poetry, film, music, mathematical logic and computing. His work is rooted in Constructivism, the art movement established in Russia in the late 1910s that aimed to design objects with a new, revolutionary, and functional approach. Inspired by such ideas, Edmonds soon developed his own artistic language based on an ongoing dialogue around colour, structure, time, and interaction.

From the early 1960s, Edmonds began experimenting with structure in his work, in his painting, drawing, and poetry. His early watercolours, his drawings in china black ink from the early 1960s, and later paintings created between 1974 and 1982 using acrylic paint, depict geometrical abstract shapes. These works reference the iconic colour structures of the Dutch artist Piet Mondrian and the experimental American artist Charles Joseph Biederman's evolution of constructivism. A work such as *Nineteen* (1968–1969), which will be described below, provides a link to Edmonds's early experiments in structure using a computer.

In the early 1980s, Edmonds's work evolved towards a praxis increasingly engaged with the notion of time. This was made possible in part by the introduction and availability of the personal computer. This represents a pivotal moment in the artist's career: when he realized there was a way in which he could combine his research into structure and add time to it, making time-based art.

Edmonds' insight was that logic programming, one of the four main computer programming paradigms, based on axioms and goal statements, could be applied in art to make generative work integrated with the notion of time. As the artist explained in 2012, logic programming can be used as a method for handling structures in time by visually representing the internal search process within a computer. Time can be used to make generative work in which the rules, specified in logic, control the form and order of a sequence of images. The sequence can go on forever without loops, depending on the rules. The logic specifies how the work unfolds;

both the structure of each individual image and its structure in time. The details of this depend on a particular way of using logic in computer systems known as logic programs. In this method, a set of logical statements (in this case about the design of images) is interpreted as a program that instructs the computer to search for some specific goal or state (in this case of the image). An important element of logic programming is that it includes “backtracking,” where, when certain rules have been tried and fail to get to the goal, the computer goes back and looks for alternative ways of using the rules. In what Edmonds calls his video constructs, a series of works created in the early 1980s, this process of backtracking is used to generate an unfolding search and the artwork, the image sequence, is a trace of this search.

Nineteen (1968-1969)

Nineteen (1968–1969) (Figure 1) represents Edmonds’s first use of a computer program in his art. *Nineteen* was exhibited for the first time in the Invention of Problems exhibition at the Leicester Polytechnic in 1970. It was a large panel, which consisted of twenty squared reliefs attached to a white supporting structure and arranged in a grid of five pieces wide by four high. Each piece shows a number of abstract shapes delineated by vibrant colours.

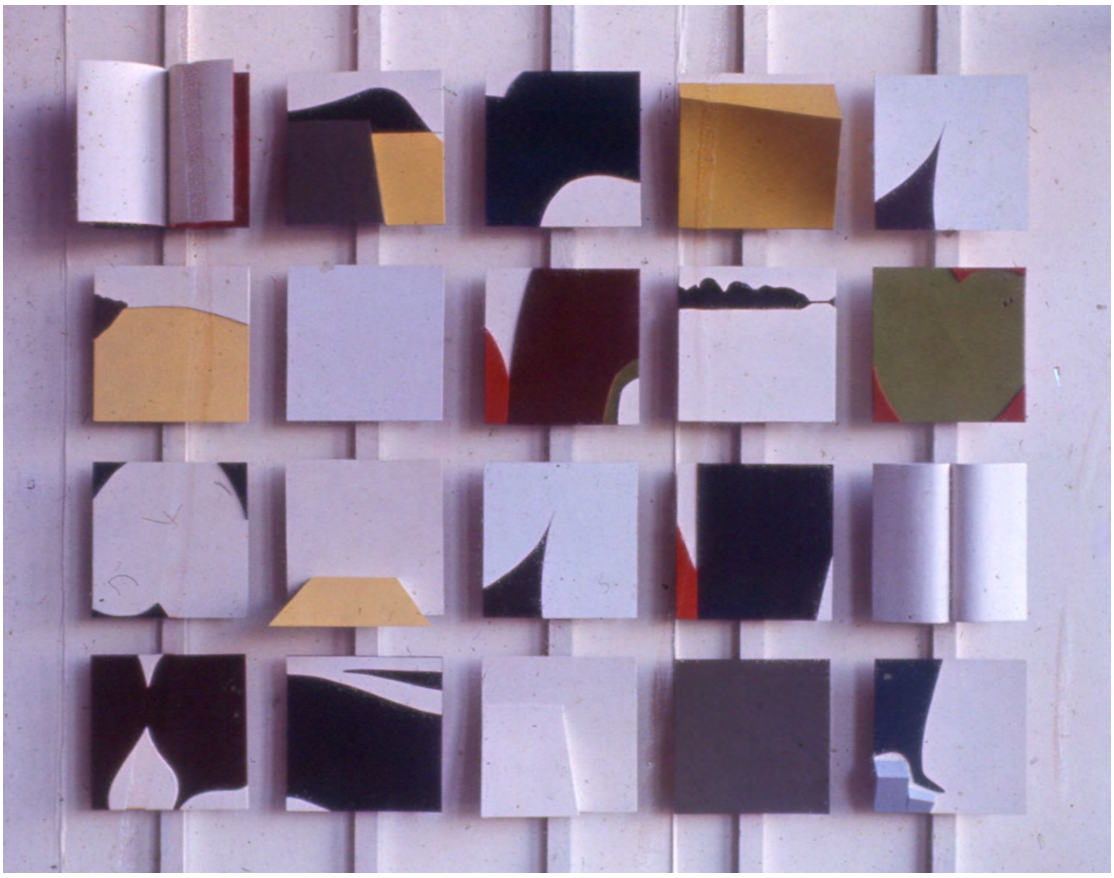

Figure 1: Ernest Edmonds, *Nineteen*, 1968–1969. ©Ernest Edmonds. Image courtesy of the artist.

While working at *Nineteen*, Edmonds – who was at that time a research assistant at Leicester Polytechnic and had begun a PhD in logic at Nottingham University – had started to program the institutions computer, out of curiosity. He found a use for programming in solving a logic problem and it worked well enough to result in a publication in the Journal of Symbolic Logic. In arranging the twenty pieces into a grid he had difficulty finding a satisfactory positioning. On reflection he realised that he could identify a set of rules that, if they were met, would solve his problem. So he started to think about introducing a number of organising principles to the whole composition. The second realisation was that he could compose a computer program, very similar to one that he had written for the logic problem, that could search for the solution. That helped complete *Nineteen*. But, as we will see, this use of computer programming for *Nineteen* was much more significant and eventually transformed Edmonds' art.

The computer became a tool used by the artist to search for an aesthetic problem's solution. However, the consequence of this development had far wider implications. It caused Edmonds to realize the significance of using more formal processes and procedures in art-making and raised the question in his mind of what the implications for art of computer programming might be.

Fifty One & Fifty Two (1980)

Fifty One & Fifty Two (Figure 2) are part of a series of acrylic paintings on canvas created by Edmonds, when exploring new ways of structuring and executing an artwork by using rules as organizing principles. This was a direct consequence of the discovery of the value of the computer in organizing the structure of an artwork Edmonds made in 1968 when he created Nineteen. This discovery also taught Edmonds that the computational process was of interest to the making process of an artwork.

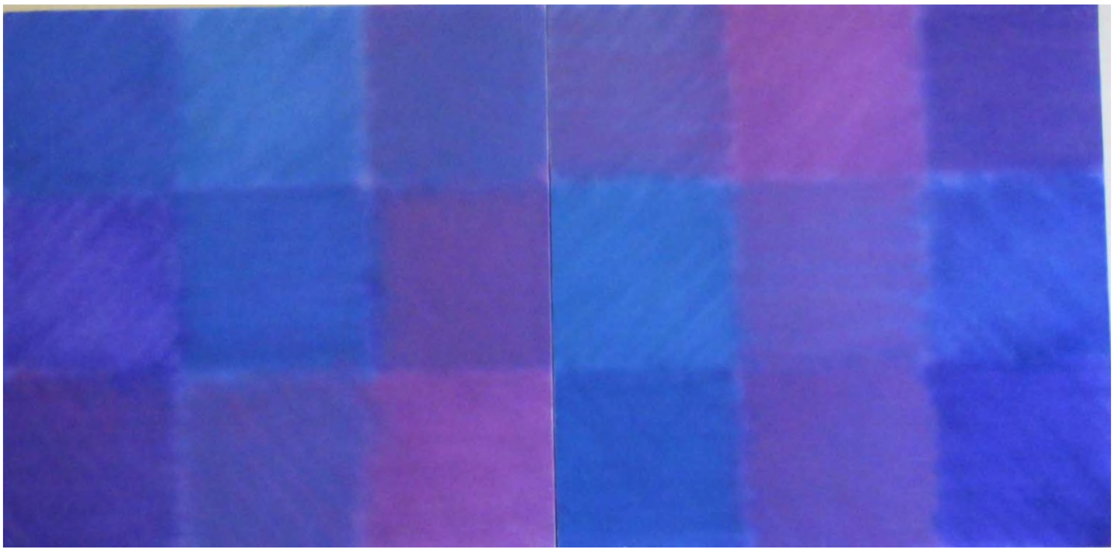

Figure 2: Ernest Edmonds, *Fifty One & Fifty Two, 1980*. ©Ernest Edmonds. Image courtesy of the artist.

Fifty One & Fifty Two were structured in two concurrent respects: firstly, the organization of the surface and the colours; secondly, the process of execution of the painting. As to the organizational aspect of the artwork, this had no implications on how it was done, whereas the process drove how the painting was made, in what order the paint was applied, and where.

Fifty One & Fifty Two are two separate squared canvases placed side by side and represent two variations of a theme, or structure. Each one uses three basic colours, called "seeds colours." Let us take the first variation, *Fifty One* (Figure 2, on the left), as an example. The first rule specified by the artist is that the image be divided into nine sections of equal area that define a three by three grid. There should be three seeds colours in it; each of those three colours should be allocated a square in the grid where none of them has to appear on the same row or column as another. For ease of explanation, Figure 3 exemplifies the grid; the numbers in it refer to a specific square in the grid. The three seeds colours in *Fifty One* therefore appear in square number 4, 2 and 9.

1	2	3
4	5	6
7	8	9

Figure 3: organizing grid (*Fifty One & Fifty Two*).

The second organizing rule states that when any one of these colours appears in any particular row or column, then such colour has to be in all of that row or column. So for example, the colour in 9 has to appear in 7, 8, 6 and 3; the colour in 2 has to appear in 1,2,3,5 and 8; and the colour in 4 has to appear in 1,7,5 and 6.

As to the process of execution of the painting, this followed other sets of rules. The paint was applied with an electric way control spray gun. As one of the organizing rules implied the presence of two colours in one single square of the grid, the artist decided that, when combining the two colours, they should be sprayed both without mixing them. This created a result that visually recalls the work of Seurat, where the combination of different colours appears unified by the physical process made by the eye of the viewer.

Edmonds decided to make the spraying process obvious, so the colours were intentionally sprayed lightly. This meant that the direction of the spray was made visible. The artist therefore chose three ways of spraying: bottom left to right top, horizontally, and top left bottom right. These three directions formed, similarly to the three seeds colours mentioned before, three different generating squares following the same organizing rules set up for each seed colour. As a result, if square 8 was allocated horizontal spray, then 7, 8, 9, 5 and 2 will have to use horizontal spray, and so on. There are now two overlapping patterns: the pattern of colours and the pattern of spraying. In this way, the artist has defined the structure of the organizational elements of the painting, and the process of making it. The second painting, *Fifty Two* (Figure 2, on the right) is a variation of the same theme, where the allocation of the colours and spraying directions are changed.

For Edmonds, this process of creating an artwork derived from two important sources of inspiration. Firstly, as mentioned above, was the process activated by *Nineteen*, which represented to Edmonds the first critical point of change in his art. Secondly, was the work of Charles Biederman.

It was particularly the way Biederman understood art as the solution of a problem to be found in pure observation that connected with Edmonds' research and art practice. As Biederman suggested, "Nature teaches us the methods and structural conditions by which to solve problems."[iv] The next step for the artist was to abstract from the structural process of nature. This point led to the notion of structural procedure and minimal complexity that excited Edmonds' curiosity.

These two experiences helped Edmonds crystallize the understanding that making the elements of the work simpler added power to his work.

Four Shaped Forms, Venice (2015)

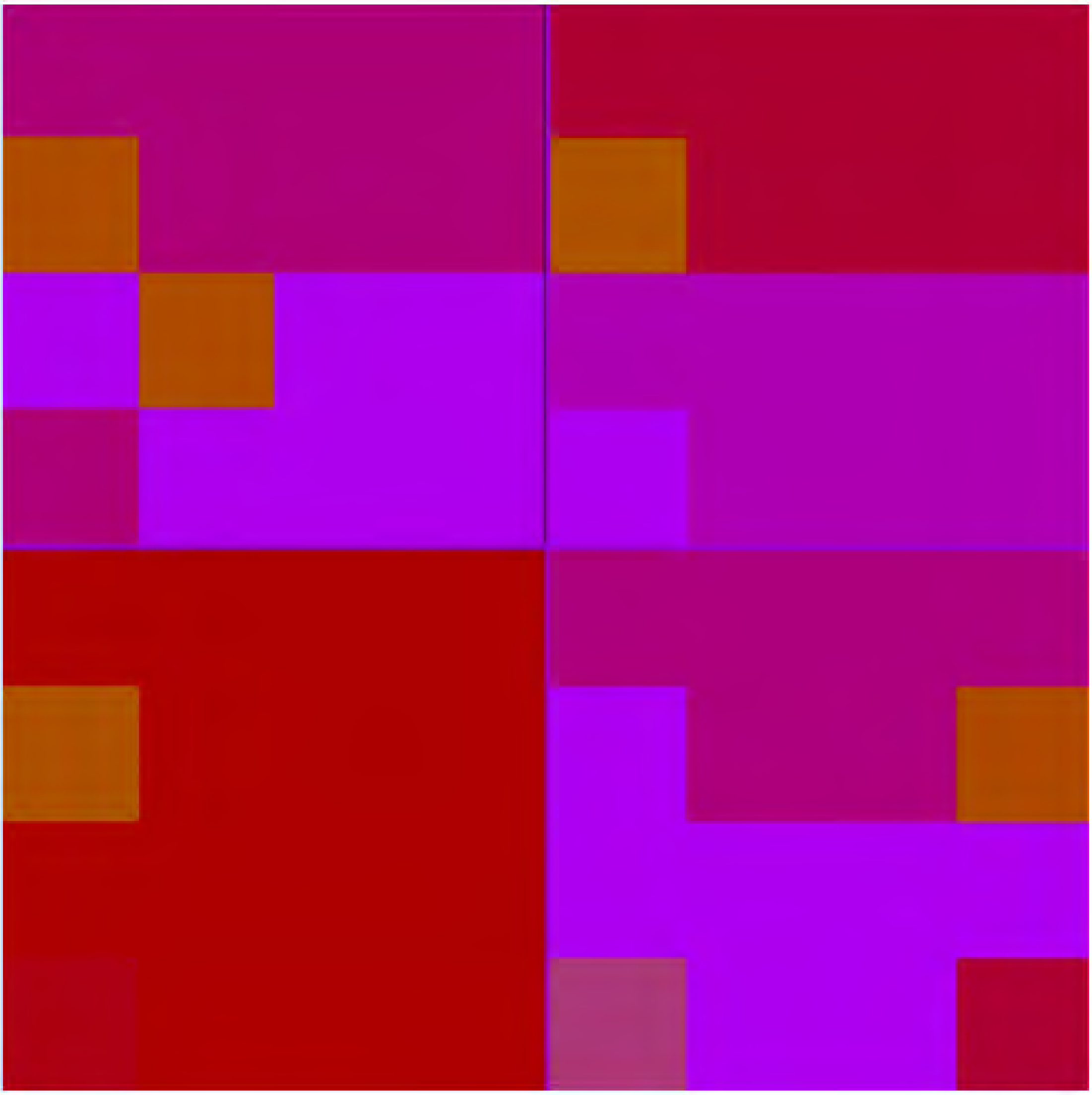

Figure 4: Ernest Edmonds, *Four Shaped Forms, Venice*, 2015. ©Ernest Edmonds. Image courtesy of the artist.

Four Shaped Forms, Venice (Figure 4) is a four-piece digital print on aluminium based on a series of acrylic paintings on canvas called *Four Shaped Forms* (Figure 5).

These are strongly connected to *Shaping Forms*, a series of time-based works Edmonds made from 2007 exploring the notion of interaction. Interaction has been one of the focuses of Edmonds' investigations, since the early 1970s. It developed even further in recent years, as demonstrated by his *Shaping Forms* series. Here, interaction is intended as an exploration of "long term influences rather than short term reactions." [v]

Figure 5: Ernest Edmonds, *Four Shaped Forms (Park Hill B)*, 2014.
©Ernest Edmonds. Image courtesy of the artist.

Shaping Forms (Figure 6) are a series of generative and computational works displayed on a square monitor, surrounded by a purpose-designed frame built in plastic and wood by the artist.

Figure 6: Ernest Edmonds, *Shaping Forms*, 2007. ©Ernest Edmonds. Image courtesy of the artist.

Shaping Forms are individual works where images are constantly generated by a computer program that decides which colours, patterns, and timing the work should display at any given moment. The movement in front of each work is detected by a camera and produces changes in the image, shape, and duration, so that the environment, the active spectator, and the work influence each other. Edmonds once described his unique way of perceiving interactivity in his art as an interest in "seeing how computer generated art systems can interact with the most purposeful enquiring systems—human beings." He continues,

> I am interested in how humans react to artworks that behave differently because of their presence and whose form and appearance change over time…The atmosphere, the light, the space, the audience are all part of the experience of a work…In interactive art, the audience is deliberately made a component of the work: the person in the art space becomes an active participant. In participative interaction, the artefact is just one element of the whole experiential space.[vi]

The four canvases making *Four Shaped Forms*, represent four variations of a theme directly connected to *Shaping Forms*. The selection of colours, in both cases, is generated from a system that uses colour models, where the hues are equidistant according to some rule and the saturation levels are the same or close together according to a system.

In *Four Shaped Forms*, the structure of the elements within the picture organized in a four by four square grid looks similar to the way *Fifty One & Two* were organized. As a matter of fact, its structure is much more complex and less easily explained by geometry, as *Four Shaped Forms* are four moments selected out of a time-based sequence. The way *Four Shaped Forms* is structured is therefore more obscure, but nevertheless it provided Edmonds with a procedure and process for generating the images in a rigorous way, similarly to the earlier experiences of *Nineteen* and *Fifty One & Two*.

The colours and patterns chosen for each canvas of *Four Shaped Forms* are selected by the artist from stills of *Shaping Forms*. The colours are then manipulated and adjusted by eye onto the canvas. The dialogue that this relationship creates between the time-based work and the paintings is strong. In the time-based works, the viewer can only appreciate colours and patterns in one sequence with different lengths of time between them, which generates a kind of rhythm through time. Although this musical quality is lost in the paintings, by looking at the four variations of Four Shaped Forms, the viewer is able to experience four different moments of a theme at the same time.

Conclusions

This paper has explored a selection of works by Ernest Edmonds that delineates one of the possible roots of the very complex field of generative art. The mathematical rules applied by the artist to create *Fifty One & Two* and the software work that inspired *Four Shaped Forms* have generated paintings that are in constant dialogue with their computational counterparts, *Nineteen* (1968-9) and *Shaping Forms* (2007). *Fifty One & Two* and *Four Shaped Forms* demonstrate that rules and computation methods can be seen as inventive forces that delineate a new order in the creative process of an artist. Although the computer was not used directly to create such works, these could have not been created without the earlier computational works generated and programmed by Edmonds from the late 1960s onwards. There is a dialogue between the painting works and the software pieces analyzed in this paper, and they represent one of the developments of generative computational art that is in constant evolution.

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Anthony Viscardi

The architecture of PLAY and the play of ARCHITECTURE

Topic: Art Architecture and Design

Authors:

Anthony Viscardi

Lehigh University

Department of Art Architecture and Design

USA

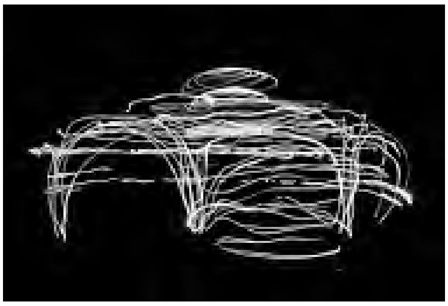
www.lehigh.edu/~av03

Main References:

Anthony Viscardi

"The architecture of PLAY and the play of ARCHITECTURE

www.generativeart.com



Light drawings from the two HDS design/build projects - Plaster casts made during the soft forming

Our department was handed a mandate to provide hands-on, design/build, intensive experiential learning opportunities for our majors (art, architecture and design). A new experimental design/build, seminar/studio was developed around two tracks; one, the architecture of PLAY, placed us in direct contact with material and its transformation and took the form of intensive three-day design/build workshops. Two workshops were focused on 'fabric forming concrete' and one workshop on stick construction. Each with its own set of parameters and procedures. The second track ran parallel to the workshops and took on a more didactic platform, as a series of public lectures on the 'play' of ARCHITECTURE. These talks were to demonstrate how several practitioners have employed aspects of materiality and form into playful actions in their own architectural practice demonstrating how "theory and practice" come together in great works of architecture and how architectural practice can evolve in the 21st century. With the advent of digital means of fabrication, the art and craft of design thinking and making must coincide and collude with the more traditional hand crafting of our cultural artifacts. What is the nature of 'craft' in this new world of construction and how does it manifest itself in the environments we make and the products we consume? These questions would be tested during each design/build workshop and verified by the each of the invited speakers.

These special design/build workshops have been designed to immerse you into the 'act of making' as intensive material explorations ("Exploration is just curiosity acted upon"). The PLAY aspect of these experiential learning workshops will direct their evolution and outcomes.

Keywords: Architecture, Teaching

The architecture of PLAY and the play of ARCHITECTURE

Prof. Anthony Viscardi, Masters of Architecture

Dept. of Art, Architecture and Design, Lehigh University

www.lehigh.edu/~av03

email: av03@lehigh.edu

Abstract

Our department was handed a mandate to provide hands-on, design/build, intensive experiential learning opportunities for our majors (art, architecture and design). A new experimental design/build, seminar/studio was developed around two tracks; one, the architecture of PLAY, placed us in direct contact with material and its transformation and took the form of intensive three-day design/build workshops. Two workshops were focused on 'fabric forming concrete' and one workshop on stick construction. Each with its own set of parameters and procedures. The second track ran parallel to the workshops and took on a more didactic platform, as a series of public lectures on the 'play' of ARCHITECTURE. These talks were to demonstrate how several practitioners have employed aspects of materiality and form into playful actions in their own architectural practice demonstrating how "theory and practice" come together in great works of architecture and how architectural practice can evolve in the 21st century. With the advent of digital means of fabrication, the art and craft of design thinking and making must coincide and collude with the more traditional hand crafting of our cultural artifacts. What is the nature of 'craft' in this new world of construction and how does it manifest itself in the environments we make and the products we consume? These questions would be tested during each design/build workshop and verified by the each of the invited speakers.

"Creativity in architecture can be based on the process of transformation of matter. This transformation occurs in the realm of perceptive imagination where to generate and develop new ideas means to pre-figure matter in the course of the idea's realization. In creative acts of play, a certain type imagination is provoked directly from our immediate confrontation, interpretation and manipulation of matter. These images may be assigned category by the eye but only the hand truly reveals them. They depend on visceral readings that are projected through qualities such as mass, material surface or texture, light, space and time."

Hammerschlag Design Series |H|D|S|

Fall Semester 2014/2015

The Hammerschlag Design Series [HDS] is sponsored by a special fund bestowed upon our department to generated experiential design build opportunities for our students in particular our architecture majors. Over the last two years I, as the executor of the fund have produced a series of design/build workshops and lectures culminating with the current project to design and build an acoustical ceramic shell based on the principles of Guastavino style construction.

Beginning in the fall of 2014 a two track series of events took place as the kick off of the HDS whose focus was the architecture of Play and the play of Architecture. One was developed as a series of design build workshops and the other as a series of public lectures.

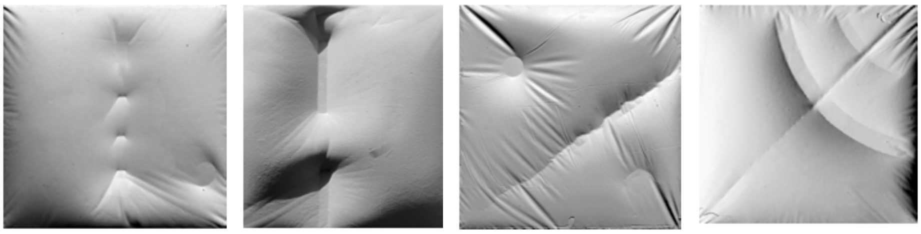
Track One acted as a series of 3-day design workshops to occur on Thursday, Friday and Saturday, the second week of September, October and November (see attached schedule). The students that were part of a special class were required to attend these intense design/build workshops as much as possible. During the regularly scheduled classes we discussed, read, scheduled and prepared for the design/build workshops. These special design/build workshops were designed to immerse you into the ‘act of making’ as intensive material explorations (“Exploration is just curiosity acted upon”). The PLAY aspect of these experiential learning workshops directed their evolution and outcomes. The manpower requirement for these design/build workshops was a crucial aspect of the success of this course and of each individual's learning experience.

Each design workshop professor also gave a talk as part of the Public Presentations on Thursday evenings at 6pm.

Track Two acted as a series of (6) six Public Presentations by Architects/Artists who have been successful incorporating the play of Architecture into their own critical practice. They occurred on Thursday evenings at 6pm in Room 230 Chandler-Ullmann. The AIA of Pennsylvania advertised the schedule of all these workshops and lectures among its members and were welcome to participate on all levels. And the AIAS student chapter at Lehigh assisted in recruiting student participation for all these exciting workshops.

General Workshop Description

Playing with materials, the design decisions based on responses from material processes are integral to the art of craft. The embodied knowledge of making is gained through the physical interaction with materials, searching for an order rooted in history, perception and materiality. How do we embrace the imperfections, the material risks and resistances always present in fabrication and making as we adopt new technologies primary intended to maximize the predictability? (1) All the workshops addressed this issue in its own form and materiality. Two workshops explored 'soft forming' techniques, where we used plaster to simulate concrete. Both visiting professors brought with them much experience in working with this technique. All of these techniques have been used in experimental forms of full-scale construction. Listed below are the workshops with some of the results.



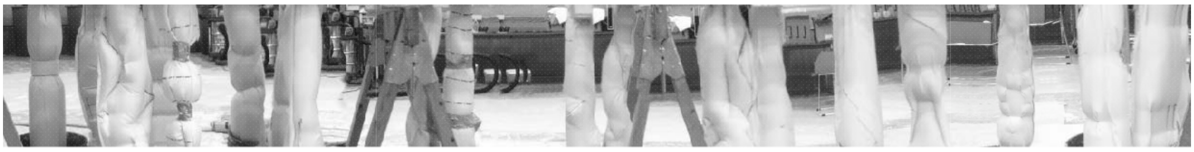
Ronnie Araya

http://cargocollective.com/ronniearaya/About

Fabric Formwork For Concrete Structures And Architecture

This first design build workshop will explore through playing and making; it is about finding ideas and engaging the interactions of natural laws through physical models made with analog materials that represent full-scale concrete construction. While many improvements and innovations are being introduced in the composition of concrete, the format of its mold has not changed significantly since ancient times. In our traditional approach to concrete's formwork, we still address only solid, rigid and dry qualities of this material, ignoring the rest. However, with concrete becoming globally used in the construction of buildings, cities and infrastructure, the objective of this workshop is to rethink and reshape the potentials of this material by using the casting technology of flexible molds.

Working with concrete is a process in which the mold has crucial importance as it, essentially, originates the form. The idea of fabric formwork is quite simple: flexible membranes replace the majority of rigid parts of a traditional mold, introducing a fundamental change in design and production processes. (2)



Kentaro Tsubaki

http://ktstudiokt.net/KT_Studio_KT/KT_Studio.html

Pleated Concrete Surfaces

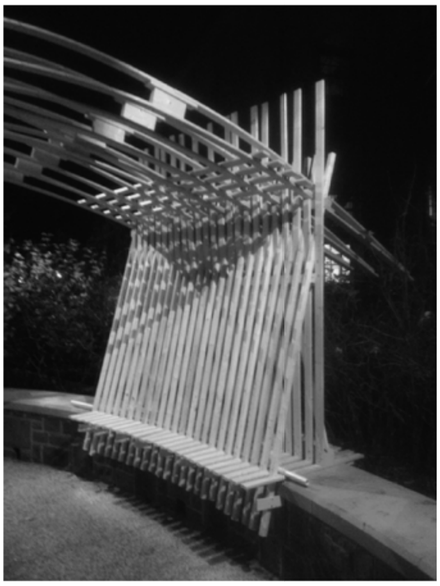
The project intends to expose ways to negotiate the issues of risk and precision contrary to the reality of current building practices; to execute efficiently with minimum risks with computational muscles at its disposal. It attempts to harness the self-organizing tendencies of the physical materials under gravity within the fabrication process and to provoke the deeply entrenched architectural practice through questioning the obvious and the rational in a fundamental way.





The workshop investigates the potential for Smocking, a pleating technique on a fabric-formed plaster surface as a manifestation of an equilibrium reached between the surface tension and omnidirectional hydrostatic pressure. In order to stabilize the dynamic process for iterative design improvements, we will engage the laser-cutting technology to fabricate templates that control the pleated geometry of the fabric surface. Simultaneously, the relationships amongst the geometry of the templates, the pleated fabric surfaces and the plaster-cast columns will be explored in hybrid drawings. (3)



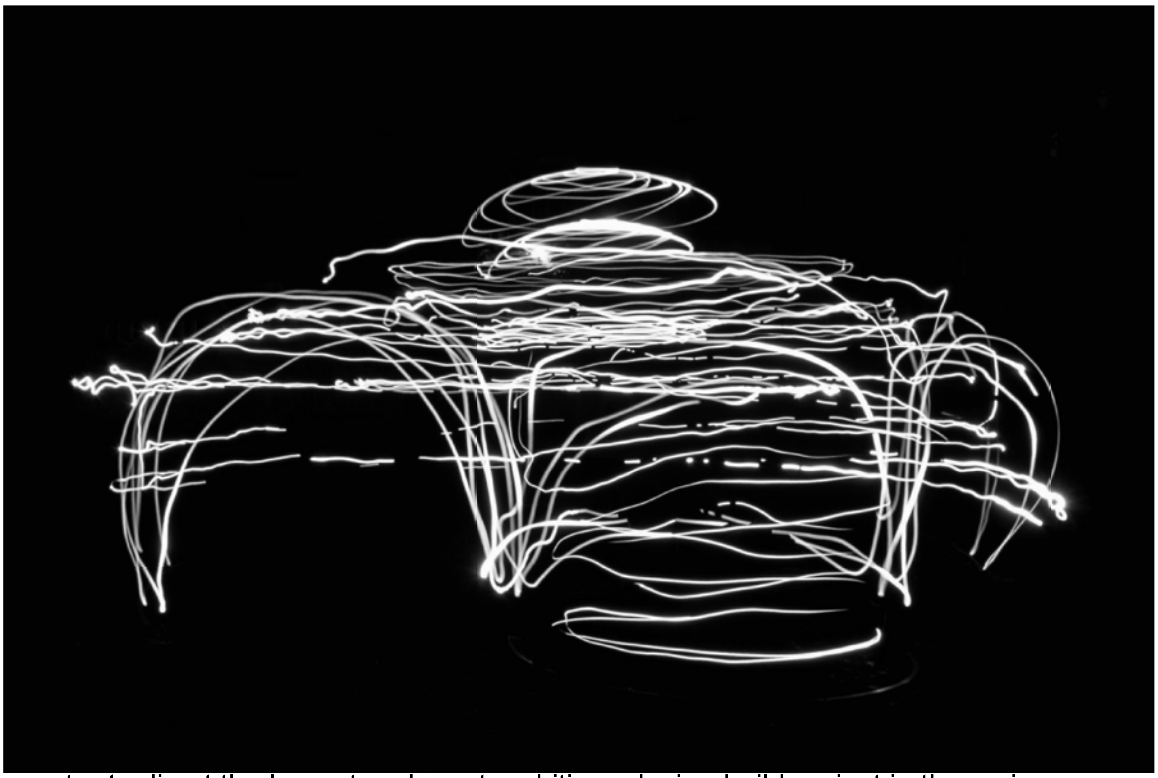
Richard Kroeker

http://www.richardkroekerdesign.com/

TIME AND MATERIALS

“The Winged Arch”

The third workshop dealt with the properties of wood and how to employ the making of full-scale models into a complete design built structure in two days. We began with making small exercises in using small sections of 1x3 lumber to fabricate arches, trusses and bench constructions. The next day we designed as a group an installation to be placed on or near the fountain in front of Chandler-Ullmann where the Architecture Program resides. All the students working together as a group built the final constructed “winged arch” in one day. It exemplified and synopsized the complete series of workshops into a truly wonderful construction that demonstrated the idea of ‘experiential learning.’



Richard Kroeker

“Peggy’s Bell”

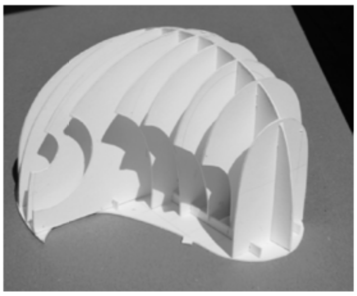
The final design build project from this first HDS is currently under construction. I asked Professor Richard Kroeker to return as a visiting professor for the 2015 Fall semester to direct the largest and most ambitious design build project in the series.

This design/build studio worked with architecture and engineering students at Lehigh to create a beautiful public space on the campus. The campus is in a park setting, with many paths connecting the various departments and their buildings. There are also sculptural works placed along many of these paths. There is still the sense that the outdoor spaces are mainly connecting interstitial space: a means for getting from one department to another. In fact, the main purpose of a university is to provide the spaces and occasions for social interactions and for reflection, between the defined institutionally defined tasks of course outlines and examinations. These public social spaces slow down some of the specific task-defined processes of a University to provide social spaces as destinations in themselves for meeting, or reflection. This interstitial outdoor space need not just be something you get through in your way to something else, and experience only in transit, but can become the fundamental ground for our collective, democratic life that is basic to the very idea of “University”. The workshop group is designing and building a space using a ceramic tile vaulting technique to create a shell form that can be used by the public for group events, informal gathering, or individual reflection, inviting people to pause in the beauty of the campus garden.

The material palette will be primarily ceramic tile, and cement, using a Catalan vaulting method that uses a minimum of structural formwork. Students learned the history of the vault building method, brought to this region of North America by the Guastavino family in the early 20th century. They will learn the structural principles involved in shell forms, the construction method, and the nature of the materials used. (4)

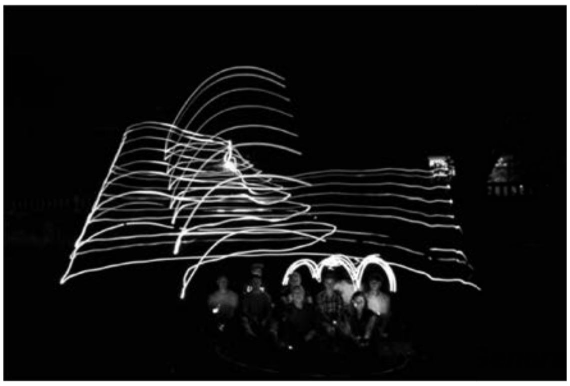
The design of the shell was generated with enhanced acoustical properties in mind. “Peggie’s Bell” is an acoustic space produced by Lehigh University’s Department of Art, Architecture and Design, built by interdisciplinary students from the department and the College of Engineering under the direction of Professors Richard Kroeker, and Professor Anthony Viscard. It is one of the major design/build projects funded as part of the Hammerschlag Design Series.

The BELL is activated by the human voice. It is intended for the use of singers, singing groups, and others seeking a place of conversation, contemplation or for playing with sound. Peggie (Peggie Sisson 1922-2015) was a dance teacher whose love of music and dance inspired this singing bell.


Light Drawing

We began the project as we did “The Winged Arch” project with a series of Light Drawings. Light drawings are done in the evening using flashlights attached to sticks of wood. We invited several photography students from Professor Anna Chupa’s class to capture the movement on film. In our first series last fall we performed around the fountain area in from of our architecture building. This spot would eventually become the site for our wooden structure, “The Winged Arch.”   These type drawings allow one to see virtually how their design would appear in relation to the scale and form of the selected site. This was almost a ritualized consecration of the site as well as acting as a playful way of uniting the work group.




Bashar Swaid

Multifractal Geometry Role's in Historic Urban Morphogenesis

Topic: (Architecture, Design Approach)

Authors:
PhD. St. Bashar Swaid
University of Calabria,
Department of Civil Engineering
Italy
Prof. Roberta Lucente
University of Calabria,
Department of Civil Engineering
Italy
Prof. Eleonora Bilotta
University of Calabria,
Department of Physics
Italy
Prof. Pietro Pantano
University of Calabria,
Department of Physics
Italy

Main References:
[1] Charles Jencks, "The architecture of the Jumping universe, a polemic: how complexity science is changing architecture and culture", A john Wiley & sons, Inc. Singapore, 1997
[2] Eleonora Bilotta & Pietro Pantano, "Structural and functional growth in self-reproducing cellular automata". A john Wiley & sons, Inc. 2006

Abstract:

Urban intervention processes in the historical cities demands a thorough comprehension of the urban morphogenesis approaches in these complex structures. It took hundreds or even thousands of years urban structures to emerge and evolve till the current morphology co-evolving with the human bio-functional interrelations evolution. The focus of this research is on fractal geometry role's in emerging urban morphogenesis, by analyzing two main rules (**Multifractality** and **Sensitive Adaptability**) capable of achieving comprehensive homogeneity at all Urban and Architecture levels. To understand these new approach and to create a new epistemological framework for urban morphology, evolutionary techniques could be used in order to have a set of rules for building different genotypes of Architecture and urban forms which, by using computational processes, develop as output 3D models of urban processes, more suitable with complex adaptive systems such as historical contexts.

- The interrelation between forms and functions is one of the crucial deterministic should guiding morphogenesis approach. Fractal geometry utilized various levels of Mono-fractal and Multi-fractal scaling for reconciling between the function needs (social agents contribution) and the architectural typologies in the historical context. The ability of fractal geometry of emerging **Self-Similar** structures is the secret behind achieving homogeneity at spatial and functional relations.
- Sensitive Adaptability of Fractals manifested through high capacity of responsiveness to different environment situations and changes by changing their structure, behavior and function through manipulating in their "**Genetic Code**".

The research hypothesis based on considering historical urban structures as complex as living bio-organic species has similar attributes, advantages and characteristics, behaves in the same way towards adopting and adapting with different environmental conditions by changing their "genetic code". These complex structures took hundreds or even thousands of years to emerge and evolve till the current morphology, co-evolving with the human bio-functional interrelations evolution. Therefore, the core questions that research will investigates are How, Why and What:

- **How** living organisms could reconcile between their functional needs (reproductive behavior) and their form (produced pattern)?
- **Why** they are using specific rules for evolution or mutation?
- **What** are the secrets/learned lessons that urban morphogenesis and Architecture typologies should be aware of?

Verification of research hypotheses and responding the core questions requires adopting creative architecture and urban concept depending on convergence between Scientific Complexity approach and Artificial Intelligence on one hand, with Complexity approach of Architecture and Urban Morphology, on the other hand.

Contact:
swbashar@gmail.com

Keywords: Genetic Code, Urban Morphogenesis, Scaling Behavior, Multifractality

Multifractal Geometry Role's in Historic Urban Morphogenesis

Bashar Swaid, MSc. Arch, Dipl-.Ing, Prof. Roberta Lucente, PhD.

Department of Civil Engineering, University of Calabria, Rende (CS), Italy

bashar.swaid@unical.it roberta.lucente@unical.it

Prof. Eleonora Bilotta, PhD, Prof. Pietro Pantano, PhD.

Department of Physics, University of Calabria, Rende (CS), Italy

eleonora.bilotta@unical.it pietro.pantano@unical.it

Abstract

Urban intervention processes in the historical cities demands a thorough comprehension of the urban morphogenesis approaches in these complex structures. It took hundreds or even thousands of years urban structures to emerge and evolve till the current morphology co-evolving with the human bio-functional interrelations evolution. The focus of this research is on fractal geometry role's in emerging urban morphogenesis, by analyzing two main rules (**Multifractality** and **Sensitive Adaptability**) capable of achieving comprehensive homogeneity at all Urban and Architecture levels. To understand these new approach and to create a new epistemological framework for urban morphology, evolutionary techniques could be used in order to have a set of rules for building different genotypes of Architecture and urban forms which, by using computational processes, develop as output 3D models of urban processes, more suitable with complex adaptive systems such as historical contexts.

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Keywords*:* Genetic Code, Urban Morphogenesis, Scaling Behavior, Multifractality

– 1. Introduction

Urban interventions in historical cities contexts have ever been considered as an important topic at different urban and social levels, as well as a major vector of economic development. Till now it was not possible to make a clear prevision of these interventions because urban morphology processes which are applied in most of the historical structures lack of finding harmonies configurations [1]. But with the use of computational urban generative approach that moves the creative acts from static events to dynamic transformations (This dynamic process could be easily represented and managed with a set of algorithms [2]), it is possible to achieve harmony, coherence and homogeneity by involving the scientific complexity approach's, based on the role of Complexity and Connectivity factors as essential orientation for the growth of historical urban contexts [3].

Traditional technology (Top-down) of urban systems which used on historical urban ontology has been considered as an obstacle, confronting to the emerging creative processes of urban morphogenesis, because it could only study semi–liner urban structure, but it is unable to analyze the biological-like (Self-Organizing) development of organic urban forms. While the traditional urban analyses have utilized linear and standard statistical techniques to study urban phenomena from the 'top down', techniques of scientific complexity such as Chaos theory and other 'new' methods of analysis such as cellular automata, agent based modeling, spatial metrics, artificial intelligence, neural networks, non-linear simulation and fractal generation represent means to study urban phenomena from the 'bottom up' [4].

According to Jenkins, a new language of form based on fractal design is beginning to permeate our landscape - and skies [5]. The embodiment of fractal characteristics in the urban context relates to the mechanisms involved in the bio-functional evolution process and to the urban context's morphological characterization using fractal analysis [6]. Fractal analysis(1) challenges the traditional methods of analyses such as linear and standard statistical techniques, and presents an innovative Mechanism to analyze and generate Urban Structure/Form corresponding with two interrelated relations: **Spatial Relation** and **Functional Relation**.

The research will highlights on the main obstacles coming from reconciling between techniques of scientific complexity and techniques of complexity of Architecture, especially the fractal technique in both complexities theories', due to the ability of fractals to analyze and emerge coherence, hierarchy and complex self-similar structures from simple rules as biological and organism ones.

1.1. Research General and Specific Problematic

Most of Urban design studies in the historical context associated with a lot of architectural, economic and social interventions are lacking to development a new mechanism/process and an innovative spatial analysis tool for Urban Forms and Architecture Typologies, As a result of these studies and interventions many cases considered as cancerous cells in the historical city, appeared within the urban fabric and contributed in isolating cells surrounding areas inside the historical context as well as destroying adaptability of reuse and infill development in these contexts.

Although many Urbanists and Specialists such as Batty (1994), Longley (1994), Salingaros (2001), Alexander (2004), Jeffrey West (1999), Frankhauser (1998), McAdams (2007) and others had studied fractal Technology and used it in urban analysis, also had recommended to develop this creative technique; and many of pioneer Architects utilized Fractal Architecture such as Libeskind, Zaha Hadid, Rogers, Otto, Jenkins, Celestino Soddu and Renzo Piano. But fractal technology since its discovery by Mandelbrot in 1979 has so far suffered in the application field, and continues to suffer from serious problems especially at the Macro level of urban analysis; and Micro level of evolving adaptive architectural geometrics, due to a set of problems that will address in detail:

Three impediment factors have prevented of Building Genotype(2) and Phenotype(3) Definition and Optimization of new Architectural typologies and urban morphologies for filling urban gaps in the historical context coherently and adaptively, which could be considered as the main significant problematic topics at the Emerging Level. The research will highlight on these factors:

A) Ignoring the spatial and functional relations with historical environment surrounding the Urban gaps and thus reducing the significant and crucial impact to these relationships on formulating and determine the Genetic Code(4) of architectural types/patterns and urban forms, as well as the omission of the historical development of this relationships and its effect and their role in the emergence of new forms and patterns were able to adapt with the variable functional and spatial requirements over time.
B) Imbalance process and misleading Architectural language utilized to identify buildings Genotype, because of absence an integrated mechanism for studying the inherited characteristics derived from the building genetic code's, which reflected negatively on the Phenotype of the building because of giving priority to one factors in forming the genetic code and neglecting the rest of environmental or spatial or functional factors, which led to a serious disruption in the physical and behavioral properties that constitute the building phenotype; and emerging abnormal architectural models contributed largely in fragmenting the complex urban structure in the historical context.
C) Follow destructive mechanism for generating architectural forms based on the cancellation of all spatial and functional links with the historical context surrounding the urban gaps, and destroying the focal points at all levels, which led to disengagement the impact of the Field Effect and to reduce its role for emerging the Seed of architectural and urban forms. Resulted to creating exotic 'cancerous cells' on the historic context, instead of being able to achieve desired optimization.

– 2. Methods

– The research(4) methodology adopted a Morphological Approach (consisting of three main phases). A new Adaptive Dynamical Model **ADM** for Parametric design written in Python and combined with visual programming of Grasshopper(5) as a plug-in to "Rhinoceros 5"(6) software, will be presented in this paper. Incorporation ADM with optimization algorithm is under investigation to develop a modelling software tool called Morphogenetic Fractal Architecture **MoFA** as final research output's.

– The First Phase(7) has developed a novel technology for A) Assessment both urban connectivity & complexity; B) Thresholding urban interactions and self-similarity structure dimensions' by Local Connected Fractal and Lacunarity Algorithms'. This technology represents a paradigm shift for the very first time in architectural and urban design toward transformation urban network analysis from qualitative to quantitative measurements, and establishes a solid basis for the evolutionary process of network interactions (Swaid, Lucente, Bilotta, & Pantano, 2015). This value of urban connectivity and complexity threshold forms a phase transition of the dynamical urban behaviour, and forms a P_c Critical Percolation Threshold that guarantees the historical sites Continuity's, Homogeneity's and Coherence's.

This paper will describe the latest Second Phase results' of an ongoing research project that aims at using the power of Multifractal Geometry (based on Field Effect, Point Attractor and Power Law Scaling Models') for designing and optimizing Building Genotype and Phenotype as a first step of the Seed Emergence for developing a modelling software tool which has been called **MoFA** (Morphogenetic Fractal Architecture) and contains an **Efficient Algorithm for Evolving Fractal Architecture** (Figure 1). The second (Generator Techniques) and third steps (Optimization Algorithm) will be investigated in the research Third Phase's.

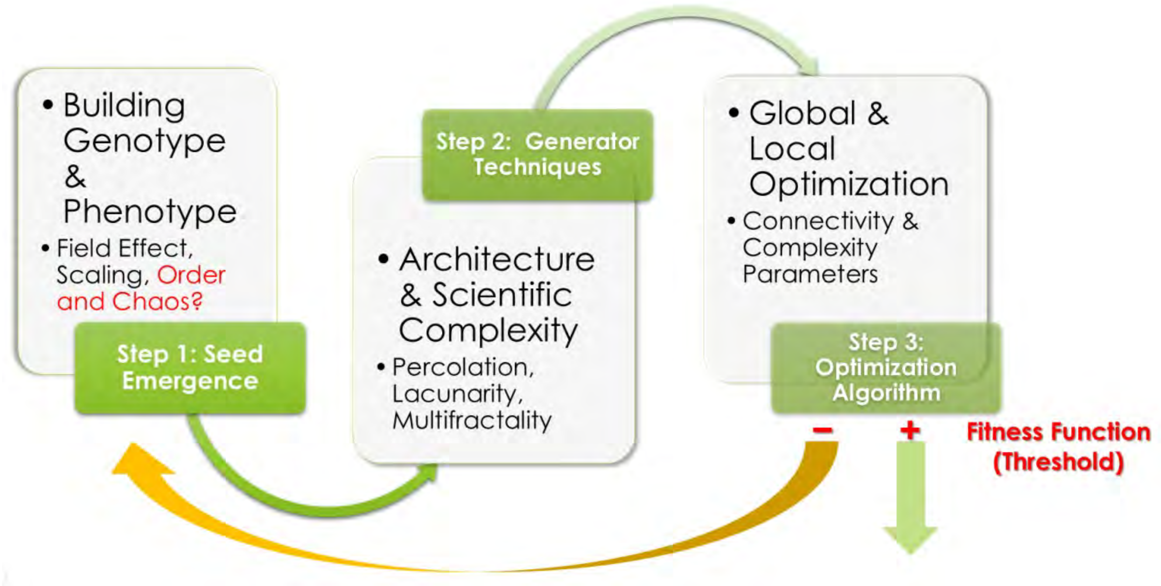

Figure 1: Developing an Efficient Algorithm for Evolving Fractal Architecture

The implemented methodology was applied to Cosenza city as a pilot project and involved two consecutive stages: Maps Generation and Designing Adaptive Dynamical Model.

2.1 Maps Generation

The city maps' were generated by "ELK" Technology combined with visual programming of Grasshopper as a plug-in to "Rhinoceros 5" software. Where data of Streets, Railways. Waterways, Buildings, and various facilities maps collected from OpenStreetMap.org and Shuttle Radar Topography Mission (SRTM) data from NASA/Jet Propulsion Laboratory, and were fed to the Mapping component OSM location to generate digital maps "baked" in Rhinoceros multilayers' (Figure 2).

Figure 2: Cosenza Digital Maps Generation’s

2.2 Designing Adaptive Dynamical Model (ADM)

An Adaptive Dynamical Model for Parametric design is written in Python and incorporated with Grasshopper as a plug-in to Rhinoceros 5. The significant motivation with ADM is to model the optimization of Building Genotype and Phenotype for seed emergence in complex adaptive system[8]. In this context a number of computational approaches (**Field Effect, Point Attractor and Power Law Scaling Models’**) to modelling morphogenesis are compiling to study an integration. These approaches collectively form the Multifractal geometry skeleton’s.

Developing a set of rules for building different genotypes of Architecture and Urban forms requires specifying precisely the relationship between the main systems that constitutes these forms genetic code. Hiller considered the question every theory must address is: What, if any, is the relationship between the two systems (Spatial and Functional)? [7]. Fractals mechanism which control this correlated relationship characterized by high Sensitive Adaptability through capacity of responsiveness to different environment situations and changes by mutating their structure, behavior and function through manipulating in their Genetic Code. Which interprets how Multifractal geometry emerged, where the last one utilizes various levels of Mono-fractal and Multi-fractal scaling for reconciling between the function needs and the architectural and urban forms.

This Multifractal geometry abilities’ of emerging **Self-Similar** structures is the secret behind achieving homogeneity at spatial and functional relations. Where scaling and self-similar configuration, create complex patterns lying in planes with different orientations in a multidimensional space and subject to the approach **Power Law Scaling** model [8]. Which is the most successful approach at achieving morphogenetic outcomes that are faithful to complex adaptive systems such as historical reality.

The surprising regularities in the way in which all city networks are constructed, covering both the geometry and configuration of spatial networks, and functional as well as spatial phenomena were emphasized by what Hacking [9] has called “created phenomena”. On the basis of these structures Hillier proposed a new universal definition of a city as a network of **linked centers** at all scales set into a background network of residential space [7]. Hillier showed that universal pattern comes from two interlinked but conceptually separable phases: a spatial process through which simple spatial laws govern the emergence of characteristically urban patterns of space from the aggregations of buildings; and a functional process through which equally simple spatio-functional laws govern the way in which aggregates of buildings become living cities.

Another Approach is Field Effect model's. The main functions of this model are: defining the local criteria for emerging the Multifractal geometry interlinked centers'; and distributing these centers coherently. Interlinked centers form a crucial condition for achieving universal distribution harmony's. According to Christopher Alexander theory of centers, Harmony seeking computation in terms the identity of each center scale become blue because (of achieving) the coherence is a field effect, so no longer possible to identify individual centers. In universal distribution emergence become a field effect. The model to watch out for is the fractal, since the fractal every little piece belongs to the larger whole, so it is not possible to take out any small piece form fractal because there are an emergence unity.

The local criteria which has responsibility for emerging Multifractal geometry interlinked centers' based on generic relation between spatial and function structures. This relation lies in two key new phenomena, explained by Hillier: the first called **Spatial Emergence:** the network of space that links the buildings together into a single system acquires emergent structure from the ways in which objects are placed and shaped within it. The second is **Spatial Agency:** the emergent spatial structure in itself has lawful effects on the functional patterns of the city by, in the first instance, shaping movement flows, and, through this, emergent land use patterns, since these in their nature either seek or avoid movement flows [7]. These two key new phenomena of spatial emergence and spatial agency forms together the self-organizing processes which grant the urban structure universal spatial form. Adopting the approach of Field effect model for emerging the Multifractal geometry interlinked centers' represents a realistic and practical model for applying the self-organizing processes. According to Jencks In the new sciences and architectures the fundamental idea relates to feedback, self-organizing change, "which the computer is well-adapted to portray [5].

Point Attractor model of Multifractal geometry morphogenesis is yet another approach. Since the whole simulation is a non-linear dynamic system, but the result should be static the crucial objective is to bring the system to a stable state. In the theory of dynamic systems this is called a point attractor in the phase space of the system [10]. Indeed all organisms appear to be organized by internal attractors. Where it's a truism for Jencks that all organism and Architecture must show some self-similarity and the influence of attractors.

One of the most leading example of utilizing point attractor model for geometry morphogenesis done by Goff with the Bavinger and Garvey Houses 1952, when Goff uses a strange attractor to organize a force-field of movement around and up a ramp. Bavinger plan (Figure 3) shows

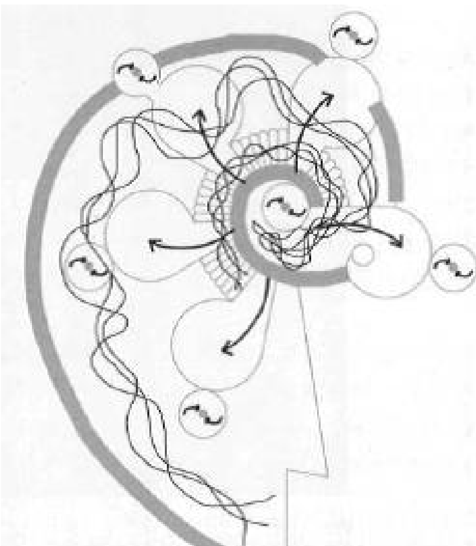

Figure 3: Bavinger Plan by Goff [5]

strange attractor of spiral movement. In the center it oscillates chaotically around the stairway and on the edges within limit cycles of walls. Five larger and six smaller point-attractors are suspended pods [5].

This example shows how much extent the Point Attractor combined with Power law models' plays a significant role for emerging what Jencks had called **Cosmogenic Architecture** made by fractal language, exactly at the edge between chaos and order, started with chaotic behavior by evolving the point attractor (attracts motion and visual direction) but it does so differently at each ascent and descent, thus ended with deterministic chaos behavior mixture. This fractal language could absorb such heterogeneous material from nature and culture is a lesson to all practicing architects, even that great bricoleur Frank Gehry [5].

– 3. Results

– Following the concept of Power Law, Field Effect and Point Attractor Models, the basic idea for the solution of the pilot project was to 1) generate the interlinked centres; 2) create a simulation that takes every center as an autonomous agent that tries to find its "optimum" place within a focal points set, competing with the other agents and governed by the **local criteria** mentioned above to evolve point attractor.

3.1 Generation the Interlinked Centers

The interlinked centers were generated by applying Python model integrated with visual programming of Grasshopper as a plug-in to "Rhinoceros 5" software. Where three consecutive Adaptive Algorithms had implemented: **1)** the first algorithm is responsible for spatial emergence to generate the network of space that links the buildings together, through select 2D grid with square cells (A) which is consistent with the city spatial structure, also have two input parameters (size of grid cells and number of grid cells in both directions X and Y), after choosing the project boundary (B) both (A and B) would be encoded as inputs into region intersection component, the result outlines of intersection A and B (Figure 4). This emergent spatial structure represent the first chromosome for population genesis.

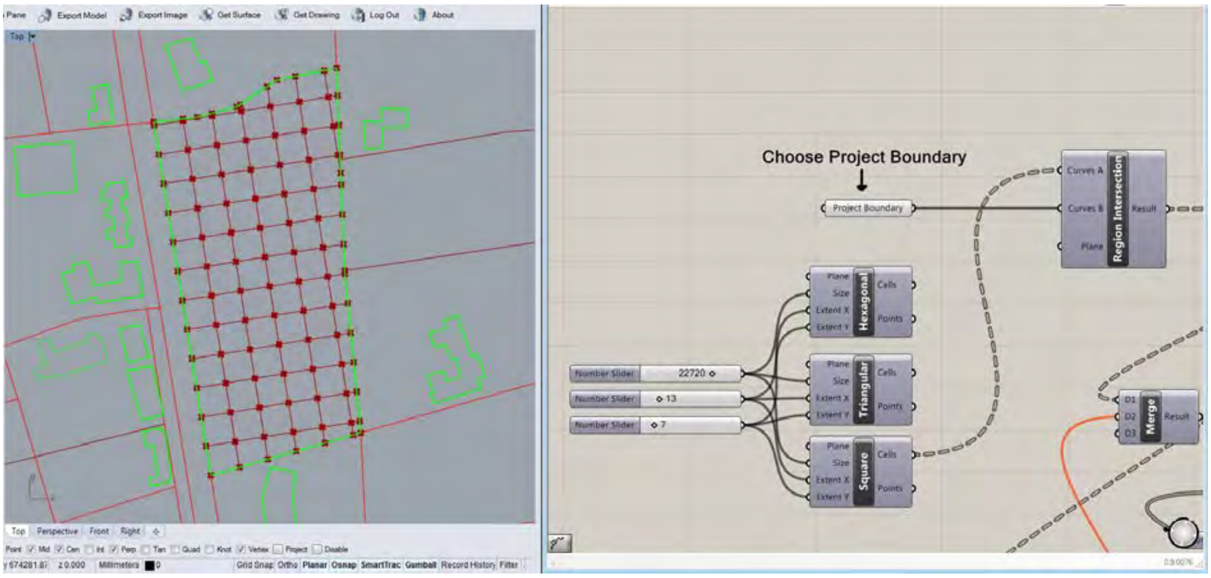

Figure 4: Spatial Emergence Algorithm of Cosenza Project

2) The second algorithm is responsible for spatial agency to stimulate all probable movement flows, through extending these flows resources (green color) by a specified distance (Input parameter: extension amount), which generate points intersection at Project boundary, then by python script component all intersection of movement flows will be taken and draws one line between every pair of points, this will generate 119 centers forms all possible “centers” caused by the movement flows intersections (Figure 5). The centers represents the second chromosome for population genesis.

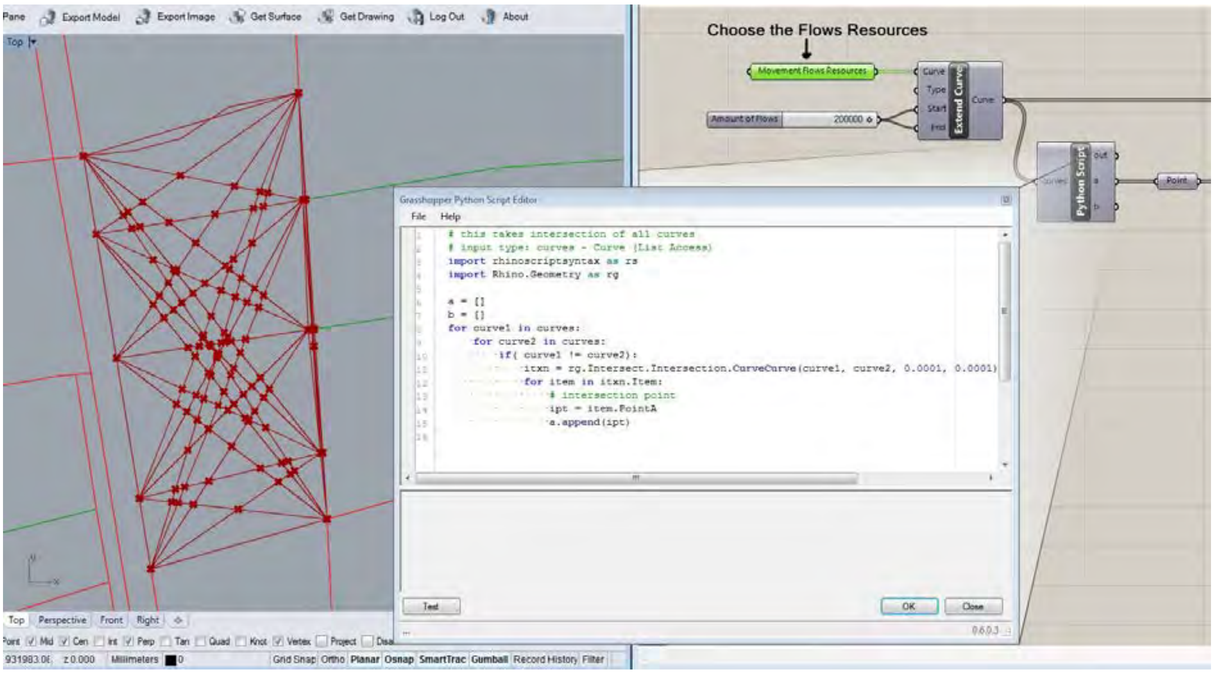

Figure 5: Spatial Agency Algorithm of Cosenza Project

3) The third algorithm is responsible for govern the way of distributing these centers on the spatial emerged structure coherently, by reconciling between the emergent spatial structure and generated centers, through select chaotic thee centers from the 119 then searching for the Closest Points **CP** (red color) of each center to the spatial structure intersections point’s and merging the CP into the field effect of this center, finally adapting (mutation) the spatial structure (cyan color) with the field effect center’s power (Field Effect power specified by dynamic input parameter) (Figure 6).

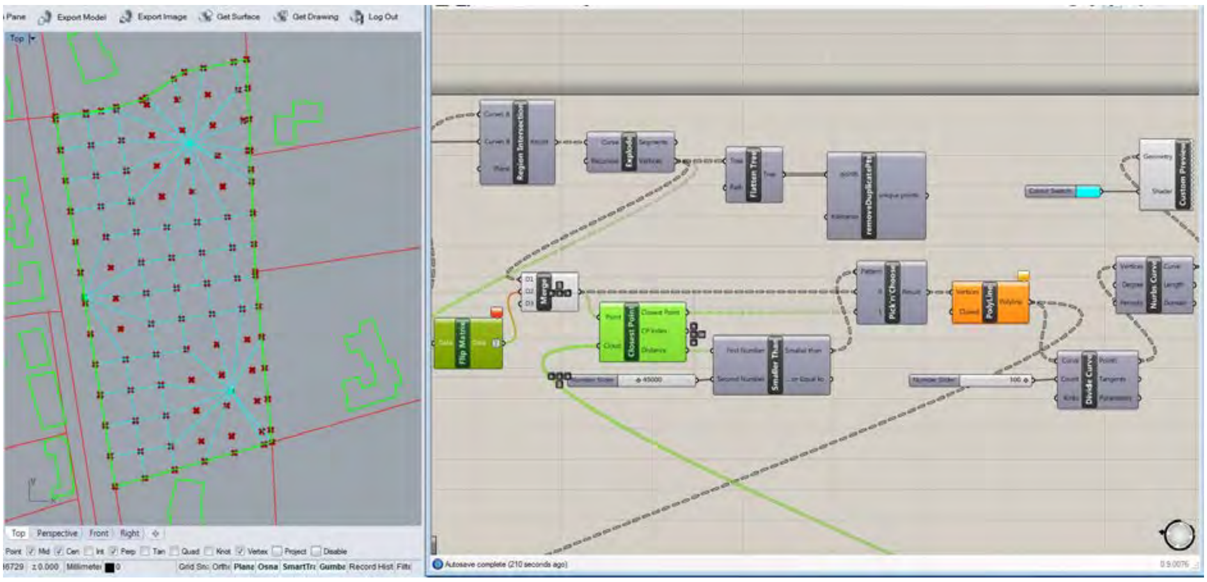

Figure 6: Field Effect Algorithm of Cosenza Project

For each three centers chaotic selections a new mutant spatial structure will be generated in self-organizing process. But for more than 350 interlinked centers scenarios, there is only one optimum solution achieving universal distribution harmony's. This algorithm represent the second step of the evolutionary process "Genesis" by merging two chromosomes to mate selection for creating the first population of solutions. These population will be differentiated in terms of achieving high level of bond percolation (urban structure continuity).

3.2 Creation the Interlinked Centers Simulation's and Optimization's

Looking for the optimum solution of interlinked centers were done by "Shortest walk" Technology combined with visual programming of Grasshopper as a plug-in to "Rhinoceros 5 software. The shortest walk technology is based on a topology calculator and the A* search(9) algorithm [11]. The simulation takes every center as an autonomous agent that tries to find its optimum (in terms of its proximity to the next center, where the closest achieves faster percolation) place within interlinked centers (focal points set), competing with the other agents. Where every agent of the interlinked centers encoded into the shortest walk component, and for each scenario the shortest polyline (yellow color) was generated (Figure 7).

This competition between centers governed by the **local criteria** mentioned above (to evolve point attractor) and governed also by the fitness function (**global criteria**) for the objective Multifractal geometry, in this sense an Evolutionary Multi-criteria Optimization (EMO) will be performed (at the third phase of the research approach) to achieve more than one objective in parallel.

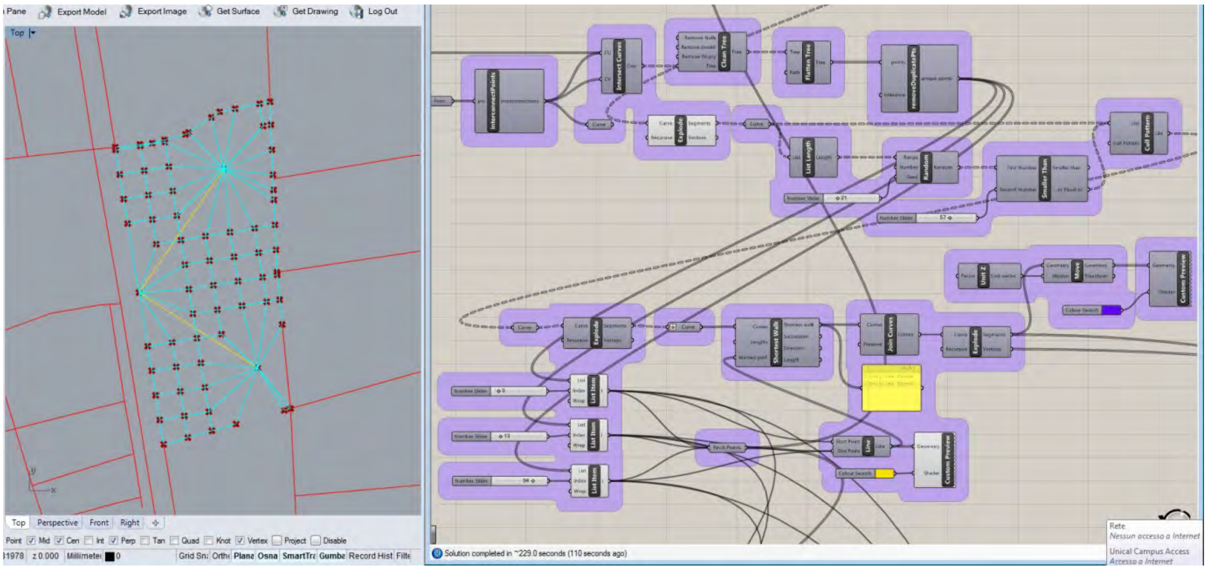

Figure 7: Shortest Walk Algorithm of Cosenza Project

But this yellow polyline does not fit with the mutant spatial structure (erected by algorithm 3) therefore a new algorithm of Filed line was applied to compute the field line through selected centers and to enforce the shortest polyline of respecting the mutant spatial structure shape's. Generating the field line requires utilize merge field component to merge all the fields created due to a centers (as attractors or repeller) charge (Figure 8). Where an attractor or repeller is defined as a point in 3D space. Around this point movement is warped to force the movement closer to the attractor or farther from the repeller. The amount of warping depends on distance from the attractor or repeller and the force of the attractor or repeller. This force is parameterized for the user to set. Attractors and repellers significantly alter the generated fields from its specification in axiom and production rule terms [12].

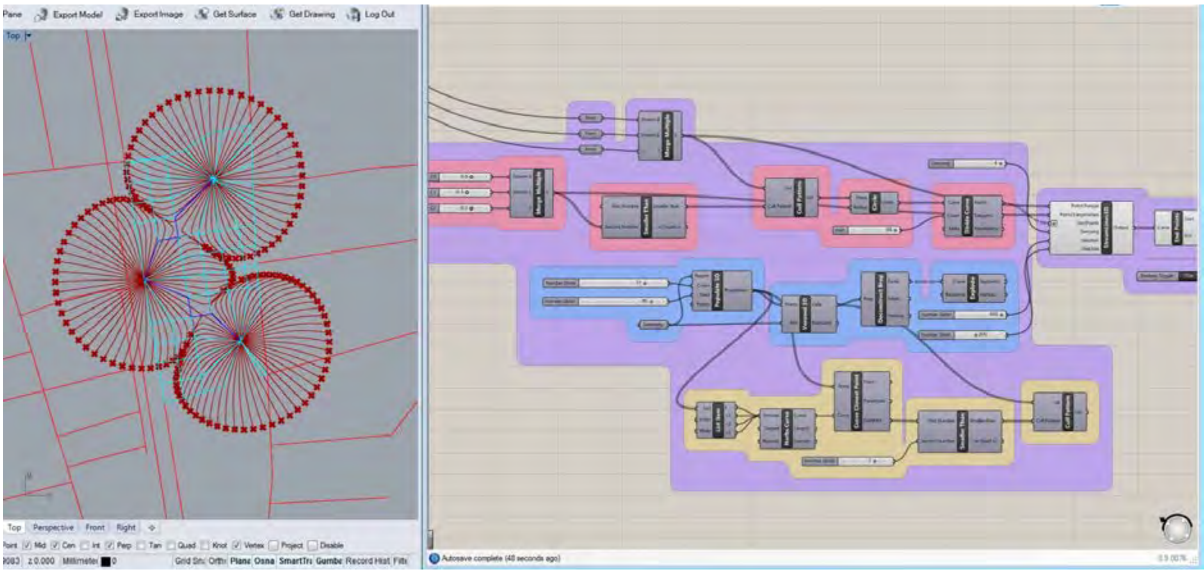

Figure 8: Filed Line and Attractors Algorithms' of Cosenza Project

The new generated shortest line (Blue color) represents the generator polyline that will be subject to the approach **Power Law Scaling** model for Multifractal geometry morphogenesis. Optimizing this polyline will be investigated in the third phase of the research approach considering local and global criteria as Stopping Criterion.

4. Discussion

– Before discussing the core questions of the research, it's really worth to emphasize the crucial inherited instructions of the new generated shortest line. These instructions were derived from spatial emergence and spatial agency processes. Therefore constituting together self-organizing process for building different genotypes and phenotypes of Architecture and urban forms. The second phase of the research methodology is credited to transfer the self-organizing processes form theoretical to the implementation realm by applying multiple correlated algorithms.

Where consecutive Adaptive Algorithms (Spatial, Emergence, Spatial Agency, Field Effect, Shortest walk, *Filed Line and Attractors*) generated and optimized the Interlinked Centers, that gives living Organisms (cities) the capacity to reconcile between their functional needs and their form through adopting and adapting with different environmental conditions (Local and Global Criteria's') by Manipulating their genetic code for mutating their genotype and phenotype.
Living Organisms (cities) are using specific rules for evolution or mutation, due to the fact that all organisms appear to be organized by internal attractors. Therefore all Organism and Architecture must show some self-similarity and subject to the influence of Point attractor model, because it brings the system to a stable state, thus living organism which started their evolutionary chaotically ended with deterministic chaos behavior mixture.
The secrets/learned lessons that urban morphogenesis and Architecture typologies should be aware of: approaching **Power Law Scaling** model is the most successful approach at achieving morphogenetic outcomes that are faithful to complex adaptive systems such as historical reality. Particularly when accompanied with fractal language, which could absorb such heterogeneous material from nature and culture.

– 5. Conclusion

– Applying the new computational urban generative approach on Cosenza pilot project has proven that is a valuable method for creating and optimising genotype and phenotype of Multifractal geometries within the architectural process. Where developing an Adaptive Dynamic Models (**ADM**) for Parametric Design based on number of artificial intelligence computational approaches' (Field Effect, Point Attractor and Power Law Scaling Models') played a crucial role in discover and model an infinity Multifractal geometries, then optimize it, to correspondence with the local and global criteria's' of a complex adaptive system such as historical cities.

–

– This ADM represents a tipping point in computational and parametric Architecture design, towards achieving practical application and unifying the scientific complexity with Architecture approaches' for addressing the problematic and creating a new epistemological framework of urban morphogenesis. The powerful emergence ability of this creative model derived from the critical role of Multifractal self-organizing process in achieving harmony, coherence and homogeneity in the historical context.

Verification of research hypotheses and responding the core questions verified due to adopting creative architecture and urban concept depending on convergence between Scientific Complexity approach and Artificial Intelligence on one hand, with Complexity approach of Architecture and Urban Morphology, on the other hand. This interrelationship between various approaches presented the crucial motive for renaissance and progress of various scientific fields, it is the time for post-modern architecture to follow suit.

Notes

1- Fractal analysis is a contemporary method of applying non-traditional mathematics to patterns that defy understanding with traditional Euclidean concepts. In essence, it measures complexity using the fractal dimension [13].

2- The genotype of the Building is the inherited instructions (derived from functional and spatial relations) it carries within its genetic code. Not all buildings with the same genotype look or behave the same way because morphology/typology and behavior are modified by environmental and developmental conditions. Likewise not all the buildings that look alike necessarily have the same genotype.

3- A building phenotype (from Greek *phainein*, meaning "to show", and *typos*, meaning "type") is the composite of building observable characteristics, such as its morphology, development, physical properties, behavior, and products of behavior. A phenotype results from the expression of a building's genes as well as the influence of environmental factors and the interactions between the two. When two or more clearly different phenotypes exist in the same urban context, the urban is called polymorph.

4- This paper represent an interdisciplinary collaborative work, done as a part of PhD research in the University of Calabria. The research chooses six cities (London, Paris, Rome, Milan, Aleppo and Cosenza) which represent diverse patterns in terms of their morphological urban networks and structures.

5- Grasshopper is a graphical algorithm editor that is integrated with Rhino3D's modelling tools. Grasshopper's visual "plug-and-play" style gives designers the ability to combine creative problem solving with novel rule systems through the use of a fluid graphical interface [14].

6- Rhinoceros 5 is a commercial 3D computer graphics and computer-aided design (CAD) application software. Rhino geometry is based on the NURBS mathematical model, which focuses on producing mathematically precise representation of curves and freeform surfaces in computer graphics [15].

7- Final results of the research first phase's had been published and presented in the "European Conference on Artificial life, ECAL 2015", York, UK, https://www.cs.york.ac.uk/nature/ecal2015/paper-158.html

8- According to Gershenson (2008) A complex system is one in which elements interact and affect each other so that it is difficult to separate the behaviour of individual elements [16].

9- "A star" is a computer algorithm that is widely used in pathfinding and graph traversal, the process of plotting an efficiently traversable path between multiple points, called nodes.

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Andrea Wollensak
Judith Goldman
Bridget Baird

Ice Core Modulations: Performative Digital Poetics

Artwork/Paper

Andrea Wollensak
Connecticut College
Professor of Art, Director of Ammerman Center for Arts & Technology
www.conncoll.edu

Judith Goldman
Assistant Professor of English, University of Buffalo, NY
judithgo@buffalo.edu

Bridget Baird
Connecticut College
Professor Emeritus,
CS and Math
cs.conncoll.edu/baird

Topic:* *Interactive Digital Poetics, Data Visualization

Authors:

Abstract:

Antarctic ice core samples embody a rich historical timeline of climate change. Going back as far as 800,000 years, the cores reveal that Antarctic glaciers have trapped the ancient atmosphere in layers of gas bubbles as dateable and distinct as tree rings.

In this inter-disciplinary collaboration, a visual artist, a poet, and a computer scientist collectively develop generative and affective processes that explore and creatively interpret the climate data derived from ice cores, resulting in a performance-based interactive environment.

The work has two main visual-graphic elements, both developed in the Processing visualization language. The first features representations of CO_2 bubbles present in the ice core, using atmospheric data of changing CO_2 levels through geological time as a driver for the behavior and appearance of the bubbles. The second makes use of various representations of ice cracking and additional features present in the ice core data.

The language of the poetry in this work is culled from research into the material processes through which ice archives the atmosphere and through which, because of global warming, it can become vulnerable to deformation and cracking. This poetry component is both visual and sonic. As the poet performs (reads aloud) the glacier-research poem, textual fragments appear and visually interact within the landscape of evolving and dissolving gaseous and crystalline forms. This on-screen generation of phrases is also driven by ice core data, as is the real-time audio processing of voice, utilizing effects such as reverb and distortion. As the ice's CO_2 content increases, the processing of the poet's reading becomes more extreme.

Still image from "Ice Core Modulations"

Contact:

[***ajwol@conncoll.edu***](mailto:ajwol@conncoll.edu)

Keywords: Generative, Visualizing Data, Digital Poetics, Processing

Ice Core Modulations: Performative Digital Poetics

Prof. Andrea Wollensak, MFA

Professor of Art, Director, Ammerman Center for Arts & Technology,

Connecticut College, New London, USA

e-mail: ajwol@conncoll.edu

Prof. Judith Goldman, Ph.D.

Assistant Professor, Poetics Program, Department of English,

University of Buffalo, Buffalo, USA

e-mail: judithgo@buffalo.edu

Prof. Bridget Baird, Ph.D.

Professor Emeritus, Computer Science and Mathematics,

Connecticut College, New London, USA

e-mail: bbbai@conncoll.edu

Abstract

Antarctic ice core samples embody a rich historical timeline of climate change. Going back as far as 800,000 years, the cores reveal that Antarctic glaciers have trapped the ancient atmosphere in layers of gas bubbles as dateable and distinct as tree rings. Such is the point of departure for our inter-disciplinary collaboration, in which a visual artist, a poet, and a computer scientist have collectively developed generative and affective processes exploring and creatively interpreting ice core climate data, culminating in the development of a performance-based interactive environment.

Ice Core Modulations has several main visual-graphic elements, all developed in the Processing visualization language. One of the visual elements involves a representation of the CO_2 bubbles present in the ice core, using atmospheric data of changing CO_2 levels through geological time as a driver for the time-based behavior and appearance of the bubbles. Another element feature makes use of various representations of ice cracking present in the ice core data.

The language of the poetry in *Ice Core Modulations* is culled from research into the material processes through which ice archives the atmosphere and through which, because of global warming, it can become vulnerable to deformation and cracking. The poetry component led to the development of the poetic works *Gassigns* and *Fractography*, and includes both visual and sonic elements. As the poet performs, textual fragments appear and visually interact within the landscape of evolving and dissolving gaseous and crystalline forms. This on-screen generation of phrases is also driven by ice core data, as is the real-time audio processing of voice, utilizing effects such as reverb and distortion. As the ice's CO_2 content increases, the processing of the poet's reading becomes more extreme.

1. Background and Motivation

The authors have created independent and collaborative works about the Arctic and Antarctic over the past few years. *Ice Core Modulations* brings together similar interests in a new collaborative and interactive performance work inspired by data found in Antarctic ice core samples.

To begin with, we established a set of core guiding principles that would govern our investigation. These included:

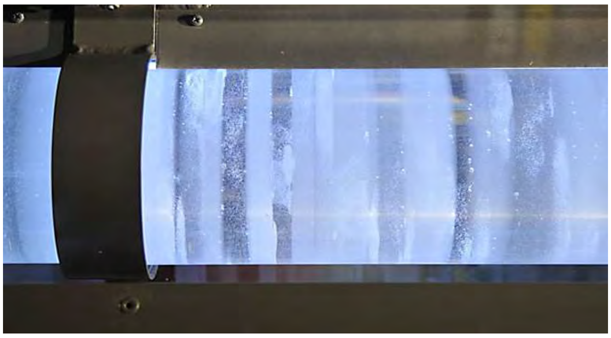
1. Exploring a number of different artistic disciplinary perspectives that would inform how we might visualize environmental data from Antarctic ice core data.
2. Integrating with and being contextually sensitive to poetic texts authored by collaborator Judith Goldman.
3. Supporting a live performance element for the poetic speaker leading to ways in which the spoken poetic text might influence the visual environment.
4. Developing agent-based models to support generative paradigms for the CO_2 ice core sample creative visualizations.
5. Having the performance progress through time in five sections, each with generative sonic and visual elements that reference the environmental changes.

– 2. Research

We decided to use data from the Carbon Dioxide Information Analysis Center (CDIAC) because their documents show a long timeline in ice core records from the last 800,000 years. The data came from Dome C at the Vostok site in the Antarctic and includes a fluctuation between 170 and 400 parts per million by volume (ppmv) that corresponds with conditions of glacial and interglacial periods. Higher volumes indicate glacial decline. "Atmospheric CO_2 levels have increased markedly in industrial times; measurements in 2010 at Cape Grim Tasmania and the South Pole both indicated values of 386 ppmv and are currently increasing at about 2 ppmv/year." [1]

We met with Dr. Mary Albert, Professor of Engineering at Dartmouth, and Executive Director, U.S. Ice Drilling Program last spring. Dr. Albert summarized that "Ice cores drilled in cold areas of the Greenland and Antarctic Ice Sheets provide high-resolution climate records that are essential for understanding abrupt climate change. The only remaining samples of the atmosphere from past centuries and millennia are contained in bubbles found deep in glacial ice. We are measuring the physical structure, transport properties, and microstructure from ice cores from Greenland and

Antarctica to better understand mechanisms of the trapping of gases in ice cores for improved understanding of abrupt climate changes in the past.” [2] Figures 1 and 2 show imagery of ice core samples and entrapped bubbles viewed close-up.



(figure 1, at left) Ice core close-up. American Museum of Natural History.

(figure 2, on right) Air bubbles in an ice core photo by Eric Wolff / BAS /EPICA

2.1 Poetry Research

The composition of *Gassigns*—a poem inspired by the physical archive of bubbles in the ice core—involved research on the make-up of the atmospheric record entrapped in Antarctic and Alpine glaciers as profiled by ice core sampling, as well as on how ambient gases are incorporated into glacial ice. Further research was done on the global carbon cycle as its dynamics change over geological epochs, especially in terms of its role in generating and terminating Ice Ages. The main materials used here focus on the distortion of the ice record as ice gets older and as it gets closer to warm bedrock (which melts and changes it); in other words, these articles address how cryologists account for these distortions and acknowledge the limitations of ice as data as they build a picture of atmospheric/climate phenomena over time. Such an approach contrasts strongly with the more simplistic framework found in the scientific literature itself but most especially in its representations of an ice core to the larger public as a “perfect archive” or “one-million-page book”.

The composition of *Fractography*—a poem on ice mechanics—involved research in glaciology, engineering, and chemistry/physics literatures on ice as both a brittle and ductile material, with an eye to the massive ablation of ice as ice shelves calve and sea ice melts, due to global warming. Here the focus was in part on the competition and transition between creep and fracture processes in ice (whether ice acts as a liquid or solid), as well as on the initiation and arrest of crack propagation, the modes in and pressures/forces by which cracks crack, and the differing kinds of cracks that are formed. This poem further deals with the fracture of ice at micro and macro levels, taking into consideration how the former affects the latter—understanding a particular glacier’s patterns of recrystallization at the granular level can potentially give important information about very large-scale calving events.

2.2 Audio-Visual Research

The research to develop the audio-visual elements of *Ice Core Modulations* included the evaluation and development of means to process the spoken poetic text as well as the means to process ice-derived sounds. Experimentation was done with different modes of audio processing, utilizing filtering, reverb/delay, and time stretching in order to develop audio that suitably integrated with the spoken poetic text and generative visual elements. Ice sound sources included sounds of melting ice, and sounds recorded via hydrophone underwater microphones such as cracks occurring in frozen lakes. Experiments were also done with how visual text might be granulated and distorted to reflect the chronological elements.

3. Poetic Elements and Processes

The content and form of *Gassigns* and *Fractography* connect to *Ice Core Modulations* on many levels, including specific connections between the sonic and visual processes.

Most obviously, these poems are *non-lyric* poems, meaning they are made of language that does not represent human speech or (psychologized) interiority or subjectivity. A non-lyric poetic mode is fitting for our topic in that it decenters the intentional, humanist subject-as-I. Not only can the poems better reflect the (tragic) irony that the Anthropocene and contemporary climate change are human-authored phenomena not of human design, but they allow the characteristics of ice – its trapping of gases and its mechanics – to take center-stage. Though portrayed in language, ice is not framed from a human point of view; indeed, the poems attempt to approach geological time as well as the carbon cycle as *inhuman* time and to show that our knowledge of the cryosphere, the climate record, and climate change will to some extent always be incomplete and indefinite. Simply by dealing with such extreme landscapes and their phenomena, the poems refuse to pastoralize nature, yet they are also post-pastoral in the sense that they take into account the conditions of the Anthropocene, in which the human has thoroughly interpenetrated the natural, even at the antipodes, in ways largely beyond human control.

Further, the poems make use of very specific non-lyric language – that of highly specialized scientific discourses. They thus overcome normative disciplinary divisions, to stage an encounter between scientific terminology and knowledge and aesthetic practice, doing so through a poetic treatment of scientific texts. This treatment involves, in part, foregrounding the inhuman but nonetheless affecting materiality of their language. Through selection and recombination, the poems make the most of science's unlikely potential for rhythm and rhyme, drawing attention to scientific texts as a part of an apparatus of representation and mediation, while at the same time faithfully communicating the entities and processes they describe. This amplified, experiential presentation of scientific texts is meant to face the challenge of making scientific knowledge relatable and graspable to non-specialists and specialists alike.

Yet precisely in their use of scientific discourse, the poems seek to go (impossibly) beyond that discourse, to establish a relationship of radical mimesis with that language's referent, the natural world. In this sense, while the poems may describe the cryosphere, they attempt at the same time, through the verbal medium, to enact or perform it, alongside it, the human-driven, accelerated chaos of its current flows. In their proposed mimicry of ice worlds, the poems use language as a material to carry or transmit affect, such that their human audience might take on the affect of geophysical processes.

The formal attributes and thematic content of the poetry here have also been chosen in light of poems' status as a component in a larger generative artwork. These poems share with generative art a non-subjective mode of composition. Further, the attention to lively, suggestive scientific jargon as well as to the sonic and rhythmic patterns within the poems allows their phrases to be used as units, and thus to be broken down modularly and submitted to randomizing algorithmic and data-indexed processes of selection, as well as to dynamic visual treatment. Given the focus on climate change-related phenomena in the poem, both the text and vocal performance gain a great deal from audio and visual processing meant to degrade, distort, and blur this material. This larger project's narrative follows a trajectory of increasing densification and chaos as the piece unfolds, in accord with the rising CO2 levels found in the most recent ice in the ice cores. A further interactive, mimetic dimension among the media in the piece involves how the data drives the audio processing of voice, while the voice will also trigger changes in the visual environment. This feedback loop reflects a number of the global natural processes, for instance, how global warming increases CO_2 levels, while CO_2 levels increase warming.

3.1 Excerpt from *Fractography*

linear elastic fracture mechanics

balance in crack propagation

tensile fracture stress:

dislocation pile-up nucleates crack at grain boundary

interatomic bonding overcome by stresses at crack tip

crack grows in its own plane, progressed by stick-slip

direct crack path:

crack propagates in a self-similar manner

unstable (rapid) growth of a single flaw,

perpendicular to direction of maximum tension

opening, sliding, or tearing crack

crack as infinitely narrow hole

crack tip relative to crack body

cracks propagate to a free surface

thermal cracks from thermal shock

crack growth and crack arrest

long-wave cracks; catastrophic crack propagation

onset of unstable rapid cracking

driving energy drops: crack stops

inelastic zone at crack tip

softening active ahead of the crack

tensile microcracks in a compressive stress field

critical crack density

interaction of small feather fractures

weakened shear zone

local edge fractures (spalls)

ice edge shape evolves: result of local failure processes

edge geometry

contact forces redistributed:

spall has been expelled

tensile stresses separate crack faces;

compressive loading causes contact

grain boundaries are weak in shear

crack tries to slide or shear along the crack length

opening-mode cracks curve: free ends contact

sliding parent crack: plates bend and break

radial bending cracks grow from center

ice plate decomposed into wedges

energy released dissipated

by creating crack surface: not plastic work

ice plate may fail by a conic crack under the load *or partial crack as a line spring in the crack line*

4. Visual/Sonic Elements and Generative Processes

The visual environment of *Ice Core Modulations* includes a continually modulating assemblage of generative forms and shifting colors as a backdrop from which foreground oval-shaped forms emerge and move outwards, towards the viewer and out of the visual field. The oval forms represent and are meant to connote the CO_2 bubbles as they are liberated from the ice, becoming data as well as historical narrative. Excerpts from the two poems continually appear and are juxtaposed with the oval forms. The poetic fragments exhibit two principal behaviors, either forming in the back of the visual environment and moving out towards and past the viewer, or emerging from abstract granular noise and coalescing into recognizable text phrases before fading away. The poetic visual gestures make use of randomness and ice core data to govern when they appear and how they move.

The primary driver for the time-based behavior and appearance of the oval forms is the changing CO_2 levels over the vast span of geological time. Notably, much of the CO_2 data does not vary greatly until quite recently. In *Ice Core Modulations* these changes start to happen in section 2. The CO_2 data has a huge upswing in the quantity of gas recorded in recent time (1865-2015), which ultimately results in the chaos and density exhibited in the final, fifth section of the work. The overall timeline serves as the background for the reading and recorded processed poetry. The overall expression of the performance comes through the visual densifications, the poetry, and the volume and dense layering of audio and increase of visual forms.

The sonic component of the environment includes both recorded vocal and environmental sounds as well as live spoken poetry. The recorded environmental sounds (*e.g.,* melting ice, cracks occurring in frozen lakes) were processed using compression, granular synthesis, reverberation and low pass resonant filters. Recorded vocal elements are generatively processed in real-time through layering, reverberation and echoing. Live spoken poetry is highlighted in the sonic environment through real-time interaction (affecting sonic/visual elements) and eventually creating its own modes of distortion.

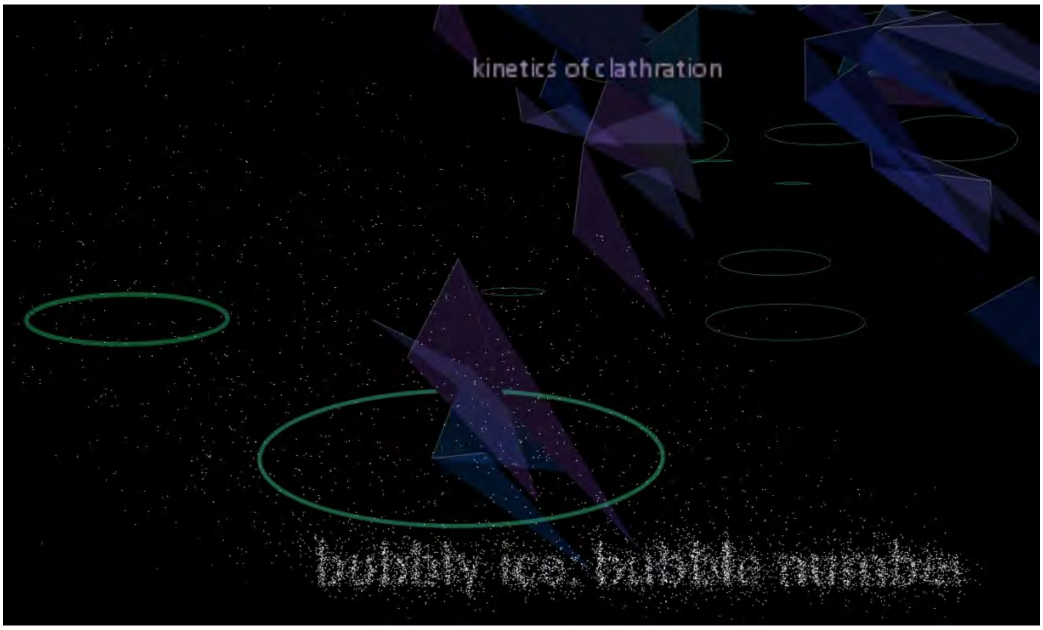
Generative elements govern the entire piece. Although operating under an algorithmic structure and timeline, randomness occurs in most of the visual and sonic elements including the shape and motion of blue ice, the location and appearance of CO_2 bubbles, the order, size, movement and distortion of poetic phrases in the visual field, the audio processing of both live and recorded audio (*e.g.,* readings from poems), and the chaotic culmination of the work.

– 5. Performative Scenes/Sections

The whole performance, as interactive poetry reading, is divided into five sections, each of which suggests a segment of CO_2 data in a linear timeline, beginning with early data and ending with current data. All five sections narrate the increase in CO_2 levels, conveyed, for instance, in the visual field, through color and density. In the following text, each of the sections is briefly introduced.

Section one is an introduction to the ‘characters’ in the work. Overall, this section has a low density of forms and sounds. Blue ice forms appear small with minimal CO_2 oval forms. The processed environmental sounds eventually fade out as generative spoken text and visual text become the figure.

In the longer section two, the *Gassigns* poem is read. Generative CO_2 forms and blue ice forms appear and move faster within the space. Phrases from the poem appear visually in generatively processed typographic form. Typographic visual phrases also appear in granulated, generatively processed form (figure 3). Environmental audio and audio segments of poem are also generatively processed, providing sonic layering.



(figure 3) Section two environment with ice cracking,

CO_2 oval forms, and granulated poetic phrases.

In the short section three, which is similar to section one, CO_2 forms continue to move at a faster pace, with increase of blue/green ice forms. Environmental sounds are heard and overall the feeling of movement and density increases.

In section four, parts of the poem *Fractography* are read with live processing, CO_2 forms appear in different sizes and move faster, while the colors of the ice forms shift to the warmer spectrum. Sonic components of processed environmental sounds and recorded processed voice are no longer linked to visuals.

In the last section, CO_2 forms are dense, ice forms are moving faster and are light and warm in color. Multiple tracks of recorded and heavily processed phrases of *Fractography* are re-introduced, with higher volume environmental tracks and live reading of rhetorical address. The pace and chaos of this section greatly increases as the piece culminates and ends.

7. Summary and Future Directions

Ice Core Modulations arose from a set of guiding principles, noted in the Introduction, that involve connections between the narratives of environmental change encoded in ice core CO_2 data and audio-visual, sonic and poetic elements inspired by the data. The collaborative intent of *Ice Core Modulations* project was to allow for interdisciplinary synergy between a creative team spanning poetry, computer science, and visual art, expanding the technological and creative means by which the CO_2 data could be conveyed and expressed. This first iteration of the project served as a valuable test-bed for our concepts and techniques and has helped us determine future research and conceptual directions. The collaboration is in its early stages, and next steps include travelling to Greenland next summer to collect audio and visual recordings to incorporate into this work. We also plan to submit a proposal to the National Science Foundation Antarctic Artists and Writers Program in 2016.

Notes

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Anna M. Chupa
Michael A. Chupa

Juxtaposes: Visual Granular Synthesis, Vernacular Architecture, and Girih Tilings
Paper + Installation

Topic: Art

Authors:
Anna M. Chupa
Assoc. Professor, Dept. of Art, Architecture, and Design
Lehigh University
Bethlehem, PA
USA
www.lehigh.edu/~anc304/tiling

Michael A. Chupa
chupa@acm.org

Abstract:

For GA2014, we produced *Wearables* using textile designs based on Islamic girih tilings constructed with bilateral symmetries using a subdivision rule to render self-similar designs. For GA2015, this textile-based work has found another avenue of expression in *Juxtaposes*, blending visual samplings of neighbourhood vernacular architectural deposits and two-dimensional Girih tilings. Using a process similar to granular synthesis in the audio realm, architectural ornamentation is sampled and reconfigured at varying spatial scales and orientations to create visually ambiguous compositions representing a neighborhood's essence. These architectural elements are blended with biomorphic structures found in the neighbourhood to produce texture mappings for Girih tilings placed alongside the more familiar forms from the built environment.

anna.chupa@lehigh.edu

Keywords: Girih, tiling, vernacular

Juxtaposes: Visual Granular Synthesis, Vernacular Architecture, and Girih Tilings

Anna M. Chupa
anna.chupa@lehigh.edu
Department of Art, Architecture and Design
Lehigh University
Bethlehem, Pennsylvania USA

Michael A. Chupa
chupa@acm.org

Pieces, Petals, Leaves and Eaves is a collection of textiles designed from photographs of flowers, foliage and vernacular architecture in historical Pennsylvania neighborhoods, specifically Allentown, Bethlehem, Harrisburg and Philadelphia. The textile designs are digitally printed on cotton and silk fabrics for wall hangings. For *Juxtaposes*, we will discuss the cotton pieces. These are quilted using a longarm quilting machine with hand-guided techniques and are displayed as wall hangings. The images are constructed with three basic elements or juxtaposes:

1. A girih tiling background in which architecture and botanicals are sampled at various scales, where sampling equals naïve granular selection with the addition of edge/object detection, (see Figure 1, left)
2. Architectural elements selected out from photographic images based on object/subject features and composited into a new urban landscape, (see Figure 1 center), and
3. A transitional layer with opacity and alpha blending between the girih "sky" on top and architectural montage on the bottom. (see Figure 1, right)

Figure 1. Three image elements.

The word *girih* is an Arabic word for knot used by Peter J. Lu in his 2007 paper on Decagonal and Quasi-Crystalline Tilings in Medieval Islamic Architecture. [vii] The visual "grains" selected for each of the three image elements evoke granular synthesis in the audio domain [viii], especially the techniques for remixing grains in varied order and at various physical scales.

The girih tile set consists of five tiles (see Figure 2): a regular decagon, a regular pentagon, a rhombus, an elongated hexagon and a bowtie (concave hexagon). Typically, these tiles are flat-colored. Our tiles are filled with photographically based floral still life compositions juxtaposed with architectural fragments from Pennsylvania urban neighborhoods of Philadelphia, Harrisburg, Allentown and Bethlehem. The effect of applying photographic textures to the girih tiles is to break the several rotational and line symmetries possessed by flat-colored tiles. This symmetry-breaking exercise preserves some of the geometric symmetries, but removes others, injecting visual energy into the tiling composition.

Figure 2. Set of five girih tiles with image textures.

Vernacular architectural elements that make up the bottom montage portion of the composition come from the same neighborhoods. Most of the details are from rooftops and upper floors, hence the use of eaves in the title. The space created is fanciful but plausible where buildings and parts of buildings maintain their vertical orientation. There are scale discontinuities and reflections over a vertical axis but no rotations. Depth is compressed as in Byzantine mosaics and lighting is often arbitrary; that is, image and subimage selection and juxtaposition was performed without regard for synthesizing a realistic tableau with consistent light direction and intensity. During the compositing process edges are enhanced or hidden using alpha blending. There are distinct compositions for each neighborhood such that the characteristics of vernacular architecture in Bala Cynwyd and Mantua (see Figure 3) in Philadelphia are readily recognizable. Other neighborhoods that have been completed are West Park in Allentown, South Bethlehem in Bethlehem, and Belleview and Downtown in Harrisburg. Vernacular architecture of northeastern Pennsylvania largely dating from the early 20th century is emphasized.

> The architectural description “vernacular style” is often used to describe all non-architect designed buildings, or hybrids displaying bits and pieces of various styles. This term is used to describe workaday urban housing forms like row houses and duplexes and also utilitarian single family dwellings lacking any particular stylistic elements. …In truth, vernacular buildings include a wide array of structures across a long span of time. [[ix]]

Figure 3. Mantua (L) and Bala Cynwyd (R) compositions.

Of particular interest to us are details such as cornice mouldings, dentils, gingerbreading, grilles, distinctive brick work and other decorative motifs, the “bits and pieces” of a broad range of styles. To this we add garden photography gathered from the same neighborhoods.

The next part of the process is isolating details in Photoshop, rotating and flipping them to create complex tiling symmetries to fill a surface. The architectural detail is utilized twice, first stacked in a montage to create a landscape albeit with scale and lighting discrepancies, and second on the insides of tiles.

As the architectural montage at the base and the girih “sky” at the top of the composition seem unrelated visually, a transition is needed to tie them together. A gradient fade applied between the girih tiling and the architectural sampling layers provides a transition between fading girih tiles and apparent atmospheric perspective in the top of the architectural landscape.

Figure 4. Transition region with gradient fade.

Each image in this series distills the structure of background space or universe (the non-built elements of the neighborhoods under study) into a two-dimensional tiling that compresses space even further, and which provides an abstraction incorporating architectural and botanical elements at radically different scales. Operations on the girih themselves include free and restricted rotations and reflections. Scaling is achieved through two level designs whereby what is created at the smaller scale repeats on a larger scale that extends past the frame. Image-based operations within each girih include retouching, color-balance and luminosity changes, and alpha operations for blending, overlapping and drop-shadows.

Quilted borders are generated from collected leaves. The gingko is one of the most ancient species still extant. The pebble fill is a common quilting filler. Given the absence of negative space in the main composition, a suitable border needed to have detail without competing with the composition.

Figure 5. Ginko leaf and "pebbles" border

In order to achieve this result, the thread color matches the border color, which was also selected from one of the fragments of architecture in the girih tiles. (See Figure 5) The border has both trapunto effects and dense surface pebbling. All of the image borders will have leaves collected from the Northeastern Pennsylvania region.

While each of the images incorporates grain selection and sampling to produce each of the three image elements, our naïve granular selection actually begins with location-based photographic image collection. Objects and parts of objects are selected with the camera by the photographer. The camera is not used to frame a finished composition; it is only used to collect objects. This habit of selecting on the basis of aesthetic choice is uniquely human, so much so, that Ellen Dissanayake labels our species Homo Aestheticus. [x] There are records of prehistoric collections of objects that have no other purpose other than their apparent beauty, shells, colored stones much the same as we collect shells at a beach. This selection process happens in camera with the flowers, leaves, and pieces of architecture to be used in montage. The aesthetic recognition and selection of distinctive properties is not a chance procedure. The single flower in the camera frame is the first grain in the visual granular synthesis of work produced here.

Acknowledgements

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CUI JIA

Design Transformations Represented by Shape Grammars for Conceptual Generative Design

(Paper and Installation)

Topic: (Computer-aided Design)

Authors:
CUI JIA
Shandong Normal University, School of Information Science & Engineering
China
http://www.sdnu.edu.cn/
TANG MING Xi
The Hong Kong Polytechnic University,
School of Design
Hong Kong
http://www.sd.polyu.edu.hk/en/
WANG JI HUA
Shandong Normal University, School of Information Science & Engineering
China

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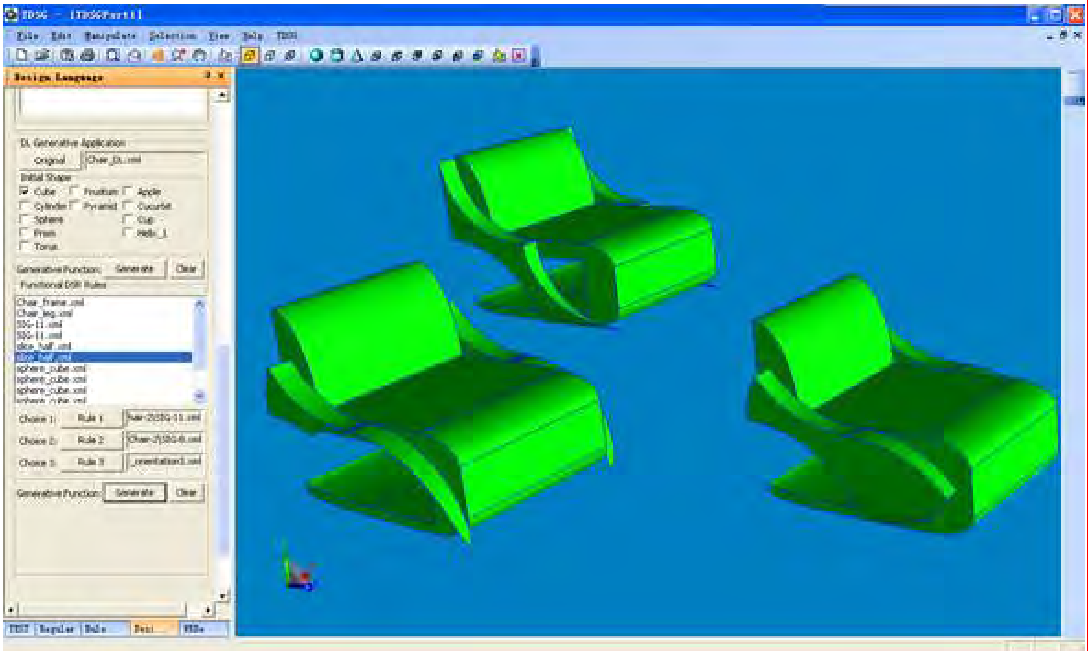
Abstract:

Design solutions are specific decisions made by designers among various potential choices which are parallel in huge design space including shape, colour, material, spatial structure and functions etc. Design transformations are tools to evolve design towards to the desired status in whole design process. The generative mechanism can be considered as the tool for managing dynamic processes of transformation by evolving design ideas along logic way from existed to unknown possible in future.

In this paper, we use the procedural modelling approach—shape grammars to represent dynamic design transformations in terms of design rules for conceptual design. In this way, design rules including transforming information can be used in different design situation for generative exploration, which is different from the traditional application of shape rules. The geometric addiction of rule application can be released. Design languages in shape grammars, similar to the design process in real design work, is a special operational sequence to generate design alternatives. They support the multiple-reading properties even for the same design object; as a result, more creative alternatives can be explored by generative approach subsequently. As a preliminary prototype, the selected furniture design is chosen as examples to testify the feasibility.

A computer installation will be presented in GA2015.



Snapshot of DSG Interpreter

Contact: email
cuijia1247@163.com

Keywords: Shape grammars, Generative design, Shape rules, Design transformation

Design Transformations Represented by Shape Grammars for Conceptual Generative Design

CUI JIA

School of Information Science & Engineering, Shandong Normal University, China

Centre for Visual Computing and Translational Informatics, China

TANG MING-XI

School of Design, the Hong Kong Polytechnic University, Hong Kong

WANG JI-HUA

School of Information Science & Engineering, Shandong Normal University, China

Design solutions are specific decisions made by designers among various potential choices which are parallel in huge design space including shape, colour, material, spatial structure and functions etc. Design transformations are tools to evolve design towards to the desired status in whole design process. The generative mechanism can be considered as the tool for managing dynamic processes of transformation by evolving design ideas along logic way from existed to unknown possible in future.

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1. Design representation

People (and different designers) have different impressions when they evaluate same design products. In other words, multiple readings in design, especially in visual design, play an important role in the conceptual creative phase [1]. Aesthetic diversity provides designers opportunities to conceive different interpretations of design representations.

This diversity will cause problems for shape representation in CAD systems which require uniqueness. Design solutions are usually represented by a decomposition process in which a product is presented in terms of geometric and topological variables (the parametric design method). From another perspective, when a designer is dealing with a specific task, s/he draws experience from more than one domain [2]. For example, a fashion designer may find inspirations from his/her past experiences of building design projects or furniture design projects. The design knowledge heritage and experience accumulation may not be derived from the same domain as that of the current working project. Correspondingly, design representation should be comprehensive and complex so as to capture the design knowledge and imagination from different domains.

2. Design exploration

Design exploration is used to find optimal and satisfactory design alternatives in design spaces. AI strategies, i.e. generative system, are widely used in this area. Design knowledge is central to design exploration, whether automatic or manual. Knowledge-based engineering (KBE) is at the core place of diverse fundamental disciplines, such as AI, CAD and CP (computer programming), which perfectly match the broad and heterogeneous fields of design [3] including psychology, philosophy, engineering, business management and fine arts. Design knowledge capture is directly related to the quality of the design exploration.

Predefined knowledge is widely used in CAD research in forms of variables, formulations and symbolic strings. Knowledge is extracted from design sources before design exploration starts. The major design information is predefined, typically following a sequence; however, designers might not do this? In practice, they do not commence with an analysis of important aspects of given design problem, and then synthesize the solutions based on this analysis, and finally choose the structural way to represent the solution [4]. Designers do not go through the entire process in a clear cycle. Instead they simultaneously process many channels of information.

Rules and frames are the two most common forms of knowledge representation [5, 6]. To support flexible smart design exploration, rules and frames should be created and applied to the design process. This means that design knowledge should be collected during the design process, not in advance. Other information, besides geometric and topological information, should be recorded. For modelling natural design actions, knowledge acquisition and applications are best when combined. Better system-user communication in design exploration is required so as to initiate more powerful computer support.

3. Dynamic design shape representation

Based on our previous work[7, 8], design transformations are used to represent design actions in terms of design rules. In this way, the dynamic shape representation can represent design shapes on both static way (geometric and topology) and dynamic way (design procedures).

Component technology reduces computational difficulties for complex shape representation. Through decomposition, shapes can be represented by some low-level elements, even decreasing the dimensional property from 3D to 0D (points) [9]. For the consideration of less limitation on shape creation, we decided to employ component technology in the new our representation. The primitives (cube and sphere) are atoms to represent a DSR (dynamic shape representation, DSR) shape. For better capturing design transformation, the DSR shape uses a series of basic shape transforms, named Elemental Rules (ER), to represent fundamental design actions. Therefore, in a DSR shape, the components are not based on the primitives, but the sequential application of ERs. The ERs are only used to construct a shape using permitted primitives. Therefore, the ERs are at a mid-level between the shape representation and solid primitives. There are 9 ER families (Fig 1), 70 different single ERs for shape construction. Although it is still not enough to satisfy all shape generations, the 9 ER families can support many different shapes including free-solid forms. All the ERs are not only used as rules to transform design, but also the approach to change design objects.

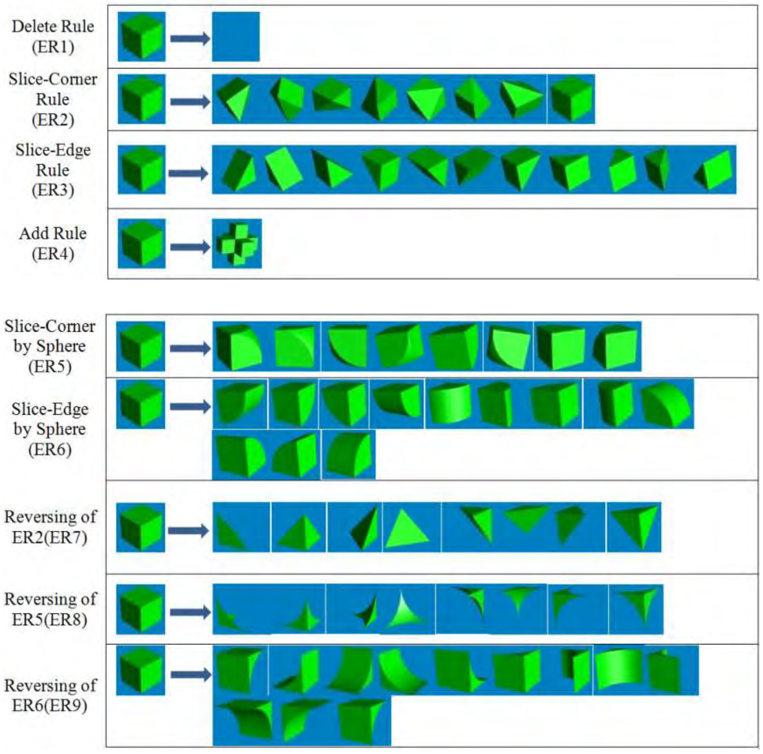


Figure 1. Elemental Rule Families

Definition: DSR shape. DSR shape is a finite set of primitives, which are manipulated through a family of Elemental Rules in a specific order. A DSR shape can be formally represented by the primitive set and the family of ERs following the operational sequence, {S*|ER (i1), ER (i2), … , ER (in)}.

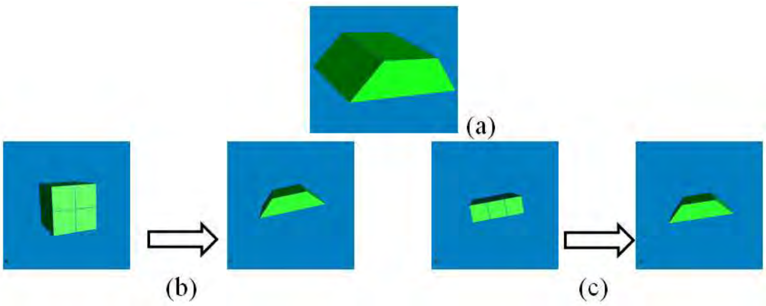
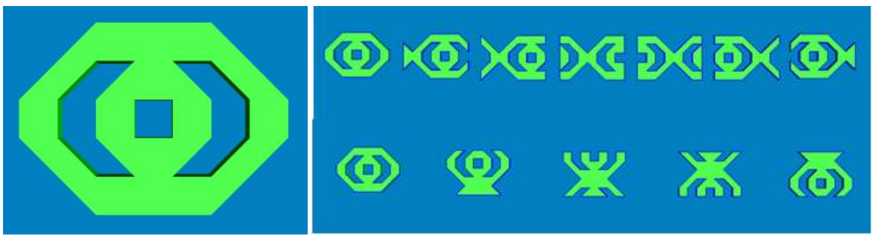


Figure 2. Multi-representation of DSR shape

There are two benefits to use the DSR shape. One is the multi-representation for one same shape. In Fig 2.a is a rhombus shape. The different generating process can be represented by DSR shapes, such as Fig 2.b and Fig 2.c. In Fig 2.b, for example, the formal DSR shape representation is {S1 | ER(3), ER(3), ER(3), ER(3), ER(3), ER(1), ER(1)}. The Fig 2.c can be formally represented as {S2 | ER(3), ER(3), ER(3), ER(3), ER(3)}. The two DSR shapes are the same from their final status (a rhombus shape). However, the way of generating is different. Another benefit is the convenient generative transform from existed one to new ones. In Fig 3, the same shape (a) can be easily transformed to different shapes (Fig 3.b) by changing the position of every primitive.



(a) (b)

Figure 3. Generative transform of DSR shape

The shape representation for conceptual design creation needs to satisfy two requirements: shape ambiguity [9] and shape emergency [10]. The former one represents the multi-reading of design. Different designers have different feelings when they a design. Therefore, the design representation should have enough flexibility to describe the same design. The example shown in Fig 2 proves the shape ambiguity on the DSR shape. The Fig 3 shows the changeable ability on shape representation. One single shape does not mean too much for design ideation. The changeable shape can inspire designers at conceptual design stage. When a DSR shape is generated, various new shape generations show the shape emergent features of DSR shapes.

4. Rule-based 3D shape generation system

The DSR shape interpreter is a general three dimensional CAD system. It is designed as a modular structure for better functional extension and maintenance. There are seven main modular which concentrate on different functional aims: UI commander, Design actioner, Interpreter, Shape Engine, ER Pool, Shape Modeller and Data centre shown in Fig 4.

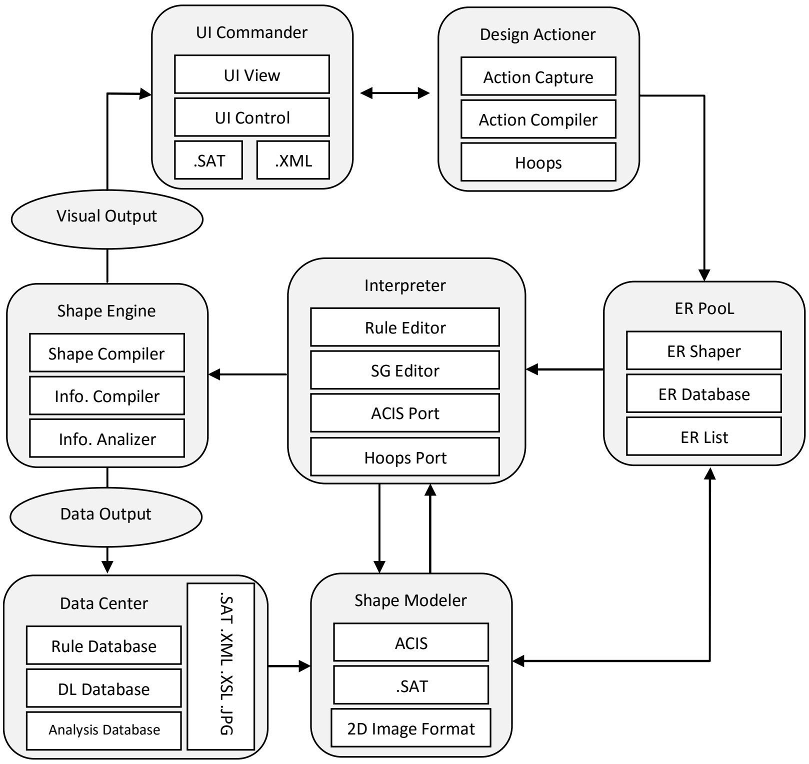


Figure 4. Modular structure

There are three control panels in the DSR shape interpreter, the DSR rule creation panel, the design generation panel and the design language panel. The system works in 3D environment. All generations are 3D entities, which support the directly visual response to designers. The interface is shown in Fig 5. There is a three-dimensional orientation arrow to indicate the current working 3D view at the lower left hand side of the screen. In the working environment, there is a tool bar at the top of the window. These tool functions may help users to adjust the 3D views and drag, move the entities and zoom in/zoom out the objects. At the left down corner, there is a ‘switch tab’ which is used to switch the three control panels.

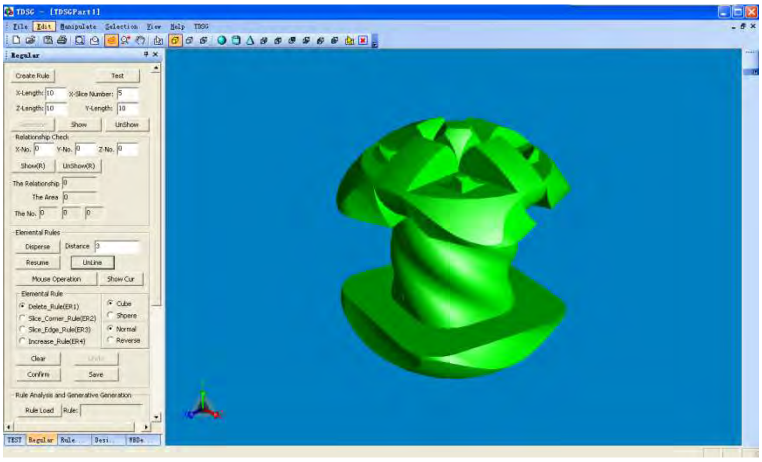


Figure 5. Snapshot of Interface

The DSR rule creation panel takes charge of the DSR rule generation by the ERs. Through mouse movements, the 9 ER families can be used to model the initial union of primitives to the desired form. The ‘Un-do’ operation is supported. During DSR rule creation process, when the final shape is finished, the ‘Confirm’ button will be used to add the finish mark in the DSR shape, and the ‘Save’ button will be used to call a new window to save the object to specified place in hard-disk.

The Design generation panel is used to create design solutions by the rule based system. There are three kinds of rules working in this panel, the layout rule, functional rule and auxiliary rule, which will be illustrated in next chapter. There is a DSR rule database. Users can choose their designed DSR rules to work in their design process. Through ‘update’ button, user can see the newest DSR rules in the rule database.

For the panel of design language, there are two parts of functions. The first one is the language reading function, which is used to read the existed design language and re-generate the whole process. The manually step-by-step way and automatically one-time way are supported for design demonstration. Another is the generative application function of design language, which is used to read the selected design language, and re-create more novel solutions for design exploration.

Parameter modelling technology becomes prevailing in current academic areas because of its computing compatibilities. In design, designers, even the new generation, still cannot control the number-driven methods easily. Their preferences on sketching and hand drawing are due to the vision-driven working habits. Therefore, as mentioned before, if a system permits users to design their shapes in a visual environment and generate the parameters unconsciously, then it will be a more suitable approach to the visual parameter modelling. My rule-based generative system supports the validation of this thinking. In our system, users can generate their designs by mouse and keyboard events under the vision involvement, simultaneously; DSR shape interpreter translates the visual operations into the data information in terms of parameters (Fig 6). By the recursion of rules, these parameters can guide the automate generation for better design effectiveness.

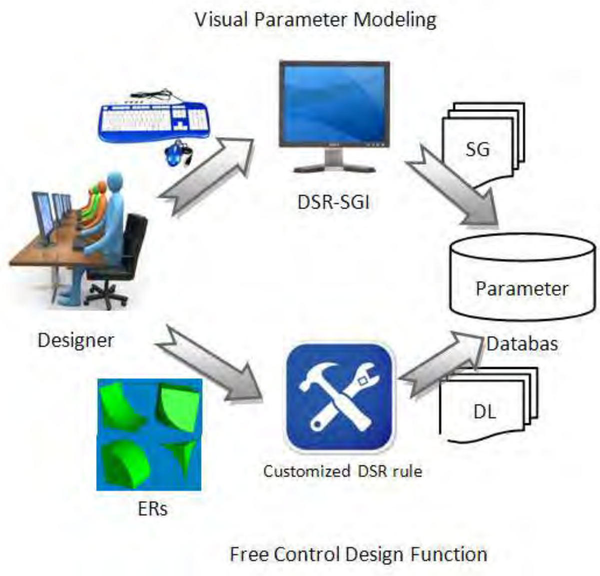


Figure 6. Working flow

The visual parametric modelling technology is not conflicted with the current parametric design. The difference is how to generate parameters. For traditional parametric design, the parametric representation is the formal representation on a design system. Different values demonstrate different results. However, users/designers can only change the values but not the parameters, which means that if a new design object needs to be generated, then the re-parameterized process is necessary. For the visual parametric modelling, the parameters are generated based on the visual operations which are captured from users/designers. Different design actions will generate different parameters. The designers understand the parameterized process as the visual procedures. In this way, more designers can get involved in the design formalization process. As a result, the parameters can load more design information than in the traditional way.

Another restriction of modelling system is the predefined functions. There are some improvements which have been done in this research. DSR rules are generated by the sequential applications of ERs which are predefined as the elemental components. The main body of the running mechanism—the DSR rules are generated by users themselves. System users can generate the DSR rules by the ERs and 'UI Commander', and then save them into the 'Data Centre'. There is no limitation on the DSR rule creation which means users can design their desired rules as tools applied in their design process. In a conceptual design process, users can make use of the rules in the database to shape their designs. The real-time rule creation in design process is supported.

Generative design is helpful for creating more alternative to stimulate designers' inspiration and save time during design process. There are two kinds of generative design mechanisms in computers: the automatic process and semi-automatic one. No matter which one is used, the basic computation always involves the use of parameters. For the automatic form, some AI technologies and pre-defined constraints can be used to limit the design generations towards to a preferred direction. The evaluating criteria are generated from the parameterization process of design knowledge by both designers and design researchers. For the semi-automatic form, user interactions are necessary to select the interested ones from solution space. Therefore, it can be concluded that the designers' involvement is necessary for both kinds of generative design process.

5. Experiment

There are two experiments to show the feasibility of the dynamic shape representation: conceptual cup case and generative chair case.

In the first case, designers create relevant DSR rules based on the DSR shape in our system. The single ER used in the DSR shape is so elemental that can be captured by common computer operations, such as the keyboard and mouse events. Actually, after finishing shape transformations, the atom operations, ERs, are recorded automatically by computer for generating new DSR rules. There are three DSR rules for a cup design: cup-frame rule, cup-handler rule, handle-refine rule, as shown in Fig 7.

The DSR shape and DSR rule represent single design actions in design process. The consecutive design actions can describe a complete design idea of designers. By the initial shapes and the set of DSR rules, the design languages which capture the design procedures can be generated. Design languages are helpful for understanding design processes by designers as the visual demonstration. At the same time, the grammatical rule-based approach permits the possible for computer to analyse the logic of design proceeding.

When the design languages are generated by DSR shapes & DSR rules, the design procedures can be represented and captured step by step. It supports an avenue to test the effects of the same language working on other initial shapes or design environment. The design knowledge inside the recorded information leads the design automation towards the direction represented by design languages. There is a simple example of an application of design language on conceptual cup design, given below.

At first, designers create relevant DSR rules based on the DSR shape in an interactive computer system. The single ER used in the DSR shape is so elemental that it can be captured by common computer operations, such as the keyboard and mouse events. Actually, after finishing the shape transformation visually, the atom operations, ERs, are recorded automatically by computer for generating new DSR rules. There are three DSR rules for a cup design: cup-frame rule, cup-handler rule, handle-refine rule, as shown in Fig 7.

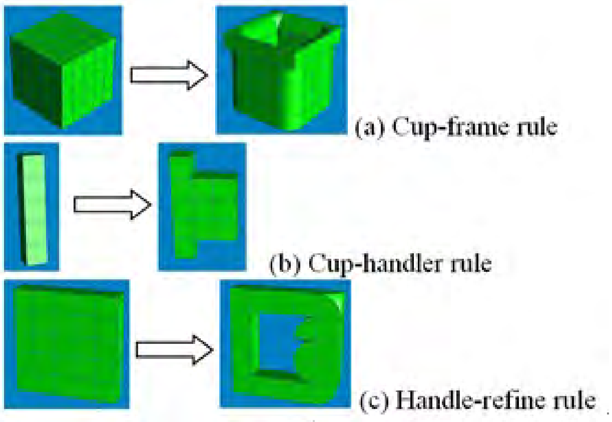


Figure 7. Three DSR rules for cup design

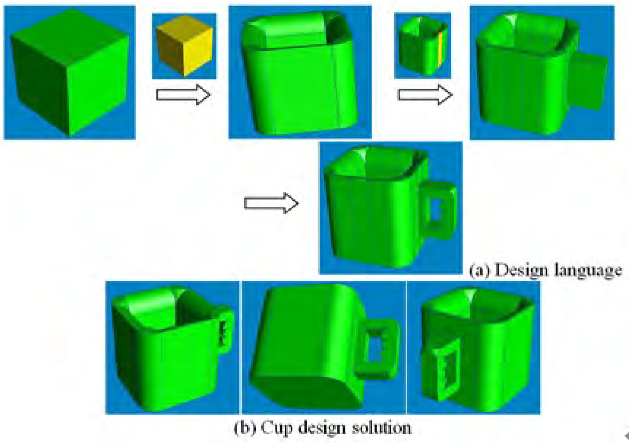


Figure 8.Cup design language

The design language is shown in Fig 8.a. The parts marked yellow are the object shape or sub-shape for the next rule application. When the initial shape is a cube, the design solution is shown in Fig 8.b from different views. As mentioned above, the intended design actions are the priorities for the application of DSR rules. Therefore, when getting a design language by DSR shape, not only the design solution itself, but also the design actions are saved. If applying the design language to other different initial shapes, some novel solutions can be generated. Meanwhile, the desired design actions are kept in the new solutions. This can enhance the functions of the design language. When having one design language by DSR shape, the more alternatives can be generated within a generative system.

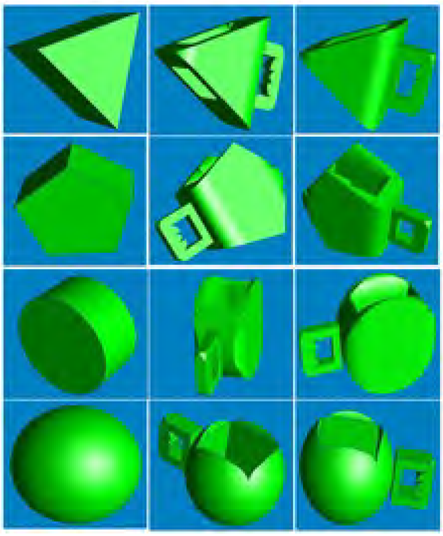
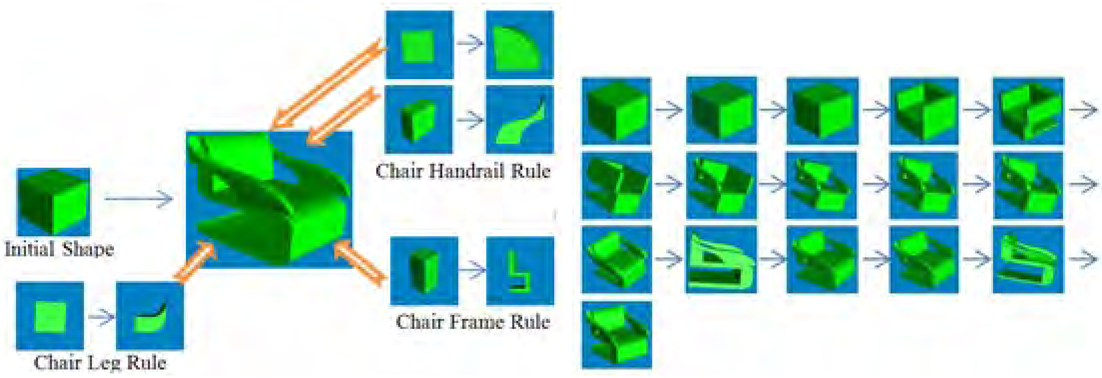


Figure 9. Generative results of cup design case

In the second case, a chair is created in our system, shown in Fig 10.a. There are four DSR Rules used to create this chair: two ‘Chair handrail Rule’, ‘Chair Frame Rule’ and ‘Chair Leg Rule’. The design language is shown in Fig 10.b.



(a) (b)

Figure 10. Conceptual chair design case

We invited several candidates to re-build the chair in system. As the multi-reading, different candidate generate the same chair in different ways. There are three design languages are chosen here (Fig 11).

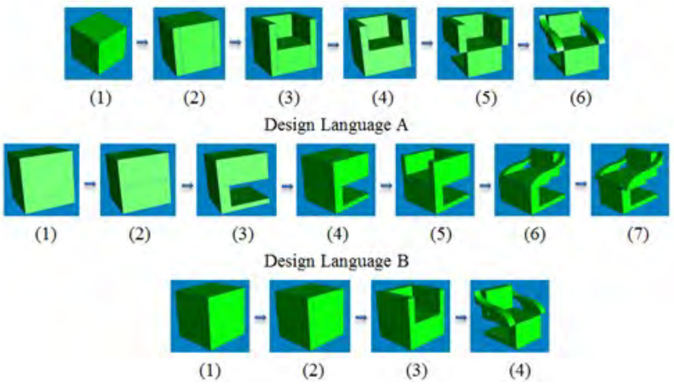
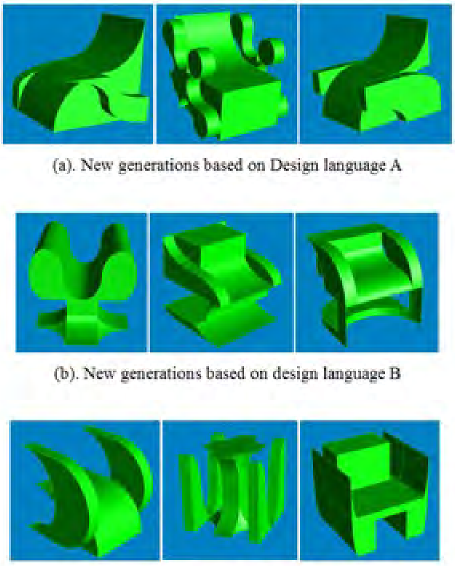


Figure 11.Three design language by three candidates

In Fig 11, there were 6 steps in Design Language A. The step 2 and 4 used layout rules. The former one divided the whole cube into three parts in the order of (handler, body, handler), and the latter one divided the two handlers into two parts (upside and downside). The step 3, 5 and 6 involved DSR rules which were used to change the shape of the chair.

In Design language B, there were 7 steps, in which step 2 and step 4 involved layout rules, whilst the others were DSR rules. In Design language C, there were 4 steps and only step 2 used the layout rules, which divided the cube into three parts. For the three parts, three times of using DSR rules generated the final 3D chair model.

After receiving the three design languages, we used them in the generative design system. In a short time, three design families were created, shown in Fig 12.



(a). New generations based on Design language A

(b). New generations based on design language B

(c). New generations based on design language C

Figure 12.Generative results from different design languages

6. Conclusion and discussion

In this work, design transformations can be represented by shapes and rules in terms of dynamic shape representation. Shape rules can represent basic shape transformations which are dynamic information in design process. In this way, the procedure knowledge can be captured by generative mechanism which supports more flexible and rich approach to generatively create more novel design alternatives related to the existed design knowledge.

Currently, the system can only capture basic shape transformations, such as add, delete and slice. More meaningful design transformations should be considered in future for better understanding to semantic information of design process. As the Boolean operations are widely used in shape modelling operations, the effectiveness of shape generating should be improved further.

Acknowledgement

This paper is sponsored by NSFC project (61472233, 61502285, 61572300), Shandong Natural Science Foundation (ZR2014FQ013).

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Pelin Öztürk Göçmen, Oğul Göçmen

Recall The Past: An Interactive Visual Story Telling Simulation Of Deterioration Of Semantic Memory In Alzheimer Disease

Paper, Artworks

Topic: Art

Authors:
Pelin Öztürk Göçmen
University of Gazi,
Department of Visual Communication Design
Turkey
www.gazi.edu.tr
Oğul Göçmen
University of Başkent,
Department of Computer Engineering
Turkey
www.baskent.edu.tr

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[2] Nancy Kalow, “*Visual Storytelling The Digital Video Documentary*”, A CDS Publication, North Carolina, 2011

Abstract:

This paper is about to make awareness to Alzheimer disease. In this study a hardware and software system was designed for interactivity with people. This system has an ultrasonic range finder for human detection, a web camera for image acquisition, main control board for communication between hardware and software, motor driven circuit, three servo motor for mini mechanical drawing arm, stylus touch screen pen and a cell phone. When system detects a person in front of kiosk by using ultrasonic range finder, it snapshot’s a photo of cell phone screen with webcam. Images coming from the camera processed by Matlab in order to detect if they are colored or not. By serial communication, main control board (Arduino) was triggered according to image processing results and mechanical arm stars doodling on mobile phones screen via touch pen. This interactive cycle simulates the “recall the past” symptom of Alzheimer disease.

In the early stages of Alzheimer, most of the family member may not instantly aware the problem. In the early stages of this symptom, patients start to forget the recent events. They forget the names, dates, places and so on. In a conversation they remember the past as if they are living in that time because they concatenate the daily events, with childhood. At the end patients forget eating, drinking and breathing. Regression of their brain doesn’t stops, until they are death…

Both of us lost our grandparents because of that disease. So we want to raise awareness for their memories in this study, for that reason a system was developed for a visual simulation of the deterioration of semantic memory in Alzheimer disease. One of the signs of this disease “recall the past” event wished to be demonstrated. Simple hardware setup, image processing and other programming languages are used for an interactive visual story telling system.

Contact:
pelingocmen@gmail.com

Keywords: Interactive Visual Story Telling, Color Detection, MATLAB, Arduino, Webcam, App Inventor, Alzheimer Simulation

Recall The Past: An Interactive Visual Story Telling Simulation Of Deterioration Of Semantic Memory In Alzheimer Disease

Dr. Pelin Öztürk Göçmen
Gazi University, Fine Arts Faculty, Visual Communication Design Dept.

Oğul Göçmen
Başkent Üniversity, Engineering Faculty, Computer Engineering Dept

.Abstract

This paper is about to make awareness to Alzheimer disease. In this study a hardware and software system was designed for interactivity with people. This system has an ultrasonic range finder for human detection, a web camera for image acquisition, main control board for communication between hardware and software, motor driven circuit, three servo motor for mini mechanical drawing arm, stylus touch screen pen and a cell phone. When system detects a person in front of kiosk by using ultrasonic range finder, it snapshot's a photo of cell phone screen with webcam. Images coming from the camera processed by Matlab in order to detect if they are colored or not. By serial communication, main control board (Arduino) was triggered according to image processing results and mechanical arm stars doodling on mobile phones screen via touch pen. This interactive cycle simulates the "recall the past" symptom of Alzheimer disease.

Keywords: Interactive Visual Story Telling · Color Detection · MATLAB · Arduino · Webcam · App Inventor · Alzheimer Simulation

1 Introduction

In the early stages of Alzheimer, most of the family member may not instantly aware the problem. In the early stages of this symptom, patients start to forget the recent events. They forget the names, dates, places and so on. In a conversation they remember the past as if they are living in that time because they concatenate the daily events, with childhood. At the end patients forget eating, drinking and breathing. Regression of their brain doesn't stops, until they are death…

Both my wife and me lost our grandparents because of that disease. So we want to raise awareness for their memories in this study, for that reason a system was developed for a visual simulation of the deterioration of semantic memory in Alzheimer disease. One of the signs of this disease "recall the past" event wished to be demonstrated. Simple hardware setup, image processing and other programming languages are used for an interactive visual story telling system.

2 Background

Our grandmothers died after living with Alzheimer for many years. One of them was born in 1927. She grew up as an intellectual woman. She has given education to many young girls and boys, including her three children, for being a tailor until she got ill. After eighty years of her life, she began to forget daily events, especially the new memories.

The other one was born in 1908 and migrated to another country with her family at her early ages. After graduating from most popular and successful schools, she decided to be a sculptor. A prosperous life with three children paused because of forgetting daily events, especially the relatively new things.

However both of them could tell their childhood memories perfectly, they started to ask the same questions again and again about any fresh experiences towards the end of their lives.

We try to tell this story by associating the past memories with black & white photographs and the daily ones with colored. This system is programmed to respond when a color photograph encountered which means "brain can't remember the event".

3 Hardware, Software and Mechanical Parts Of The System

Hardware and software components of the system are as follows.

3.1 Hardware

As shown on Fig.1, for image acquisition hardware Logitech model webcam is used to simulate patient's eye. Asus Zenfone6 (Fig. 2.) screen is used for visualizing the memories on patient's mind.

Fig. 6.

Logitech HD Webcam C310

Fig. 7.

Zenfone6

Fig. 8.

Arduino Uno

Fig. 9.

Micro Servo

Fig. 10.

Motor Shield

Fig. 6.

HC-SR04

3.2 Boards & Shields of the system

As shown on Fig.3-6 Arduino Uno R3, Motor Shield for Arduino Uno, HC-SR04 ultrasonic range finder, micro and normal servomotors are used for brain reactions and other communications between hardware and software. Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board. Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can communicate with software running on your computer (e.g. Flash, Processing, MaxMSP.)[1] The Arduino Uno R3 is a microcontroller board based on the ATmega328 . It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. [2] The Arduino Motor Shield is based on the L298, which is a dual full-bridge driver, designed to drive inductive loads such as relays, solenoids, DC and stepping motors. It lets you drive two DC motors with your Arduino board, controlling the speed and direction of each one independently. You can also measure the motor current absorption of each motor, among other features. [3] The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object like bats or dolphins do. It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package, from 2cm to 400 cm or 1” to 13 feet. It operation is not affected by sunlight or black material like Sharp rangefinders are (although acoustically soft materials like cloth can be difficult to detect). It comes complete with ultrasonic transmitter and receiver module. Test dist. = (high level time×velocity of sound (340M/S) / 2. [4]

3.3 Mobile

To characterize brain activities, “Alzheimer” named application has been developed for android operating system. This app shows the images on the screen randomly. By touch pen, doodling can be done over loaded image by mechanical arm as in Fig 2-a,b,c. This application was developed with MIT App Inventor.

Fig. 7. App Inventor - Blocks Screen

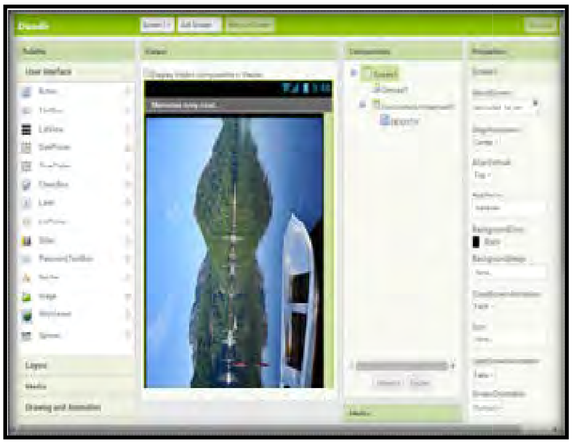


Fig. 8. App Inventor- Designer Screen

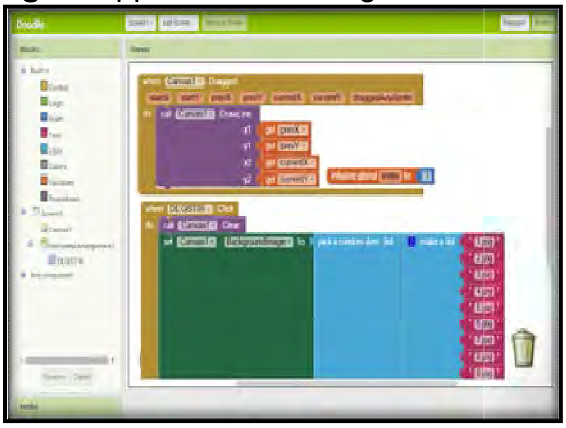


Fig.9. Alzheimer App - Doodling by mechanic arm

MIT App Inventor is a blocks-based programming tool that allows everyone, even novices, to start programming and build full functional apps for Android devices. Newcomers to App Inventor can have their first app up and running in an hour or less, and can program more complex apps in significantly less time than with more traditional, text-based languages. Google's Mark Friedman and MIT Professor Hal Abelson co-led the development of App Inventor while Hal was on sabbatical at Google. Other early Google engineer contributors were Sharon Perl, Liz Looney, and Ellen Spertus. App Inventor runs as a Web service administered by staff at MIT's Center for Mobile Learning - a collaboration of MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) and the MIT Media Lab. MIT App Inventor supports a worldwide community of nearly 3 million users representing 195 countries worldwide. The tool's more than 100 thousand active weekly users have built more than 7 million android apps. An open-source tool that seeks to make both programming and app creation accessible to a wide range of audiences, MIT App Inventor has grabbed the attention of: Formal and informal educators, Government and civic employees, Researchers, Hobbyists & Entrepreneurs. [5]

3.4 Matlab

Matlab code has been written for real time computer vision to simulate the recalling event. Using the theory of image acquisition and fundamentals of digital image processing, images on phone screen has been detected and categorized in real time. Because of captured images from webcam are all in RGB space, we need to separate the gray ones from colored by image processing techniques. [6] For communication between image processing result and the rest of the hardware, serial programming has been developed with Matlab.

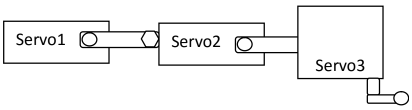
3.5 Arduino

The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the processing multimedia programming environment. [7] To trigger the servomotors of the system for interaction, ultrasonic range finder is used and programmed in Arduino programming IDE. By the way, simulation of brain neurons and its reactions to “lost memories” may be showed.

3.6 Mechanical Design Of The Arm

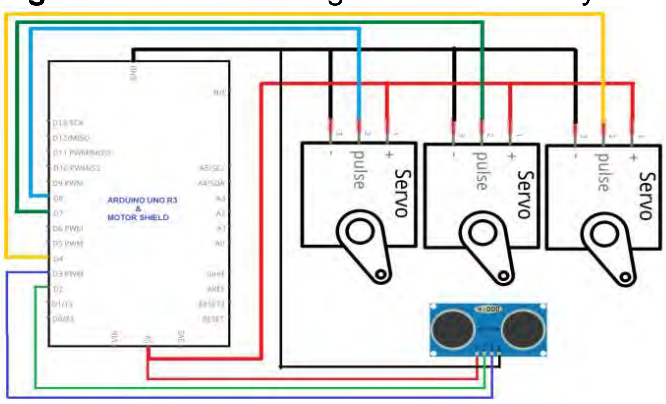
For drawing random doodles on phone screen normal and micro servos was connected to each other as figured in Fig.3 Their negative poles was grounded and +5V connected to positive poles.

Fig. 10. Mechanical diagram of arm



In this study images stands for “the memories remaining on patients mind”. Some images are gray colored, which means that this memory belongs to childhood. The colored images stand for the near past, like daily events. Over 100 images were photographed by Nikon D90 and resized to 380x275 pixels for best fit on phone’s screen. For memory efficiency all images copied to SD card of the phone.

Fig. 11. Circuit diagram of the system



4 How System Works

When system is turned on, Matlab starts listening the serial port of computer and also ultrasonic range finder, which is connected to Arduino, starts measuring the distance of the empty space in front of the kiosk. Normally this ultrasonic range finder can measure up to 4 meters away. When a person comes and stands maximum 50 cm away from the kiosk, a time counter starts incrementing in Arduino program. If more than 5 seconds with a distance shorter or equal to 50cm is calculated, system regards as “somebody is standing”. Then Arduino card sends “human detected” signal to Matlab via USB cable. When serial data is available, Matlab triggers the camera for snapshot that was focused to the screen of the phone before. As described above, phone screen is brain of the patient and the photos shown on the device is the recorded daily or childhood memories of him. The captured image processed by Matlab with image processing algorithms. The color detection algorithm [6] says that if all the RGB values of a pixel are same with each other, then this image is said to be in gray color mode. Because of the lightning and shading over phone screen we need to do some tricky steps over processing results.

```
1    vid = videoinput('winvideo', 1,'RGB24_640x480');
2    img = getsnapshot(vid);
3    [h,w,d] = size(img);
4    Sum = 0;
5    Arr = zeros(1,w*h);
6    for w=1:480
7      for h=1:640
8        if (abs(img(w,h,1)-img(w,h,2)>=35) ||
9    abs(img(w,h,1)-img(w,h,3)>=35) ||
10   abs(img(w,h,2)-img(w,h,3))>=35 )
11           Sum = Sum +1 ;
12        end
13     end
14   end
15    if (Sum < 5000 )
16        % do nothing wait for the next image…
17    else
18        % send start doodling signal to
          % mechanical arm which is connected to
          % arduino!
19   end
```

As seen on Matlab script, absolute value of difference of RGB values is checked over the whole image that if they are greater than or equal to threshold value on lines 8,9 and 10. Decision for color or gray is also done to a threshold value as seen on line 15. If its colored image Sum will be more than 10000 according to chosen size of snapshot data as seen on line 1. Doodling is done with stylus pen over phone screen, which is connected to servo3. Mechanical arm’s servo angles are randomly selected within the range of the 6-inch screen size of the phone. Servo3 makes up and down movements like hand when doodling. When brain remembers the image (is gray) it does not doodle over it. This means this image belongs to childhood. If the image can’t be remembered (is colored), because of the deterioration of the semantic memory, it starts doodling over it.

5 Conclusion

Both hardware and software parts are included in this project. Communications between different platforms are the hardest part of this project especially in data transfer. Also in this project, as in the most of others, the detection and classification of local structures (i.e. edges, corners and T-junctions) in color images is important for many applications, such as image segmentation, image matching, object recognition and visual tracking in the fields of image processing and computer vision [8]. This project is still working by the authors. In the newest version of the hardware, human like entertainment robot is planning to be done for showing rather than telling. Showing rather than telling means to make the documentary primarily visual. You can establish location, relationships, story transitions, and other elements visually, and reduce explanatory text or narration [9]. Short video of the system can be watched on authors' YouTube channel.

6 References

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[9]- Nancy Kalow, "*Visual Storytelling The Digital Video Documentary*", A CDS Publication, North Carolina, 2011

Quelic Berga Carreras

An online short-film editing machine with a fixed structure and pseudo-infinite combinations. - Paper

Topic: Audiovisuals, Generative Editing, Art

Authors:
Quelic Berga Carreras
Universitat Oberta de Catalunya, Department of informatics, telecos and multimedia.
www.uoc.edu
Juliá Minguillón
Universitat Oberta de Catalunya, Department of informatics, telecos and multimedia.
www.uoc.edu

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[1] Gifreu-Catells, A. (2011). "The Interactive Documentary. Definition Proposal and Basic Features of the New Emerging Genre".
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[3]Manovich, L. (1999). Database as Symbolic Form. *Convergence: The International Journal of Research into New Media Technologies*
[4] *See the working project at: http://iam.caotic.net*

Abstract:

The article reflects on 3 main ideas, using an art project to analyse them.

It is known that viewing the same video many times give us different information and our perception of it evolves. Would viewing many instances of a pattern be more efficient on communicating an abstract concept than the repetition of an specific instance several times? Can the montage of a film be generative and still allow a story with it's climax and flow to stay alive? Is it relevant for the audience to know that what they view is a unique instance or do they prefer a common cut?

The online art project intends to reflect on the possibilities of generating automated, pseudo-aleatory cuts of a 25" short-film. The director's cut becomes a software's cut created, by a viewer's demand, as a unique random instance of the potential combinations of the short.
The artifact involves the shooting of an audiovisual repository according to a specific script, a web-based software interface based on a visualization of the amount of footage and its possible instances/combinations, and a server-side software that dynamically edits the selected shots in real time and encodes the result into a web-friendly format for online viewing.
The audiovisual content of the shots reflects on how technology is changing our daily lives and often shifting us from natural contexts to stressful landscapes of information overload. It questions who is really in control: humans or machines.

The very design of the project reinforces this dilemma by generating an automated cut, never edited before and only conditioned by the pattern set up by the director, but out of his control.
The content has 6 different situations/sets, with a total of 123 different takes, 5 sound tracks, 5 sub-themes with 32 written sentences and more than 20 minutes or archive footage that can be randomly combined in a structured manner to generate a 25-second almost unique resulting clip.

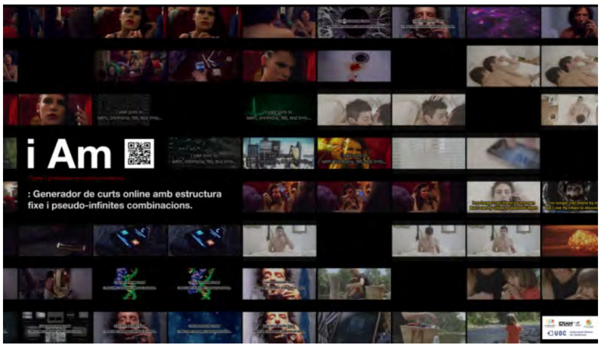


Image: Poster of the on-line short film project.

Contact:
qberga@uoc.edu

Keywords: generative video editing, interface, data visualization, co-authorship, technology, patterns, processing.org, web-based, open-source

An online short-film editing machine with a fixed structure and pseudo-infinite combinations

Quelic Berga Carreras

Department of Computer Science, Multimedia and Telecommunication,

Universitat Oberta de Catalunya, Barcelona, Spain

www.uoc.edu

www.quelic.net

e-mail: qberga@uoc.edu

Julià Minguillon

Department of Computer Science, Multimedia and Telecommunication,

Universitat Oberta de Catalunya, Barcelona, Spain

Abstract

Books, recordings and films are common media in our culture to create and share stories. Due to their physical support, once they are published the story is fixed. In other mediums used to transmit stories, for example, in oral communication of tales, popular songs or myths, the message is transmitted in a more organic way, and it has not a fix form but still keeps the essence of the story.

With the popularization of computers and IT, new possibilities on the ways to narrate and transmit information appear. This article explains how an online artefact has been build as an artwork to experiment on the possibilities of opening audiovisual fictions into a more flexible and changing formalization while keeping the essence of the story. It is based on theories of generative computational art, computational design and database cinema. We describe a technical solution to implement a generative self-editing short-film.

The resulting artwork is an artefact to study further possibilities on how to narrate nowadays.

1. 1. Introduction

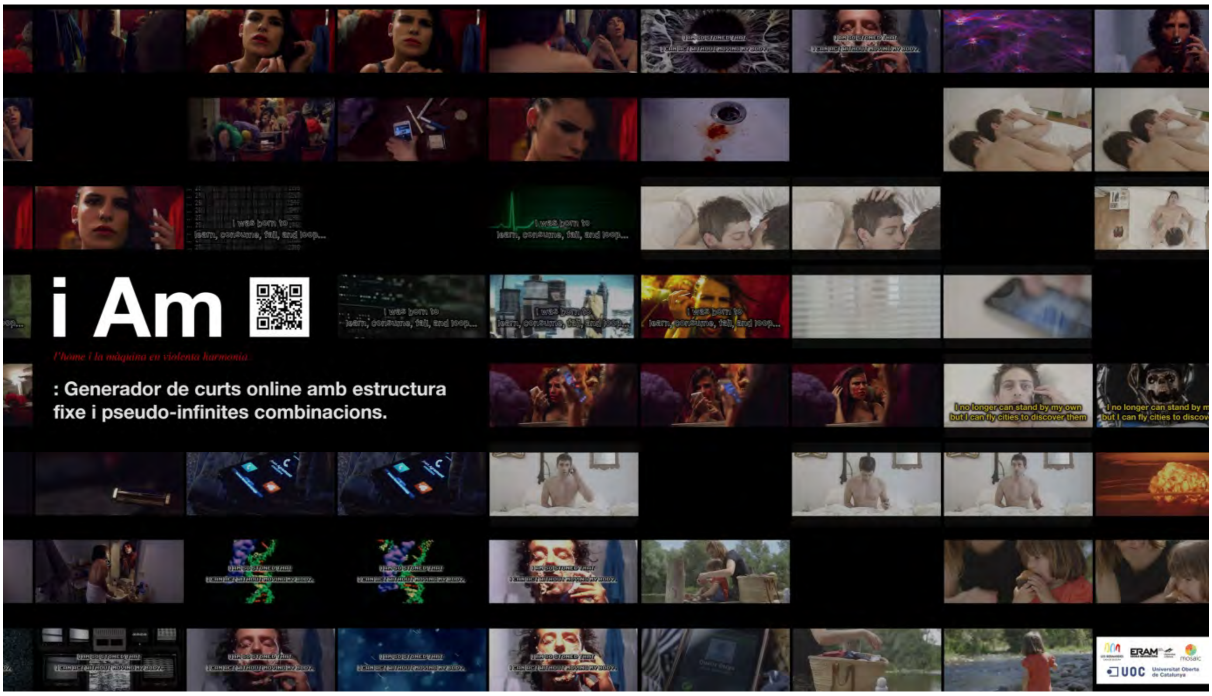
From print, to sound recording and film, our culture has been developing machines to record and reproduce culture and memories. Those mechanical processes have help us storing information and archiving data. Saving memories and keeping a record of almost everything we do is a common practice today.

With the development of computers and networks, several new paradigms appear. Data is coded and electrically transmitted. This makes that all textual and audiovisual objects stored in a computer have to be transformed into information (abandoning their original physical support) and converted into binary code. Once digital, physical supports and materials are not transmitted, but information is [1].

Once information is transmitted it needs to be decoded and processed in order to be rendered. Nowadays seeing a film in a computer means to decode it.

In "The language of new media" Manovich [2] describes cinema using the metaphor of data base. He also refers to hypertext and data base as new ways to access the audiovisual footage online. "Film editing in general can be compared to creating a trajectory through a database" [2]. Furthermore, "we can think of all the material accumulated during shooting as forming a database, especially since the shooting schedule usually does not follow the narrative of the film but is determined by productions logistics. During editing, the editor constructs a film narrative out of this database, creating a unique trajectory through the conceptual space of all possible films that could have been constructed. From this perspective, every filmmaker engages with the database-narrative problem in every film, although only have done so self-consciously" [2], and argues that "Given the dominance of the database in computer software and the key role it plays in the computer-based design process, perhaps we can arrive at new kinds of narrative by focusing our attention on how narrative and database can work together. How can a narrative take into account the fact that its elements are organized in a database? How can our new abilities to store vast amounts of data, to automatically classify, index, link, search and instantly retrieve it, lead to new kinds of narrative?" [2].

In this project we followed the ideas of Manovich with the aim to create a working demo. The iAm project [Figure 1] is an online artwork that more than a tool in itself, it should be rather considered a piece of generative computational art, "produced by leaving a computer program to run by itself, with minimal or zero interference from a human being." [3], with the aim of generating fictional short-films



online.

Figure 1. Poster of the short-film

Since the early XXI century, online video have been democratized due to an increasingly higher bandwidth, better compression codecs and the popularization of technologies like Macromedia Flash and, more recently, HTML5. Platforms like Vimeo (2004) and YouTube (2005) have fostered the presence of audiovisual documents in the net.

Nowadays, in this context, audiovisuals are realized, produced and distributed mainly using this new digital environment [4]. According to Murray, instead of just translating the analog content to a digital container, "digital design is about shaping interaction within new combinations of the format and genre conventions that make up a new medium" [5]. Some of the audiovisual genres have been adapted to those new properties, such as video-games, videoclips or web-docs [6]. For this paper we will not focus on interactive projects, or installations, but on generative audiovisual fictions.

In our research the aim is not to generate an interactive documentary where the viewer feels part of the investigation process, nor is to create an interactive fiction or a participatory story telling project. Neither we are interested in an immersive experience of virtual reality or video-game. We are interested in the idea of changing the formal aspect but keeping the essence of the narration, keeping the linearity and flow of the film, with its rhythm and climax. John Maeda, with his theories and works on computational design and creative coding [7], is a good example in the field of graphic design. Several ideas from his work have been translated to our field of research to think about a possible *computational audiovisual*.

In the field of generative art we can find the Galatema (2010) project, by Alain Lioret that is much more focused on generating synthetic images. Or the Energy Flow [7] by Vera-Maria Glahn and Marcus Wendt from the Field studio which is an app that creates stories with a 3D rendering motor. In both cases, they do work with synthetic images, while we are more focused on photorealistic footage and on the possibilities of generative film edition.

2. 2. Description of the demo process

2.1 Conceptualization

The seed of the project was a poem [8] by Quelic Berga, reflecting on our relation with computers from a personal point of view. The poem was mainly composed by aphorisms and images that reflect on the co-dependence, the addiction and the increasing adoption of technology in our daily life. The sentences of the poem can be read randomly and still make sense.

Berga was asked to turn the poem into an audiovisual project, and then a clear synopsis raised “When we connect with technology, we disconnect in a way with other things”, but when trying to write the script and the storyboard he found there were many ways to express that synopsis. The author did not intend to fix it with an specific case. Should the protagonist be a man or a woman? Young or old? Techie or hippie? To answer those questions he decided to meet two filmmakers to discuss on the possibilities to do a generative short-film.

2.2 Design and creation methodology

One of the first issues that had to be addressed was to think in a different way and to understand the possibilities of computational media, avoiding the conventions made for example by Final Cut or Adobe Premiere. The team had to discuss on methodologies to allow new ways of thinking and writing the script. The second issue was that the coding part of the project was developed while deciding how to do the shooting. That could be seen as a problem, but as Design and Creation Methodology was being used, the team stablish some discussions on how to develop both, the script and the program, in several iterations [Figure 2].

For the ideation process of how would the story work, and to solve the first problem, several conversations between the programmers, project director and the filmmakers were done to address the preconceived notions of what can be done and what cannot be done. During the process of setting the possibilities of the software, a balance between the budget, the knowledge and the efficiency of the resulting proposal had to be adjusted to ensure the success of it. Some ideas or proposals had to be discarded due to lack of time, knowledge or budget, others are now part of the further research intentions.

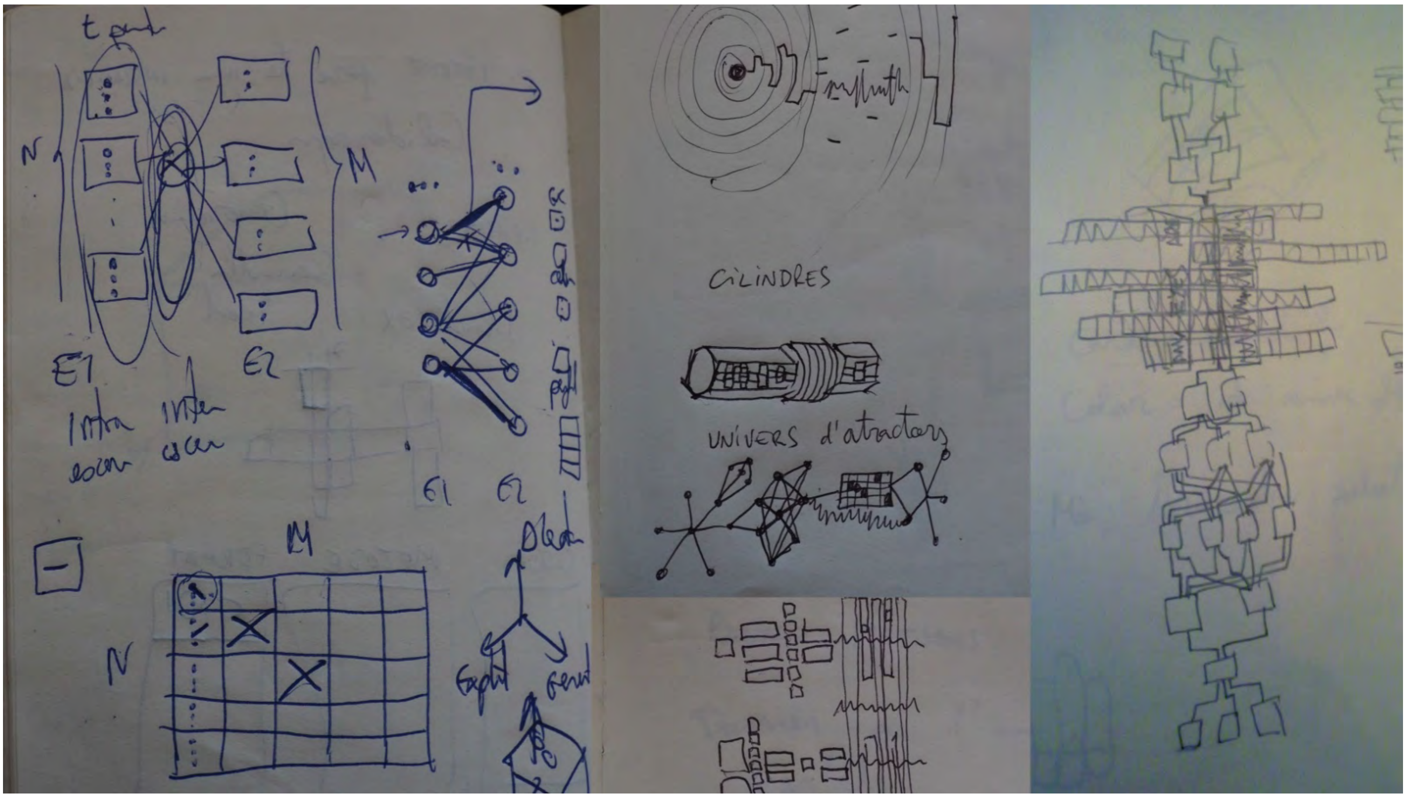


Figure 2. Pictures of some sketches

Finally the team decided to plot 6 stories that all shared the same synopsis:

“Someone is doing a common thing and gets distracted by a phone call; when trying to talk on the phone he/she get exposed to a big amount of images/information; when they hang up the phone what they where doing has changed dramatically.”

The team decided that every scene would have several shoots to let the software choose between them, and also decided that the sentences and images that would appear during the phone trip would be common for any of the 6 plot stories. They divided the original poem into 37 sentences, letting one sentence appear at a time for each short-film made. To enrich the project, 9 different soundtracks produced by two different musicians, and 2 hours of archive films related to the subject of the poem were added.

Each resulting short-film followed 1 of the 6 plots, choosing in between all the shoots per scene, choosing one over the 37 sentences, choosing 1 of the 9 soundtracks and choosing several frames from the 2 hours of film archive. For this first prototype, all the choices are selected randomly and the resulting short-film has a duration of 25 seconds.

This solution allows to control the flow and rhythm of the film, making sure it makes sense and it stays coherent, and at the same time a great number of combinations are possible.

3. 2.2 The filming process and the shooting

The filmmaker team followed the common filmmaking notation to develop a synopsis, storyline, storyboard and film planning, but considering as many shoots from different angles as possible, so for each scene at least two different possible shoots where available. With this way of working the synopsis became a very strong guideline, and it allowed to add more rich diversity of shootings while respecting the structure.

For the whole project, a multidisciplinary team was created with 28 members, including filmmakers, producers, artists, actors, UX experts, and coders. The main difference between a common filming team was the presence of two software developers and an interface designer as well as having a director that had a background on filmmaking and software development.

Let us point at the main differences between a normal filmmaking process and the process that was followed for iAm:

During the 3 shooting days, the team was trying to record as many valid takes as possible for each set. The premise was not to search for the good or right one, but the potential ones in each set. So for each take, at the end of the process there were at least two or more valid takes per set. After the 3 days of shooting more than 130 takes were recorded to edit multiple 25'' short-films.

The second specific thing of this project was that, instead of editing a short-film, each take was edited individually and kept as a clip in order to to combine them freely later. For so, each clip was stored in a tree folder structure allowing storage of many clips in each set-scene folder. The same process was followed for the 9 soundtracks, the credits and the 37 poetic sentences [Figure 3].

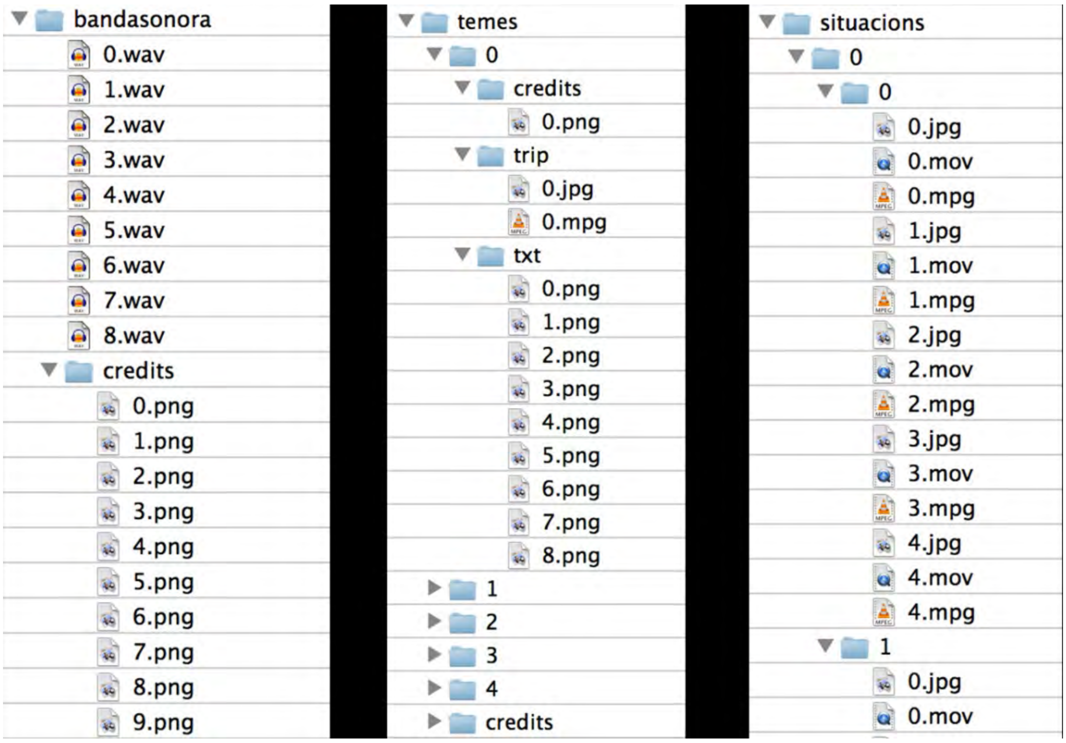


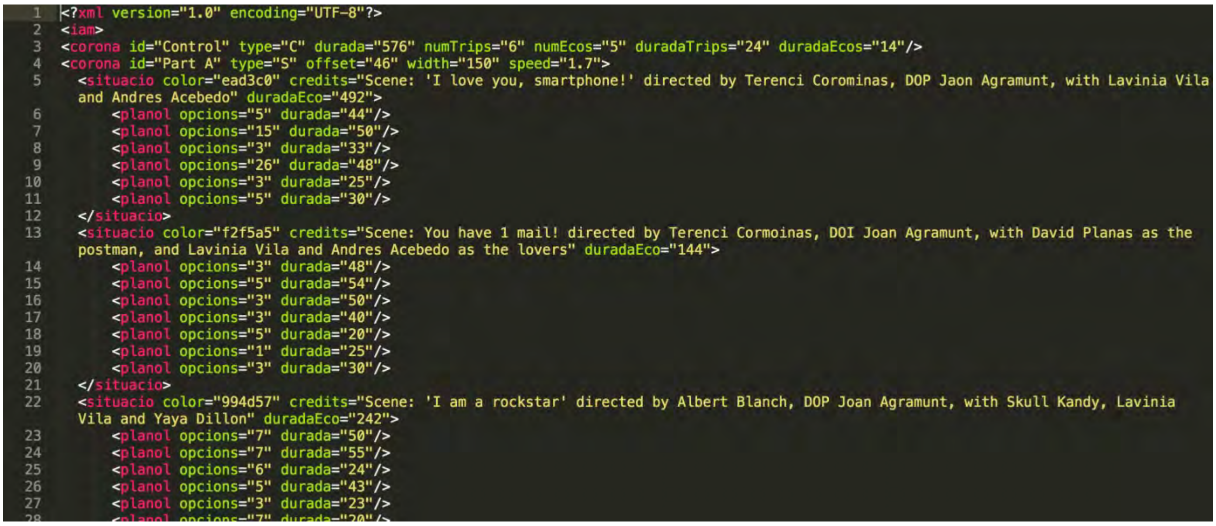
Figure 3. Folder structure

4. 2.3 Metadata

After that, an XML file [figure 4] was created to store the metadata. All the available information for each clip (cast, folder location of the file, duration in frames, and to which narrative group it belonged) was stored in that file.

Once the clips and metadata were ready the programmers could test the software already online and the first films where generated.

The fact that we used an XML file to dynamically control de process allows the experiment to be extended to other footage or structures.



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<?xml version="1.0" encoding="UTF-8"?>
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<corona id="Control" type="C" durada="576" numTrips="6" numEcos="5" duradaTrips="24" duradaEcos="14"/>
<corona id="Part A" type="S" offset="46" width="150" speed="1.7">
  <situacio color="ead3c0" credits="Scene: 'I love you, smartphone!' directed by Terenci Corominas, DOP Jaon Agramunt, with Lavinia Vila and Andres Acebedo" duradaEco="492">
      <planol opcions="5" durada="44"/>
      <planol opcions="15" durada="50"/>
      <planol opcions="3" durada="33"/>
      <planol opcions="26" durada="48"/>
      <planol opcions="3" durada="25"/>
      <planol opcions="5" durada="30"/>
  </situacio>
  <situacio color="f2f5a5" credits="Scene: You have 1 mail! directed by Terenci Cormoinas, DOI Joan Agramunt, with David Planas as the postman, and Lavinia Vila and Andres Acebedo as the lovers" duradaEco="144">
      <planol opcions="3" durada="48"/>
      <planol opcions="5" durada="54"/>
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      <planol opcions="3" durada="30"/>
  </situacio>
  <situacio color="994d57" credits="Scene: 'I am a rockstar' directed by Albert Blanch, DOP Joan Agramunt, with Skull Kandy, Lavinia Vila and Yaya Dillon" duradaEco="242">
      <planol opcions="7" durada="50"/>
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      <planol opcions="6" durada="24"/>
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Figure 4. XML file

3. Online editing and film rendering process

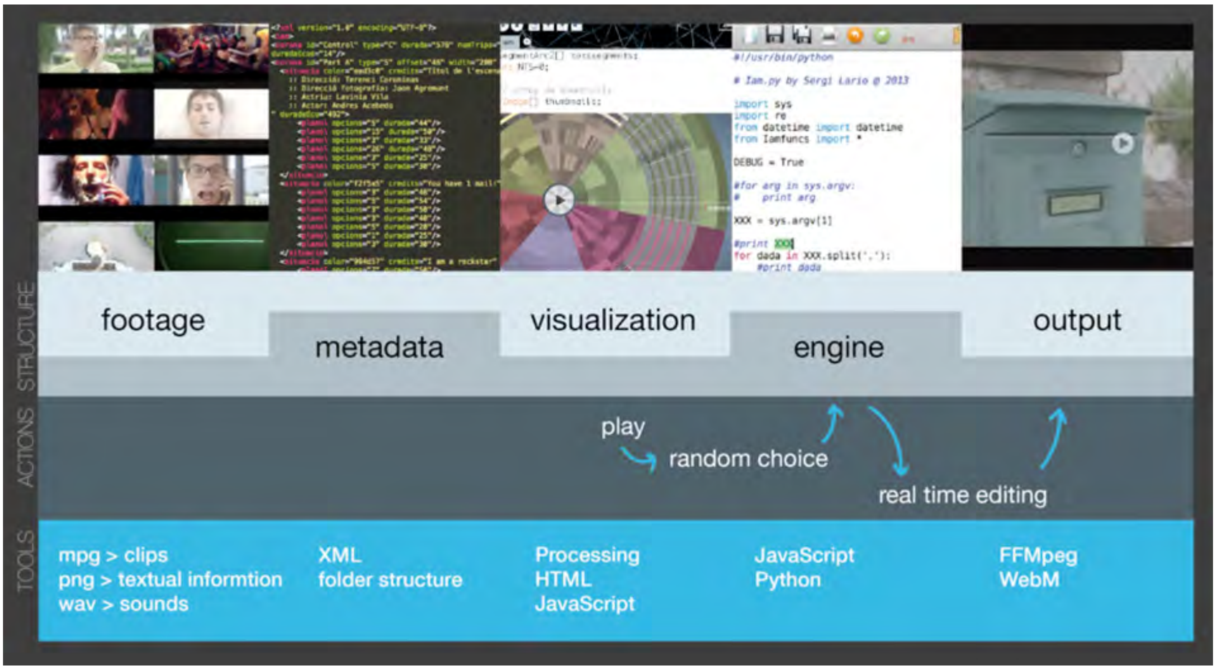

Figure 5. Software steps and architecture

When a user visits the website a *PHP* file loads a *canvas* that opens the file *iam.pde* using the library *processing.js* (a *JavaSript* port for *processing.org*). The *iam.pde* loads the data from *iam.xml* to plot a data visualization of the available footage and media.

If the user press the play button, the process [figure 5] of creating a new short-film starts. The *iam.pde* file creates a random array with information pointing all the files that have to be rendered and its order. This array is sent to the *python* script that checks the existence of all the files and makes a call to the *FFMPEG* software to start the rendering of the film. Meanwhile *iam.pde* starts an animation to show which scenes and material is being used.

FFMPEG concatenates all the clips, adds a soundtrack, overlays one text of the poem in the footage, and finally composes the final image of the credits with the right staff for each version of the short-film. It saves it in *.mpg*, and then converts it to *.webm* or *.mov* depending on the version of the browser. Once ready it returns a “done” message to *python*.

Python finally sends the url of the new video to the *PHP* to update the website with the video.

The file is stored in a public folder in the server allowing visitors to access all short-films edited until the present date.

The project is designed to be able to do modifications or increment the footage archive by just updating the *XML* file and folders.

4. Visualization and web interface

The website uses *html5*, *canvas* and *php* standards to render the site. The two dynamic *php* sections of the project are the “play” section and the “All shorts 'till today”.

The “play” section [figure 6] creates a *canvas* that reads the *xml* file to draw a visual representation of all the media in the repository. It visually sorts all the media in the space and represents their belonging to one or other situation. Each type of media (text, soundtrack, clips) uses a different graphical representation.

Figure 6. Screen-shoot of the visual representation of the footage with it's legend on the top.

The visual representation intends to visually convey the amount of combinations.The timeline as graphical pie represents the fact that, although there is only one starting point, the centre, the possible endpoints (on the perimeter) and the paths to reach them are virtually infinite.

Showing the process and the potential footage is an important part of the project. As Janet Murray states, new manners to design and represent have to come with new digital tools and systems [5]. In this case, there was the challenge to question the preconceived notion of fix narration and to explain how a generative editing short-film works.

5. Results

The project was officially presented on the 18th December 2013, as an online experimental short-film with the capacity to self-edit, entitled “iAm; man and machine in violent harmony”. Since then it has been exhibited as an artwork in several places [10,11]. Also academical interest have been shown and the project have been presented in conferences [12,13].

Until today more than 700 short-films have been generated and can be viewed on the same web [14] of the project.

6. Further research

This project has become a playground to test various experiments and essays.

Many questions arise: How do people perceive this type of generative films? Do they prefer to see a unique cut? Does it trigger a sense of distinction or value, or the opposite? If a tool for filmmakers was to be developed following the iAm principles, would they use it? how would they adopt it and in which cases?

With this first prototype we have a good seed with potential to grow in several different directions. We are looking forward to invite filmmakers to explore its expressive possibilities, and how it can be applied in several different domains such as publicity or videoclips. Can we use other ways to take decisions besides randomness without doing an interactive project?

An issue that we also want to address is the interface design, and we are considering working with a team of UX experts and researchers to analyse what things can be improved or changed.

Finally, we are now preparing a faster online version by changing all the footage to webm standards. Preliminary tests show that it will speed up about 80% the time of rendering process, thus delivering the resulting video much faster.

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Ferhan KIZILTEPE

Paper : A BRIEF ESSAY ONTO ZAHA HADID'S ARCHITECTURE FROM A DIFFERENT PERSPECTIVE

Topic: Architecture, Mathematics

Authors:
Ferhan KIZILTEPE
Anadolu University, Faculty of Architecture and Design
CHD (Contemporary Sculptors Association)
Turkey
www.ferhankiziltepe.com

References:

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Abstract:

As a matter of fact, architecture that has been produced throughout the human history carries the knowledge of the society that it was created in to our present time. Among these, works of architecture have a critical place in our understanding of both ourselves and our historical development. Architecture which can also be defined as an elegant harmony between science and art in all their elements from technique to aesthetics, presents us with a vast field of research in its own right.

This article presents general and technical information regarding Zaha Hadid who enjoys a significant place in today's architecture, and who is defined as one of the deconstructivist architecture with her approach and her works while no emphasis has been placed on the technical, aesthetic and historical values she has from an architectural point of view. This article aims to analyse Hadid's architectural works from a different perspective, and to trace geometrical forms which are thought to be present in Zaha Hadid's architectural style. Also the method of comparison will be used in the discussing of the subject within the scope of this article; the first results of this study not yet completed, and only planned to be shared with readers and listeners.

Zaha Hadid, Guangzhou Opera House, Guangzhou, China, 2010

http://www.zaha-hadid.com/wp-content/files_mf/01062_cp_ib_n2_higha4.jpg

Contact:
aser@ferhankiziltepe.com

Keywords: Zahar Hadid, Deconstructivist, Architecture, Amorphous, Curves, Geometrical Forms

A Brief Essay onto Zaha Hadid's Architecture from a Different Perspective

Ferhan Kızıltepe, B.Sc., M.A.

Anadolu University Faculty of Architecture and Design

www.ferhankiziltepe.com

e-mail: aser@ferhankiziltepe.com, fkiziltepe@anadolu.edu.tr

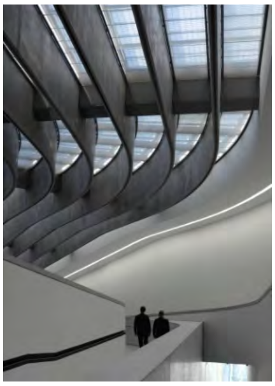
Abstract

As a matter of fact, architecture that has been produced throughout the human history carries the knowledge of the society that it was created in to our present time. Among these, works of architecture have a critical place in our understanding of both ourselves and our historical development. Architecture which can also be defined as an elegant harmony between science and art in all their elements from technique to aesthetics, presents us with a vast field of research in its own right.

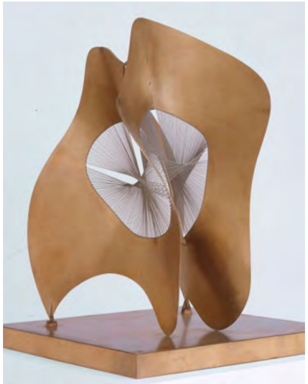
This article presents general and technical information regarding Zaha Hadid who enjoys a significant place in today's architecture, and who is defined as one of the deconstructivist architecture with her approach and her works while no emphasis has been placed on the technical, aesthetic and historical values she has from an architectural point of view. This article aims to analyse Hadid's architectural works from a different perspective, and to trace geometrical forms which are thought to be present in Zaha Hadid's architectural style. Also the method of comparison will be used in the discussing of the subject within the scope of this article; the first results of this study not yet completed, and only planned to be shared with readers and listeners.

1. Zaha Hadid

Zaha Hadid, one of the foremost architects of today, considered to be among the deconstructivist architects of today's architecture. At the same time, it can be observed certain impacts of suprematism on some of her works such as Vitra Fire Station (Weil Am Rhein, Germany, 1990-1994), Museum of Islamic Arts (Doha, Qatar, 1997), Kurfürstendamm 70 (Berlin, Germany, 1986), MAXXI / National Museum of Contemporary Arts (Rome, Italy, 1997) [1] ; and on some other projects it can be seen the traces of Russian constructivism, such as The Hague Villas (The Hague, Netherlands, 1991), Blueprint Pavilion (Birmingham, England, 1995), Phaeno Science Centre (Wolfsburg, Germany, 1999) [2]. Especially, when one considers her works, which carry certain characteristics of a non-Euclidean geometry, some Russian constructivists such as Naum Gabo and Antoine Pevsner can come to mind.

From left to right: Vitra Fire Station [6]*. MAXXI: Museum of XXI Centry Arts* [7].

From left to right: "Construction in space: Arch No:2, Naum Gabo [8]*. Dynamic Projection at Thirty Degrees, Antonie Pevsner* [9].

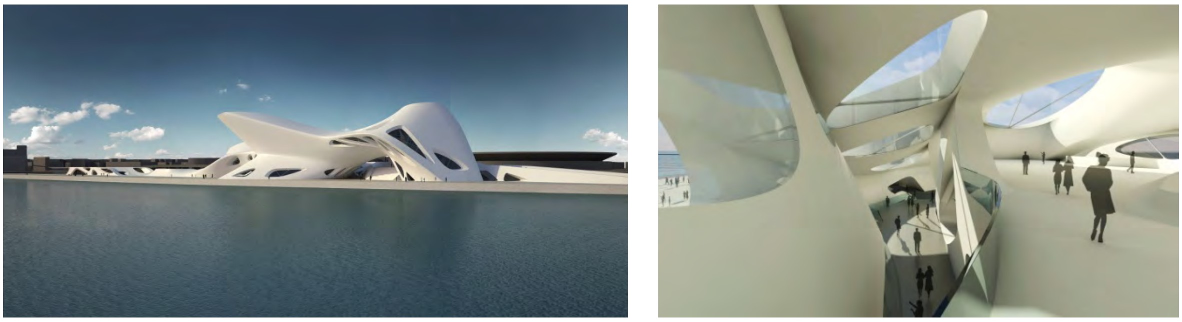
Hadid was one of the architects whose works exhibited at MoMA[5] in 1988, under the name of Deconstructivist Architecture [3]; it can be said that Hadid is stand out whether today's architecture or among the deconstructivist architects, by her understanding of forms, and the works which were look as if they were hanging on air despise the gravity.

From left to right: Haydar Aliyev Center [10]*. King Abdullah Financial District Metro Station* [11].

In architect Uğur Tanyeli's arcticle called "Zaha Hadid ve Decostrütif Söylemin Eleştirisi," he treats Hadid from modernism and postmodernism perspectives, and notes "At least Hadid is on the 'edges' more then the others." [4]. Hadid masterly uses different geometric factors such as hyperbolic geometry, elliptic geometry on her works and this is one of the reasons why her works are differentiates then the others. Thus, it can be easily build a symbolic analogy between Hadid's bulks, Euclidean and non-Euclidean geometry.

5 The exhibition was held between June 23- August 30; other architects were P. Eisenman, F. Gehry, D. Libeskind, B. Tschumi and R. Koolhass.

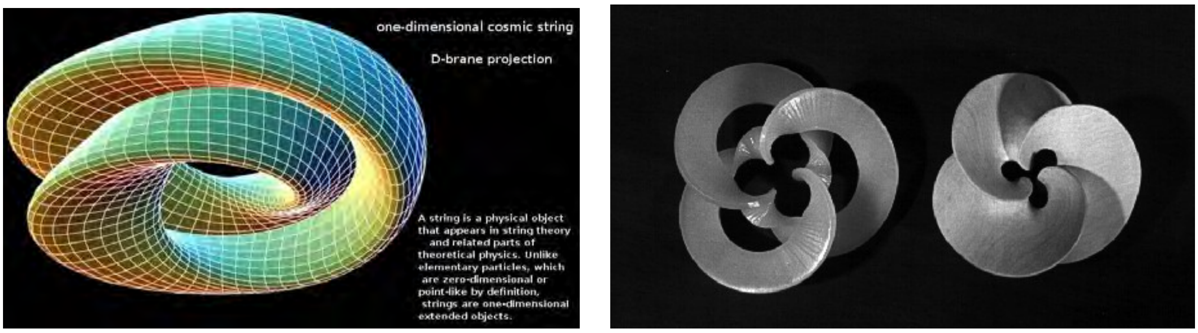


From left to right: Nuragic and Contemporary Art Museum [12].

This paper will share the initial discoveries on Hadid’s works, and since her forms and their geometric relations will be examined, it will be appropriate to give a brief geometric explanation as well.

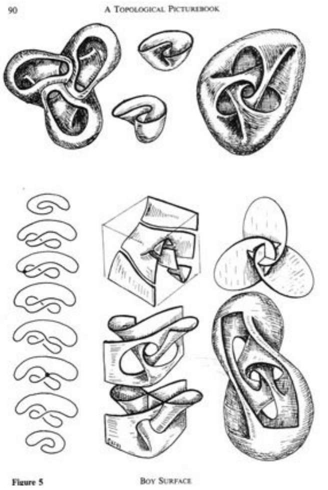
2. Euclidean Geometry and Non-Euclidean Geometry

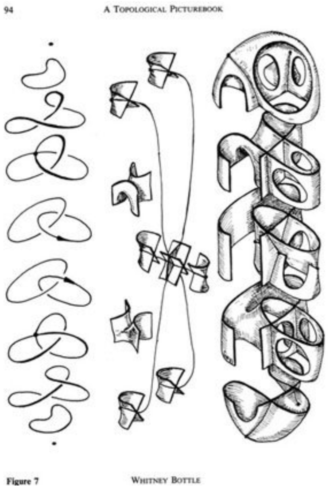
If it’s necessary to mention what geometry means, briefly it can be said it’s one of the branches of math, which considers shapes, objects and volumes (or spatial relations). First recordings of geometry can be found in a papyrus of 1550 B.C., and since then scientists are trying to improve it. One of those scientists and maybe the most known one is Euclid the Alexandrian, whom was believed the president of Alexandrian Library. Euclid combines all the scientific studies before him and his own studies, and publishes as a 13-volume geometry book under the name of *Elements*, which explains geometry’s main lines. It consists of 5 axioms, 5 postulates, 23 definitions and 48 assertions and also defines what Euclidean Geometry is.

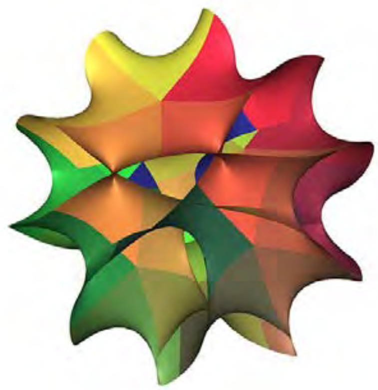


From left to right: Cosmic String [13]. *Three Knots and Twists on a Trefoil Knot* [14].

The 5th postulate, also known as parallelism postulate, can be found in Euclid’s *Elements,* is one of the most influential works in the history of mathematics, it has a very important place in the development of geometry especially in the 16th century andlater. That postulate goes like this: “That, if a straight line falling on two straight lines make the interior angles on the same side less than two right angles, the two straight lines, if produced indefinitely, meet on that side on which are the angles less than the two right angles.” [5]. Throughout the history scientists are worked whether to prove this postulate, or make it more understandable or to discover alternative new one. After the 16th century and later, these studies lead a great part in non-Euclidean geometry’s birth.

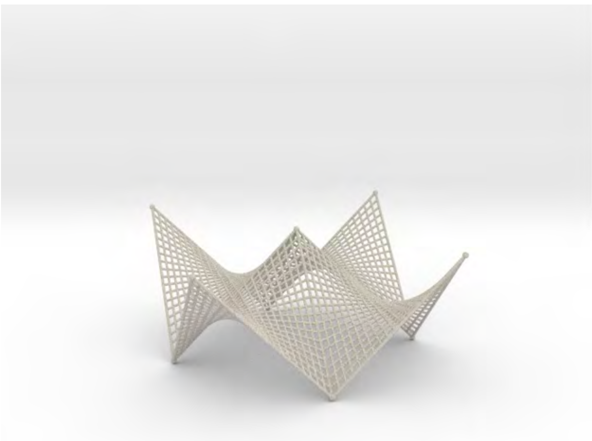
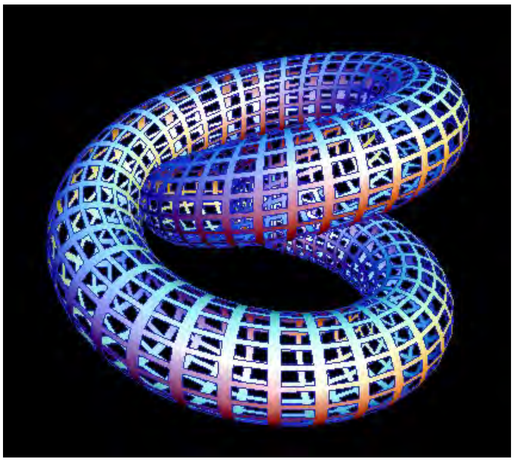






From left to right: Boy Surface, Whitney Bottle [15]. *Calabi- Yau Quintic Manifold*[16].

As it's been touched upon above, it can be argued that hyperbolic and elliptic geometries in non-Euclidean geometry are part of Hadid's forms. Let us explain what is hyperbolic and elliptic geometries are. Hyperbolic geometry while accepting some of Euclid's axioms, uses a different one for the 5th postulate, "it can be drawn an infinite number of coplanar lines to a line and sum of the angles of a triangle is less then 180^{o}." The elliptic geometry also accepts Euclid's axioms, and instead of the 5th postulate they use "it cannot be drawn an infinite number of parallel lines to a line and sum of the angles of a triangle is greater than 180^{o}."

From left to right: Hyperbolic Paraboloid Doubly Ruled Shelter [17].*Toroid* [18].

3. Conclusion

This paper attempts to discuss the initial geometric discoveries on the projects of, rather incongruous architect of nowadays architecture, Zaha Hadid, mostly by building visual symbolic analogies. Hadid is one of the deconstructivist architects, it can be noticed that his works carry certain traces of constructivism and suprematism, and also they stand out by the use of different geometry. One of the main research questions on Hadid who received a classical architecture education, is that the reasons behind his contemporary architects different approaches towards geometry. The answer is considered on that his education rather than his Iraqi-British roots.

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Dejan Grba

GET LUCKY: COGNITIVE ASPECTS OF GENERATIVE ART

Topic: Art

Author:
Dejan Grba
New Media Program, Faculty of Fine Arts, University of the Arts, Belgrade, Serbia;
Digital Art PhD Program, University of the Arts, Interdisciplinary Studies, Belgrade, Serbia
http://www.digitalartprogram.info
http://dejangrba.dyndns.org

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Abstract:

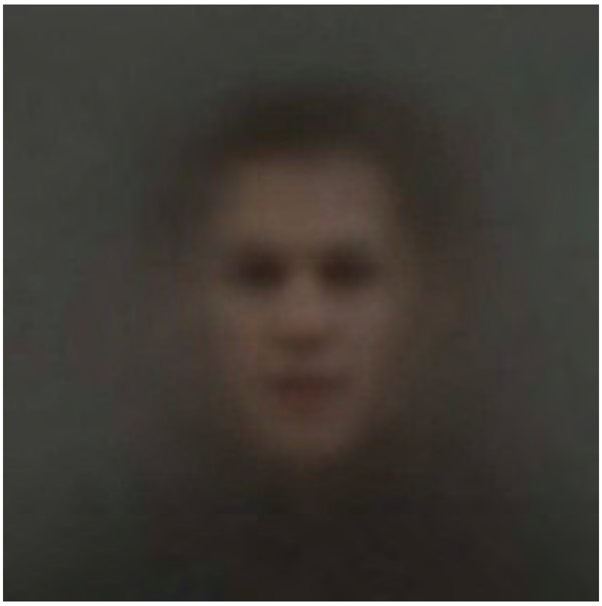
This paper addresses the creative, cultural and cognitive aspects of symbolic and procedural thinking in contemporary generative art.

Generative art is perceived broadly, as a heterogeneous realm of artistic approaches based upon combining the predefined elements with different factors of unpredictability in conceptualizing, producing and presenting the artwork, thus formalizing the uncontrollability of the creative process, underlining and aestheticizing the contextual nature of art.

The introduction provides an overview of generativeness as one of the key factors of art making, outlines the characteristics of ludic, pseudo- or proto-scientific methodology that distinguish generative art, and focuses on generative principles in digital art.

The main section includes several interrelated sets of contemporary generative art projects, with comments on the conceptual, technical and poetic qualities of their methodologies.

The conclusion summarizes the specifics of symbolic and procedural thinking which is required for the development of generative art projects, and discusses its cognitive implications for creativity in general.



Shinseungback Kimyonghun, Portrait: Bourne Identity, 2013.

Contact:
dejan.grba@gmail.com

Keywords:abstraction, algorithm, analogy, anticipation, art, code, cognition, creativity, digital art, generativeness, innovation, intuition, invention, knowledge, language, learning, predictability, procedure, programming, reduction, semantics, software, science.

Get Lucky: Cognitive Aspects of Generative Art

Prof. Dejan Grba, PhD.
New Media Program, Faculty of Fine Arts, University of the Arts, Belgrade, Serbia
http://dejangrba.dyndns.org
e-mail: dejan.grba@gmail.com

Abstract

This paper addresses the creative, cultural and cognitive aspects of symbolic and procedural thinking in contemporary generative art.

Generative art is perceived broadly, as a heterogeneous realm of artistic approaches based upon combining the predefined elements with different factors of unpredictability in conceptualizing, producing and presenting the artwork, thus formalizing the uncontrollability of the creative process, underlining and aestheticizing the contextual nature of art.

The introduction provides an overview of generativeness as one of the key factors of art making, outlines the characteristics of ludic, pseudo- or proto-scientific methodology that distinguish generative art, and focuses on generative principles in digital art.

The main section includes several interrelated sets of contemporary generative art projects, with comments on the conceptual, technical and poetic qualities of their methodologies.

The conclusion summarizes the specifics of symbolic and procedural thinking which is required for the development of generative art projects, and discusses its cognitive implications for creativity in general.

Keywords: abstraction, algorithm, analogy, anticipation, art, code, cognition, creativity, digital art, generativeness, innovation, intuition, invention, knowledge, language, learning, predictability, procedure, programming, reduction, semantics, software, science.

Generative Art and Digital Art

The conceptions of generative art in contemporary discourse differ by inclusiveness [1][2][3][4][5][6]. In this paper, generative art is perceived broadly, as a heterogeneous realm of artistic approaches based upon combining the predefined elements with different factors of unpredictability in conceptualizing, producing and presenting the artwork, thus formalizing the uncontrollability of the creative process, underlining and aestheticizing the contextual nature of art.

Similarly, the term *digital art* in this paper denotes a wide spectrum of practices based upon the innovative, experimental, direct or indirect application and exploration of emerging (digital) technologies in correlation with scientific research, which strategically redefine the notions of both traditional and new media, and challenge the distinctions between artistic process, experience and product.

Generativeness

Like all other human endeavors, the arts always emerge from an interrelation between control and accident, and exist in a probabilistic universe. The artists' consciousness about and appreciation of the impossibility to absolutely control the creative process, its outcomes, perception, reception, interpretation and further use is often not their principal motivation, but it becomes central in generative art. Generative art appreciates the artwork as a dynamic catalyzing event, susceptible to chance and open for change.

The early examples of planned inclusion of chance in western art, with aleatory music in the fifteenth century, through the musical game of dice (Musikalisches Würfelspiel) and W.A. Mozart's (unauthenticated) instruction-based random compositions in the eighteen century, lead the way to the experiments with indeterminacy in the early twentieth century.

Duchamp's works based upon chance and aesthetic indifference motivated John Cage's exploration of indeterminacy, for example in *Music of Changes* (1951), in *Imaginary Landscape* series (1939-1952) and, most notably, in *4:33* (1952) which affirmed the conscious use of chance, interaction and openness to various media as the legitimate artistic principles [7].

Contemporary generative art emerges from the mid-twentieth century Modernist exploration of the nature of creative process, of the material, semantic and contextual identity of the artwork, influenced by information theory, system theory, cybernetics and semiotics [8] [9].

Algorithm and Unpredictability

The use of instructions and language in minimalism and in conceptual art introduced the algorithm and procedure as formal elements but also as participatory factors, e.g. in Sol LeWitt, Lawrence Weiner and George Brecht. It emphasized that the operation of an algorithm, as a structured set of rules and methods, may be well comprehended but its effects can evade prediction.

The cognitive tension between the banality of pre-planned systems and their surprising outcomes became one of the major poetic elements in minimal music, for example in Steve Reich's opus in the 1960s, with the astonishing effects of phase shifting, iteration, repetition and accumulation of musical figures, in Fluxus, in some process artworks such as Hans Haacke's *Condensation Cube* (1963), and in some land art projects such as Walter DeMaria's *The Lightning Field* (1977).

Artwork as a Study: Curiosity and Generativeness

The idea of structuring a complex artwork in the form of research or study is widely adopted in contemporary art, particularly in digital art in which the fluidity of boundaries between production stages (idea, draft, sketch, final work, presentation, reproduction, etc.) is a given.

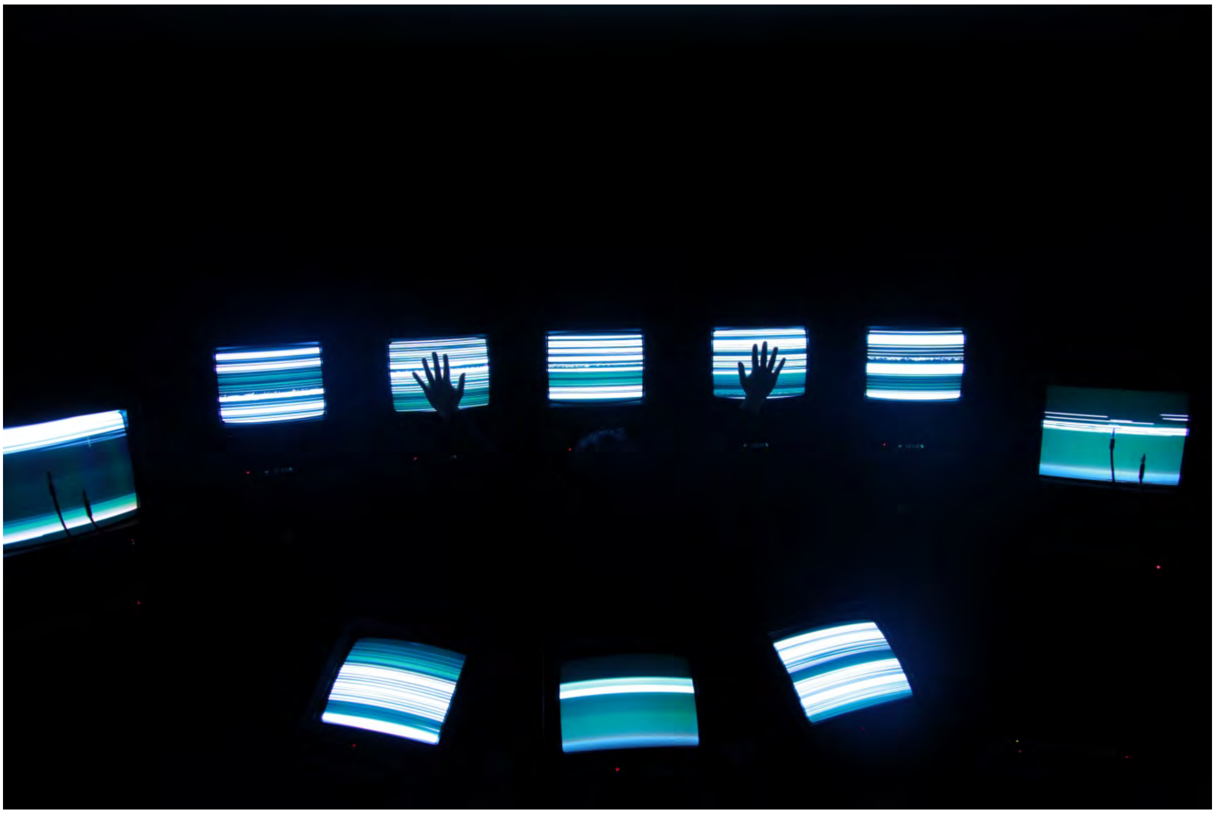
A forerunner to modern study-based art is Leonardo da Vinci whose career is defined by the intellectual, emotional and aesthetic joy of experimentation, discovery and learning [10] [11]. His exceptional curiosity and need to scrutinize and artfully share his wondering of the world have been highly influential and motivational in the arts, science and technology.

With masterful, visually compact explorations of the paroxysms of facial expression in *Characterköpfe*, *Ausdrucksstudien* and *Selbstportraits* series (cca. 1770-1783), Franz Xaver Messerschmidt is another important antecedent and emancipator of modern understanding of the study-based artwork [12] [13]. The study-based approach which emphasizes the experiential aspects of the artistic process and the experimental nature of the artwork intensifies in Modernism as epitomized in Picasso's oeuvre. The study-based approach

was prominent in Neoconstructivism and in early computer art, in which the principle of trial and error was established both conceptually and technologically [14] [15].
In recent art, Roman Signer's work highlights the idea of ludic, proto- or pseudo-scientific experiment which is performed out of curiosity to actually experience, not just envision, what will happen in certain preconceived circumstances [16] [17] [18] [19]. This idea is important in digital generative art because the computer-based methodology facilitates rapid testing and prototyping, but primarily because it points to the specific qualities of procedural thinking. A notable exponent of ludic, proto- or pseudo-scientific approach in popular culture is Gaston Lagaffe (drawn by André Franquin from 1957 to 1996) who induces warm identification with every child regardless of their age. Always keen for risky experimentation and hacking, often with catastrophic consequences, Gaston is a paradigm of fresh, charmingly nonchalant attitude toward research-based invention, but also toward institutional and social conventions of the 'grown-up' world. He embodies a ludic cognitive drive as a topological layer of creativity which comes before scientific and artistic method.
With a tendency of the art career to become a routine, secured, crafty enterprise, the study-based methodology introduces a conscious risk of failure or waste of energy and resources, thus emphasizing the ethical aspect of art in general. The fact is, however, that even the study-based methodology can regress into a formula or brand for an essentially mediocre art production. This aspect calls for special attention in contemporary art and art education in which 'research' and 'experiment' rank among the most revered keywords.
Generative methodologies in digital art indicate the probable origin of the term *generative art* in the linguistic concepts such as 'generative grammar' and 'transformational-generative grammar' [20]. The artists combine the principles of innovative combinatorics with connective and transforming operations such as analogy making and invention. Here are some examples.

Transcoding

A significant legacy of hacking and transmedia imagination in digital art stems from Nam June Paik's early experiments with electromagnetic audio and video signal. Paik's sound installation *Fluxusobjekt Random Access* (1962-1963) playfully and elegantly deconstructs the dictate of linear succession in musical reproduction and in narrative structures, and resonates with a number of sophisticated contemporary interactive works [21].
Paik's *Participation TV 1* (1963-1966) in which the audio signal from the microphone explosively deforms a generated circular shape on the TV screen is reflected in Ei Wada's *Braun Tube Jazz Band* (2008) in which the artist recorded videos by sending various audio signals to the composite video in of a CRT monitor. Then he played these videos on several CRT monitors whose video out signals were amplified as sound and modified by varying the distance of the performer's hand from the screens [22].



Ei Wada, Braun Tube Jazz Band, 2008 [Source: Dancity Festival 2011, Foligno, Italy].

In *Magnet TV* (1965) Paik distorted the TV image by placing the magnet on top of the TV set, and in some setups the audience could move the magnet and animate the picture. Carsten Nicolai's installation *crt mgn* (2013) is a direct reference and tribute to *Magnet TV*. In *crt mgn*, the light of four wall-mounted neon tubes is recorded by a video camera and transmitted to a TV screen whose image is distorted by the irregularly swinging pendulum-mounted magnet. The moving magnet induces electricity in an electric coil and the magnetic field fluctuations are transformed into sound [23].

Crowdsourced Remix

Things get particularly interesting when the programmed regularity or randomness mix with the (un)predictability of human reactions and decisions.

For his *Game Music* project (2004-2006), Vladimir Todorović developed a freely downloadable mod for the popular online game *Unreal Tournament*, which does not affect the gameplay but encodes the actions and conditions of each player and sends them back to the artist's server which converts them into sounds and arranges these into musical compositions [24].

The online exploitation of mass participation is addressed in several projects by Aaron Koblin. In *Bicycle Built for Two Thousand* (2009), Koblin and Daniel Massey crowdsourced an 'analogue' reconstruction of the song *Daisy Bell (Bicycle Built for Two)* from 1892, whose lyrics were used for the first successful computer voice synthesis in 1961 [25]. The 2088 notes of the song were served to Amazon's Mechanical Turk whose users were tasked with recording their sonic interpretations of the notes, one note per task. The recordings were collected and rearranged back to their original positions in the song. The visitors to the project web page can listen to various versions of the reconstructed song by selecting different human- or computer-generated voice tracks [26].

Golan Levin and Zachary Lieberman, Reface [Portrait Sequencer], 2007-2010 [Courtesy of the artists].

Reface [Portrait Sequencer] (2007-2010) by Golan Levin and Zachary Lieberman wittily exploits the sight as a dominant human sense and the human reliance on facial communication. Its camera captures a brief video of the viewer's portrait, divides the image in three horizontal slices (mouth/nose, eyes and forehead) and dynamically mixes them with the slices taken from previous viewers. The face tracking algorithm provides the continuous capture of the viewer's moving face, the seamless alignment and blending of the video slices, and triggers their rearrangement as the viewer blinks [27].

Distracted Computer Vision

Kyle McDonald's brilliant innovations, modifications and applications of real-time computer vision (CV) and face recognition software open the new aspects for critical assessment of the role of selective observation and depiction of details in drawing.

McDonald's and Matt Mets' *Blind Self Portrait* (2012) uses CV to build a contour portrait of the visitor who has to keep the eyes closed while holding a pen on a moving platform in order to execute the drawing, thus becoming both the subject and a slightly inconsistent 'mechanical part' of the system [28]. This seemingly passive role is similar to the role of William Anastasi's body in his *Subway Drawings* from the 1960s.

Kyle McDonald and Matt Mets, Blind Self Portrait, 2012 [Courtesy of the artists].

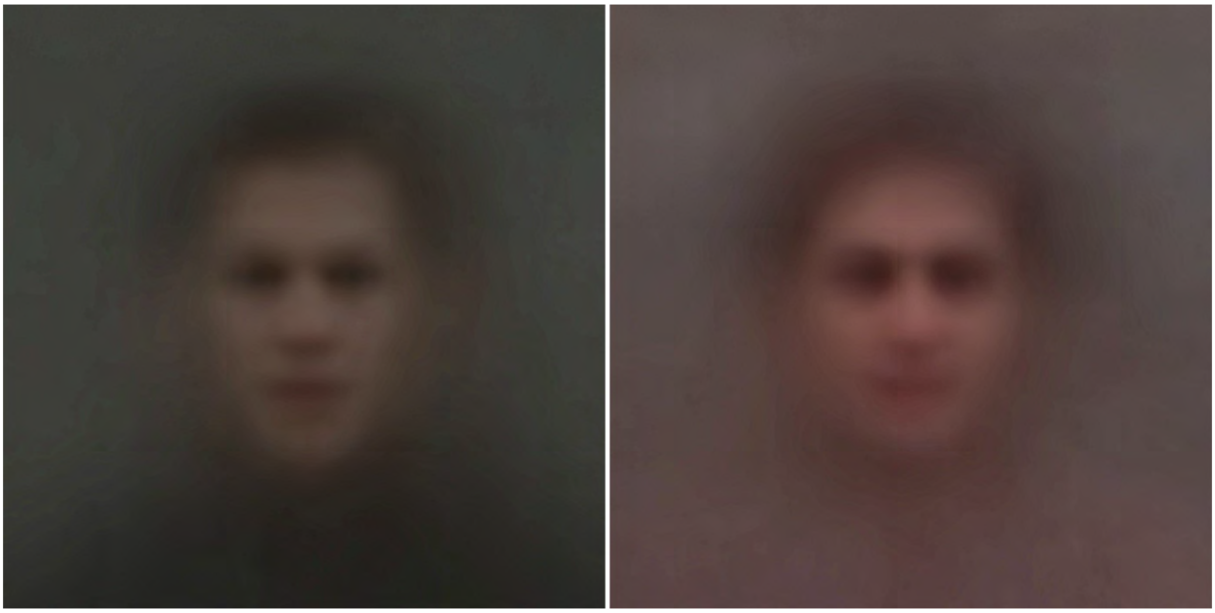
In McDonald's *Caricature* (2013) [29] the CV determines the displacements of moving facial elements in the video image and amplifies them in real time. The most radically moving parts of the face become grotesque instead of the most prominent ones in the traditional caricature [30].

Kyle McDonald, Caricature, 2013 [Courtesy of the artist].

As a mathematically formulated detection and interpretation of visual data, computer vision can be delusional. True to Leonardo's view of pareidolia as a device for unorthodox rendering of the known visual forms [31], Shinseungback Kimyonghun trick the CV in their *Cloud Face* project (2012) to select the face-like forms in the video images of a cloudy sky [32]. Pareidolia in CV, subsequently popularized in Google's DeepDream software (2015), indicates that apophenia [33] unfolds somewhere between perception and reception.

Shinseungback Kimyonghun, Cloud Face, 2012 [Courtesy of the artists].

In *Portrait* (2013) Shinseungback Kimyonghun use CV in statistically based style of Jason Salavon to generate a series of averaged portraits representing the personalized identities of different movies. The software detects faces in every 24th frame of the selected movie and blends them into one [34].



Shinseungback Kimyonghun, Portrait: Bourne Identity and Taxi Driver, 2013 [Courtesy of the artists].

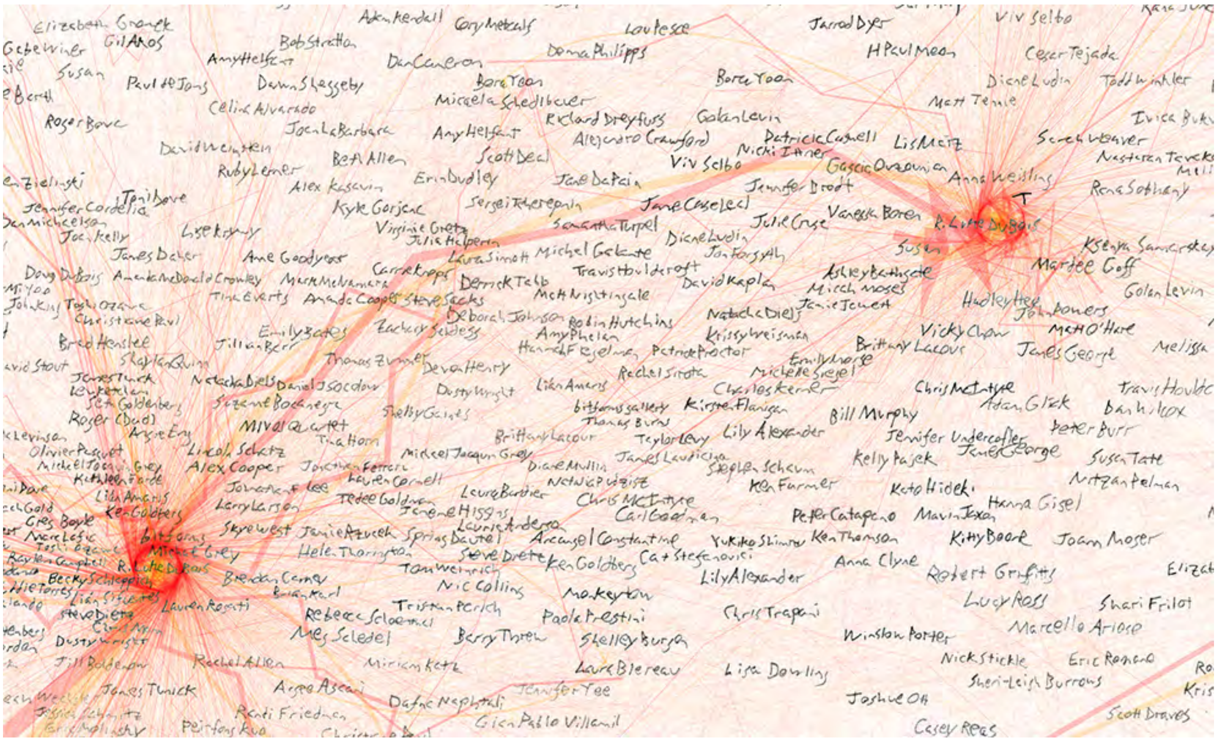
Human mind is prone to fetishizing for various reasons and in different ways, and CV can be helpful there as well. The *White Glove Tracking* project (2007) by Evan Roth and Ben Engebreth was a humorous multi-participatory online exercise in tracking Michael Jackson's venerable white glove in 10,060 frames of his landmark live performance of *Billy Jean* at Motown 25 TV show in 1983 [35].

When applied to the continuously self-obscuring or self-obliterating visual phenomena, CV reveals their complexity. In *Graffiti Analysis* series (2010), Evan Roth transforms the four-dimensional events into exciting 3d printed objects by recording the spatio-temporal dynamics of the spray can jet during graffiti writing [36]. Time is extruded over the Z axis and pen speed is represented by the thickness. Inmi Lee and Kyle McDonald used similar CV-based method in *Mother* (2012) to track, isolate and materialize the hand gestures of the people while talking in response to certain linguistic cues such as bbijook, bbejook, bogle, bbogle, bingle and bengle [37].

Inmi Lee and Kyle McDonald, Mother, 2012 [Courtesy of the artists].

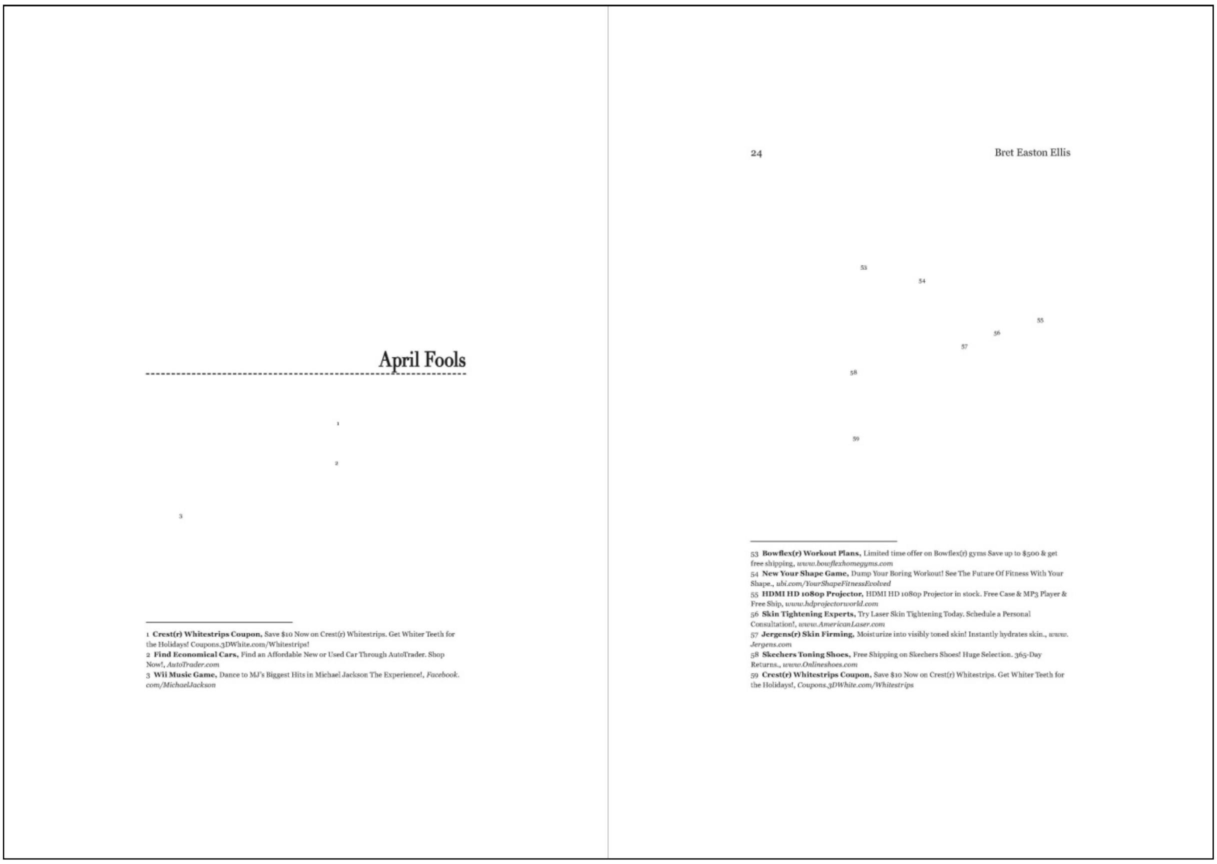
Selective Semantics

In generative art, certain qualitative phenomenological aspects are selectively quantified and turned into something else. This principle can be a theme in itself.
R. Luke DuBois explores the contextual factors of the uncanny allusiveness of selective quantification in a number of projects. In *Self-portrait 1993-2014* (2014), for example, he used semantic analysis to visualize his email correspondence over a period of twenty years. It is a force-directed graph resembling a stellar map, with DuBois' primary email addresses in the center surrounded by the addresses of several thousand people. The frequency and tone of communication, and language familiarity determine the attraction forces between the visual representations of correspondents [38].



R. Luke DuBois, Self-portrait 1993-2014 (detail), 2014 [Courtesy of the artist].

The online profit-oriented automatic recognition of linguistic and behavioral patterns was deftly subverted by Mimi Cabell and Jason Huff in *American Psycho* (2012). It was created by sending all the pages of Bret Easton Ellis' novel *American Psycho* (1991) through Gmail, one page per email, and collecting the Google ads that appeared next to each email. The ads were used to correspondingly annotate the original text which was then erased leaving only the original chapter titles and generated footnotes [39].



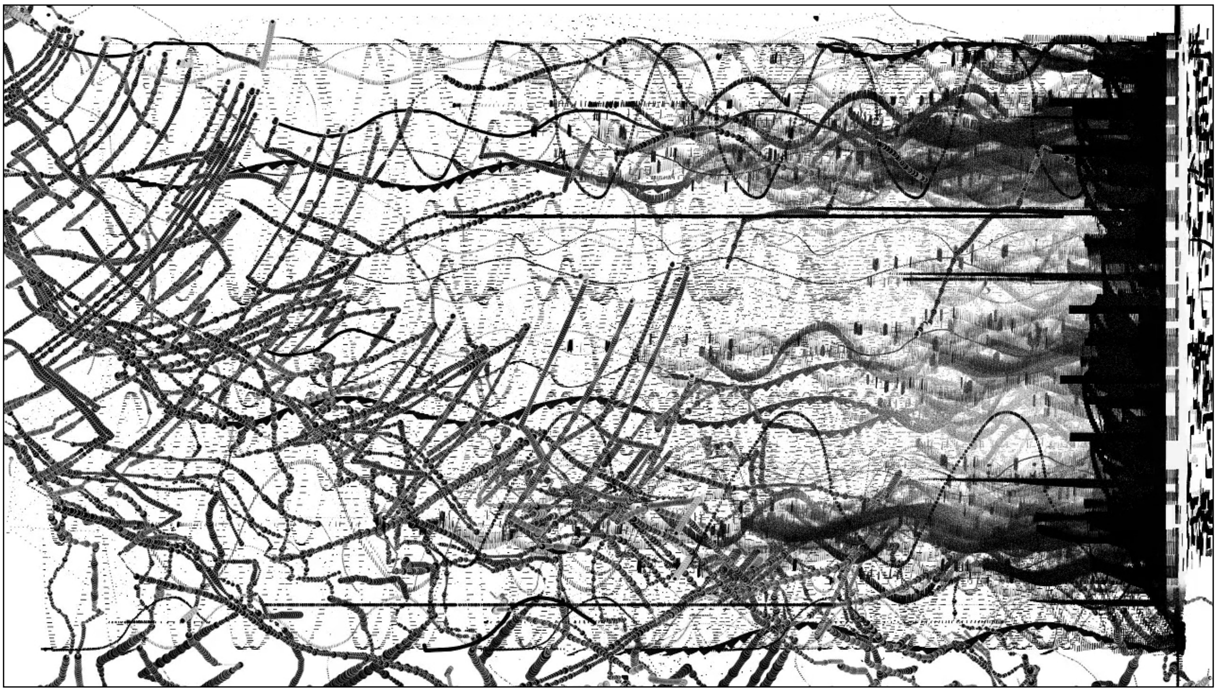
Mimi Cabell and Jason Huff, American Psycho (page 4 and page 24), 2012 [Courtesy of the artists].

Escalation

Automatic pattern recognition relies heavily on the frequency of iterations and on the efficient (speedy) accumulation of specific instances. However, even when the accumulation is infinitesimally slow, the effects can be stunning. In Jonathan Schipper's *Slow Inevitable Death of American Muscle* (2008) two 1978/1979 Pontiac Firebirds are pressed into a head on collision which takes six days. During that time each car moves about 90cm into the other, performing a 50km/h collision at a speed of 0.00000625km/h [40].

Jonathan Schipper, Slow Inevitable Death of American Muscle, 2008 [Courtesy of the artist].

Similarly, the effects can be engaging when the relatively monotonous build-ups get sporadically disrupted. Sudden changes in sound and image, generated by the random walk algorithm which was modified with cosine function, accelerated and decelerated, determine the overall ambience of Vladimir Todorović's video *1985* (2013). Inspired by George Orwell's *1984* (1949), it is an abstract visualization of the fictional activities of the four ministries (Peace, Love, Plenty and Truth) that govern Oceania one year after the events in the novel [41].



Vladimir Todorović, 1985 (Ministry of Truth), 2013 [Courtesy of the artist].

Todorović successfully employs this ambiental concept in several other animations, for example in *Silica-Esc* (2010) which remixes the works of Jean Luc Godard (*Weekend*, 1967), Velimir Khlebnikov (*The Radio of the Future*, 1921), Fyodor Dostoyevsky (*Notes from the Underground*, 1864), and quotes by Caspar David Friedrich. It uses the cloth simulation algorithm for rapid generation and movement of abstract visual elements synchronized with sound and narration.

Beyond Procedure

At least two modes of thinking unfold in the development of generative art projects. One concerns matching the algorithmic and the unpredictable elements into a coherent generative system. It relies on the anticipation or expectation of the performative qualities of the system, based upon experience, knowledge and intuition. Another mode is required for the construction of algorithms as multi-purpose tools [42]. It requires procedural literacy and programming skills, particularly for generative projects in digital art [43]. Procedural literacy, understood as "the ability to read and write processes, to engage procedural representation and aesthetics", implies that programming is not just a technical task but an act of dynamic communication and symbolic representation of the world [44].

Procedural thinking includes three steps: dematerialization of certain phenomenon into a set of signs that describe it properly, resolving that sign set into pure syntax (removing the semantic layer), and translation of the syntax into a series of operations (elements of the programming language) [45]. This 'trivialization' requires a set of cognitive abilities: intuition or sense for recognizing the phenomenon which can be algorythmized under particular conditions, imagination and flexibility of reasoning, distinguishing between the rational and irrational aspects in the mental concepts of natural phenomena, and attention to scope and inflexibility of the algorithmic (computer) system.

Procedural thinking faces some challenges, especially in creative coding. The conceptual constraints (syntaxes) of programming languages and the hardware architecture can impose certain solutions and unwillingly spin the artistic process [46]. The fixed performative capabilities of the hardware can reflect in roughness and lack of spontaneity in the simulations of natural phenomena [47]. Finally, there are the undecidable problems in computability theory, and the limits of mathematical formalization established in Gödel's incompleteness theorems. But protocols, material and formal boundaries are enforced by men or nature to all human activities, not just to procedural thinking. While optimization of productivity and

expressiveness within restricted frameworks requires hard mental work, the quality of effort in breaking out of restricted frameworks is the essence of creativity [48].
Generative approaches in digital art explore the discovering potential of the plasticity and adaptability in mimicking natural phenomena as the defining factors of universal computing machine [49] [50]. This exploration requires ingenuity, team work, interdisciplinary research, understanding of accumulated knowledge, and learning [51]. The successful generative artworks are powerful tools for blending the elements of unrelated matrices of thought into the new matrices of meaning through comparison, abstraction and categorization, analogies and metaphors. Just like computer software, they encapsulate specific intellectual energy which can be engaged implicitly or explicitly and incite original, often surprising, configurations and ideas.

The examples in this paper are distinguished by the artists' abilities to expand the potentials of generative methodology by creating new contexts which transcend the conceptual, productive, expressive and aesthetic limits of code-based art making. They elegantly demonstrate the amazing capacity of human mind to simultaneously invent the technology, absorb it, adapt to it, repurpose and transform it as needed.

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Erhan Karakoç

Performative Architecture with an Adaptive Building Facade

Topic: Architecture

Author:
Erhan Karakoç
İstanbul Kültür University, Department of Architecture,
Turkey

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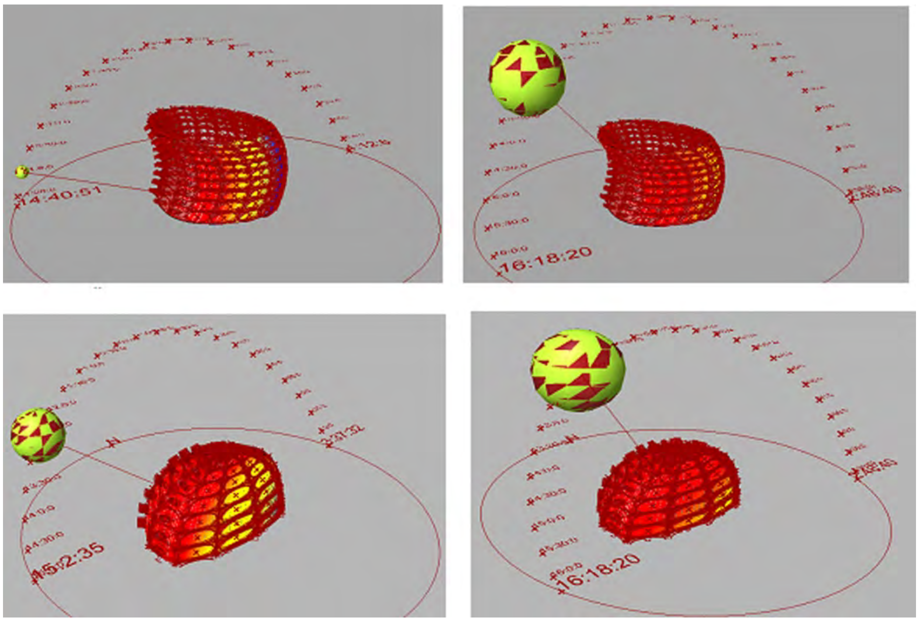
Abstract:

Performative and adaptive architecture is very popular nowadays. Especially, environmental problems such as climate changing and air pollution is increasing by the non-technologic buildings. So, designers are interested on the adaptive building to stop this environmental problems as soon as it is possible by some technological methods as performative and adaptive architecture. In this article, performance based adaptive building envelop design criteria and methods will be explained with a building envelope (model suggestion), that has adaptation ability to sun.

Within this article, it is evaluated that the theoretical works and application data. The performative, adaptive and pneumatic architecture which are explained in theoretical part of the article, are examined in terms of the place in architectural medium, design strategies and project examples. At the end of these examinations, some deductions are made. In the application part of the article, it is examined how the adaptive envelope reacts in the different time zones and different places and seasons. Also the algorithm is applied on different geometries to analyzed the forms which emerged according to the sun. These output are collected and evaluated to understand how the algorithm works. Outcome is affected differently according to the parameters. In terms of model proposal, the computer programs which related to the computational design are used.

For the method of the proposal, nature inspired approach is used. The opening and closing of the stomas which are the pores of the plants are analyzed. These systematical pressure changes which are observed in the plants provide to use a different analogy technic for the application of the model. Thanks to the nature inspired design approaches, the optimization of the building envelope according to the sun is ensured and the algorithms which are led to the changes in building morphology are created.



Model suggestion: facade and sun orientation with performative and adaptive systems

Contact:
erhankarakocitu@gmail.com

Keywords: Performative Architecture; Adaptive Architecture; biomimicry; Optimization.

Performative Architecture with an Adaptive Building Facade

MSc. Arch. Erhan Karakoç, R.A.

Department of Architecture, İstanbul Kültür University, İstanbul, Turkey

e-mail: erhankarakocitu@gmail.com

Professor of Architecture Gülen Çağdaş

Department of Architecture, İstanbul Technical University, İstanbul, Turkey

e-mail: glcagdas@gmail.com

Premise

Performative and adaptive architecture is very popular nowadays. Especially, environmental problems such as climate changing and air pollution is increasing by the non-technologic buildings. So, designers are interested on the adaptive building to stop this environmental problems as soon as it is possible by some technological methods as performative and adaptive architecture. In this article, performance based adaptive building envelop design criteria and methods will be explained with a building envelope (model Proposal), that has adaptation ability to sun.

1. Introduction

Within this article, it is evaluated that the theoretical works and application data. The performative, adaptive and pneumatic architecture which are explained in theoretical part of the article, are examined in terms of the place in architectural medium, design strategies and project examples. At the end of these examinations, some deductions are made.

In the application part of the article, it is examined how the adaptive envelope reacts in the different time zones and different places and seasons. Also the algorithm is applied on different geometries to analyse the forms which emerged according to the sun. These output are collected and evaluated to understand how the algorithm works and evaluates. Outcome is affected differently according to the parameters. In terms of model proposal, the computer programs which related to the computational design are used (Karakoç, 2015).

For the method of the proposal, nature inspired approach is used. The opening and closing of the stomas which are the pores of the plants are analysed. These systematically pressure changes which are observed in the plants provide to use a different analogy technic for the application of the model.

Thanks to the nature inspired design approaches, the optimization of the building envelope according to the sun is ensured and the algorithms which are led to the changes in building morphology are created.

2. Performative Architecture

Performance based adaptive buildings have become much more important in case of the changeable climate parameters. Performance based adaptive building envelopes, which can change according to the environmental factors, enhance the living comfort of the users, ensure the sustainability, reduce the operation costs and extend the life of the building thanks to integration the other disciplines with the architecture (Karakoç, 2015).

The architectural design has different methods. Performance based adaptive architecture is one of these methods. Because the architecture issues are related to lots of variables, it has become necessary to examine these issues with the other disciplines like engineering, natural and social sciences. In this article, it has been evaluated severally in regarding to performance based adaptive architecture and these evaluations are shown via the example analyses.

The inputs of the performance based design are examined and the effects of these inputs upon the adaptive building envelope are explained by evaluating the data (Oxman, 2008).

The important part of the article is derived from the recently developing issues according to the changes in architectural approaches like the performative, adaptive and pneumatic architecture. “Form follows performance” is a new tag for today’s architectural style (Hensel, Menges, 2008).

In this article, it is explained that the effects of computational design tools upon the design of the adaptive systems by authors. In the design process of the project which is proposed, it is examined that the effects of the parametric based design tools upon the performance based adaptive and pneumatic systems.

It is clarified that the software which are used in constitution of the different systems, morphologies and geometries, the methods and the researches in regards to algorithms providing the control of the performance based adaptive and pneumatic morphologies within the project.

3. Adaptive Architecture

Adaptive buildings and facades are emerged at the beginning of the 1980’s (Wiggington, 2002). Adaptive buildings can process the conditions inside and outside of the envelope and change its forms according to effect or turn some passive climatic systems on.

For adaptive architecture, environment must be harmonious with architecture and other natural and artificial elements must be harmonious with building envelope (Ghamari, Asefi, 2010).

Adaptive architecture provides the user to live under the comfortable and ideal conditions in the building by forming the architecture with environmental factors. Addition to this, adaptive architecture is important regarding the protecting the environment and sustainability.

In the world which the conditions change constantly, the environmental factors play an important role. It is necessary to design adaptive buildings in which the climate changes occur permanently.

Adaptive architecture as discussed in this research proposes a new strategy for performative architecture defined as a multi-layered system that communicates with environment, in this case humans, through both software and hardware and has the ability to change its rules during its interaction with the environment (Karakoç, 2015).

Adaptive building have many advantages when we compare to traditional buildings. This advantages that is during life-cycle are more comfort for building users, more stable buildings, less management expenses and sustainability.

Adaptive buildings also have some potentials for future and nowadays. These potentials are developed “decision support mechanisms”, material technology (nano- technology etc.), computer aided design and computer aided manufacturing tools.

In this article, definition of adaptive buildings, advantages and potentials of adaptive buildings and design process of performance based adaptive building will be explained.

4. A Model for Designing Performance Based Adaptive Building Envelope

Sun is the most important parameter for environment and climate, especially for a model that is performance based and adaptive. In this chapter, design process of a model that is react to the sun and its data in a simulation with different software will be explained.

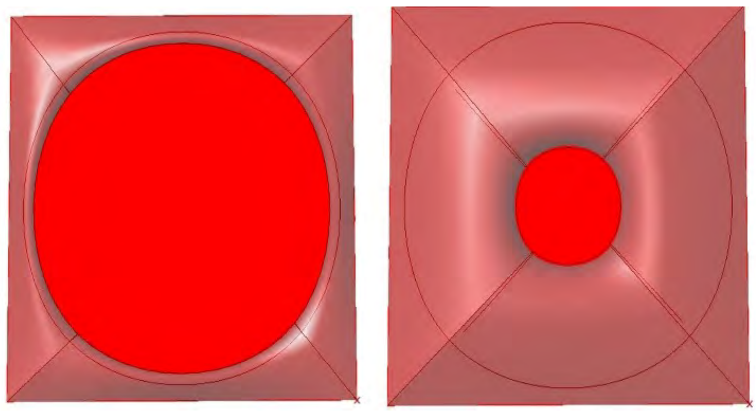


Figure 1: Sun orientation of the modules as the proposed model (Module: Left hand side is opened, right hand side is closed)

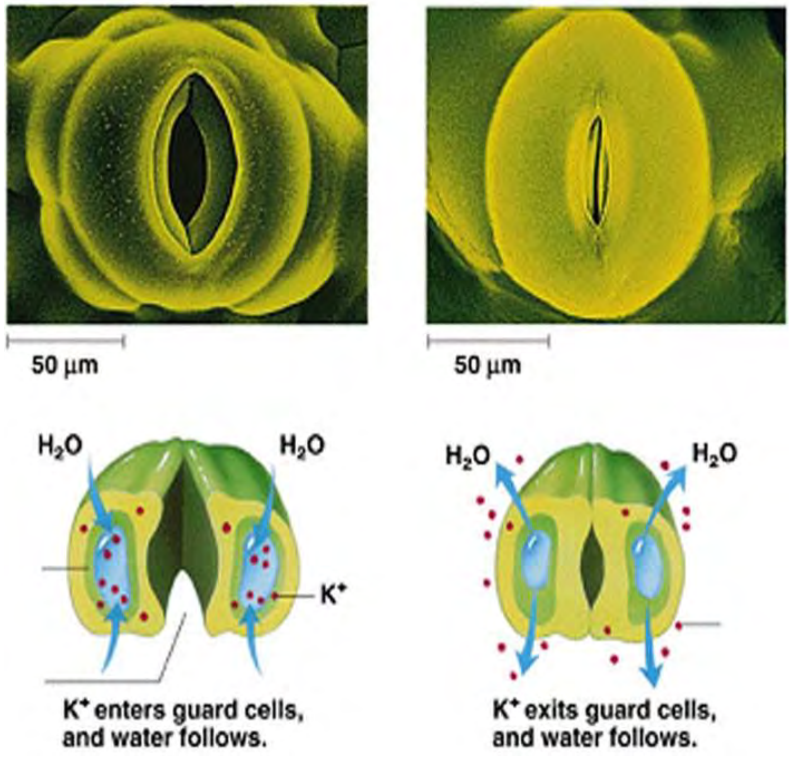


Figure 2: Sun Orientation in the nature with inner pressure of plants (plant stomata: Left hand side is opened, right hand side is closed)

Nature inspired design is really suitable to create and design optimized buildings and its envelopes. Optimization in architectural design can be used for understanding the adaptive building and performance based design (Figure 1).

Plants can optimize water levels, air quality and pressure on the stomata with a specific system. In this module design, it is aimed to reach the similar system with the “stomata optimization” (Figure 2).

Nature inspired design that is used for optimization is evolved to pneumatic design and adaptive design with a performative inputs. These performative inputs can be analysed easily by this visual code (Figure 3) and can provide a reaction to climate and especially sun.

Performance based adaptive building envelope is designed with the “Rhinoceros” and “VB.net scripts” and by the data of suns position changings as the seasons and times during the day.

Solar radiation is calculated with a parametric software script in VB.net and building envelope is changed according to sun and its data such as solar radiation, angle, latitude, longitude and other parameters (Figure 3).

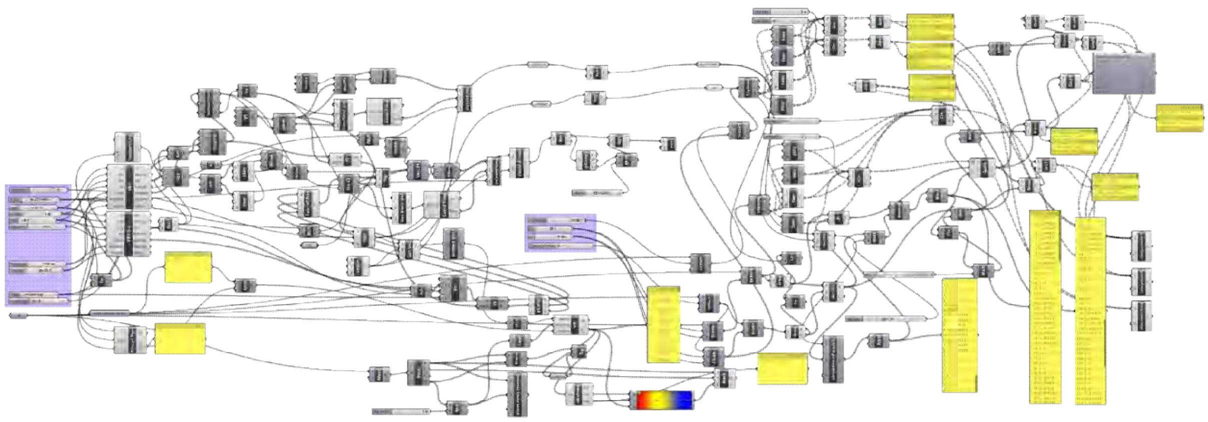


Figure 3: Visual Code part of "the model for designing performance based adaptive building envelope"

In this model design, there is a grid systems that include some modules uniquely designed and react to environment by its own data. Some parameters for this model are simulated first as a solar radiation and then angle and the other parameters and then it optimize the all modules. After all modules are calculated oriented to sun, porosity of the modules can be change by the data and this envelope control system by an decision making algorithm (figure 3).

4.1 Model Proposals on the Seasons

As the model data input changings forms can be change as the angle of the sun, solar radiation, sun direction and other parameters in the shape and modular organisation. Under this title four different experimental shapes in winter and summer results will be explained.

4.1.1 Model Proposals on the winter season (January)

The four different experimental shapes will be shown in this section as the winter seasons (January) (fig.4-7).

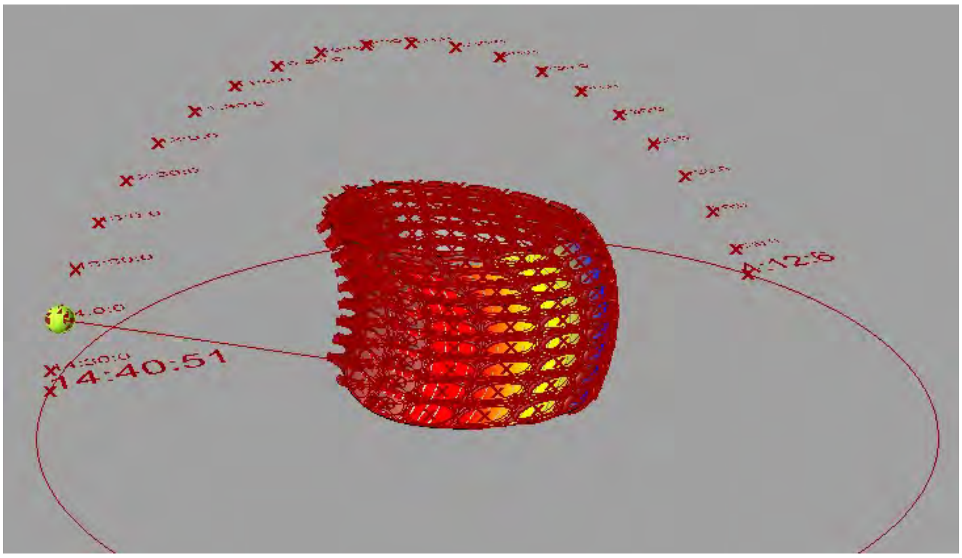


Figure 4: Example 1 form in winter (January)

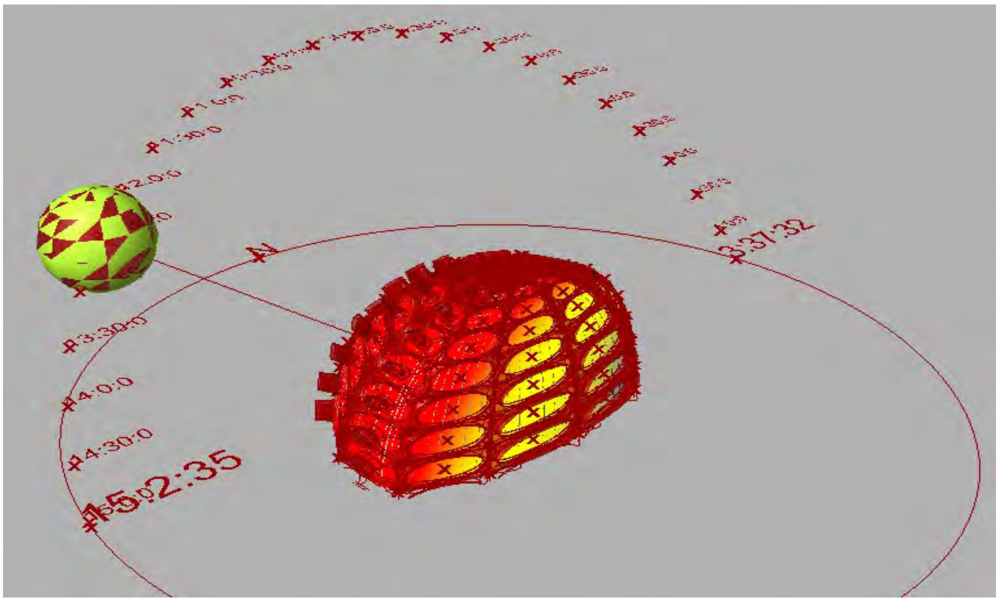


Figure 5: Example 2 form in winter (January)

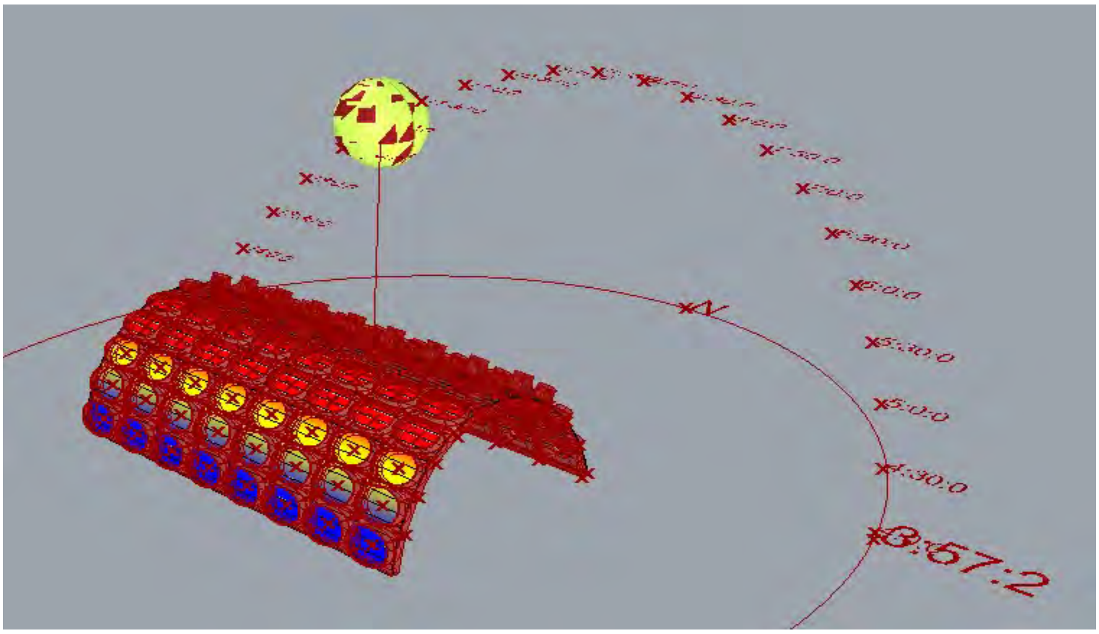


Figure 6: Example 3 form in winter (January)

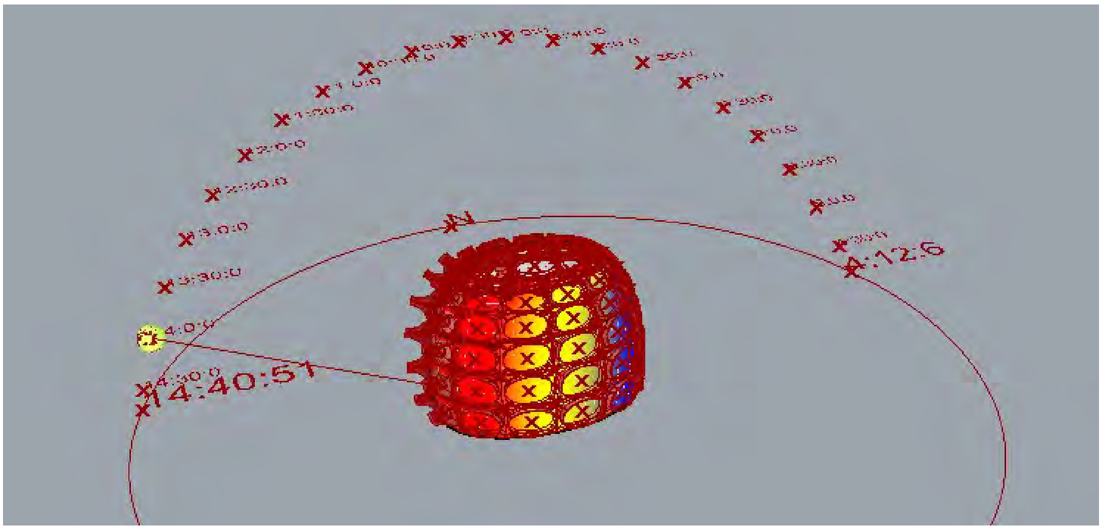


Figure 7: Example 4 form in winter (January)

4.1.1 Model Proposals on the summer season (June)

The four different experimental shapes will be shown in this section as the winter seasons (January) (fig.8-12).

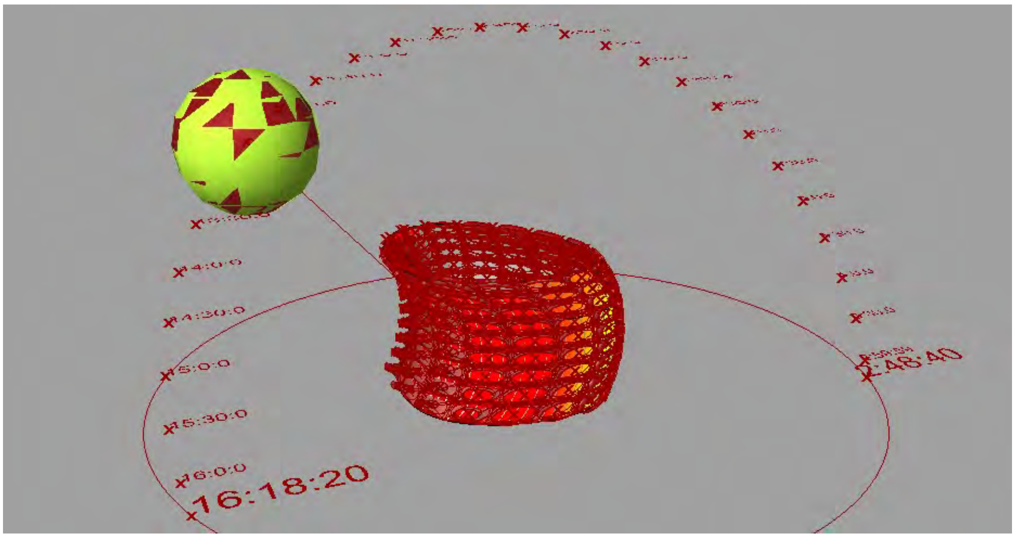


Figure 8: Example 1 form in summer (June)

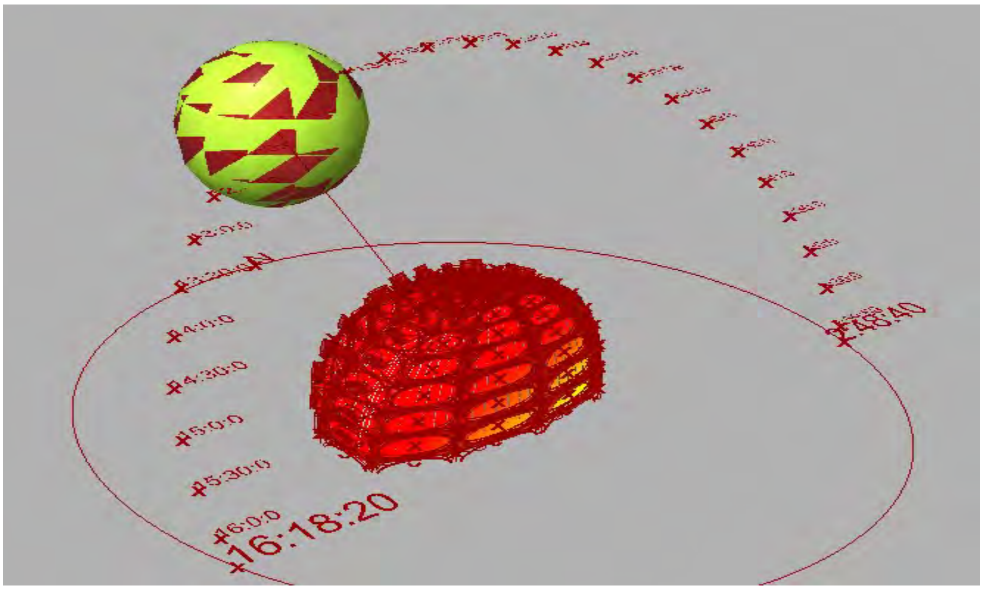


Figure 9: Example 2 form in summer (June)

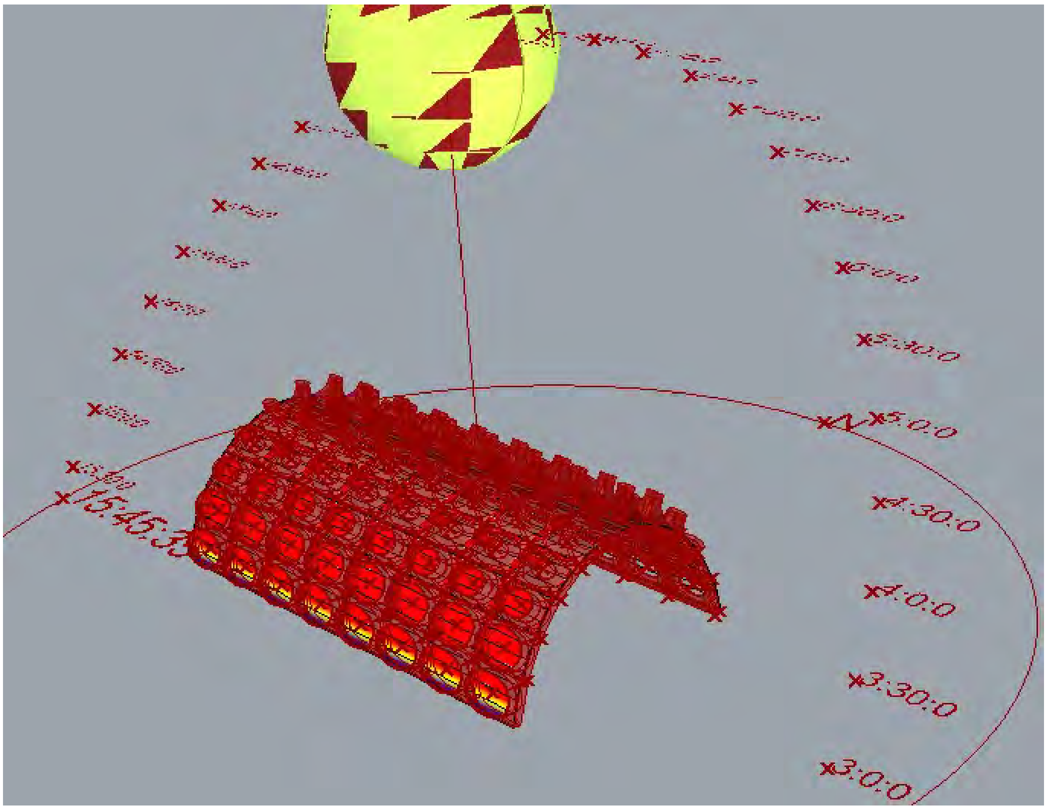


Figure 10: Example 3 form in summer (June)

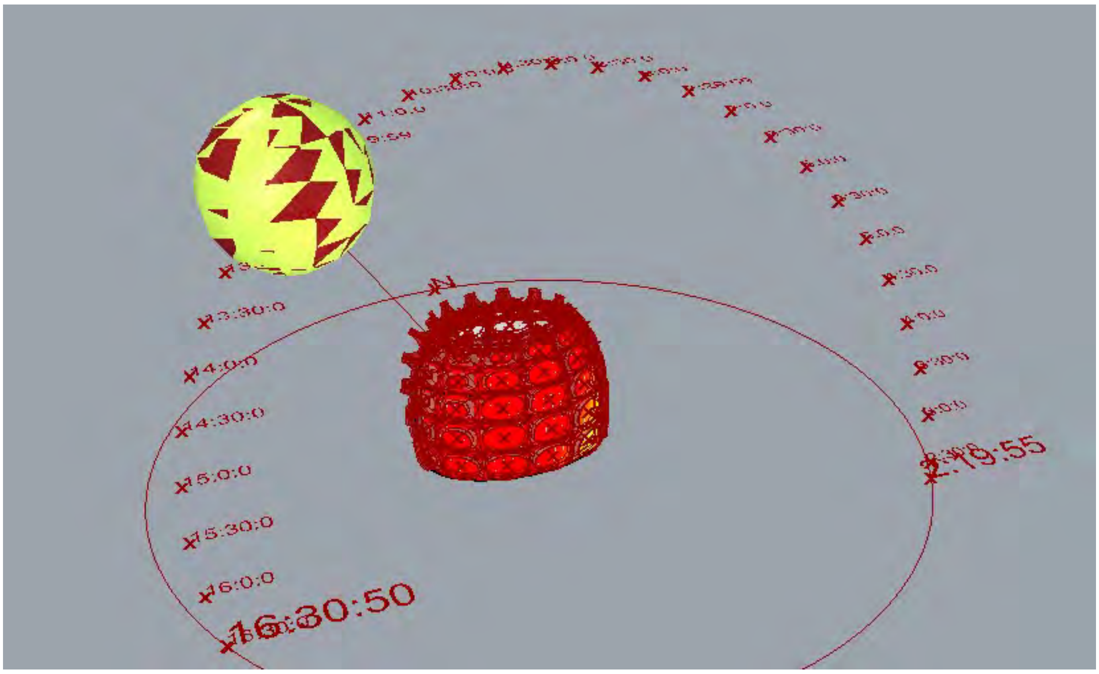


Figure 11: Example 4 form in summer (June)

4.2 Model Proposal on the Different Hours on the Daytime

As the model data input changings forms in the daytime can be change as the angle of the sun, solar radiation, sun direction and other parameters in the shape and modular organisation. Under this title four different experimental shapes in morning, afternoon and evening results will be explained.

4.1.1 Model Proposal in the morning

The four different experimental shapes will be shown in this section as the morning (fig.12-15).

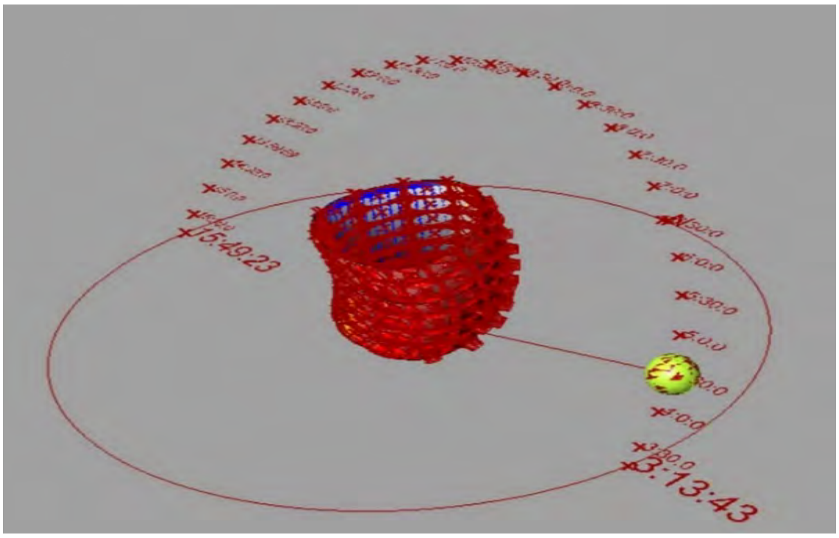


Figure 12: Example 1 form in morning

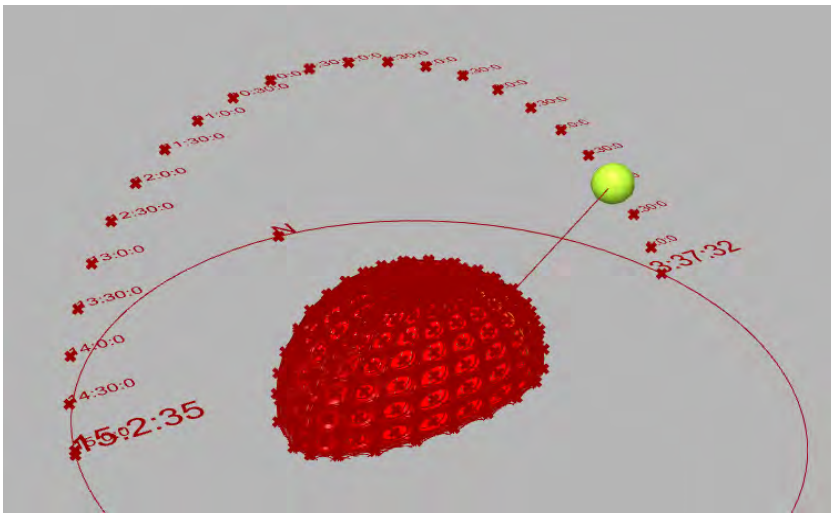


Figure 13: Example 2 form in morning

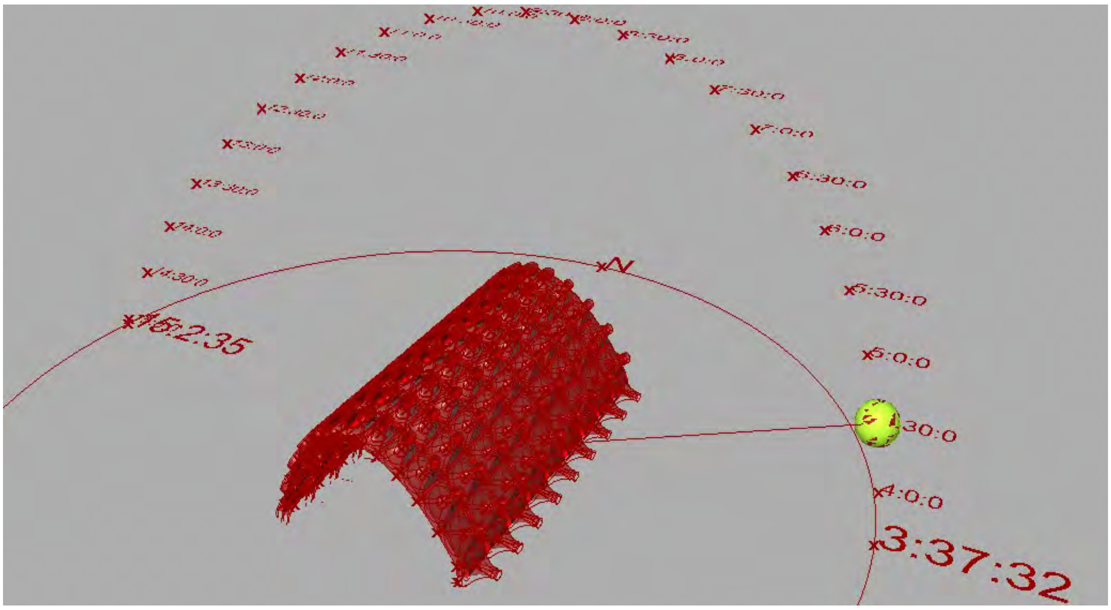
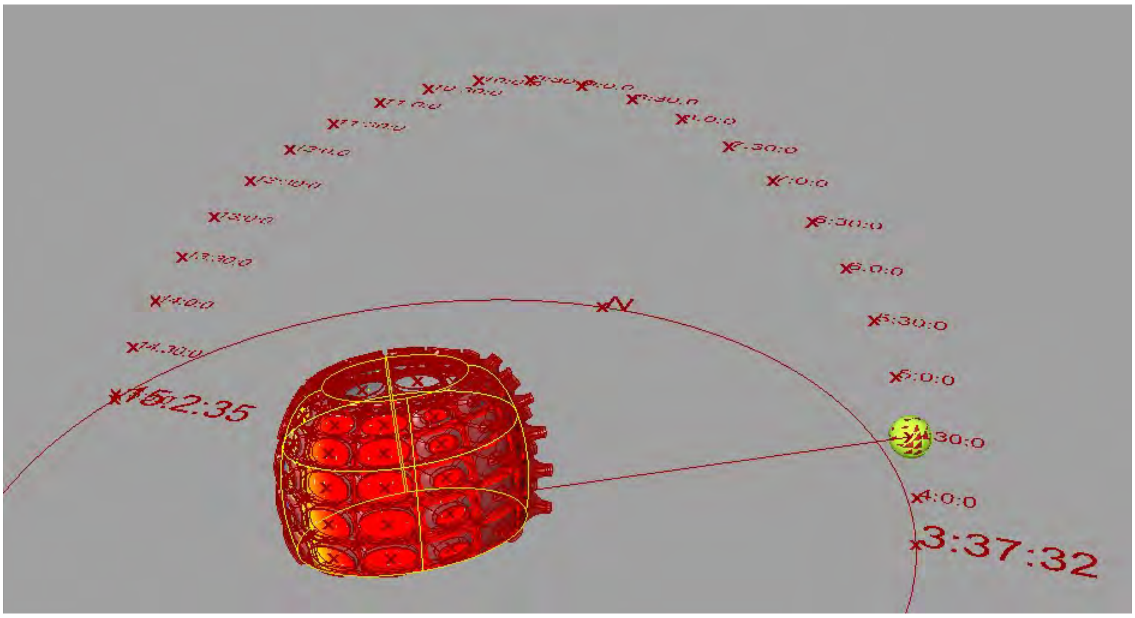


Figure 14: Example 3 form in morning

Figure 15: Example 4 form in morning



4.1.2 Model Proposal in the afternoon

The four different experimental shapes will be shown in this section as the afternoon (fig.16-19).

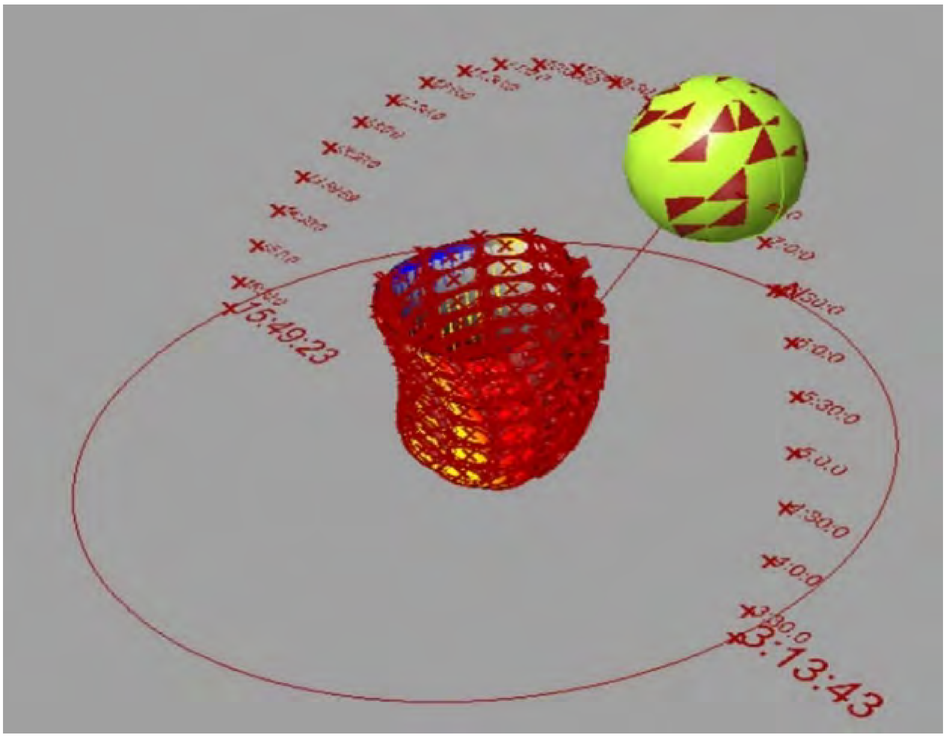


Figure 16: Example 1 form in afternoon

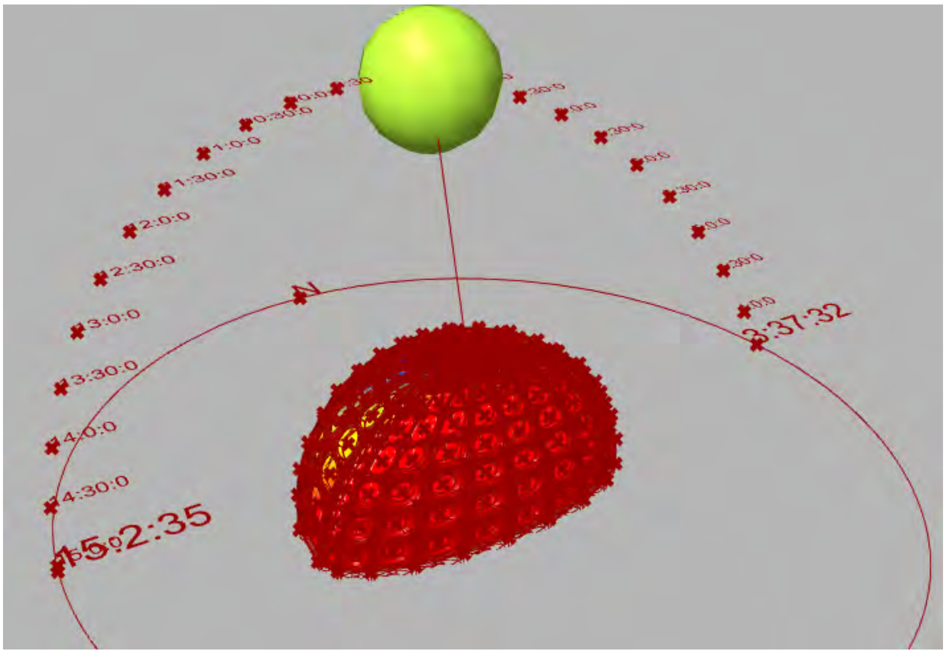


Figure 17: Example 2 form in afternoon

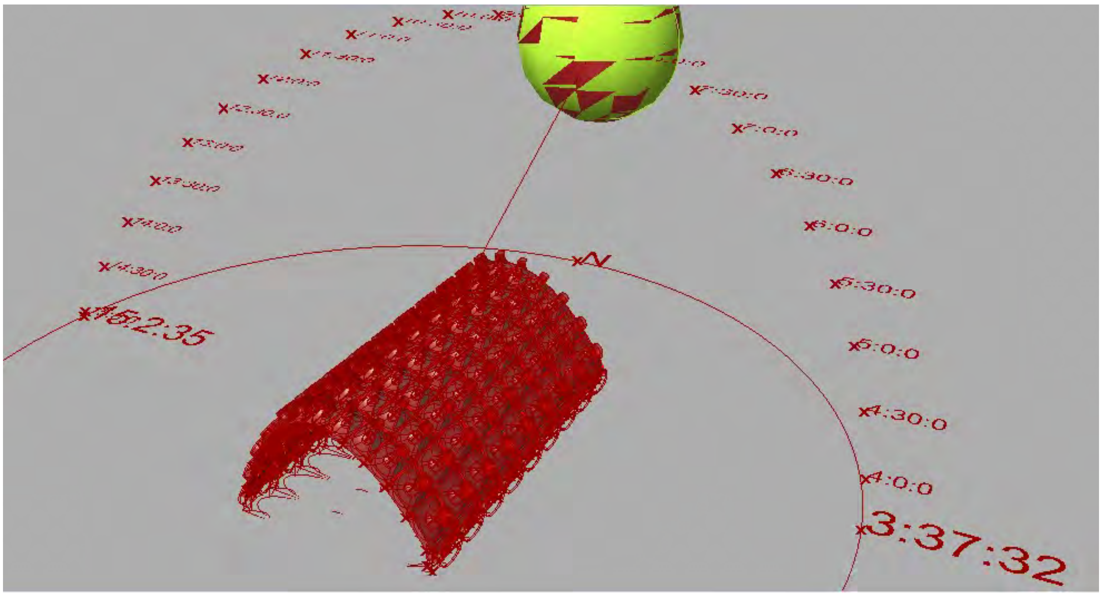


Figure 18: Example 3 form in afternoon

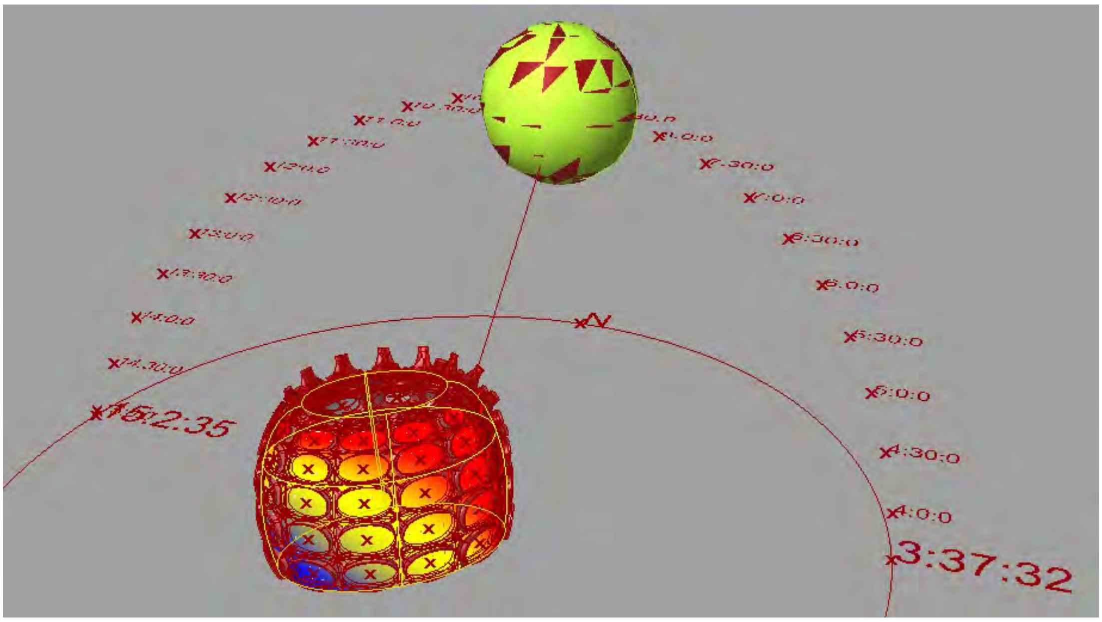


Figure 19: Example 4 form in afternoon

4.1.2 Model Proposal in the afternoon

The four different experimental shapes will be shown in this section as the evening (fig.20-23).

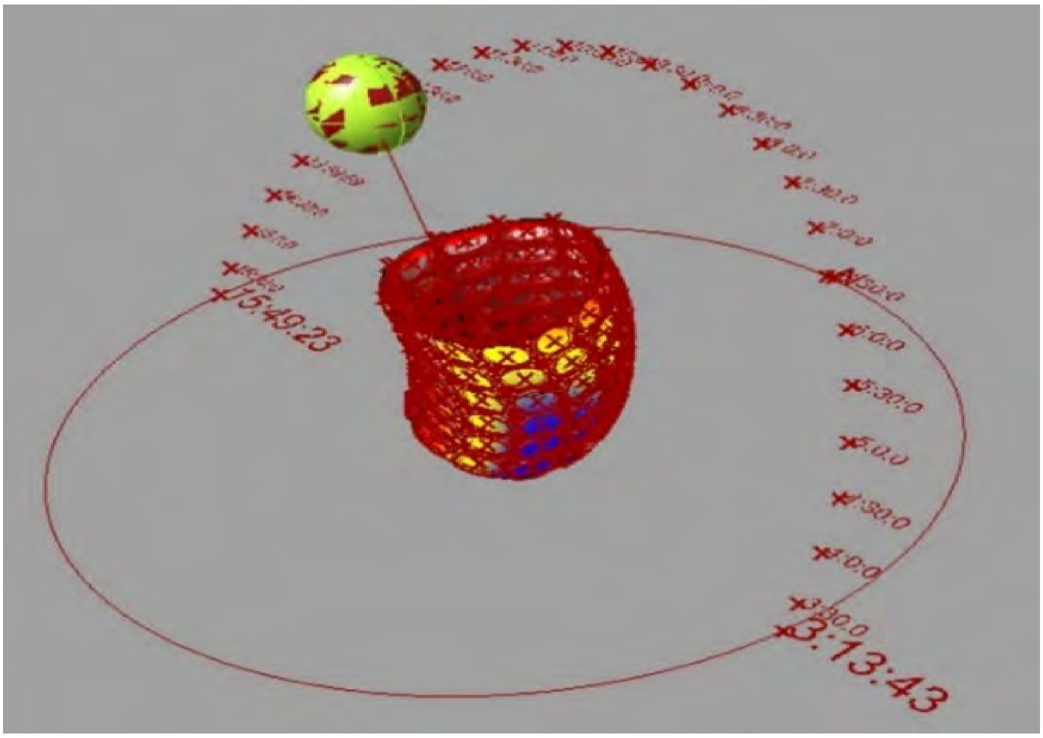


Figure 20: Example 1 form in evening

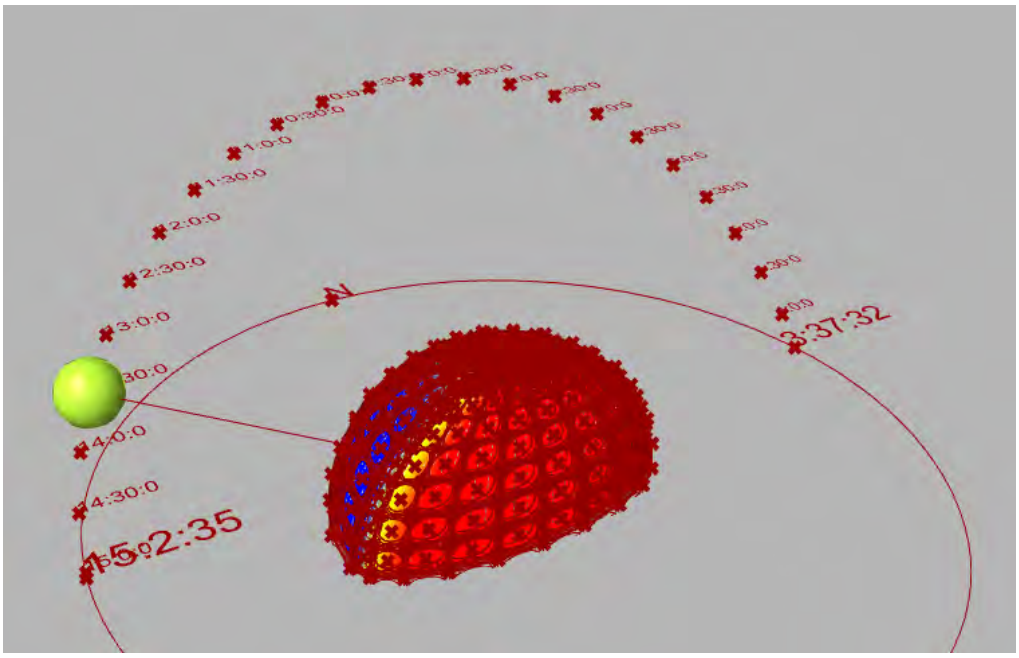


Figure 21: Example 2 form in evening

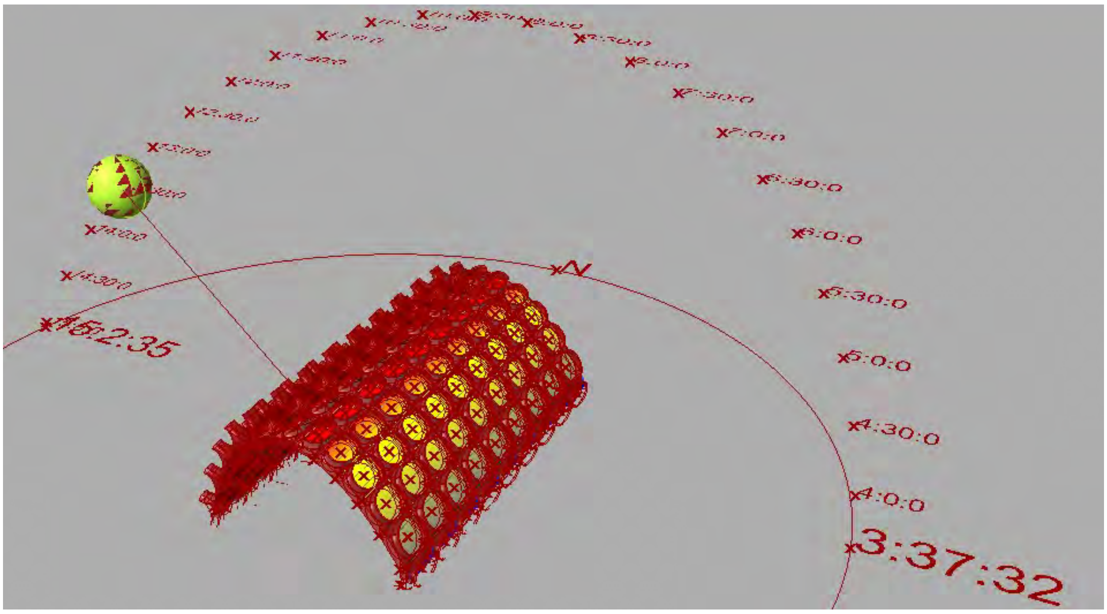


Figure 22: Example 3 form in evening

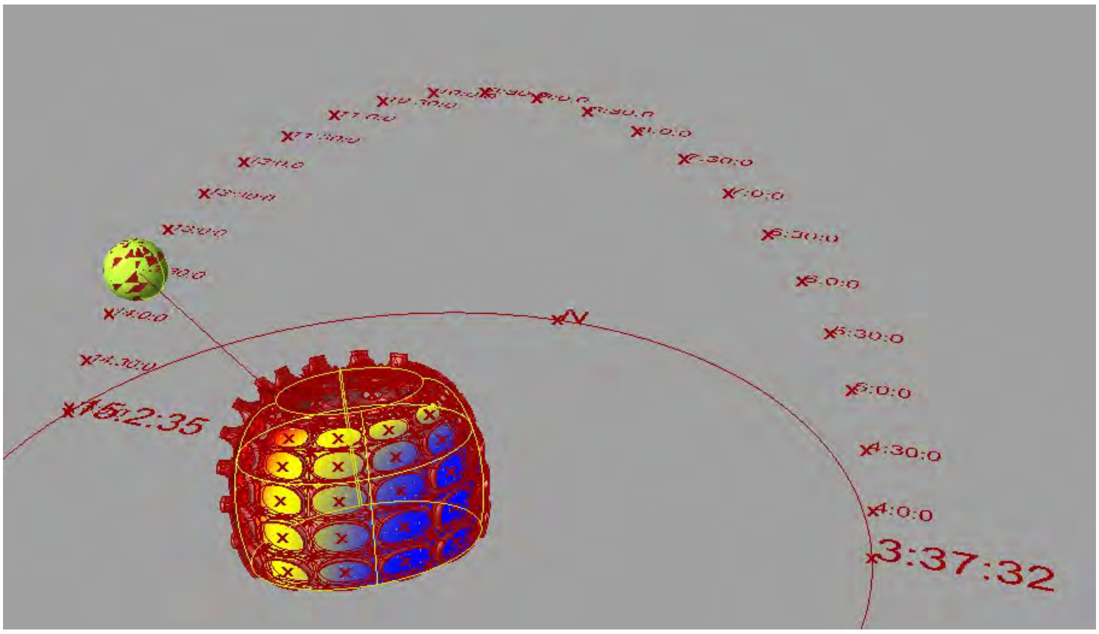


Figure 23: Example 4 form in evening

4.3 Parameters of The Model Proposals

The basic parameters of the model is shown on the figure 24. Another parameters that is used for creating basic shape (curvature degree, pressure for the modules etc.) and modules location optimisation algorithms are calculated by the computer with the Rhino and its plugins (grasshopper, heliotrope, Diva, gEco and vb.net) and visual basic. These algorithms are optimised to have most efficient form of the building envelope.

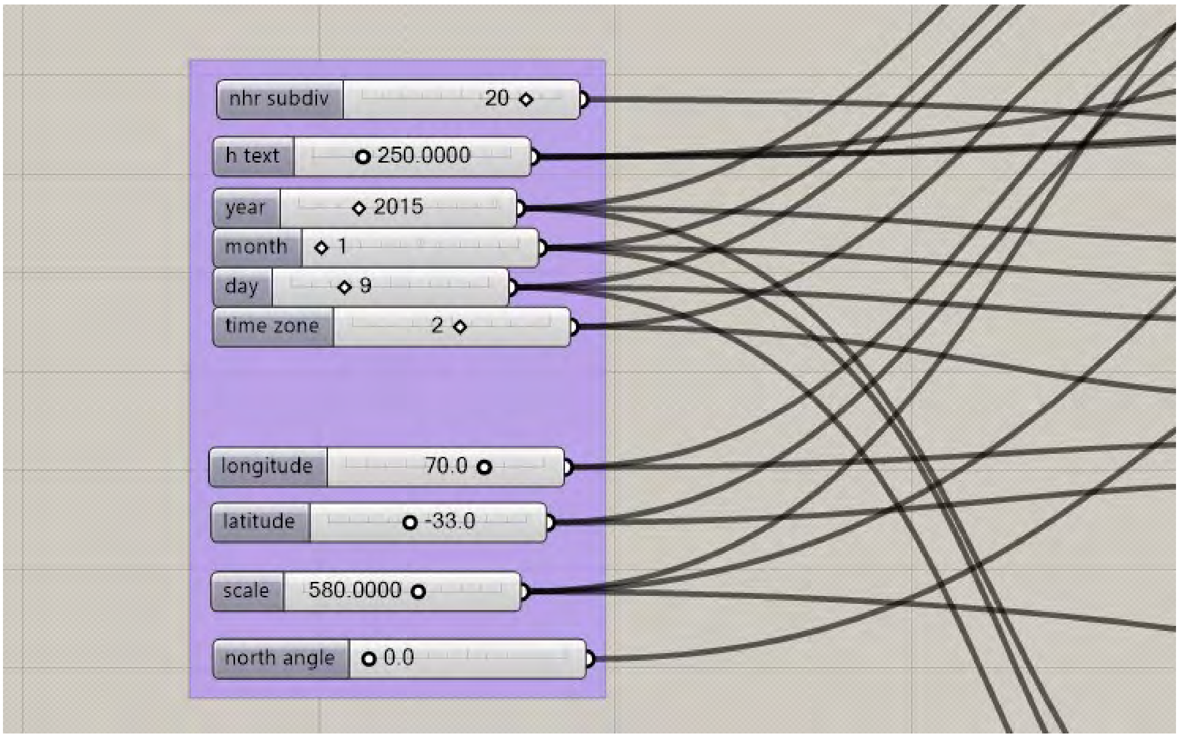


Figure 24: Parameters of the model

4.4 Potentials and Future of The Model Proposal

The proposed model of the performance based adaptive and pneumatic building has many potentials. This software and forms can be improved by the computers. Especially, Artificial intelligence is an important and innovation for the model proposal. Because computers can manage buildings as the parameters like sun, wind and so on.

For the future applications and advantages of the performance based adaptive building envelopes that can be oriented to the sun is really an opportunity for a sustainable environment. Because, by using adaptive buildings, people spent less natural resources and provide building users more comfortable spaces.

Economic reasons are the important for the building users. If architects use performance based adaptive building, building users can have all these opportunities.

Outcome is affected differently according to the parameters. In terms of model proposal, the computer programs which related to the computational design are used.

5. Conclusion

As a result, building envelopes in the future will be more optimized and more functional and it will be controlled by the decision making algorithms. After these algorithms developed in a high level, building users can give control of their spaces and their buildings. Probably, in the future by the artificial intelligence researches, people will talk their building about all the situation of the house about climate. Performance based adaptive buildings can be the solution for the healthier environment and more efficient architecture.

In this article theoretical information and a model application is explained and some details of the model are shown with graphics as a data, model and simulations and potentials, advantages of this model for the future are explained.

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Annex
Code Examples From The Model Proposal

Visual Basic Code Piece 1

```
.................

  Private Sub Print(ByVal format As String, ByVal ParamArray args As Object())

    __out.Add(String.Format(format, args))

  End Sub

  Private Sub Reflect(ByVal obj As Object)

    __out.Add(GH_ScriptComponentUtilities.ReflectType_VB(obj))

  End Sub

the Script component. </summary>

  Private Sub Reflect(ByVal obj As Object, ByVal method_name As String

  End Sub

#End Region
```

```
  Private Sub RunScript(ByVal pts As List(Of On3dPoint), ByVal riseSet As List(Of On3dPoint), ByRef A As Object)
    Dim i As Integer
    Dim newPtArray As New List(Of On3dPoint)
    Dim tempPtArray As On3dPoint
    newPtArray.Add(riseSet(0))
    For i = 0 To pts.Count - 1
      tempPtArray = pts(i)
      If tempPtArray.IsValid Then
        If tempPtArray.z > 0 Then
          newPtArray.Add(tempPtArray)
        End If
End Class
```

....

Visual Basic Code Piece 2

....

```
  Private Sub Print(ByVal format As String, ByVal ParamArray args As Object())
    __out.Add(String.Format(format, args)) component. </summary>
  End Sub
  Private Sub Reflect(ByVal obj As Object, ByVal method_name As String)
    __out.Add(GH_ScriptComponentUtilities.ReflectType_VB(obj, method_name))
  End Sub
#End Region
Private Sub RunScript(ByVal year As Integer, ByVal month As Integer, ByVal day As Integer, ByRef doy As Object)
    ''' algorithm based on OnlineConversion.com http://www.onlineconversion.com/day_week_number.htm
   If year Mod 4 = 0 And year Mod 100 <> 0 Or year Mod 400 = 0 Then
     doy = day + accumulateLY(month)
```

```
    Else
       doy = day + accumulateNY(month)
</my vb4>
    End If
  End Sub
End Class
```

....

Visual Basic Code Piece 3

....

```
  Private Sub RunScript(ByVal yr As Double, ByVal mth As Double, ByVal day As Double, ByVal hrs As Double, ByVal tzone As Double, ByVal longitude As Double, ByVal latitude As Double, ByRef zenAng As Object, ByRef azi As Object, ByRef hrAngle As Object, ByRef solarElev As Object, ByRef eqaTime As Object, ByRef solDec As Object)
    ' The Solar Position algorithm is based on National Oceanic and Atmospheric Administration's Solar Position Calculator http://www.srrb.noaa.gov/highlights/sunrise/azel.html
    'Code is ported into vb.net and integrated into Grasshopper by Ted Ngai
     Dim hourAngle, haRad, csz, zenith, azDenom As Double
    Dim azRad, azimuth, exoatmElevation, refractionCorrection, te As Double
    Dim solarZen, elevation, coszen As Double
    'timenow is GMT time for calculation
    Dim timenow As Double = hrs - tzone
    longitude = longitude * -1
     Dim JD As Double = calcJD(yr, mth, day)
    Dim T As Double = calcTimeJulianCent(JD + timenow / 24.0)
    Dim R As Double = calcSunRadVector(T)
    Dim alpha As Double = calcSunRtAscension(T)
    Dim theta As Double = calcSunDeclination(T)
    Dim earthRadVec As Double = R
```

....

Visual Basic Code Piece 4

....

```
    Dim solarTimeFix As Double = eqTime - 4.0 * longitude + 60.0 * -tzone
   Dim trueSolarTime As Double = hrs * 60 + solarTimeFix
    While trueSolarTime > 1440
     trueSolarTime -= 1440
   End While
  hourAngle = trueSolarTime / 4.0 - 180.0
   If hourAngle < -180 Then
     hourAngle = hourAngle + 360
   zenith = radToDeg(Math.acos(csz))
   azDenom = (Math.cos(degToRad(latitude)) * Math.sin(degToRad(zenith)))
 If Math.abs(azDenom) > 0.001 Then
 'Basic Functions
 'Convert radian angle to degrees
 Function radTodeg(ByVal angleRad)
   radTodeg = (180.0 * angleRad / Math.Pi)
 End Function
 Function degToRad(ByVal angleDeg)
   degToRad = Math.Pi * angleDeg / 180.0
 End Function
```

....

Val Tsourikov

Paper: **Creative Principles for Strong Emotional Impact**

Topic: Creative Principles

Authors:

Val Tsourikov,

Chief A.I. Architect

Predizo LLC

www.predizo.com

References:

[1] Tsourikov, V., , (2013). "Architecture of Self Learning A.I. Platform for Generative Art", GA2013, Milano, Italy, 2013.

Abstract:

A.I. platform for Generative Art [1] can't be built without a knowledge-base of creative principles, used in visual art and photography to create strong emotional impact.

We focused on photography and some areas of modern art to formulate a list of such principles. Currently there are twenty two principles in the knowledge-base.

Several principles are universal by nature and can be found in general systems design (dynamization, fragmentation of visual object, merger of the object with background, multiple objects).

Large group of principles are based on idea of creating conflict between common sense knowledge and interpretation of visual pattern (imitation of miracle, upside down, almost impossible, inverse expectation, technical function transfer, interaction with copy).

Three principles focus on predictable human reaction (anticipation of danger, object or action of strong emotion, opposite emotions).

Intuitively, modern photo artists very often try to find novel ideas by putting main subject into unusual environment, i.e. they actually try to increase semantic distance in composition of the photo. Unfortunately, due to "in-box thinking" phenomenon such approach results in millions of photographs, which either have no novelty at all, or have no aesthetic value. We believe that knowledge base of creative principles will help artists to find truly novel scenarios.

Creative principles can be used in combination with algorithmic generative art. For example, an artist applies creative principle(s) from the knowledge-base to design scenario of the photo or art work, then uses formal generative art to optimize parameters or find novel version of original concept.

We suggest following work flows.

Version A: An artist choses principle(s) → novel composition is created → algorithm of generative art is applied to optimize the concept.

Version B: By running generative art algorithm the artist picks up the most promising concept → knowledge-base of creative principles is used to optimize the concept.

Contact:* *valerymt@gmail.com

Creative principles, photography, A.I. platform, semantic distance

Creative Principles for Strong Emotional Impact

Dr. Val M.Tsourikov,
Predizo LLC, Minsk, Belarus www.predizo.com
email: valerymt@gmail.com

Knowledge base of creative principles

A.I. platform for Generative Art [1] can't be built without a knowledge-base of creative principles, used in visual art and photography to create strong emotional impact.
We focus on photography and some areas of modern art to formulate a list of such principles.

Author of the paper also studied creative principles in technology, science and mathematics [2, 3]. To avoid potential biased opinions the decision was made to formulate creative principles in photography and modern visual art by doing analysis of raw data, i.e. photos and art works.

Currently there are twenty two principles in the knowledge-base.

Several principles are universal by nature and can be found in general systems design (dynamization, fragmentation of visual object, merger of the object with background, multiple objects). Three principles focus on predictable human reaction (anticipation of danger, object or action of strong emotion, opposite emotions).

Large group of principles are based on idea of creating conflict between common sense knowledge and semantic interpretation of visual pattern (imitation of miracle, upside down, almost impossible, inverse expectation, technical function transfer, interaction with copy).

Intuitively, modern photo artists very often try to find novel ideas by putting main subject into unusual environment, i.e. they actually try to increase semantic distance in composition of the photo. Unfortunately, due to "in-box thinking" phenomenon such approach results in millions of photographs, which either have no novelty at all, or have no aesthetic value. We believe that knowledge base of creative principles will help artists to find truly novel scenarios.

Conflict as a source of strong surprise

By focusing on art works with strong emotional impact we found that many surprising images contain conflicts.

Conflict between the image and person's internal model of the world: for instance, well trained ballerina attracts attention by jumping unusually high in the air. Such a jump is an example of quite popular principle, called *extreme pose or move*. By nature it is parametric type of principle. Novelty - and surprise – is created not by designing a new composition, but by changing parameter (height of jump) of well-known composition.

Conflict inside the image: principle of *opposite emotions* is based on image composition, which includes two stories; each story generates its own emotion; two emotions belong to opposite groups, like joy – sorrow, for example.

Inverse expectation principle can be used to create conflict between a process with expected normal result and actual result which is inverse to expected. When a wooden arrow hits a soap bubble, normal expectation is to watch bubble burst. Flying arrow and soap bubble establish expectation based on common knowledge. To inverse expectation an artist creates an image with arrow broken into pieces and unchanged bubble.

How to design novelty with creative principles

Creative principles can be used in combination with algorithmic generative art. For example, an artist applies creative principle(s) from the knowledge-base to design scenario of the photo or visual art work, then uses formal generative art to optimize parameters or find novel version of original concept.

We suggest following work flows.

Version A: An artist choses principle(s) → novel composition is created → algorithm of generative art is applied to optimize the concept.

Version B: By running generative art algorithm the artist picks up the most promising concept → knowledge-base of creative principles is used to optimize the concept.

In ideal world we find emotional concept first by applying following principles: anticipated danger, opposite emotions, inverse expectation, almost impossible. Then one or more principles can be used from the list below. Combinations of independent principles are able to generate concepts with high level of novelty.

List of creative principles

1. Almost impossible. Image composition with very low probability of existence in physical world.
2. Inverse Expectation. Intuitive expectation of process/action is in conflict with actual result on the image.
3. Anticipated danger. Subject of an image is in risky situation, or even in the point of no return.
4. Object/action of strong emotion. Skull and bones is a good example, overused though.
5. Human behavior imitation. Animals, birds, insects imitate humans.
6. Extreme pose or move. Exceptional performance of known action.
7. Fragmentation. Main subject/object is fragmented, parts may be displaced.
8. Merger. Subject is merged with background or other objects of the image.
9. Bizarre analogy. Example: fish plays role of a tie.
10. Opposite emotions. Image includes two compositions, generating opposite emotions.
11. Multiple objects. Group of similar objects create synergy effect.
12. Tip of iceberg. Only very small part of object is shown.

13. Imitation of miracle. Image imitates violation of law of physics.
14. Interaction with copy. Subject (person or animal, bird etc.) interacts with own copy.
15. Replace environment. Put known image composition in novel environment.
16. Upside down. House standing on its roof as an example.
17. Common sense conflict. Composition contradicts commonsense knowledge.
18. Novel light. The scene is illuminated by rare type of “light”: X-ray, sparks, for example.
19. Continuation. Image includes road, lines, wires, rales, shadows. Old, but still good principle.
20. Dynamization. Move, shake, rotate main photo subject or secondary objects. Dali Atomicus, photo by P.Halsman, is great example.
21. Technical function transfer. Image of technical function is used on natural objects.
22. Chaos. Introduce chaotic moves, colors, structures onto the image. Getting very popular.

Application of several principles in ballet photography

The idea was to design concepts of photo by direct application of creative principles.

Photo on Fig. 1 illustrates two principles: *replace environment* (ballerina poses on lake instead of theater) and Almost impossible (she stands on water surface, sort of).

On second photo (Fig. 2) we see ballerina, who jumps so well, that “no gravity” illusion is created. The photo shows application of *extreme pose/move* principle.

Principle *tip of iceberg* helped to find an idea of third photo (Fig. 3).

More photos will be presented at the conference.

Figure 1 – Ballerina on lake

Figure 2 – Ballerina jumps in park

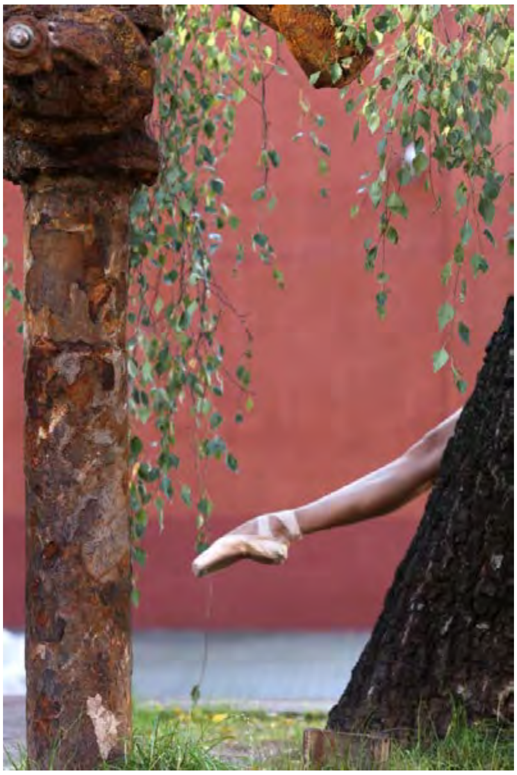

Figure 3 – pointe shoe

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rkan Zeynel Guzelci
and Handan Guzelci

An Experimental Study On Generation Process Of Geometric Patterns (Paper)

Abstract:

Artists and designers use geometric patterns to cover surfaces since ancient times. In the 13th century the architectural works show artists have a broad knowledge of creating geometric patterns. Mathematicians conduct researches and achieve creation principles of these patterns barely in the 20th century. In this context, the principles of patterns can be known by its designer but cannot be distinguished easily with a deductive approach. Geometric shapes that are typically repeating in order form a geometric pattern. Patterns are seen as an integrated composition of geometric shapes. Nowadays, computer-based programs help to create various patterns fast and efficiently. Mathematical operations are defined to make transformations on shapes. Executing simple transformations like moving, copying, mirroring and rotating on an initial shape creates 2D geometric patterns.

The first objective of this study is to search the generation process of geometric patterns and find out which parameters are used to create these patterns. This study aims not only to create shapes or geometric pattern alternatives but also to teach generation principles of geometric patterns to design students experimentally by a generative code. In the scope of this study, 2D geometric patterns are studied which are analyzed by a deductive approach.

According to analysis, the following parameters are used in generation process;

Specification of initial shape / Position of initial shapes / Distance between repeated shapes / Number of the repetition of x and y-axis / Determination of the angle transformations

By changing these parameters experimentally in coding interface, the transformation of patterns and variety in pattern geometry are examined. Before changing parameters, the main structure of code modified three times. At the first coding, hexagon shape is created by using simple lines. By copying hexagon ten times on “x” and “y” axis and moving one shape (hexagon) many different patterns are created. Besides, sub shapes are emerged in the pattern, which are not hexagons anymore. At the second coding, changing the edge number of initial shape is transformed hexagon into a pentagon. The angles between pentagons edges are modified, and pentagons become stars with different angles. These star geometries also rotate on the axis to generate different geometric patterns. During the third modification of code, hexagons edge number is set as a variable. Changing the edge number creates a pattern that includes lines, triangles, square, pentagon, hexagon and polygons with more edges than six.

As a result of modified parameters like sizes, positions, edge numbers and angles many unpredictable patterns emerge. This study shows the efficiency of coding on pattern generation. Emerged shapes can be used again as an initial shape, and new patterns can be generated with a high variety.

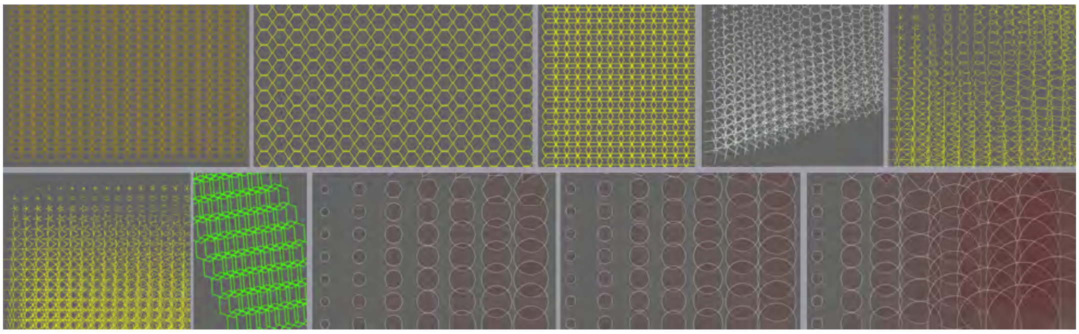

Figure: Geometric pattern alternatives generated with Processing code

Topic: (Architecture, Design, Geometry)

Authors:

Orkan Zeynel Guzelci M.Sc
Istanbul Kultur University, Interior Architecture and Environmental Design, Istanbul, Turkey

Handan Guzelci
M.Art , Istanbul Kultur University, Interior Architecture and Environmental Design, Istanbul, Turkey

Main References:

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www.generativeart.com

Contact:
orkanguzelci@gmail.com

Keywords: Geometric pattern, parametric design, shape, sub shape, coding.

3. An Experimental Study on Generation Process of Geometric Patterns

Orkan Zeynel Guzelci, M.Sc

Interior Architecture and Environmental Design Department, Istanbul Kultur University Istanbul, Turkey

www.iku.edu.tr

e-mail: orkanguzelci@gmail.com

Handan Guzelci, M.Art

Interior Architecture and Environmental Design Department, Istanbul Kultur University Istanbul, Turkey

www.iku.edu.tr

e-mail: hduyar@iku.edu.tr

Abstract

At first, the importance of emergence on pattern generation process is emphasized. The concept of emergence is also encouraged by studies of Gross and Stiny. The studies of Gross and Stiny shows that different pattern generation approaches cause emergence in particular levels. To analyze varying emergence levels, three pattern generation approaches are investigated. These approaches are classified under the title of set-based, parametric and shape-based. Then, a generative code is developed to construct patterns experimentally. Various patterns are obtained by using set-based and parametric approaches. Because of the difficulty of implementation on computer and sophisticated philosophical background, a pattern is not generated with a shape-based approach. Pattern generated by set-based and parametric methods are criticized in comparison with shape-based approach. While criticizing, it is focused on the type of emergence and use of emergent shapes in design process. As a consequence, this study is experienced not only to create geometric pattern alternatives but also to discuss the creativity levels of pattern generation approaches.

1. Introduction

The aim of this study is not only to create geometric pattern alternatives but also to discuss the creativity levels of pattern generation approaches through emerging shapes in patterns. As a scope, two dimensional periodic and aperiodic geometric patterns are considered. Before generating patterns experimentally, three different pattern generation approaches are explained upon previous studies in the design field. Investigated studies enable to analyze the generation process of geometric patterns and find out which parameters are used to create patterns. A generative code is developed based on analyzed studies. The generative code is run six times with minor modifications on parameters and codes structure. Experimentally generated patterns show the differences between used techniques and give an idea about how shapes emerge in pattern design process.

2. Geometric Patterns In Design Field

The pattern as a contemporary concept means sequence, structure, a series of a repeating unit. In the spatial pattern theory; order, scale, proportion, symmetry, balance, complexity, unity, function, nature and creativity are the related concepts. The variety of relevant concepts emphasise the role of pattern in the design process [1].

Geometric patterns inspired designers and artists since ancient times. Many designer, artist and craftsman from Ancient Rome and Ancient Greece struggle on design and built patterns. Mathematicians conduct researches and achieve design principles of patterns barely in the 20th century. Researchers establish that artist from the 13th century has a broad knowledge of design principles of patterns. In this context, the principles of patterns can be known by its designer but cannot be distinguished easily with a deductive approach [1,2,3,4].

Today, mathematical and computational tools help designers to discover the generation principles of geometric patterns which are only known by its designer. Modern techniques and original methods can differ in generation process. Creating various species of known patterns can be thought as an achievement for these modern techniques [5].

In this study geometric patterns are considered as compositions constructed by shapes. Specified shapes constructing the patterns can be points, lines, planes or more complex elements. A geometric pattern is formed by geometric shapes which are typically repeating in a given order. During this repetations new shapes or subshapes can emerge. Gross [6] also mention that computer based designs can support perception ability of human.

Stiny [7] emphasise the importance of emergence when calculating with shapes. According to Gross [6] there are 3 types of emergence for shape representation.

- Emergence from intersecting shapes: two or more shapes intersect to create new subshape.
- Emergence from alternative configurations: different configurations with same shapes.
- Emergence from figure-ground reversal: a new shape is formed by the edges of other drawn shapes.

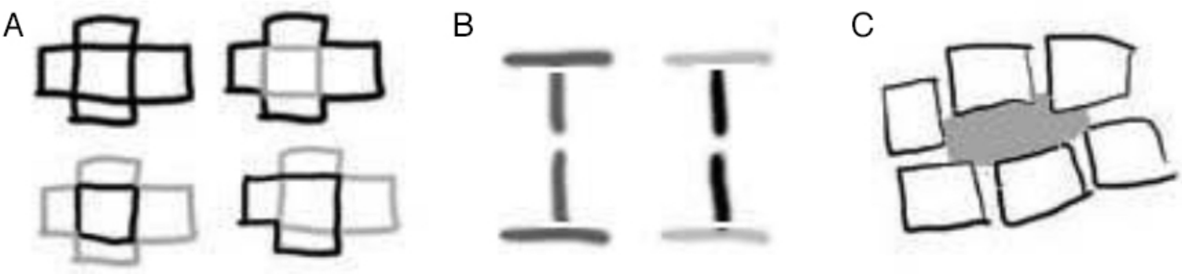

Image 1. Three types of visual emergence: (A) intersecting shapes (B) alternative configurations (C) figure-ground reversal [6]

Both Stiny and Gross [6,7] criticize computer implementations for recognizing closed shapes and specified geometries. However, the parts that are composing the shape cannot be listed because there are always alternative ways to see the shapes.

3. Geometric Pattern Generation Approaches

There are various approaches to generate geometric patterns. In this study, these approaches are classified as set-based construction, parametric construction and shape-based construction. This study make a comparison between these 3 approaches in the context of emerging shapes. First, previous studies are examined to make this comparison. Then, the evaluation will be done through developed generative code.

3.1 Set Based Construction

Set based construction approach grounded on predefined vocabulary elements. A vocabulary is a limited set of shapes and designs can be created with Euclidian transformations on given shapes [8]. In set-based construction approach, geometric patterns are created by combining a finite set of shapes. Distinct shapes can be recognized easily in the composed pattern by human eye. To be more precise about set based approach, 3 pattern generation studies are investigated.

The tile work "Zillij" is an explicit example for set based pattern design. Jowers et al. [9] work with tiles called "Furmah" to compose 2D geometric patterns. In their study, 15 furmah is obtained from original analyzed patterns. In pattern generation process, furmah tiles are modified under Euclidean tranformations, and three patterns are generated by a set based construction approach. Overlapping furmah is forbidden in Zillij works, so it is not possible to state that there is an emergence from the intersection of shapes. The only type of emergence in the Zillij works originate from figure ground reversal [9]. Eventually, the emerging shapes from figure ground reversal are still the member of the set. It can be said that there is no novelty on shapes or subshapes emerged.

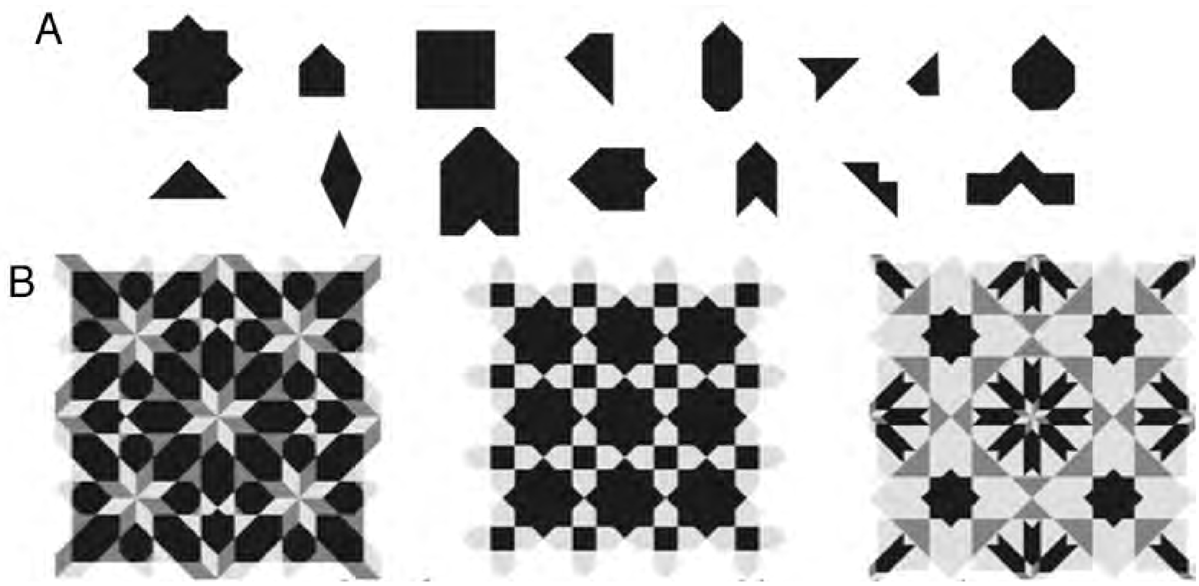

Image 2. (A) Set of Furmah (B) Generated Pattern Furmah Set [9]

Roger Penrose make researchs on aperiodic patterns. Penrose succeed on covering the surface aperiodicly with tile sets which include 6 tiles. Next, Penrose discover 2 other tile sets which use only 2 tiles to cover the surface. Thus, Penrose proved the producibility of aperiodic patterns mathematically. Later, Arık and Sancak developed a new tile set based on Penrose tiles which also include 2 tiles to cover the surface. [10,11]. Even these produced patterns are aperiodic and complex, patterns include only the shapes within a predefined set of shapes.

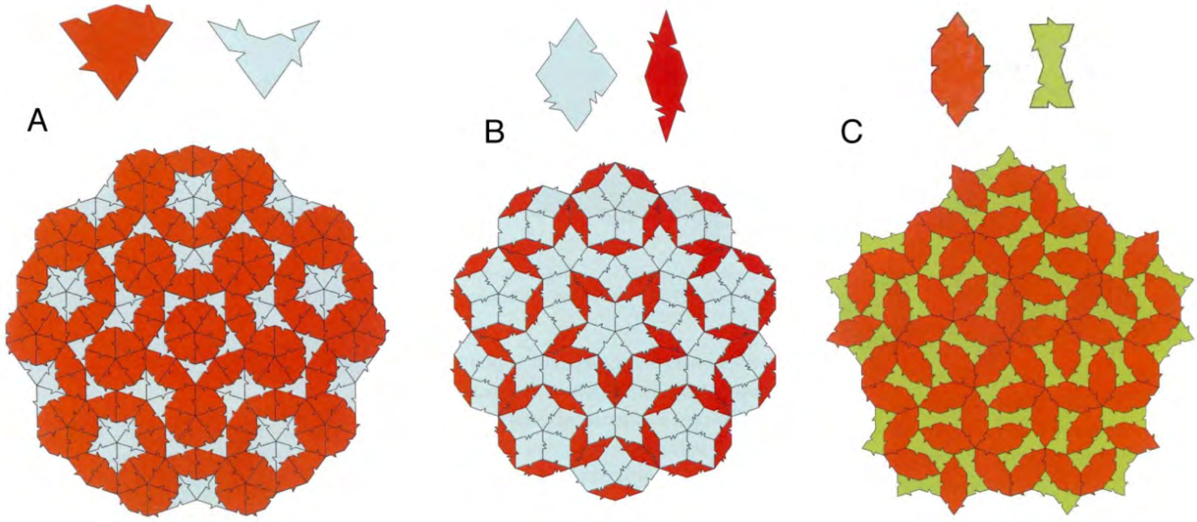

Image 3. (A & B) Penrose Pattern [10] (C) Bow and Tie [11]

Another method called Girih Tiles are used to create aperiodic geometric patterns. The set of Girih Tiles includes decagon, pentagon, hexagon, bowtie and rhombus shapes. Lu and Steinhardt [12] suggest that Girih Tiles enables to create complex aperiodic patterns from the 15th century.

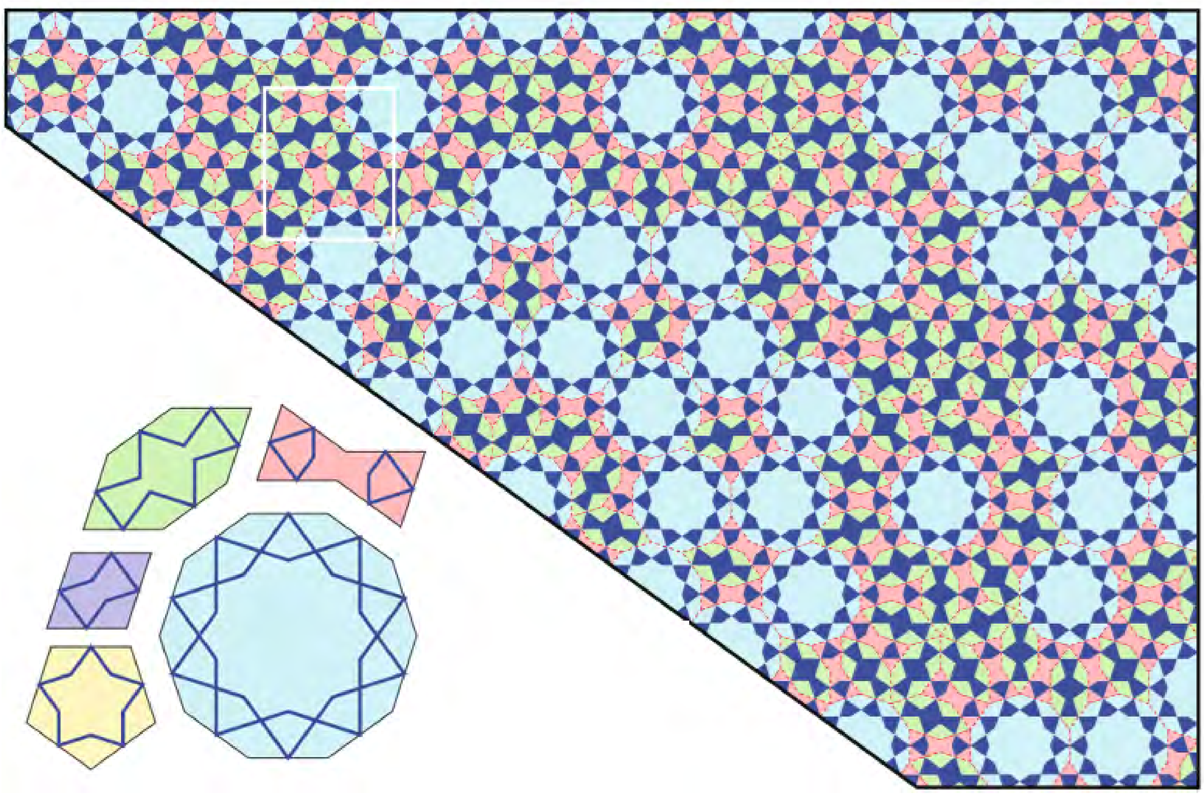

Image 4. Girih Tiles and Reproduced Facade Darb-ı Imam Shrine [12]

Penrose Tilings and Girih Tiles are both covering surfaces without leaving any gap between tiles. The tiles also do not intersect or combine. Even if the patterns are aperiodic and complex, the parts of sets which composing the pattern can be easily seen.

As stated before, points, lines and planes are basic elements that create geometric shapes. Furthermore, shapes may include many subshapes. As it can be seen from investigated examples, set based approaches do not rely on shape-subshape relations. Set based approach uses a set of predefined elements to create patterns.

3.2 Parameter Based Construction

Parametric design term indicates the use of parameters to define a design. Mathematical meaning of parameter refers to a range of values. Parametric design is based on the relationship between shapes controlled by variables [13,14,15].

According to Dino, parametric modelling approaches provide an opportunity for generating alternative design solutions. Changing parameters induce to real-time changes in the shape. With these features, parametric systems focus on manipulation of the parameter values for the purpose of change the design. The parametric design techniques help to make dynamic modelling and modifications. Parametric operations require certain values to make these modifications. Using certain values for generation is limiting to explore wider design possibilities [16,17].

A parametric model can be defined to a computer by using a programming language. Today, many computer aided design applications are developed to provide parametric functions [15].

Parametric models are also used for creating geometric patterns. Before structuring the parametric model, the underlying mathematical principles of geometric patterns can be analyzed with a deductive approach. With defining these principles to the computer, geometric pattern alternatives can be constructed. The following two studies analyze the generation processes of geometric patterns. Both studies discover different parameters and produce design alternatives.

In Bökü's [18] study, the mathematical creation principles of patterns are associated with shape grammar method, which used in the architectural field. The language of Anatolian Seljuk Geometric Patterns are analysed with shape grammar method. Later, the usability of shape grammars is discussed as a pattern generation method. With analysis of existing patterns grammar rules are derived. By using same shape grammar rules and making parametric changes various patterns are produced. Image 7 shows the effect of modified initial shape on the whole pattern.

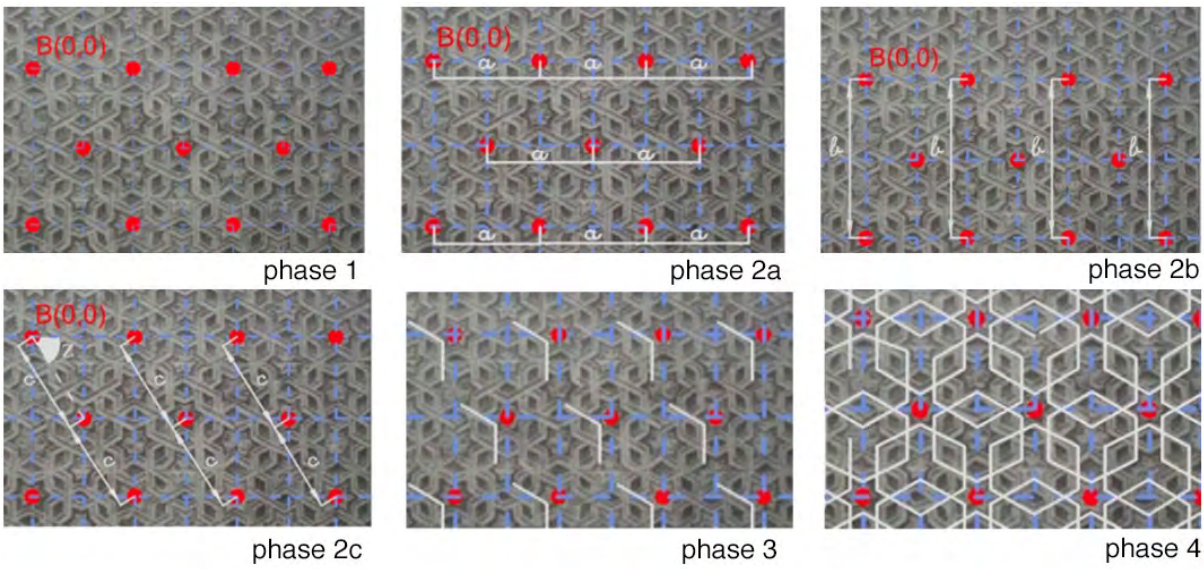

Image 5.Phases of Pattern Creation Process [18]

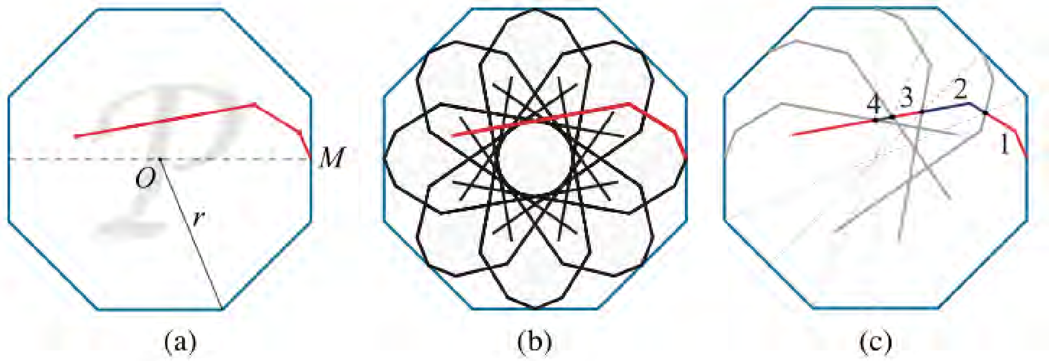

Image 6. Rotating Initial Shape Line on a center point "O" [5]

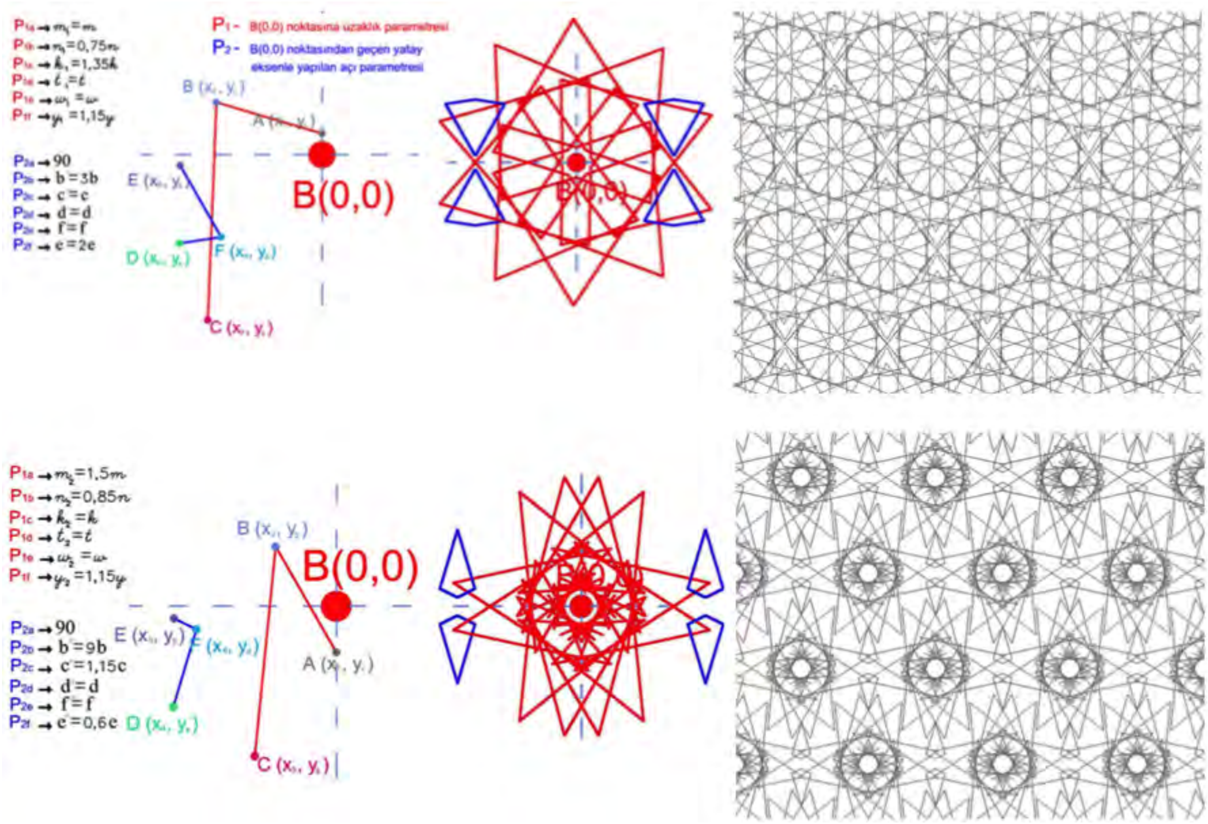

Image 7. Pattern Alternatives using the same shape grammar rules on a modified initial shape [18]

As Çolakoğlu et al. [19] stated, designers can choose how to structure the pattern parametrically. Changing the parametric structure of the same pattern can create different variations of the original pattern. The created patterns show the unpredictable results of parametric changes.

The parameters used in Pat-Gen can be listed as; the number of modules on x and y-axis; module size, the radius of the inner star, radius of infection, the angle of infection, line with and line depth. The parameters are derived from the analysis of original rosette geometries [19].

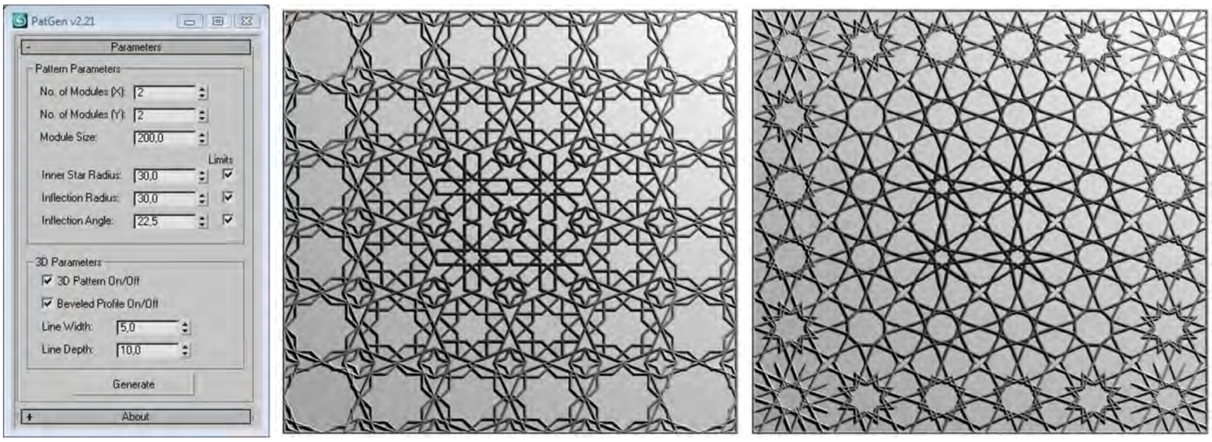

Image 8. Parameter control panel and created patterns by Pat-Gen [19]

The readily visible emerged shapes are observed from intersecting shapes. The other important point is the continuously changing shapes, which construct the patterns.

3.3 Shape Based Construction

Shape based construction approach is mainly trying to explicate the philosophy on visual calculating with a shape more than their mathematical or geometric features.

In the design process, designers make calculations intentionally or unintentionally. To understand the relation between “calculation” and “design” designers should become distant from the term calculation in a classical sense. Classical calculation deals with discrete elements called symbols, which are building up the vocabulary of design. However, shapes are not like symbols. With visual calculation, every seen shape can join design process. The interaction between shape, eye and brain helps the creativity [7].

According to Stiny [7], with the help of ambiguity, seeing shapes in different ways and making visual calculations is a vast source of creativity.

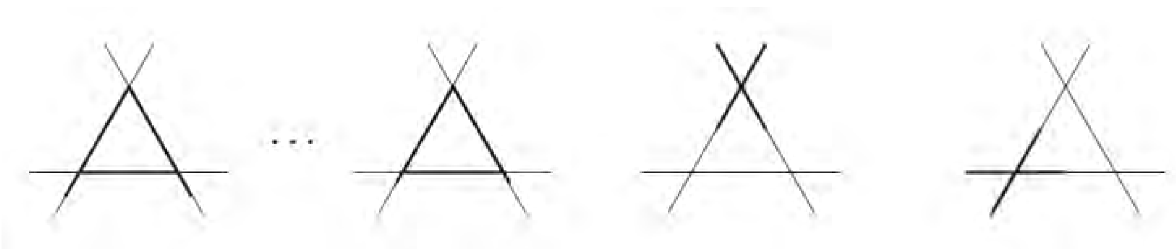

Image 9. Seeing different embedded subshapes [7]

The image 9 shows that the parts that are composing the shape cannot be listed as certain. Because of rules applying to embedding parts, there are alternative ways to see for the designer. Rule application on parts of shapes can generate new shapes that are not predefined. The recognized subparts produced by “seeing” activity. If the shapes are discussed as a class member, achieving emergent shapes become impossible [7,20].

The visual calculation on shapes is not based on a vocabulary. The examined works in this study is mostly focused on rules and predefined shapes. Set-based and parametric approaches contradict with Stiny’s ambiguity concept.

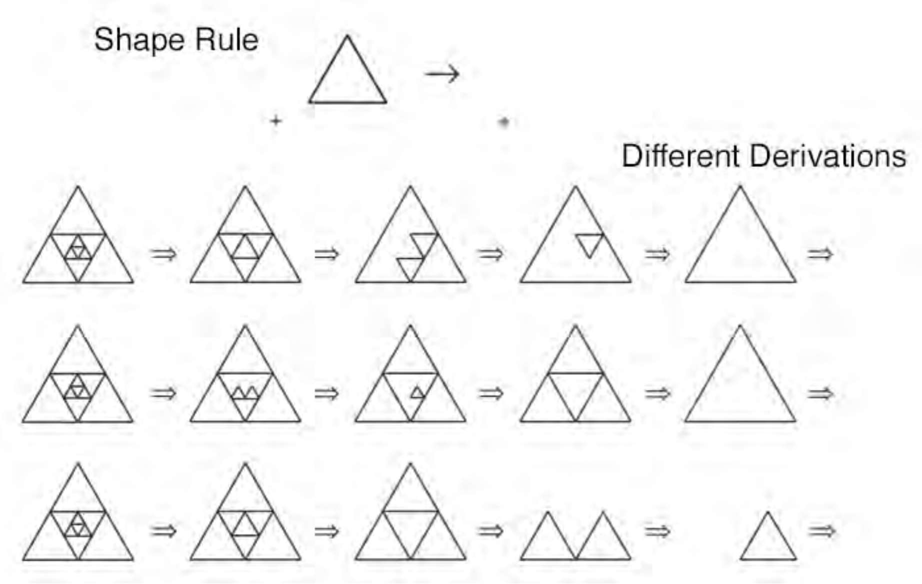

Image 10.Different derivations with same shape rule application [7]

Not like symbols shapes change freely in the creative process. People can think differently from each other or seeing different things. Calculating with shapes does not mean combining the predefined parts. Keep away from calculating is not possible when there are recognized parts to use. Subshapes appear when rules are applied to calculate with shapes [7].

For all these reasons, calculating with shapes and parts of shapes is a challenging problem for computer applications. Many shape grammar interpreters has limits for emergent subshape recognition

Keles et al. [21] emphasise these limitations and intent to discuss shapes within the part and whole relations. As Stiny stated [7], shapes may include many parts, and visual calculations continue while working with these shapes. In this context, it can be said that shapes have a continuous nature. Modelling this continuity in a computer based shape grammar interpreter is a fundamental problem. The parametric shape recognition techniques are useful for well-defined engineering problems [21].

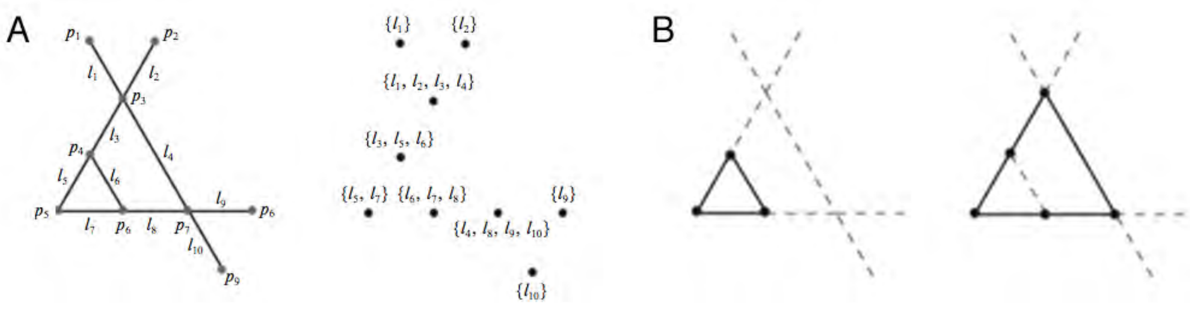

Image 11. (A)Critical point for shape representation (B) Recognizing subshapes [21]

Keles et al. in their studies developed a special recognition system based on critical points in shapes. These critical points help the computer to recognize part relations on different algebras. In the study, a new data structure called “over complete graph” is developed. This data structure does not rely on maximal elements. No limiting the shapes with maximal elements helps the computer to recognize more subshapes. An algorithm performs the searching process for parts. Presented new technique show how part whole relation support shape recognition for the computer [21].

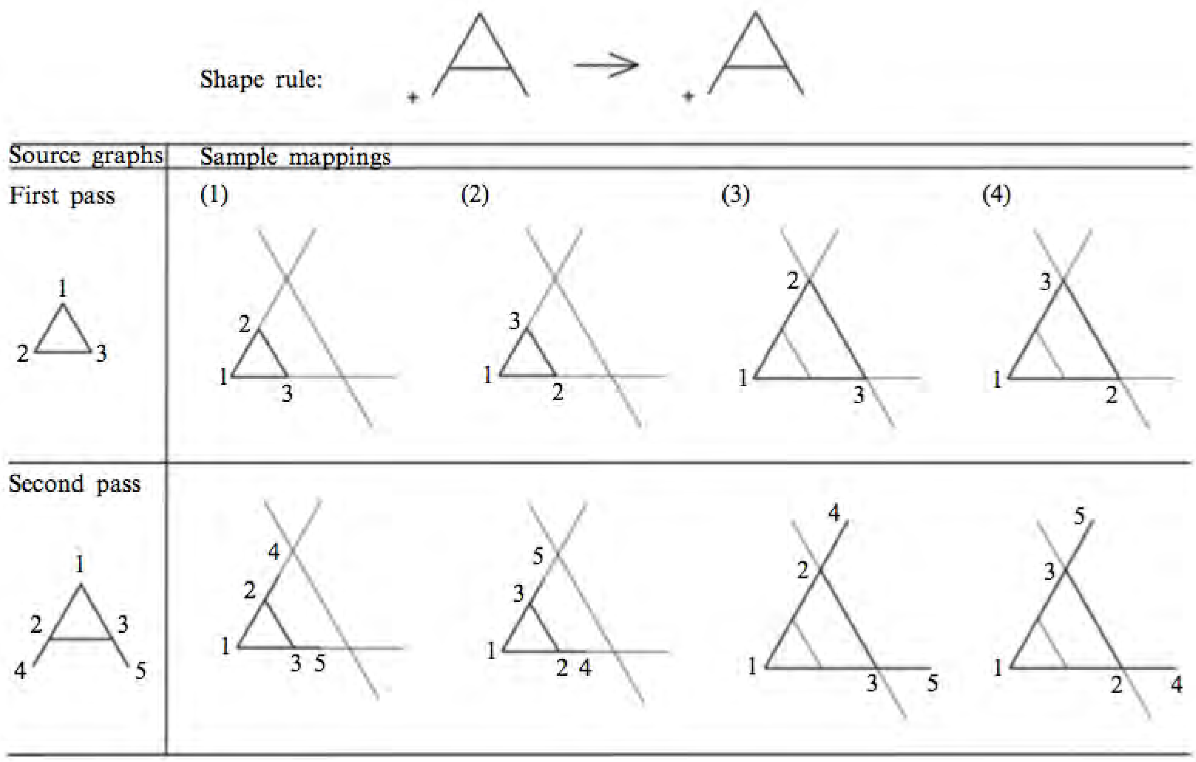

Image 12. Recognizing embedded subshapes within a rule [21]

As it is seen from the earlier shape computation studies, effort is spent on philosophy of shape calculation and technical issues. Since, shape based approach is sophisticated subject to discuss, it is not indented to model a limited implementation in the computer. In this study shape based approach is placed on a different side to criticise set based and parametric approaches.

4. Experimental Study

To make an experimental study about pattern generation process, a code is prepared associated with all parameters derived from former studies. All patterns are generated by modifying the same code structure also the parameters in a successive process.

4.1 Parameters In The Pattern Generation Process

According to analysis of previous studies on pattern generation, the following parameters are integrated into generation process;

- **Specification of initial shape:** The initial shape is the most characteristic element in the generation process of geometric pattern. Based on analyzed patterns, modifying only the initial shape without changing any other parameters occur major changes on patterns.
- **The position of initial shapes:** Position of the initial shape is defining the point where the pattern will begin to grow. Starting position may overlap with the center of the shape or a predefined label point.
- **The distance between repeated shapes:** Distance between repeated shapes is defining the frequency of repetition horizontally, vertically or angularly.

- **The number of the repetition**: Number of repeated shapes on x and y-axis. The number of repetition also determine the size of the pattern.
- **Specification of the angle for Euclidean transformations:** Operations like offset, copy, array are performed with a defined angle.
- **Angle and length of initial shapes:** The initial shape line constructs the shapes also the patterns. Defining the length and angle of initial shape are necessary for constructing regular polygons.
- **Edge number:** Polygons constructed by initial shape may have different edge numbers.

4.2 Modifying the Generative Code

By changing listed parameters experimentally in coding interface, the transformation of and variety of patterns are examined. Before every run of code, parameters are changed. The main structure of code modified once before the sixth run.

At the first run of code, hexagon shape is created by using initial shape line. By copying hexagon 15 times on x and 8 times on y axis with equal distances, geometric pattern is created. Hexagons are filled with light grey. Rhombuses as an emergent shape become visible from the relation between hexagon and its background.

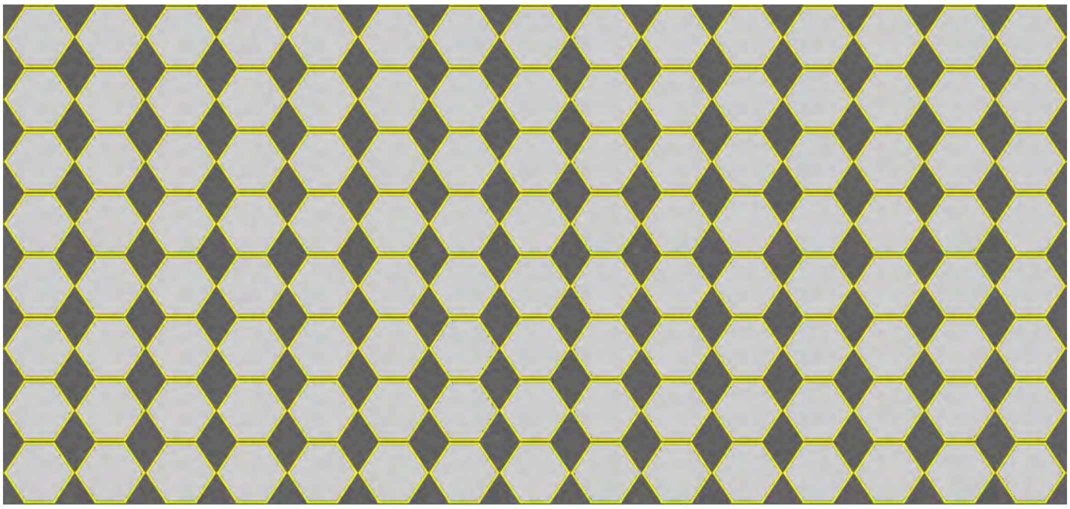

Image 13.Periodic pattern constructed with only hexagon shapes

At second run, the distance between repeating shapes (hexagon) is changed, and various patterns are created. Although, hexagon is the only element that composing the pattern, sub shapes have emerged from overlapping parts in the pattern which are not hexagons anymore. Even there are some other shapes that emerge from intersection of hexagons. These emerging shapes are not recognized or used in the design process. The created patterns do not respond to the idea of using emerging subshapes in design process.

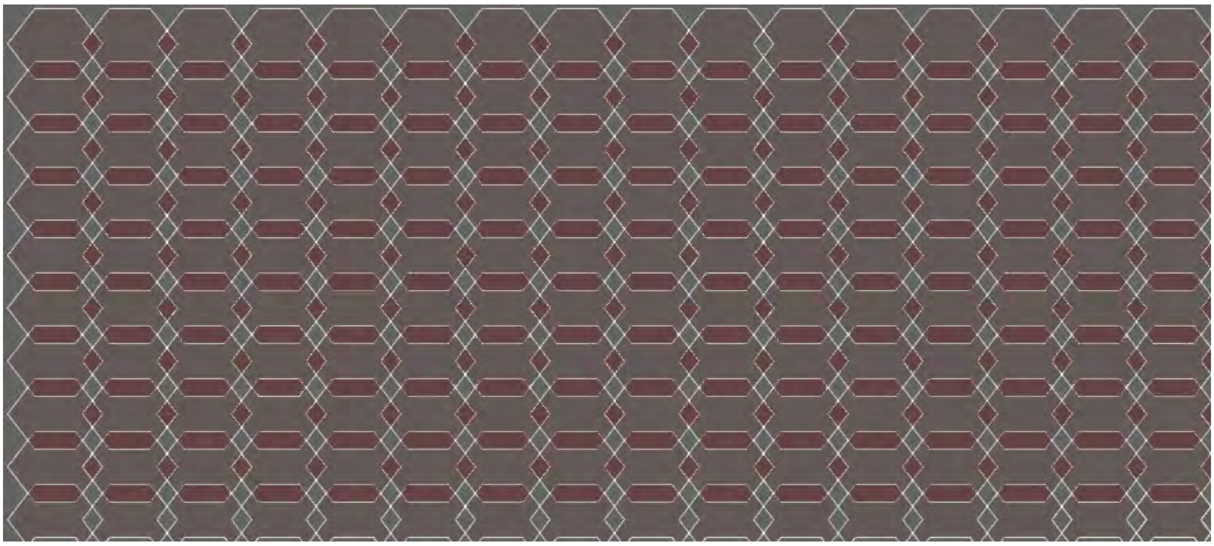

Image 14. Periodic pattern constructed with intersecting hexagon shapes

At third run of code; the angle of transformation is changed depending on mouse coordinates. Rotating hexagons also intersect at different angles and a variety of subshapes are emerged.

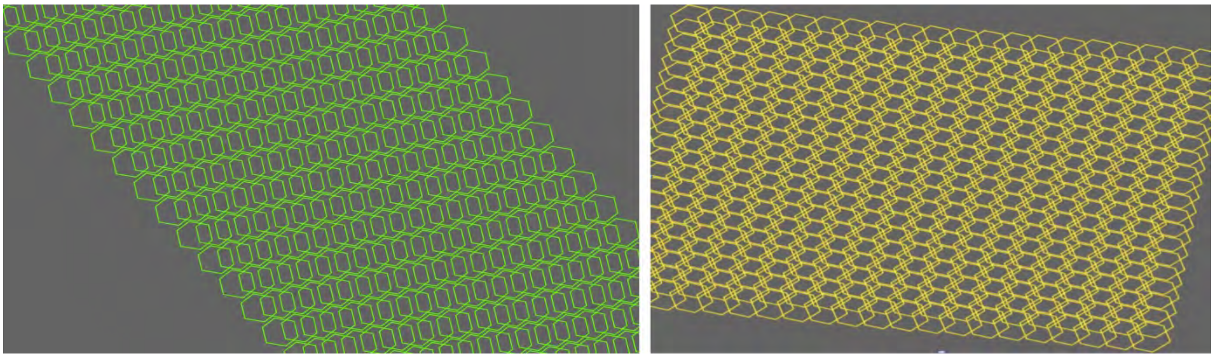

Image 15. Pattern constructed with rotated hexagon shapes

At fourth run, the length and the position of lines that compose the hexagon shape are modified. For this reason, initial shape line does not construct a proper hexagon or any predefined shape. The repetition of this not defined shape creates different patterns within the same structure of other patterns. Unexpected subshapes emerged from intersection of these distorted shapes.

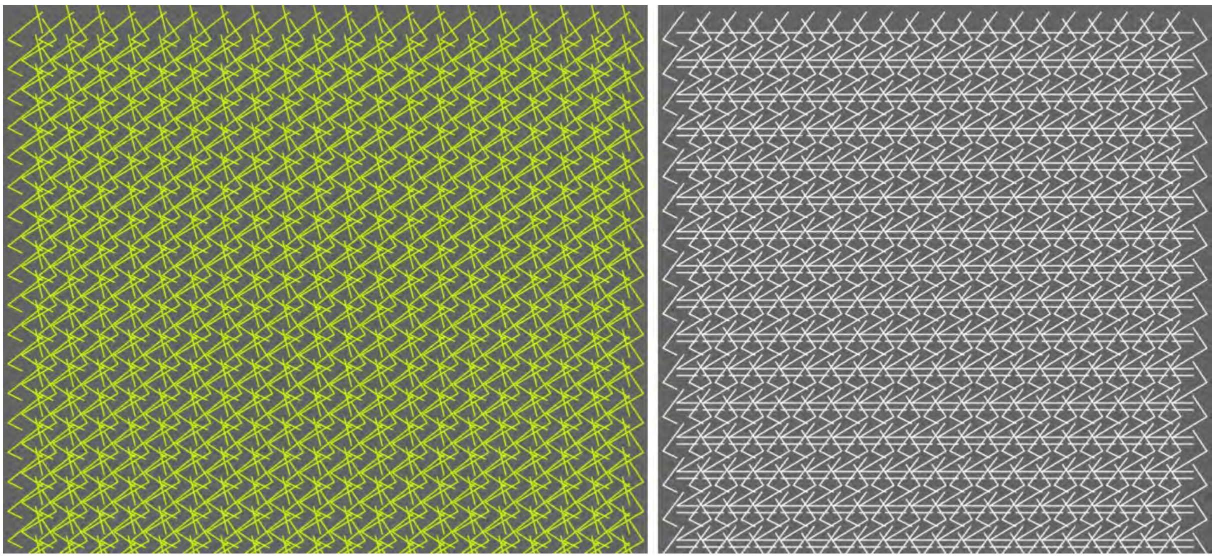

Image 16. Pattern produced from distorted initial shape within same structure

Before the fifth run, changing the edge number of initial shape is transformed hexagon into a pentagon. The angles between pentagons edges are modified, and pentagons become stars with different angles. These star geometries also rotate on the axis to generate different geometric patterns. A large number of stars is composing the pattern. Still, it is possible to say that the number of stars is finite.

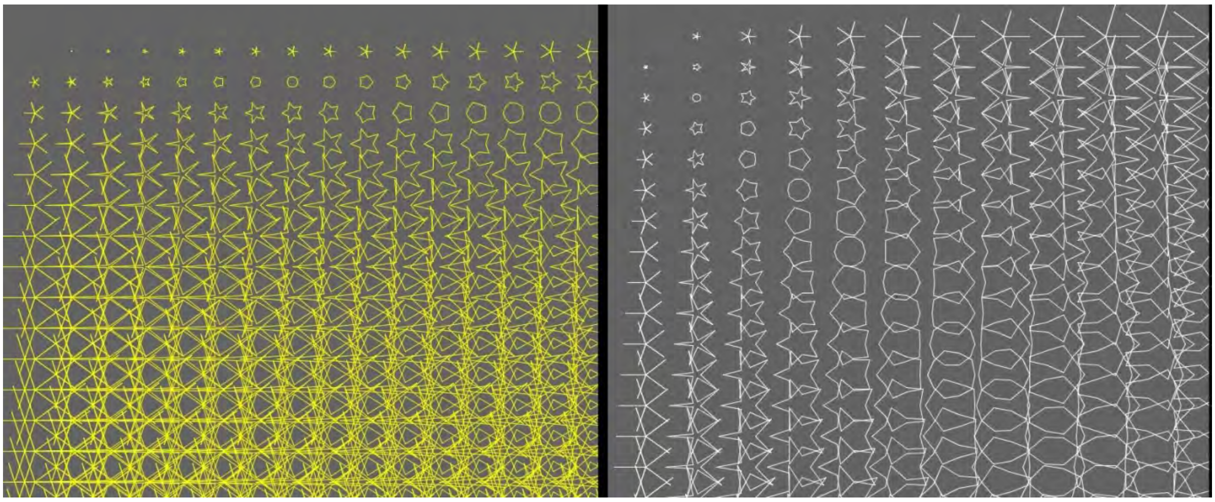

Image 17. Pattern produced with star geometries

At the sixth run of code, structure of code is modified with setting edge number as a variable. Changing the edge number creates a pattern that includes lines, triangles, square, pentagon, hexagon and polygons with more edges than six. A single initial shape is constructing all shapes that are composing the whole pattern. In these patterns, subshapes have emerged from intersection of shapes and gaps between shapes.

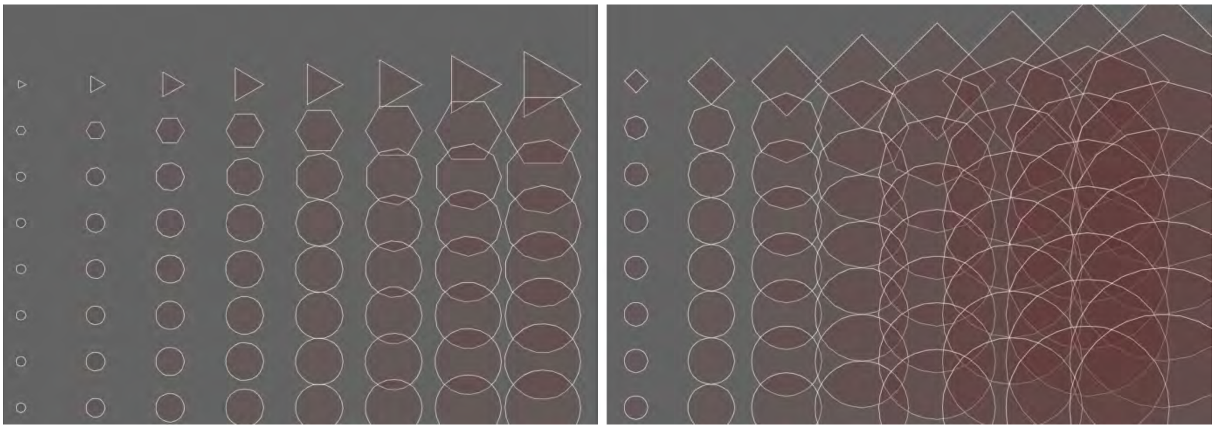

Image 18. Pattern produced with various polygons

5. Conclusion and Discussion

In this study, a generative code is developed and modified by six steps. The same code is used for every generated pattern to provide a common ground to analyses of created patterns. Experimented pattern generation process contains no rules but a sequence of operations. These operations are applied to a given initial shape. The operations of every step of generation process can be modified independently. For creating new patterns codes structure and parameters are changed in every step. Pattern generation techniques can be discussed through the generated patterns.

Parametric tools consist of generative components to produce design alternatives. It has experimented that a parametric model can produce set based design. Patterns generated by set based approach can be seen as a complex structure. On the other hand, these patterns are composed of certain elements which are not supporting the idea of emergence. Parametric design approaches create numerous alternatives and defend the opinion that used generative components are expanding the limits of designs. At this point, Stiny [22] mentions that since the essence of the initial shape that construct the pattern is not changed, the outcomes of parametrically created patterns are not novel designs. The investigated studies about parametric approach are also modifying the initial shape to extend the pattern alternatives. Still the parametric approaches do not recognize or use emerging shapes in the design process.

Shape-based design is based on activities see and do where ambiguity is the key concept. Stiny point out parametric design approach is unable to perform seeing activity. Shapes emerge when they seen by the designer. Designers can look geometric patterns and see many shapes in various ways. With these features shapes are continuous by their nature, people see and make visual calculations.

With these ideas, designers can look pattern production processes with a critical point of view. Computer implementations about pattern generation need to focus on issues about recognizing and using emergent shapes in the design process. Thus, designs can become more sophisticated, customized and far from being alternatives of existing design.

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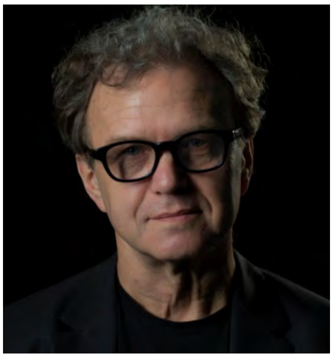
Ryszard W. Kluszczynski

Two generative tendencies in the Polish 20th century avant-garde

paper



Topic: Art

Author:
Ryszard W. Kluszczynski
University of Lodz,
Department of Electronic Media
http://media.uni.lodz.pl/rwk

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Abstract:

Art historians while analysing the development of the avant-garde in Poland in the second half of the twentieth century, mostly refer to formal currents, rooted in the ideas characteristic for the historical avant-garde of the 20s and 30s. They concentrate on the work of such artist like Tadeusz Kantor or Henryk Stażewski. However in the late 60s and in the 70s completely new tendency appeared, the progressive activities based on such media as photography, film, video. We may say thus avant-garde artists in Poland were developing two different approaches. We can notice the same situation while observing the beginnings of generative art in Poland. In my paper I want to analyse this issue, taking as examples works of two artist: Ryszard Winiarski and Wojciech Bruszewski,, to show two different way of making generative art. This analyse will let me also to reflect on some theoretical issues connected to the topic.

Contact: email

Keywords: Generative art, avant-garde, Polish art, interactive art, installation, Ryszard Winiarski, Wojciech Bruszewski

Topic: Molecular Art

Author:
Paul G. Mezey
Memorial University of Newfoundland
Department of Chemistry
Canada
www.mun.ca/research/chairs/mezey.php

Main References:

[1] Paul G. Mezey, "*Shape in Chemistry: An Introduction to Molecular Shape and Topology*", VCH, New York, 1993,
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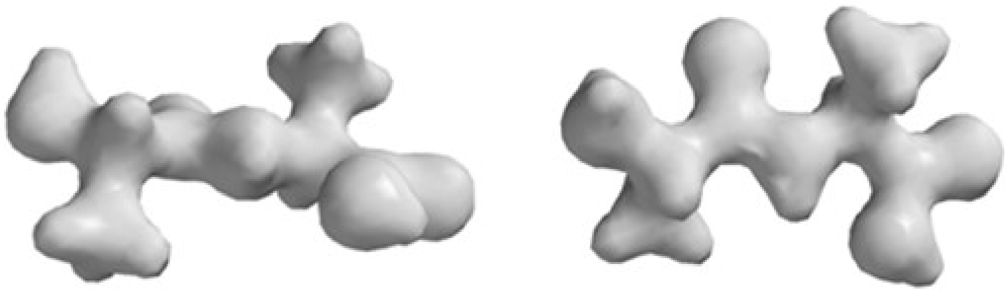
Abstract:

Motivated by the early efforts of the mathematical genius of Felix Klein of the Erlangen Program fame, who made interesting efforts to provide some mathematical description of those geometrical shapes which people find beautiful, the study of molecular shapes involves both geometrical and topological approaches [1-4]. The perception of molecular beauty, intricate shapes, as well as an intriguing combination of functionality and shape changes, provide impressions which are leading to the initial scientific associations as the seeds for both novel scientific methods and to a new appreciation of the artisitc richness of the microscopic world of molecules. The two images of the electron density cloud of the alanylalanine dipeptide molecule, shown below, exhibit many of the richness, beauty, and grace of molecular shapes. The mathematical tools of topology used for their characterisation provide the intellectual beauty of logical harmony of human thought processes with the natural world.



Contact:
paul.mezey@gmail.com

Keywords:

Molecular shape, topology, molecular beauty, shape analysis, shape groups, similarity measures, complementarity measures

Topological Beauty and Molecular Shape

Paul G. Mezey, PhD, DSc

Canada Research Chair, Scientific Modelling and Simulation,

Memorial University of Newfoundland, St. John's, NL Canada

email: paul.mezey@gmail.com

Motivated by the early efforts of the mathematical genius of Felix Klein of the Erlangen Program fame, who made interesting efforts to provide some mathematical description of those geometrical shapes which people find beautiful, the study of molecular shapes involves both geometrical and topological approaches [1-4]. The perception of molecular beauty, intricate shapes, as well as an intriguing combination of functionality and shape changes, provide impressions which are leading to the initial scientific associations as the seeds for both novel scientific methods and to a new appreciation of the artisitc richness of the microscopic world of molecules. The two images of the electron density cloud of the alanylalanine dipeptide molecule, shown below, exhibit many of the richness, beauty, and grace of molecular shapes. The mathematical tools of topology used for their characterisation provide the intellectual beauty of logical harmony of human thought processes with the natural world.

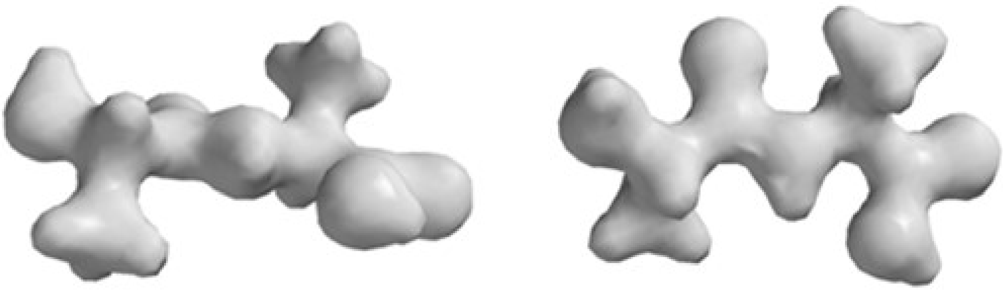


Figure 1. The shape of the electron density cloud of the alanylalanine dipeptide molecule, shown at the relatively high density threshold value of 0.1 atomic units

One of the most fascinating aspects of topology is its special adaptability not only to a great variety of earlier, seemingly very divers mathematical fields, but also to applies fields of science, everyday life, and art. It is mot by accident that he nick-name "rubber geometry" is often used for topology, where not the precise geometrical distances, angles, and coordinate values are important, but the way various entities are connected. Just as my identity is not changed when the distance between my eyebrows become shorter if I think hard, that is, when some geometrical aspects change, the same is true for molecules, which do preserve their identity during minor geometrical changes, for example, in some vibrational processes. However, my topology is still the same if I frown or smile, and the identity of molecules is also preserved during formal geometrical changes in vibrational processes.

The beauty of a dancing ballerina is enhanced in the harmonious movements which all preserve something essential: they preserve the topology that is common for all the smoothly changing geometries realised during the dance moves. The beauty of the dance is not in the detailed description of the precise geometry and in a listing of all the actual coordinates of each and every cell of the ballerina, but in the harmonious way of preserving the topology, common for all the never-ever captured, incessantly changing geometries of her body. The same is true for the fascinating shapes of incessantly vibrating, moving, an rotating molecules. The shape analysis, shape recognition, and complementarily recognition of molecules, all involve topological concepts, whether this is recognized or not.

Topology can also be regarded as the mathematics of the essential: for solutions of real problems which can be precisely phrased, whether on the scientific level, or in everyday life, or in art, the minor geometrical variations are typically less important than the more essential topological features.

There is another aspect strongly suggesting that topology and beauty are a great match when one has the desire to try to obtain some more formal understanding of what appears esthetically pleasing. Typically, natural objects and live creatures, such as a flower or a galloping horse, or even lifeless utilities, such as an elegant spoon, often appear beautiful for us if they are well-functioning - we seem to have an experience of pleasant feeling if we have a chance to realize that something functions well, it does well what it is supposed to do, so that part of the world works the way it is good for us. Yes, this can be a pleasant, reassuring feeling, that we may, sometimes, associate functionality even with the feeling of beauty. Let us recall, that topology is often referred to as “rubber geometry”, so there is a special role for topology in the context of well-functioning, accommodating, and pleasing objects, since by contrast, the rigid, geometrically precisely defined entities, unyielding, stiff objects are often generate negative feelings, in fact, we might find them ugly too. This is another way of recognizing that topology in our mind is connected to the assessment of beauty. Even without realizing this, we often look at the world and the objects, creatures, and even concepts through an innate topological assessment.

In the case of molecules, the intricate shapes of their electron density clouds naturally lend themselves to a topological analysis. This electron density cloud is the very fuzzy object that is the formal “body” of molecules, the body that is sensed by the body of any neighboring molecule and the one that may trigger a stronger interaction leading to some chemical reaction.

There are several factors which have greatly improved our chances to take more and more artistic excursions to the fascinating world of the beauty of molecules. Traditionally, objects which have been easily available to the human senses, observation, and perception, for example, to vision, have been dominating the artists choices as subjects of artistic representation, for example, a colorful tree in the autumn sunshine, or a smiling face. In earlier times, it has been impossible for an artist to be motivated by seeing a molecule, because, simply, molecules are so small that even the best of optical microscopes are useless, if some detail is to be studied. It is a relatively recent development that computer-based molecular modelling approaches are capable of showing in great detail the shapes of electron density clouds, not only in their static arrangements, but in full, three-dimensional motion.

It is also a relevant consideration that the laws of nature on that microscopic level of molecules often lead to phenomena we are not well equipped to follow in detail. Even our concepts are not well suited for that size-range of the universe. On that microscopic level, nature shows a very high degree of variety, there are many millions of already recognized, different molecules. Yet, their study and analysis involves many branches of science, and understanding their behaviour is far from complete. One such consideration is the fuzzy nature of the electron density cloud, manifested on two levels. On the more fundamental level: the Heisenberg Uncertainty relation, one of the most fundamental laws of physics, renders the concept of a “molecular surface” ill-defined, since due to the particle-wave duality of electrons, and the requirement that the uncertainty of the position of an electron, multiplied by the uncertainty of the momentum (velocity times mass) of the electron cannot be smaller than some positive value. This restriction is entirely “alien” to our everyday concepts, where we cannot perceive that nature has such a limitation. Simply, evolution has not provided us with any sensory experience that could ever require to experience such a limitation, so, naturally, our everyday concepts do not include any hint of such a restriction, as a limit to observations.

Another, somewhat less surprising consideration is the fact that molecular electron density clouds are fuzzy, they have no boundaries, they gradually fade by distance, and in a strict sense, a molecular electron density, decreasing exponentially with distance, does not become exactly zero even at very large distances from the atomic nuclei of the molecule. This fact may complicate somewhat the visualization approaches when representing electron density clouds, but by choosing some molecular isodensity contours, MIDCOs, such as those of the alanylalanine dipeptide molecule, shown in the Figure, one can still obtain some pictorial representation.

These images, generated by computer, using false colours, provide often stunningly beautiful, intricate shapes. Yes, even though for their generation one needs a computer, these are still natural shapes just as the shape of a droplet of rain on a leaf, or the bud of a flower.

Molecular electron density clouds are beautiful. Smooth but intricate forms, with abstract, but often thought-provoking forms, they are providing very enjoyable, even addictive visual experiences

I hope that the intellectual beauty of the mathematics of the topological analysis of such electron density shapes, and the actual visual experience of their beauty, as images, or as even changing images during some chemical processes, will provide many with the sense of beauty.

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Rodrigo Setti

Generative Dreams from Deep Belief Networks
Paper

Topic: Generative Robots

Authors:
Rodrigo Setti, M.S.
Sr. Software Engineer
USA

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[1] Geoffrey Hinton, et al. “The" wake-sleep" algorithm for unsupervised neural networks”, Science, 1995.

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Abstract:

According to the “Memory Consolidation Theory of Dreaming”, dream exists as a way to process and consolidate information that we have acquired during our waking lives. In that perspective, it’s right to say that minds that produce dreams are also minds capable of learning. If we include in the category of capable of learning, not only living creatures, but also artificial systems, we can explore the consequences of those systems being able to dream as well, and, most interestingly, what do they dream about.

If machines can dream, they can also be creative, and even produce art. Deep Belief Networks are artificial systems Inspired in the brain, and capable of learning representations of data with multiple levels of abstractions. These methods have dramatically improved the state-of-the-art in speech recognition, visual object detection, and many other domains such as web search and genomics. These artificial minds are composed of multiple processing layers, much like how visual cortex of humans are structured. One of the remarkable properties of the learning algorithm called “wake-sleep” [1] used to train these systems is that it has to have a “dreaming” period. This dreaming period is necessary for effective learning, and it’s when the neural network generates signals from within, without any external input. An interesting analogy with the psychological theory.

We introduce to the reader how these artificial neural networks are structured, and how they are able to learn images hierarchically within they many layers. Then, following the steps revealed by Google Scientists' “Inceptionist” blog post [2], we explore how we can probe into their dreams, after being trained with million of photographs, and show that it hallucinates fantastic realms, of bizarre and psychedelic variations of reality (figures). The aesthetics and creativity extent of such machine dreams are discussed in the paradigm of generative art. Interpreting each dream as one of the endless expressions realized by the particular artificial mind's anatomy (neural network topology) and experience (trained images), recognizable as its particular vision of the world as has been shown to it.

Example of generative dreams: people and cars (left); animal forms (right).

Contact:

rodrigosetti@gmail.com

Keywords:

Artificial intelligence, neural networks, deep learning, dreams, generative, image recognition, machine learning, deep belief networks

Generative Dreams from Deep Belief Networks

Rodrigo Setti, BSc, MSc.

United States

Email: rodrigosetti@gmail.com

Abstract

According to the “Memory Consolidation Theory of Dreaming”, dream exists as a way to process and consolidate information that we have acquired during our waking lives. In that perspective, it is right to say that minds that produce dreams are also minds capable of learning. If we include in the category of capable of learning, not only living creatures, but also artificial systems, we can explore the consequences of those systems being able to dream as well, and, most interestingly, what do they dream about.

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– How to Build an Artificial Mind

They say that when the apprentice surpasses the master, then the later has fulfilled his duty as a teacher, and reached his greatest achievement. In that sense, one can say that mankind greatest achievement is about to come when we are able to build machines smarter than us. What the prominent futurist Ray Kurzweil (Kurzweil, 2005) calls the “singularity”, a point around 2045 when machine intelligence will be infinitely more powerful than all human intelligence combined.

An artificial mind exhibiting general intelligence is yet 30 years ahead, but advances in computer science has led to remarkable progress in artificial systems capable of performing tasks likewise or better than humans.

One of these capabilities, which we are going to explore in this paper, is visual recognition (object classification), and its artistic dual: visual creativity. Building a machine capable of identifying hundreds of classes of images is not a small feat, and in fact it took years of the most brilliant scientists, as well as good progress in hardware performance to finally produce some real world applications.

Errore. L'origine riferimento non è stata trovata., **Errore. L'origine riferimento non è stata trovata.**, and **Errore. L'origine riferimento non è stata trovata.**, demonstrate some incredible capabilities of such systems by correctly labelling the images. Those examples were taken from the online “Image Identification Project” from Wolfram Research, available at www.imageidentify.com.

Figure 11 "coupe"

Figure 12 "double bass"

Figure 13 "grey wolf"

One does not approach this kind of problem, as would otherwise with other software engineering tasks. It is impractical for someone to explicitly program the rules of image interpretation that will allow the machine to differentiate between an image of a “dolphin” and a “tree”. Thousands of shapes, colours, forms, shades, poses, all intertwined and interrelated in extremely complex ways defines the boundaries of the difference between a “dog” and a “cat”.

Instead, scientistss approach this problem by building an artificial brain capable of learning. Then, they feed this knowledge-hungry empty brain with thousands of training examples, *i.e.* associations of images with their corresponding labels, *e.g.* examples of “dogs”, and examples of “dolphins”. If the brain learns well, it will successfully tell the correct answer the next time it sees an image of a “dog”, even if it has never seen that particular dog before. That is pretty much the way you can tell that something is a tree even if is the first time ever you're ever seen that particular tree. The reason you can do it is because you have been exposed to countless different variations of trees before, so you know what kinds of patterns are unique signatures of trees.

The mathematical model scientists are using for image classification are the so-called "neural networks". Heavily inspired in their biological counterparts, they are beautiful abstractions that are helping us not only to build fantastic applications, but also to understand better ourselves.

– The Artificial Neuron

When building an artificial mind, if we want to be inspired by biology, that is, the human brain and how from billions of neurons and trillions of synapses emerges intelligence, then is reasonable to focus on the functional aspects of the neurons and the brain – i.e. the workings in terms of information processing, rather than modelling specifics to the biological substrate.

With that perspective, one can say Warren McCulloch and Walter Pitts introduced the pioneer work in artificial neural networks in 1943 (McCulloch & Pitts, 1943). They proposed a mathematical model for the neuron. In their model, the neuron is an information-processing device that takes signals from other neurons connected to it through synapses and produces an output signal of activation, which can be -1 or 1, inactive or active respectively.

The synapses themselves encode the amount of "inverse-resistance" of signal as an amount called weight, which is valued between 0 and 1, full-resistance (no signal) and zero resistance respectively. The reason the weights encode the inverse-resistance is because it makes calculations simple.

Finally, the body of the neuron, takes all input signals, multiplies by their respective weights, sums, and decides whether or not it passes a certain threshold (specified by the neuron). If it does, then it fires a positive 1 signal, otherwise, it fires -1. Figure 14 depicts graphically the McCulloch-Pitts model. Equation (1) formalizes the artificial neuron processing.

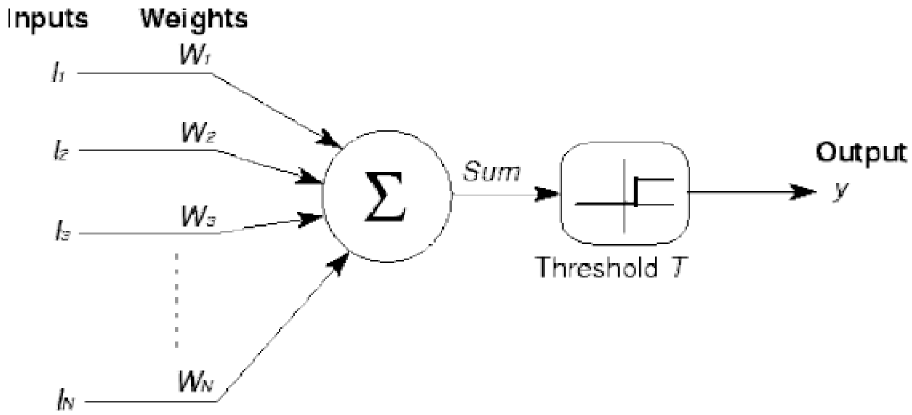

Figure 14: model of McCulloch-Pitts neuron

$$y = \begin{cases} \mathbf{1}, & \sum_{j=1}^{N} I_j W_j \geq T \\ -\mathbf{1}, & \mathbf{otherwise} \end{cases} \qquad (1)$$

– The Memorable Machine

One cannot learn if one cannot remember. Our neural network must be able to be exposed to training examples and then remember patterns to recall them the next time it sees a real example.

Traditionally, the memory in the brain works much differently than memory in your computer, the key distinction is on how the information is retrieved. In your computer, data is **addressable**, and one can look up the data if one knows the address location of the data. In your brain, on the other hand, memory is **associative**, and therefore accessed by parts of the original content, *i.e.* in order for you to remember something, you need to start by something else that is associated with the former. Think about how you can remember an entire song by just initiating with the first word, or a location by experiencing the same smell. The brain stores information in a way that makes it easy to access by using a subset of that original information.

Let's introduce some interesting mathematics that shall be useful to have a better sense of what we are trying to achieve in the next sections, starting with the Hopfield network. Popularized by John Hopfield in 1982 **(Hopfield, 1982)**, a Hopfield Network is a mathematical structure that can be implemented in a computer, which exhibits the property of information storage and retrieval using associative memory.

Each neuron in a Hopfield network is a McCulloch-Pitts neuron; also, on top of processing information, they also have state, in the form of a property of "excitement", specifying if that particular one is "active" or "inactive". This property is modeled as a number that can have a value of -1, for inactive, and 1, for active.

Finally, each neuron in the Hopfield network is connected to all other neurons thru the synapses both for input and output. With the additional constrain of being symmetric, that is a synapse from neuron A to B always have the same weight as the synapse from B to A.

The network updates itself throughout time, by following the McCulloch-Pitts signal processing, and setting their activation state with the resulting output.

The collective (binary) information of all neurons activations is what the network is "thinking about" (the pattern). One interesting property of the network is that it converges to stable configurations of low energy. If you start “near” a low energy pattern – *i.e.* with a subset of neurons activations in synchrony with the pattern – after some cycles of update, the network will eventually converge to a low-energy attractor pattern and stabilizes there. This is, in essence, associative recall. Equation (2) formalizes exactly what we mean by measure of energy.

$$E = -\frac{1}{2}\sum_{ij} W_{ij}s_is_j + \sum_{i} W_is_i \qquad (2)$$

Where s_i is the state of the *i*-th neuron. The equation states that pairs of neurons active together contribute to a lower energy the bigger the synaptic weight between them. Likewise, pairs of neurons that are out of sync, contribute to a higher energy (because the states are negative), the bigger the synaptic weight between them. **Figure 15** is a (one dimensional) visualization that energy equation as a function of the neurons state, highlighting the current state being attracted to a local minima of low energy during update – once reached the local minima, the network stabilizes.

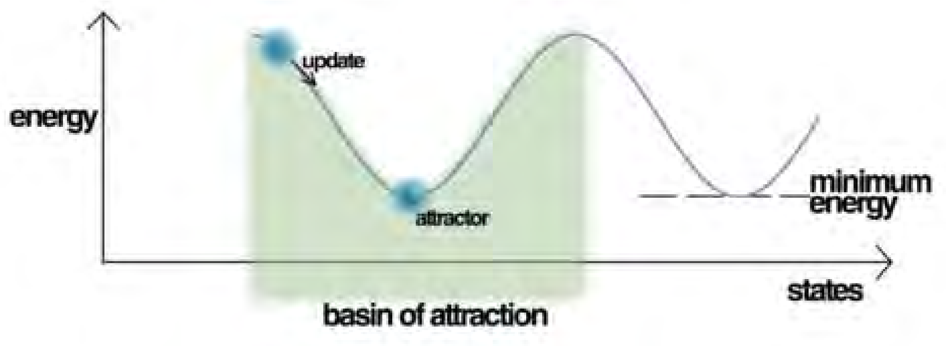

Figure 15 Energy landscape of a Hopfield network. Local minima states will attract the current state during the update (Wikipedia).

Training a Hopfield network involves lowering the energy of states that the network should "remember", and this is precisely solved by a learning rule introduced by Donald Hebb in 1949 **(Hebb, 1949)** (a.k.a. Hebbian learning rule). Basically, during the training phase, the network is presented with a pattern to remember, this is done by setting the activation levels of all neurons to be like the presented pattern (*e.g.* an image), and then we follow just two simple rules of learning:

- Decrease the synaptic weight between neurons that out of sync.
- Increase the synaptic weight between neurons that are active together.

This rule is often summarized as "Neurons that fire together, wire together. Neurons that fire out of sync, fail to link". These modifications will transform the network to have these training patterns as low-energy attractors.

The capacity of the Hopfield network is proportional to the number of neurons, and is considered a corner stone to more sophisticated algorithms used to build modern neural networks.

– Visual Cortex

One of the major milestones in image recognition was the refinement, by Yann LeCun, *et. al.*, of the Convolutional neural network (LeCun, Bottou, Bengio, & Haffner, 1998). The invention of this technique was principal to the major developments of today’s applications in image recognition.

Intuitively, the conception of the Convolutional neural network comes from the realization that many visual patterns found in images are repeated in different positions of the image, for example, when identifying a tree in a figure, leaves, branches and roots are found at different places (and at different scales across the visual space).

It is a waste of computing to force a system to learn the same patterns at different places of the visual field, in fact, without Convolutional networks, is impractical to learn patterns from relatively larger images effectively. The way those networks works is by learning what is called “convolutional kernels”, which are smaller versions of neural networks, specialized at learning one specific parameter. A typical system will have several of these kernels, each concentrated in learning one specific type of pattern. Since those patterns can be “everywhere”, the kernels are replicated across the image and fed with the input from each replicated region.

Figure 16 depicts an example where, starting from an original image (left), three different convolution kernels are applied. The kernels are numeric matrixes (on the top), which are applied (multiplied by the image pixels) across the entire image. Convolutional neural networks use all convolution output in order to learn the relation of different aspects of one image. For example, detecting horizontal lines in one kernel, and vertical lines in another kernel in order to make higher-level considerations of full object boundaries.

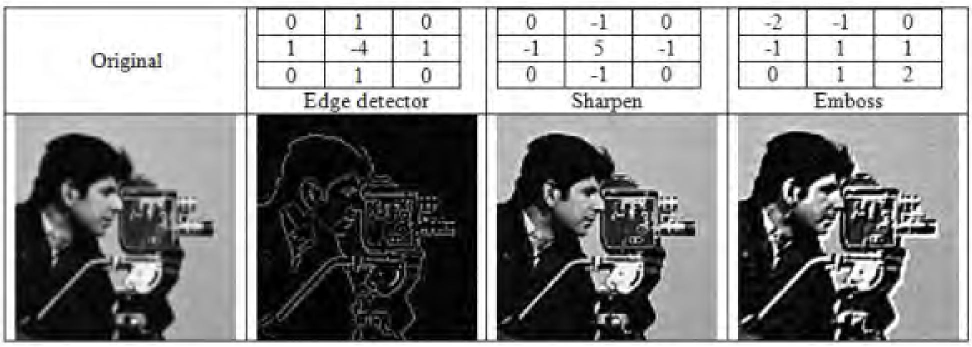

Figure 16 example of three convolution kernels applied to an image

– Deep Learning Revolution

Learning how to “see” is one of the most remarkably tasks our brain does. There is a big neural path dedicated to processing images – the visual cortex, and research has shown that its structure is hierarchical.

It has been shown that different layers of the hierarchy of the cortex in mammals are responsible for leaning one specific feature of images, and the higher the layer, the higher the conceptual space of the features. Lower levels, right after the retina, are responsible for understanding edges and lines, after that, subsequent layers processes more sophisticated patterns like perspective, shadow, *etc.* Moving further, upper layers identify full objects like an eye or a nose. Finally, top layers are the ones putting all those pieces together to identify a person or a full scene, composed of numerous objects.

Deep Learning, inspired by the visual cortex architecture, is a fundamental innovation in neural networks, pioneered by Geoffrey Hinton and his team (Hinton & Salakhutdinov, Reducing the dimensionality of data with neural networks, 2006). In this paradigm, the artificial brain is composed of several neural networks stacked on each other – each layer of the stack is responsible for learning a particular pattern in the conceptual hierarchy, interpreting that pattern, and feeding the upper layer with some digested information, very analogous to the biological counterparts.

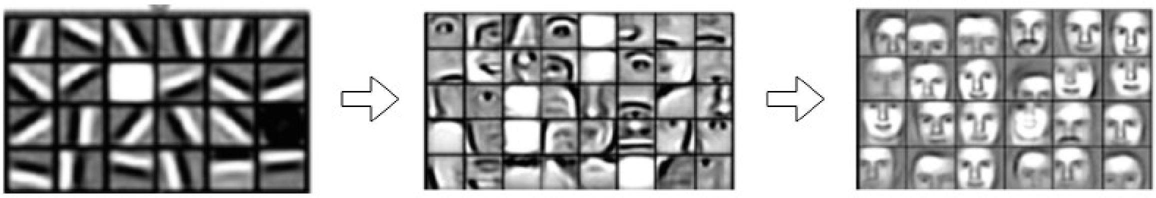

Figure 17 Increasingly complex pattern recognition in the visual cortex hierarchy

That, combined with convolutional neural networks, and an optimization of the previously discussed Hopfield network, called Restricted Boltzmann Machines, introduced by Hilton (Hinton, A practical guide to training restricted Boltzmann machines, 2010), finally allowed computers to perform like or even beat humans in image recognition tasks.

One particular thing to note about the Restricted Boltzmann Machines learning algorithm, is that for effective learning, it has to be submitted through a “dreaming” process, in which patterns are generated by the network without real input – and those patterns are “forgotten” by it, in order to make space for the real stuff, during the “awake” phase. It’s wonderful how we are mimicking biology in all these different facets in order to paint the big picture of artificial intelligence.

– **Inception**

What happens, then, if you take those Deep Learning systems and, instead of feeding them data for classification, look inside in the hope of inspecting what they are “thinking of”?

That is the sort of question made by a group of Google engineers in 2015 (Mordvintsev, Olah, & Tyka, 2015). It is known that after training, each layer progressively extracts higher and higher-level features of the image, until the final layer essentially makes a decision on what the image shows. On the quest to understand what exactly goes on at each layer, the engineers turned the network upside down and asked it to enhance an input image in such a way as to elicit a particular interpretation. Say you want to know what sort of image would result in “banana.” Start with an image full of random noise, and then gradually tweak the image towards what the neural net considers a banana (Figure 18).

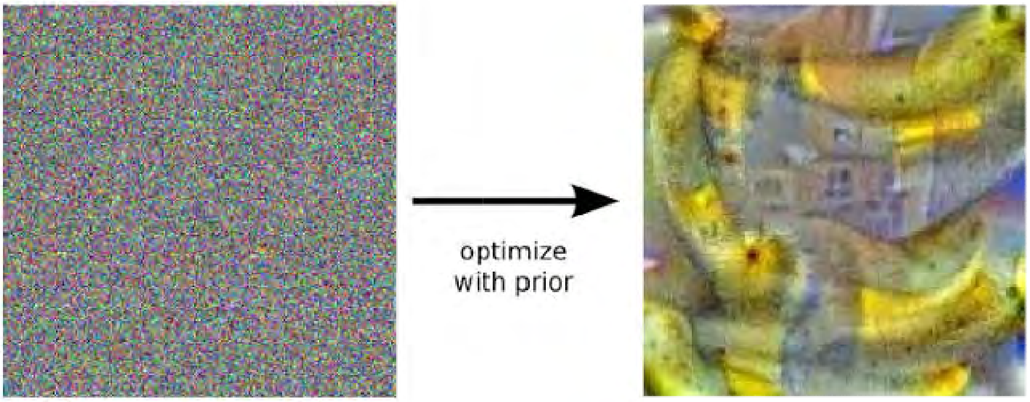

Figure 18 Optimizing a network to "see" bananas in random noise (figure from blog post)

The network used is called “GoogLeNet” (Szegedy, et al., 2014), a 22 layers deep network that was trained on the prominent ImageNet (Russakovsky, et al., 2015) dataset, a collection of hundreds of thousands of images of 200 different classes. From this network, we used the techniques described by the Google engineers to produce wonderful and bizarre images from the “deep dreams” of that network. The remainder of this section will expose a few of these results.

Figure 19 The strange city of car-men

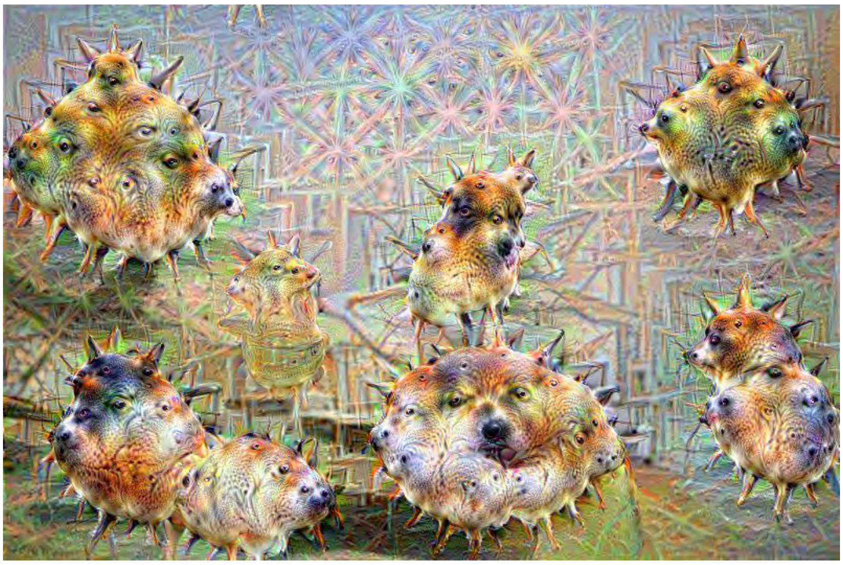

Figure 20 The horrific melted-puppies

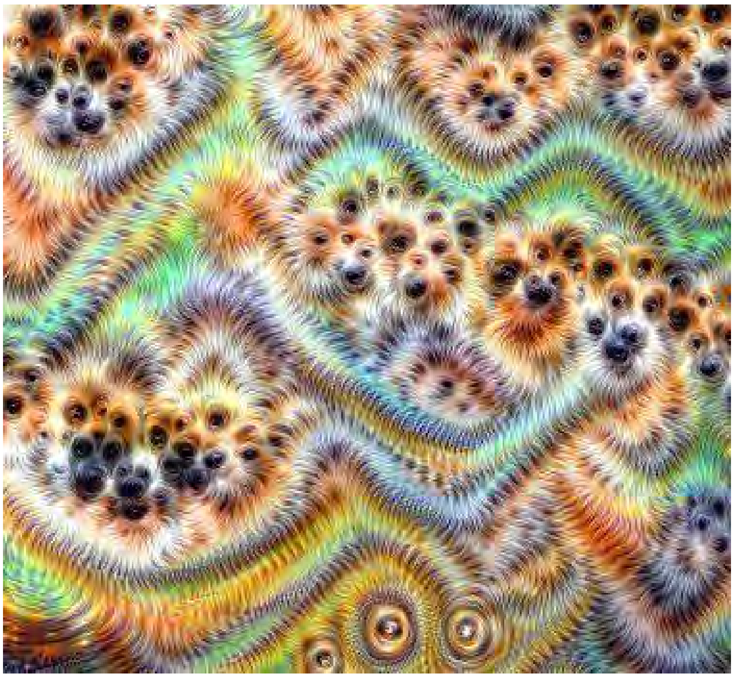

Figure 21 The atrocious puppy-faced carpet

Figure 22 Bizarre containers

Figure 23 Wonderful spider nets

Figure 24 Mister grasshopper frog

Figure 25 The curious two-headed bird

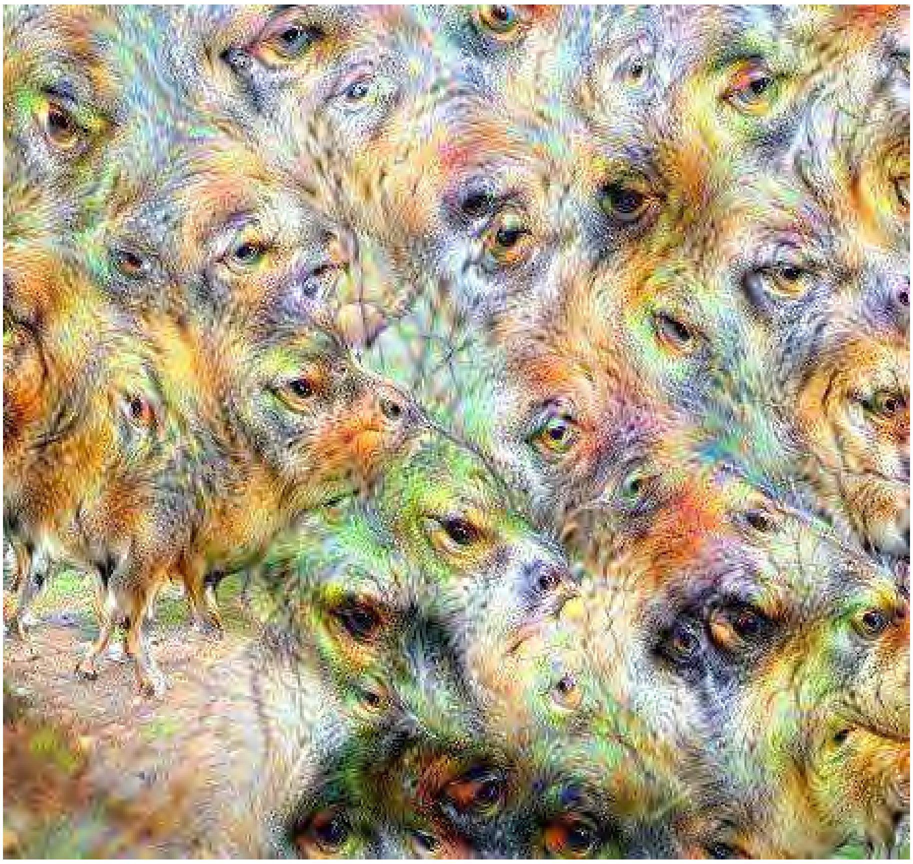

Figure 26 The dreadful wall of judgemental eyes

Figure 27 Several iterations over the original image on the top left (Bathers at Asnieres), over different layers of the network. Starting from lower layers (optimizing edges and curves), down to upper layers (optimizing objects and complex forms)

– Conclusion and Future Work

We would like to explore different Deep Learning topologies, not only GoogLeNet. There are topologies specialized in different domains like hand-writing recognition and face recognition that would definitely bring something new to the generated images.

Another area of exploration is to train the same network (or other networks) with different image datasets (not only ImageNet). For example, one can train one network with works of art of specific category (like impressionism), and hopefully have being provoked this system to dream about impressionist strokes.

On top of different networks and image datasets, there is also a broad space of parameters and techniques when generating the images themselves, layers can be optimized in conjunction, and with different optimization functions – certainly there are interesting discoveries waiting to be made on that front.

Finally, we would like to add that there are other approaches to image classification that don't use neural networks, Support Vector Machines, and K-Means, are among the supervised machine learning algorithms that can be used for that purpose. They also can be used to generate images from trained models, likely with completely different characteristics.

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Ernest Edmonds

FROM INTERACTION TO INFLUENCE: generating form and space

Paper

Topic: Art

Authors: Ernest Edmonds
Name1
University of Technology, Sydney Creativity and Cognition Studios
Australia
Creativityandcognition.com
and
De Montfort University, IOCT
UK
ernest@ernestedmonds.com

Main References:

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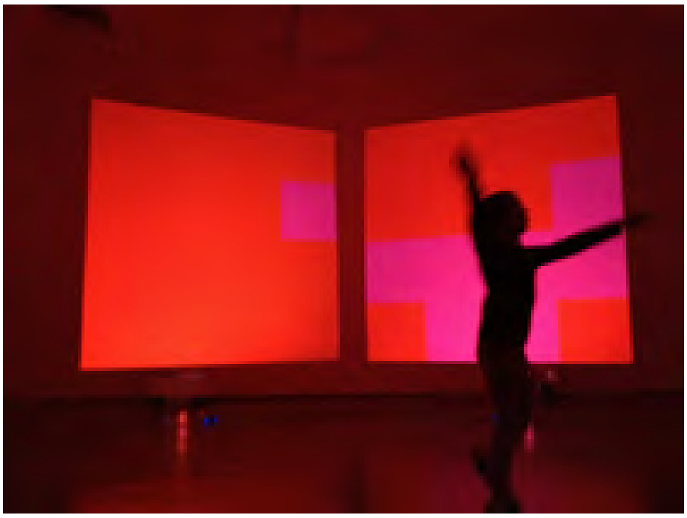
Abstract:

What do we really mean by interaction in generative art? In some respects, with delayed response, as a result of mode change, and even delayed influence on autonomous output, in the same way, interaction does not seem an appropriate word to use. Perhaps the words *influence, stimulus*, and *interchange* are more evocative of the meaning discussed above. Perhaps the influence of one system on another could be said to come about as a result of stimulus, interchange or even co-operation and conversation, if we add a layer of meaning to the situation. We may talk about the audience's "influence" on an art system where the development of its behaviour is affected by the interactions that it has experienced.

As an example, my *Shaping Form* (and *Space*) series of generative artworks consists of unique abstract interactive artworks that are each generating colours and forms in time from a set of unique rules. They also take data from a camera and continuously calculate the amount of activity seen in front of the work. The computer software then steadily modifies the rules. The artwork and its development over time are influenced by the people who look at it: the audience help to shape the work. *Shaping Form* is a representation of computed life, moving and changing of its own accord but maturing and developing as a result of the movement of audiences. Each work interacts gently with its environment. The *Shaping Space* installation is in a darkened room where there are two changing images in space creating a field of colour. The screens show a living matrix of colours that sometimes change very slowly and at other times burst into life. The colours use a small, but changing, pallet of hues. Images are generated using rules that determine the colours, the patterns and the timing. These are generative works that are changed by the influence of the environment around them. People can readily detect the immediate responses of the work to movement, but the changes over time are apparent only when there is more prolonged, although not necessarily continuous, contact with it. The shaping of the form is a never-ending process of computed development.



Shaping Space in the Light Logic Exhibition, Site Gallery, Sheffield 2012-13

Contact:
ernest@ernestedmonds.com

Keywords:

Generative, interactive, art, installation, influence

From Interaction to Influence:

Generating form and space

Ernest Edmonds

University of Technology, Sydney, Australia

and

De Montfort University, UK

ernest@ernestedmonds.com

Keywords:

Generative, interactive, art, installation, influence

Introduction: Interaction in Generative Art

What do we really mean by interaction in generative art [1,9]? Do we only refer to direct and immediate action-response or can we also include mode changes (e.g. changes to the generative rules) and consequential delayed responses? In some respects, with delayed response as a result of mode change, and even delayed influence on autonomous output, interaction does not seem an appropriate word to use. Perhaps the words *influence, stimulus*, and *interchange* are more evocative of this meaning.

Perhaps the influence of one system on another could be said to come about as a result of stimulus, interchange. We might even use the terms co-operation and conversation, if we add a layer of meaning to the situation. We may talk about the audience's *influence* on an art system, where the development of its behaviour is affected by the interactions that it has experienced over time.

As an example of art influenced by experience, rather than simply interacting in the action-response sense, consider my *Shaping Form* (and *Space*) series of generative artworks. These are abstract interactive works that are each generating colours and forms in time from a set of unique rules. See figure 1. They also take data from a camera and continuously calculate the amount of activity seen in front of the work. The computer software then steadily modifies the rules. The artwork, and its development over time, are influenced by the people who look at it: the audience help to shape the work. *Shaping Form* is a representation of computed life, moving and changing of its own accord but maturing and developing as a result of the movement of audiences. Each work interacts gently with its environment. In this paper I discuss the *Shaping Form* works as well as the extension of that work into the installation *Shaping Space* and the related generative paintings and prints.

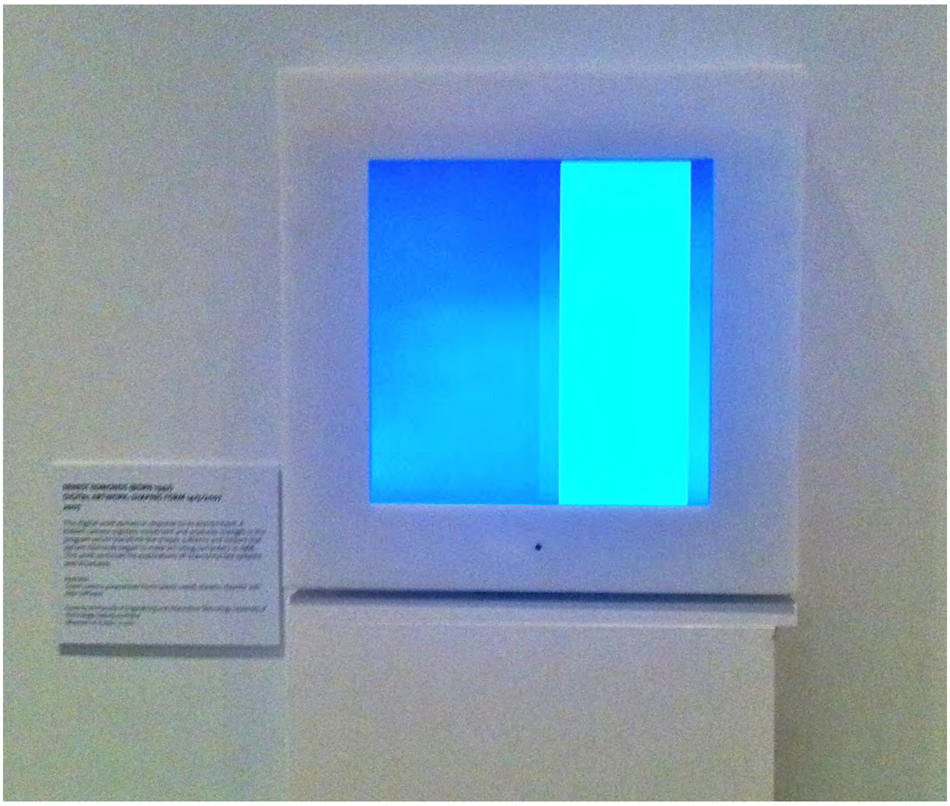


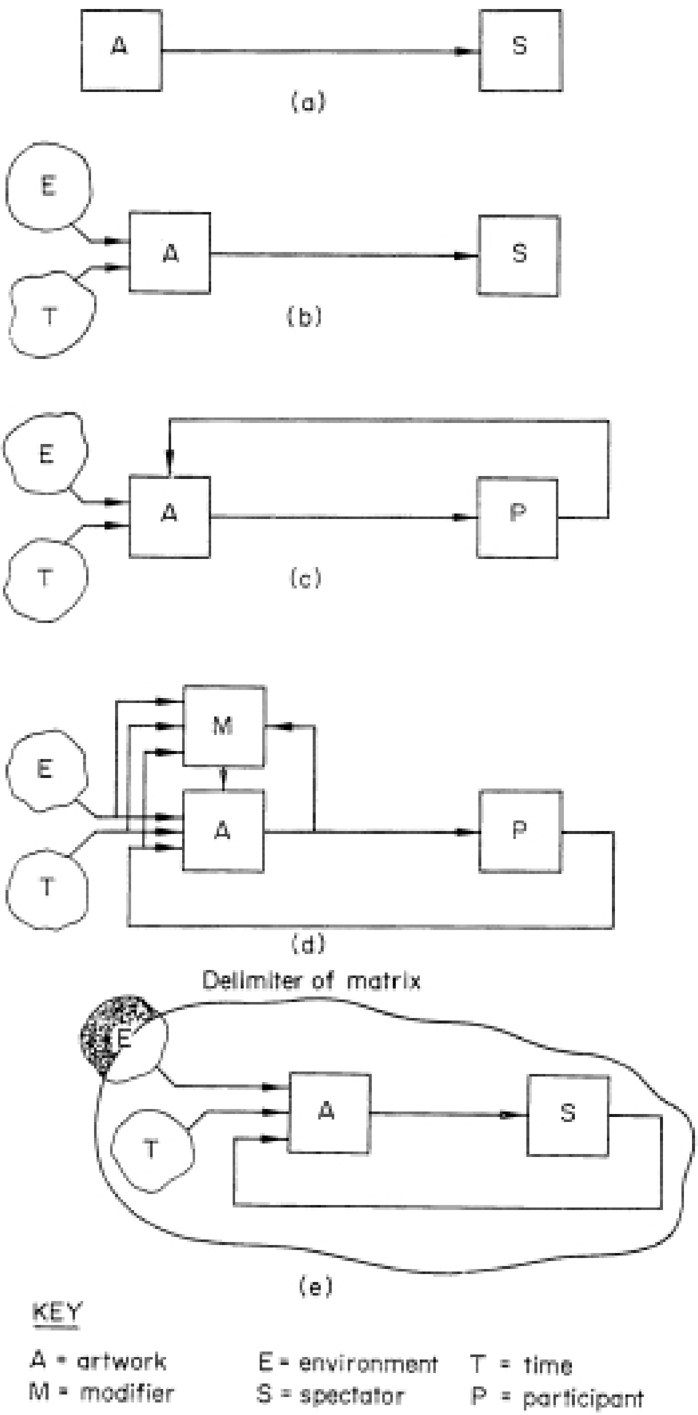
Figure 1: *Shaping Form*: Ernest Edmonds; in "*Selected New Acquisitions",* Victoria and Albert Museum, London, 2012-13 .

Background: Exploring Interaction

I first worked with a computer to make an interactive artwork in 1969 with Stroud Cornock. We showed that work, **Datapack*, at the CG70 exhibition and conference, where we also presented a paper that discussed the implications of the computer for art and, in particular, for participation and interaction [3]. We identified a number of forms of interaction, represented by the diagram reproduced as figure 2.

I went on to develop a range of artworks that explored interaction through networks [7]. I looked both at interaction between people and artworks and at interaction between people through artworks. These works were not strictly generative, but, together with the theoretical discussions in the Cornock and Edmonds paper, they can be seen to represent a fairly comprehensive investigation of interactive art. Much more recently, I have collaborated in developing and reviewing work in the area, as seen in the 2011 Candy and Edmonds publication [2].

Soon after I made these early interactive works, all of my art became generative. At first I devised structures, rules and procedures that I followed by hand. My paintings and drawings were generative and I was the generative engine that realised them. By 1980, however, I found ways of making time-based generative art using computer programs [4]. I realised from the start that this way



(a) *Static system.* (b) *Dynamic–passive system.* (c) *Dynamic–interactive system.* (d) *Dynamic–interactive system (varying).* (e) *Matrix.*

Figure 2: Interactive art systems, from Cornock and Edmonds [3].

of working allowed the possibility of including exchanges between the artwork, its environment and people. Interactive generative art was the next step [5].

As I have described in various places, including the book mentioned above [2], I came to realise that there was something missing in the conceptions of interaction that I, and very many other artists, had been using. I will explain this step in the next section.

From Interaction to Influence

In 2006 I realised that the kind of interaction that I had been looking at and using in my art was based on a direct action-response model. It assumed that if, for example, a participant did something relevant to the artwork the work would immediately respond. Clearly, this need not be the case. Consider interaction between humans, to take a different context, where I might be told that my train is an hour late, have no apparent reaction but, after a while, go for a coffee instead of walking to the platform. My response was embedded in a change of intention rather than a direct action.

Of-course, I understood the principles behind this systems view of interaction well before 2006. I was quite familiar with them in 1970, when making that first interactive piece, taking considerable interest in systems theory, biological systems and emerging ideas in psychology. However, somehow the implications for artworks were not fully put into practice until this century.

I wrote about the theoretical implications for art in a 2007 paper [6]. In that paper, I pointed out, for example, that:

> "An interactive system is an open system that exchanges information or matter, in both directions, with its environment. One key concern is the relationship between any input and later output. In the simplest such system, any given input is followed, after a certain interval, by a certain predictable output. One depresses a switch and the light comes on. If we add the notion of an internal state, then a slightly more complex version can be described. The output associated with a given input may be a function of both the associated input and the current internal state or, as it is often described, the mode that the system is in."

I asserted that:

> "… we can consider the artwork and the audience as interacting systems that influence one another. We can consider the development of computational art systems that are open to influence and that develop over time as a consequence. Equally we can think of the influence that such systems will have on their audiences. We therefore need to consider this kind of computational generative art in open systems terms from the very core of their design."

These ideas have been explored in my generative artworks, the *Shaping Forms,* by using "the history of interactions between participants and the work to modify the generative behaviour by changing the rules or changing which rules are used". From the audience's point of view, these works need long-term engagement. They presume that, for a complete experience, that engagement is extended over days, months or years. Art that benefits from this kind of engagement brings to mind Donald Judd's comments on emotion in art:

> "European art … is based largely on immediate emotions…Rembrandt, for example, is a compendium of gloom sadness and tragedy. This immediacy of feeling is basic to all his paintings… Newman and Pollock have no immediacy of this kind. The thought and emotion of their work … is underlying, durable and concerned with space, time and existence. It's what Bergson calls 'la durée'." [8]

Influence, rather than simple interaction, in generative art may have a greater significance than simply exemplifying natural, for example biological, interactive systems.

Shaping Forms

Each *Shaping Form* work consists of a square LCD monitor, typically 17", on which the abstract images generated by the work are displayed, figure 3. Attached to, or around, the monitor is a camera that is also connected to the computer. An image processing system analyses the image stream from the camera in real time and determines the amount of movement taking place. That information is used to influence the rule structures being used to generate the image sequence.

The rules operate on the colours, shapes and timing patterns being used. Colour is broken down into hue, saturation and lightness and, typically, very close hues are used for most of the pallet. As the generative rules change all of these parameters are likely to shift so that, for example, the hues might gradually move from a red dominance towards the blues.

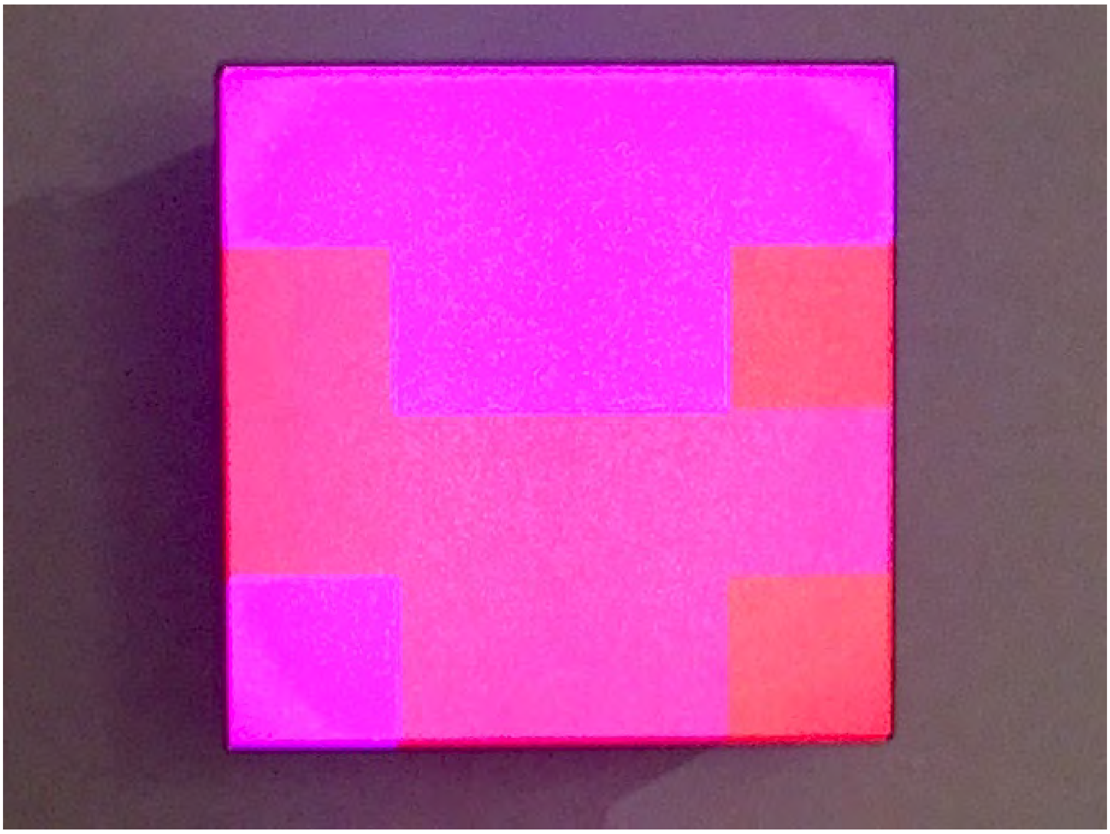


Figure 3: *Shaping Form 1 May 2015*: Ernest Edmonds; in "*Primary Codes"* [9].

An important aspect of these works is their formal systems-based exploration of colour through generative processes and, in the context of this paper, with the slow, evolving influences that the movement of audiences cumulatively have on the development of those processes.

The *Shaping Space* series continues, using new structures, new rules and new system architectures. At the same time, I am using the concepts in other kinds of work, such as full room installations, paintings and prints.

Shaping Space and Shaped Forms

The *Shaping Space* installation is in a darkened room where there are two changing images in space creating a field of colour, figure 4.. The screens show a living matrix of colours that sometimes change very slowly and at other times burst into life. The colours use a small, but changing, pallet of hues. Images are generated using rules that determine the colours, the patterns and the timing. Just like the small *Shaping Forms*, this is a generative work that is changed by the influence of the environment around it. People can readily detect the immediate responses of the work to movement, but the changes over time are apparent only when there is more prolonged, although not necessarily continuous, contact with it. The shaping of the space is a never-ending process of computed development.

Figure 4: *Shaping Space*: Ernest Edmonds; in *"Ernest Edmonds: Light Logic"*, Site Gallery, Sheffield 2012-13.

Photo Robert Edmonds.

As discussed in the companion artwork paper [6], the interactive time-based works also lead me back to still images where the implications of the generative processes are explored in paint and print and where my colour investigations, in particular, are refined leading to new colours and structures in *Shaping Forms*.

Conclusion

I have outlined the development of the thinking, in my practice, about interaction as a significant element in generative art. I have described an approach that I term *influence*, in which the primary effects of actions on the artwork, through its sensor systems, change the generative processes rather than instant behaviour. The *Shaping Form* series, *Shaping Spac*e and the *Shaped Forms* exemplify and use this approach in various aesthetic ways. Following Donald Judd's thoughts, perhaps what Bergson calls 'la durée' can be seen as key to these works.

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[9] www.generativeart.com

Mohamed Zaghloul

Machine-Learning aided architectural design
Self-Organizing map generate in between design alternatives

Topic: Architecture Design

Authors:

Mohamed Zaghloul
ETH Zurich, Department of Architecture, Chair for Computer Aided Architectural Design,

Switzerland

www.caad.arch.ethz.ch

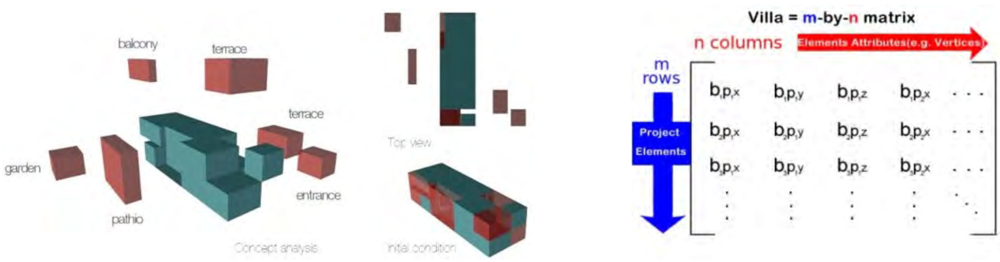
Main References:

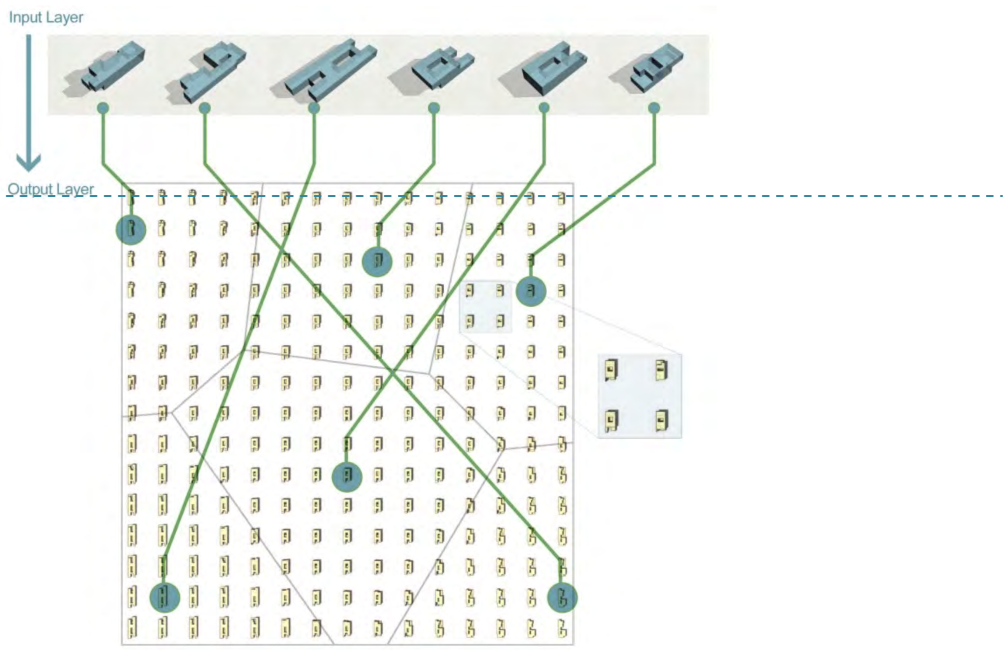
[1] L. Hovestadt, "*Eigen Architecture*", Ambra Verlag MMag, Switzerland, 2013

[2] T. Kohonen, "*Self-organizing maps*", Springer-Verlag Berlin Heidelberg, 2001

Abstract:

The study is a part of an on-going research that focusing on using Self-Organizing Map – SOM – as an unsupervised learning algorithm in order to classify and cluster Design-data inputs and integrating them with the design process. A Villa experiment is presented to target using SOM in the form finding phase through a non-linear morph of geometrical elements and spatial solution varieties. The Villa Design-data has multiple attributes that had been encoded as Matrices. By applying SOM algorithm on 6 initial different design alternatives Matrices, The output is a 2d topological map shows the "close" and "far" of the 6 input variations that in center of 6 Voronoi cells. Moreover, by rendering the weights of SOM neurons which are in-between these initial inputs, that creates a non-linear morphing in between the 3d models. Finally, the paper shows creating a design system – by using SOM – that captures, stores, analyzes, clusters and presents a non-linear morph in between many 3d models at once according to their distances.





SOM input layer: 6 design alternatives of villas. Output layer: a non-linear morphing in between 6 design alternatives

zaghloul@arch.ethz.ch

Keywords: Self-Organizing map - SOM - Machine learning Algorithm - non-linear morphing

Machine-Learning aided architectural design

Self-Organizing map generates in-between design alternatives

Mohamed Zaghloul

ETH Zurich, Department of Architecture, CAAD

Chair for Computer Aided Architectural Design

e-mail: zaghloul@arch.ethz.ch

Abstract

– The study is a part of an on-going research that focusing on using Self-Organizing Map – SOM – as an unsupervised learning algorithm in order to classify and cluster architectural design-data inputs and integrating them with the design process. A Villa experiment is presented to target using SOM as a form finding through a non-linear morph of geometrical elements and spatial solution varieties. The Villa design-data has multiple attributes that were encoded as Matrices. By applying SOM algorithm on 6 initial different design alternatives' matrices, the output is a 2d topological map shows the "close" and "far" of the 6 input variations that in the center of Voronoi cells. Moreover, rendering the weights of SOM neurons in-between these initial inputs create a non-linear morphing in between 3d models. Finally, the paper shows creating a design system – by using SOM – that captures, stores, analyzes, clusters and presents a non-linear morph in-between many/any 3d models at once.

– **Keywords:** Self-Organizing Map – SOM – Machine learning – Non-linear Morphing – Architectural Design Process – Unsupervised Learning Algorithm

Introduction: Neural Networks vs. conventional computing

– A dominant mode of using computers in architecture is as merely machines to save time from doing an overwork; notwithstanding that the beauty of computers is that they are not machines; they are abstract machines [1] which enable formulating general concepts by abstracting common properties of instances.

– An argumentation since 1950 about using computers: How are the computers talking to us / how should we talk to computers / can we teach them to interplay with us in the data processing – In brief "*Could machines think*?!"[8] – I will say, "Yes, machines can think as much as they learn." And a clue for that is discussed in this study from architectural point of view. By integrating machine learning algorithm with the design process, e.g. SOM, a process of discovering patterns inside data is easily attained, and that will push the limits of developing the start-up steps of the design process.

– Neural networks – NN – use a different approach to problem solving than conventional computers. NN and conventional algorithmic computers are not in competition but complement each other [6]. The conventional computers use specific steps – Algorithm – to solve a problem and without these steps the problem cannot be solved. On the other side, Neural Networks can learn by feeding them with examples.

– A neural net consists of any number of processing elements called neurons or nodes. Each neuron is connected to other neurons each with an associated weight. Neural nets can be applied to a wide variety of problems such as classifying patterns, performing general mappings from Input patterns to output patterns and grouping similar patterns. [9] NN uses a family of machine learning algorithms, which inspired by – used to model – the biological nervous systems. [5] Among NN models, SOM is commonly used unsupervised learning algorithm.

– The regular morph techniques are between two entities in a linear way, and that uses diverse of mathematical and representation levels for these linear morphing that used conventional morphing algorithms [3]. A different kind of linear morphing technique had been presented in Eigenchair project [2] which used Principal Component Analysis – PCA – algorithm. By integrating NN with the 3d modelling as presented in this paper via using SOM algorithm, a non-linear morphing technique is emerged in-between many and any at the same time.

1. Machine Learning aided architectural design

– "Machine-Learning aided architectural design" is suggested in order to integrate learning from data that produces discovering patterns, understand and manipulate the data entities in a holistic way, with architectural design. The proposed design process goes parallel with an unsupervised learning algorithm – SOM – which will not tell how to end-up solving a problem directly but will tell how to begin preconceiving data and discovering its heuristic rules. It shows you complex data sharp borders and boundaries were morphing anything is possible, and anything may be related to any.

1.1 Learning from Data vs. Design by Data – Theoretical Approach

– By being surrounded by a massive amount of information, integrating a classifying and clustering analysis requires a balanced intelligent environment that able to learn from the information. If design elements of objects are abstracted and coded as multidimensional vectors, they become more effective and manipulative. SOM is suggested to integrate with the architectural design process explicitly with any of design steps. It's a new way to preconceive our data and dive into the hidden similarities and to discover patterns inside the used data. That data can express geometrical elements - physical attributes – building performances and any.

– SOM is one of the unsupervised learning algorithms that no labels are given to the learning algorithm, leaving it on its own to find structure in its input. It can discover hidden patterns in data [4]. SOM scientifically is used to classify and cluster data, but this paper focuses and pushes the limits of linear morphing to a non-linear morphing in between 3d models by rendering the SOM neurons' weights.

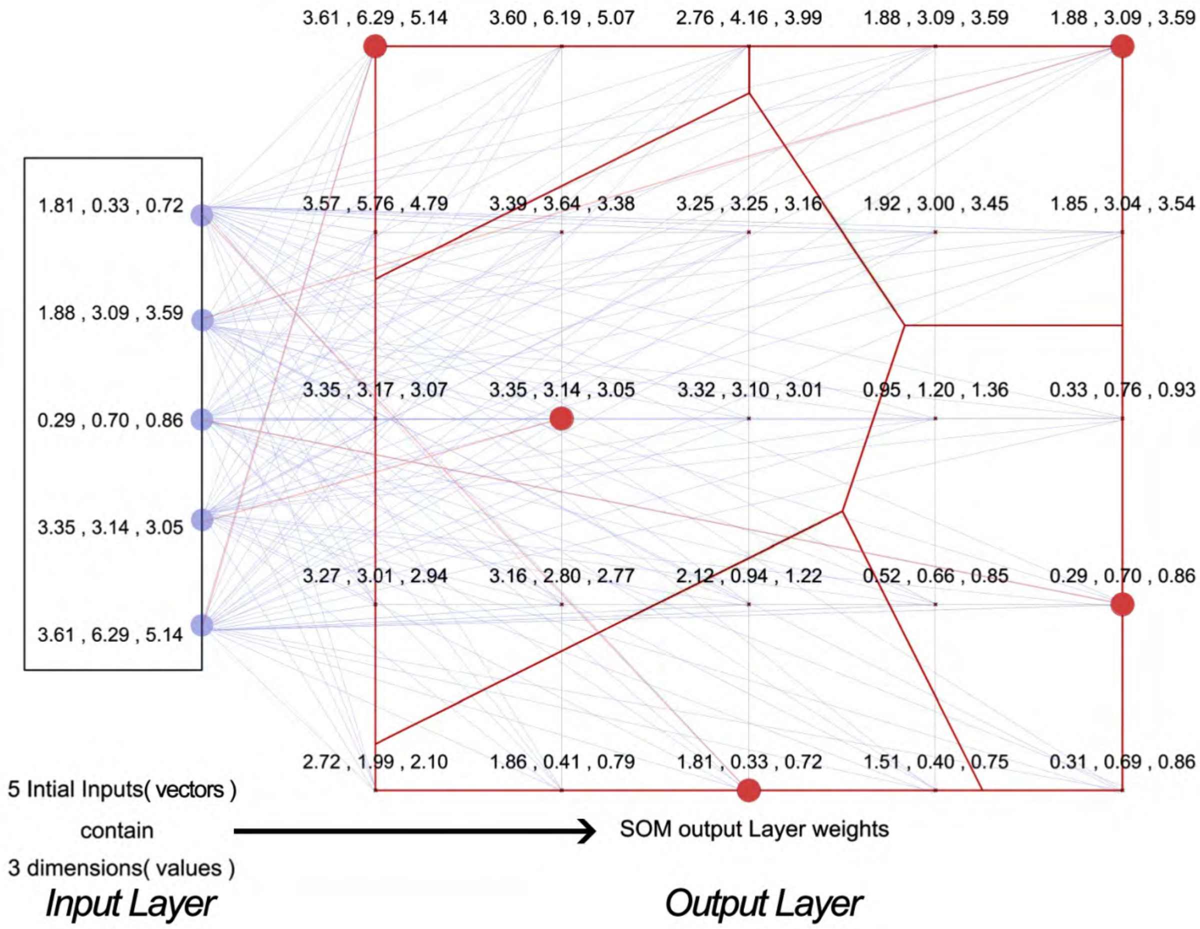
– A lot of data are used within the design process at different levels such as project elements areas, relations, geometrical data, weather data, building performance and Energy consumption…etc. This paper isn't talking about data optimization, but about understanding and preconceiving data patterns by SOM because of its ability to reduce the data dimensionality and express it in our limited Cartesian space.

– 1.2 Dimensionality Reduction by SOM – Technical Approach

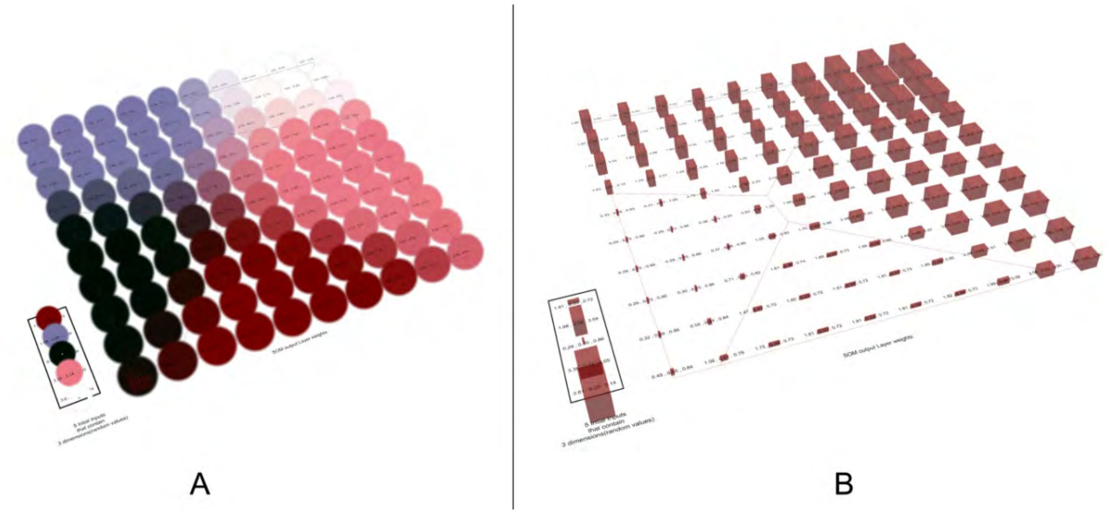
– We use Cartesian logic of modelling in order to formulate our ideas, which limited especially with multi-dimensional models. SOM enables reducing those multi-dimensional values and represents it in lower dimensional spaces (1D, 2D and 3D). Consequently, we are able to extract the hidden similarities in between these data, and visualise the degree of belonging in between the data elements via clustering.

– A detailed algorithm example – Villa experiment – will be described later in section 2.2. This section shows an example – Figure1 – of how simply SOM represents graphically the relations between, on one side, the input layer that contains initial inputs. The inputs are 3 dimensional vectors that can represent any RGB colours or box dimensions (Figure 2).

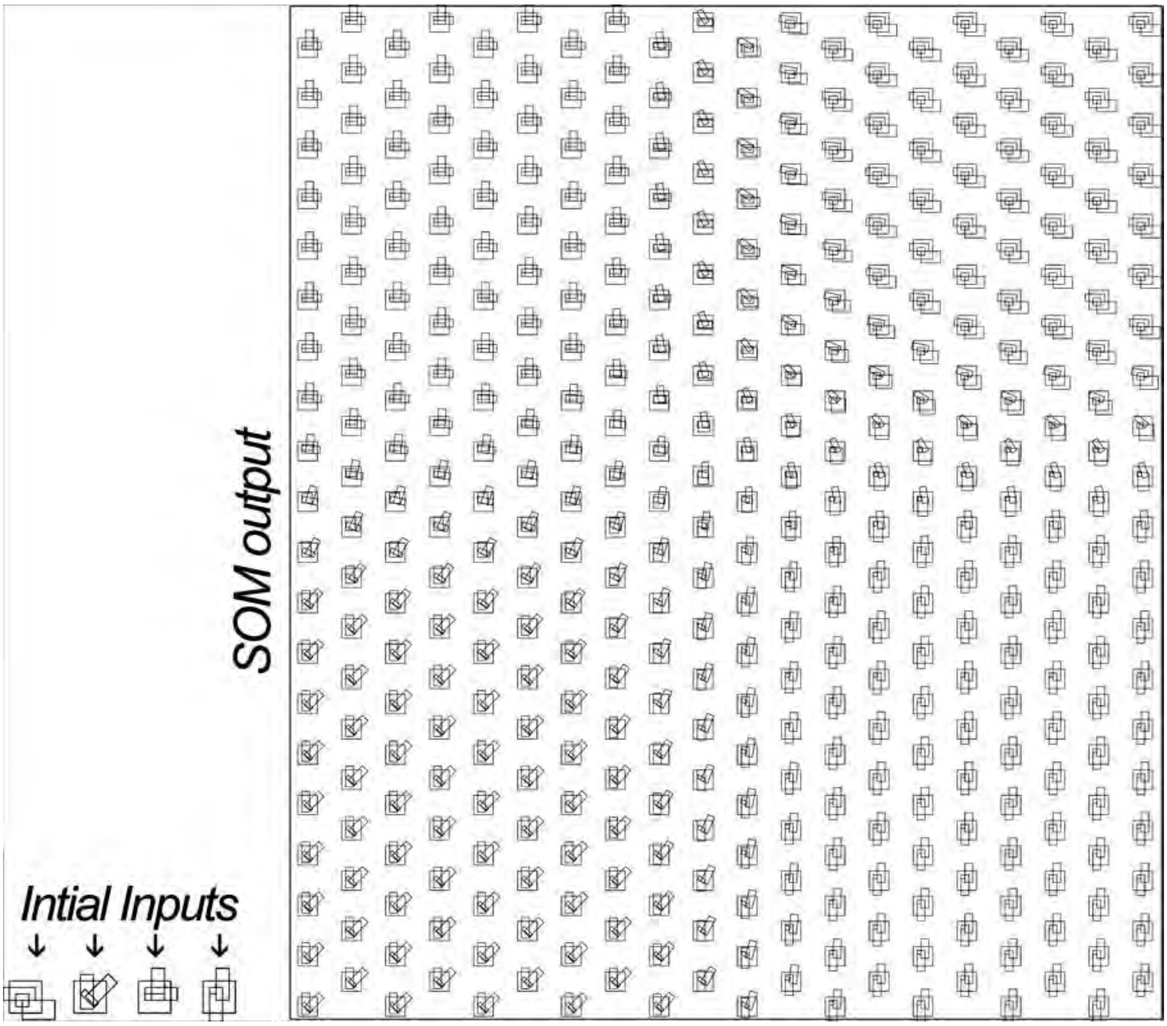
– On the other side, the output layer is a topological grid – rectangular or hexagonal or any type of grids – of neurons/nodes, which projects 3-dimensional data in a 2-dimensional representation. The similarities between inputs can be recognized according to the close/far distances between them. Moreover, by generate in-between the inputs, heuristic non-linear morphing paths between the inputs are emerged.



– *Figure 1: Shows the 2D topological output map of SOM that represents the distances between 3D Input vectors.*



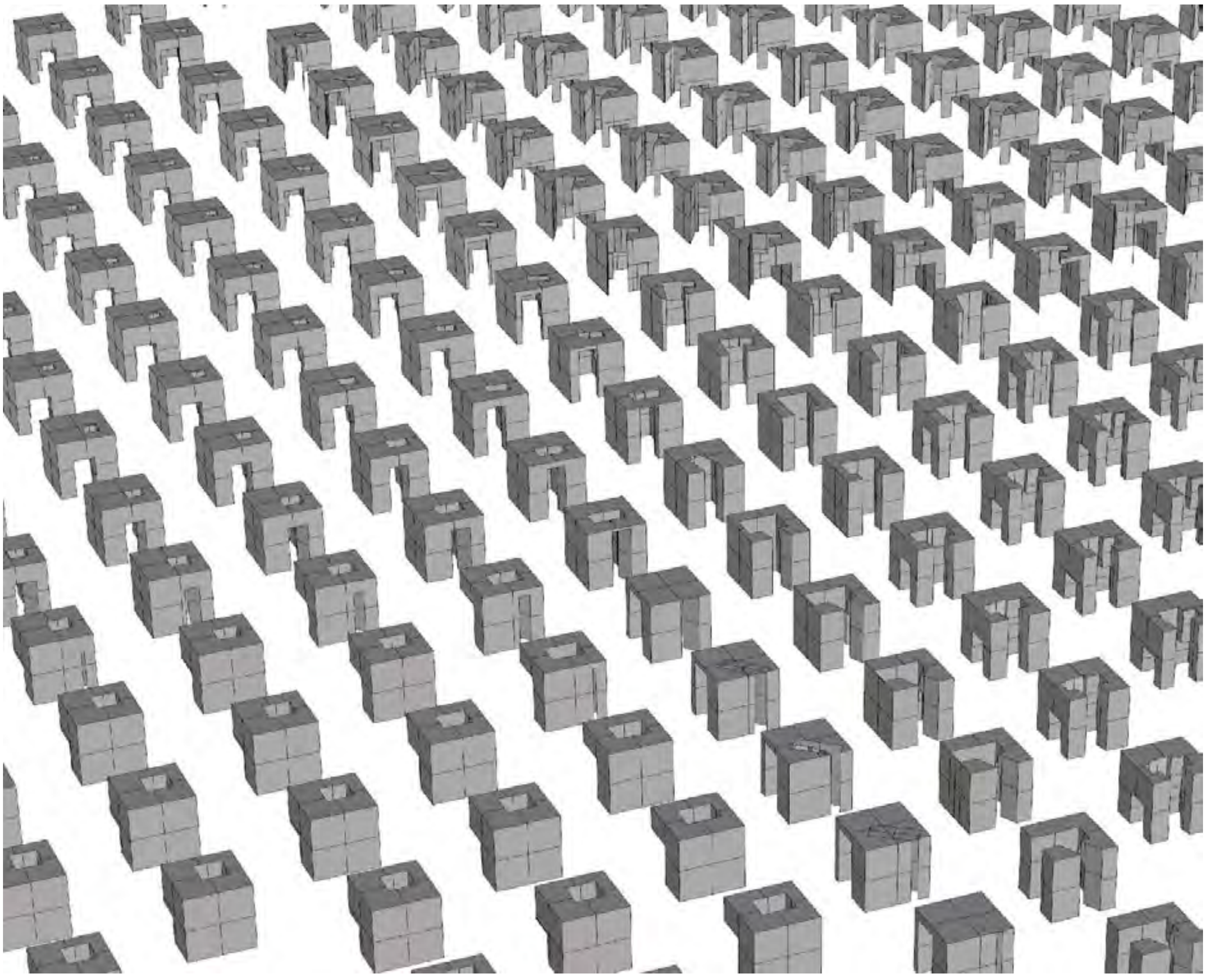
– *Figure 2: adding more neurons for the output layer and visualising the inputs' values (random) A) as RGB colours of dots – B) as dimensions of boxes, SOM returns a parametric mapping of the in-between input values.*



– *Figure 3: SOM defines automatically the behaviour of rotation and scale of the 3d initial objects (Boxes) without pre-parameterization process.*

– In Figure 3, four initial inputs, each consists of three boxes that rotated and scaled inside a bigger cube. The inputs were coded as a sequence of vertices of each box, so each input vector has 72 values. Hierarchal relations are stored between the values that transform the values later to vertices, faces and solids. After training SOM, which learned from the inputs, it returns out morphing in-between the inputs' values.

– Then, the models are subtracted from a box – Figure 4. Imagine that these subtracted boxes express entrances and courts that changing its dimensions and rotations according to the domain of the inputs. Thus eventually, SOM starts with multidimensional vectors that represent entities in an un-parameterize encoding, then it sorts the indices around the input data to produce a nonparametric mapping.



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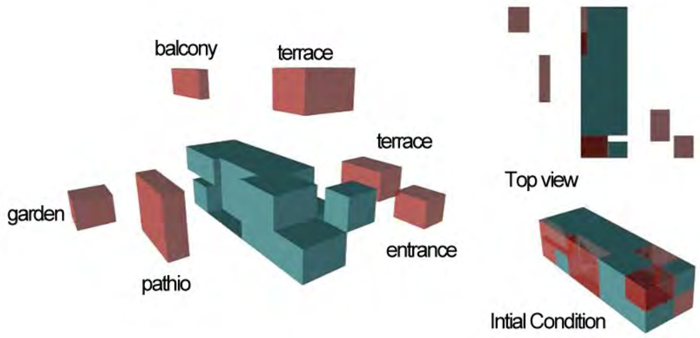
– *Figure 4: representing the subtraction of 3 Boxes (entrances – courts) from a main cube that can express simply a building.*

–

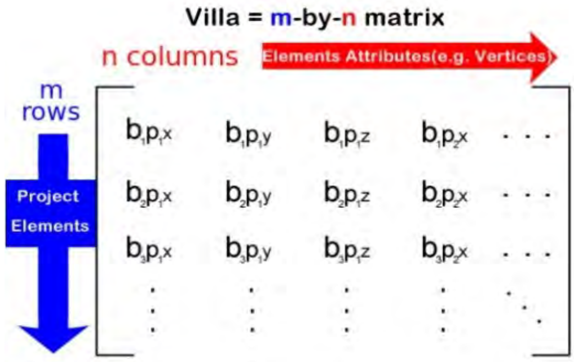
– 2. Villas experiment

2.1 Encoding Matrices

– Most of the design-data have manifold attributes. These attributes can be articulated as dimensions of multiple vectors. If there is a data set of element X, $X=\{x_1,...x_n\}$ as a set of values that describe the n-dimensional space of the vector X. For instance, a program element – e.g. reception – will be articulated as a vector with multiple attributes. The Reception has the following properties {40 m2, facing a good view, away from direct sun-rays and away from private area, and direct relation with entrance}. This can be written as follows: Reception= {40,1,0,0,1} the measuring units of this vector attributes – dimensions – are different from each other area is in m2 and the other attributes is a binary or rational number between 0 and 1. Another example, a box has eight vertices and each of these point vertices has three values $p_n=\{x_n,y_n,z_n\}$.So we can describe it as a Box $b=\{x_{p1},y_{p1},z_{p1}, x_{p2},y_{p2},z_{p2},\ldots\ldots x_{p8},y_{p8},z_{p8}\}$.



– *Figure 5: shows design elements which based on addition or subtraction of the whole building volume according to the design objectives.*



– *Figure 6: shows an architectural project as matrix of m elements (vectors) by n attributes (dimensions).*

– If we have many boxes in the Space R – R is denoting a villa design in this Figure (1), then we can describe them as entities of this space $Bn \in R$. While $B1$=Entrance, $B2$= Court, $B3$= Terrace...etc. Some of these Boxes are added, and others are subtracted from the whole volume according to the design objectives.

– A parallel process to encoding the matrix is encoding the hierarchical relations between its values. These hierarchical relations will be used again at the end of the decoding process. Example of those hierarchal relations between the matrix values - Figure (2): each Box b contains face f, and each face contains points that have values x, y and z.

– $b_n=\{f_1\{p_1\{x,y,z\}, p_2\{x,y,z\}, p_3\{x,y,z\}, p_4\{x,y,z\}\}, f_2\{\ldots\}, f_3\{\ldots\},\ldots f_6\{\ldots\}\}$.

– The last step is defining different design alternatives of villas V.
$Vn=\{b_1\{f_1\{p_1\{x,y,z\},\ldots p_4\{x,y,z\}\},\ldots,f_4\{p_1\{x,y,z\},\ldots p_4\{x,y,z\}\}\},b_2\{\ldots\}\ldots\ldots b_n\{\}\}$.

2.2 Decoding Matrices by SOM

– Here we describe the main steps of the classical SOM algorithm that were applied to 6 different alternatives of designing villas. Each prototype has different positions of zones (entrances-courts-terraces-reception areas…etc.) and each of them added or subtracted later from the whole volume. The equations and algorithmic steps of SOM that were used are referenced by T.Khonen [5], The main steps of this experiment are as follows:

– 1) Normalizing the vectors: If all the attributes are different in measuring units, then the normalization step is important to put all of them within the same domain values according to the weight of each attribute to the whole vector [7]. Nevertheless, in this experiment, all the values have the same units that related to positions of vertices $\{x, y, z\}$, So this step can be skipped in this experiment.

– 2) Specify the Out-layer grid number and Initial random weight for each of the Output layer nodes. The weight vectors have the same dimensionality as any of the input vectors dimensions.

- e.g each zone has eight vertices and each vertex has three values {x,y,z}, That gives 24 values. Here in this experiment, each villa has 10 zones, thus each one is described by 240 values.

- It's important to note that the same sequences of zones for each prototype are the same.

- A rectangular grid with 15 column x 15 rows is used as an output layer for this experiment.

– 3) Compute the Euclidean distance Matrix between out-layer grid nodes – neurons – . That will be used later in updating the weights within the iterations gradually according to a neighbo urhood function. *[5]*

$$DistFromInput^2 = \sum_{i=0}^{i=n} (I_i - W_i)^2$$ *The Euclidian distance equation [5]*

– 4) Training SOM – For each Iteration of a time step (t):

- Select randomly any of input vectors I

- Calculating the Best Matching Unit BMU: by iterating the Euclidean distance calculation of all the nodes between each node's weight vector and any input vector. The node with a weight vector closest to the input vector is tagged as the BMU or the winning neuron. This equation is for iterating the Euclidean distance, I is the current input vector, and W is the node's weight vector.

- Updating the weights: $W(t+1) = W(t) + \Theta(t) L(t)(I(t) - W(t))$ .the Greek letter theta Θ, represent the amount of influence a node's distance from the BMU has on its learning. L is for the learning rate. For further details about Θ and L is described in details by T. Kohonen [5].

– 5) The output layer weights have 240 sequential values for each node. Three values are a Cartesian position of point {x, y, z} then rendering each eight vertices as a box that be added or subtracted according to the previous hierarchal encoding of the input layer elements.

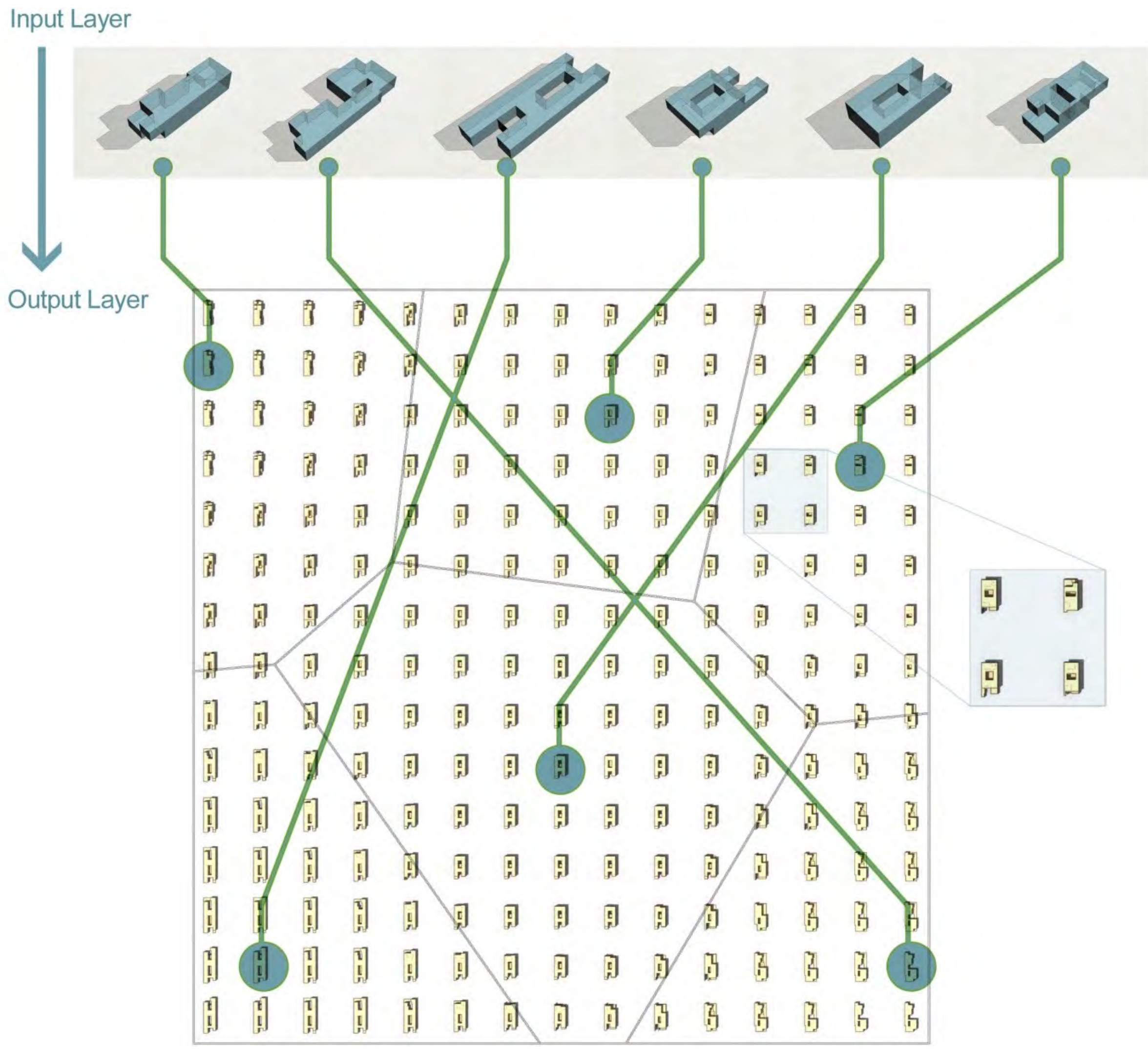


Figure 7: shows SOM input layer: 6 design alternatives of villas. Output layer: a non-linear morphing in between 6 design alternatives.

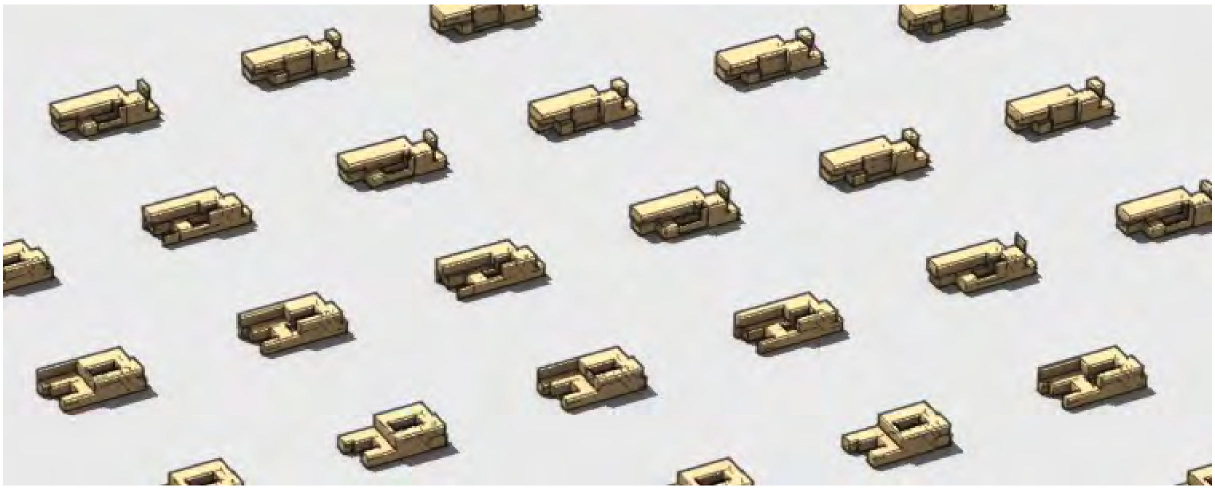


Figure 8: preview for some models of the Output layer: a non-linear morphing in between the 3dmodels.

2.3 Design concept refining - development

– A cyclical process can be established by the designer who decides a trip from any object in this topological map to another passing with the in-between models in a non-linear way. Then, the designer can select from these in-between models to start a new stage of data morphing. It's possible to choose new designs – as shown in Figure (8) – between the emerged outputs to train SOM with the new designs' data. This process can run in parallel to basic building performances' simulations, e.g. shadings – solar radiation – heating/cooling energy consumption for the buildings' envelopes…etc.

3. Application interface

– The SOM code was implemented using Rhino, Grasshopper GH and Mathematica via SOM tool – developed by the author – similar to Mantis.[10] On one side Rhino and Grasshopper were chosen for dealing with constructing and deconstructing the 3d-Modeling elements in an intuitive parametric manipulation. On the other side, Mathematica was chosen for its symbolic computational language that enables dealing with a huge amount of data inputs in fast time and processing intuitively. The Main SOM code was written in Mathematica then be called via an add-on SOM tool in GH.

4. Conclusions

– Finally, the paper shows creating a design system that captures, stores, analyzes, manages, clusters and presents in between the geometrical data that are linked to the designs' alternatives. SOM is integrated with the tool to compute the changes in building geometry and visualizing the hidden relationship between designs in a non-linear analysis method that produce a new non-linear morphing technique.

– SOM can affect strategic decisions in the early conceptual design stages that lead to new optimal alternatives. It also means that ideas can generate alternatives then be pursued, tested and accepted/rejected at early stages of the design process.

– 5. Acknowledgment

– I would like to thank my supervisor Prof. Dr. Ludger Hovestadt, head of the CAAD chair at the ETH Zurich for support and mentoring my PhD research, and thanks to Federal Commission for Scholarships (FCS) for their financial support. In Addition, I would like to thank ENCODE studio teamwork that participated in the villas' proposals that presented to SODIC construction company in Egypt.

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– [10]http://www.grasshopper3d.com/group/mantis

Hülya Oral

Interactive Structures In Nature Inspired Design *(Paper)*

Topic: (Architecture)

Authors:

Hülya Oral

Istanbul Bilgi University, Department of Architecture

Turkey

Erhan Karakoç

Istanbul Kültür University, Department of Architecture

Turkey

Main References:

[1] Burke, A. & Tierney, T. *“Network Practices: New Strategies in Architecture and Design”*, Princeton Architectural Press, Cambridge, MA, 2007.

[2] Zuk, W. & Clark, R. H., *“Kinetic Architecture”*, Van Nostrand Reinhold Company, 1970.

www.generativeart.com

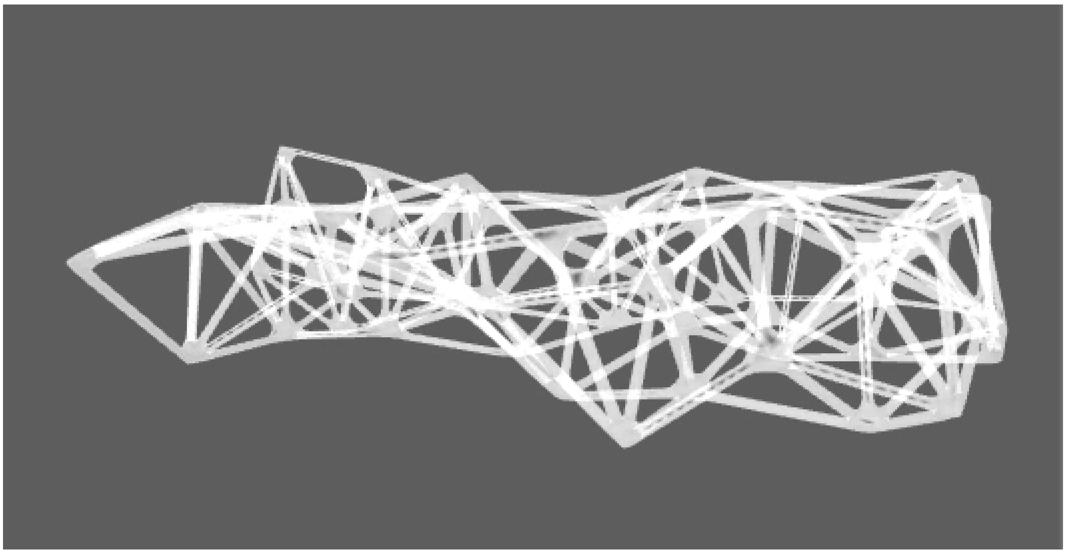
Abstract:

Adapting to change which is embedded in nature has become much more important under the changing conditions of our world. Especially, the orientation of the plants roots’ according to the water and leaves according to the sun, which is called tropism is ensured the adaptation of the plants to the changing environment. Thanks to tropisms, the structure of the plant which consists of the xylem is bending, lengthening or widening if it is necessary for adaptation. By this means, the structure of the plant which consists of the nodes and links between them yields the survival of the plant in the extreme conditions.

Agent-based systems are used for the modelling of the complex network systems like the structure of the plants. In such systems, a micro behaviour affects the whole system and ensures the interaction of the structure with the environment invariably.

In this paper, the interactive character of the plants is examined upon the several projects and searched for the architectural potentials. Next, an interactive structure is designed according to the tropism movements of plants. The structure is based on the human movements and density of people as an input following the algorithm flow chart. The inputs affect the nodes of the structure directly and change the coordinates of them. So that, the structural system surpasses the static behaviour and acts in motion. The structure acts as a console or long span beam according to the human density and location of the density and shows some emergent behaviours.

Model has future potentials which can answer the micro and macro scale different architectural needs. Structures are obtained which vary in size and shape thanks to the human interaction of the algorithm. The structures which are obtained can be integrated with the functional needs of any kind of the building and used as a part of the design process. By designating the less and more densified spaces in a building, the algorithm can generate the structure of it. Besides, the macro scale adaptation of the algorithm, urban plans, green areas and infrastructures can be designed. In conclusion, nature inspired interactive structures can be used in different design phases thanks to its potentials and opportunities which serve to the designers.



Example: Image of the interactive structure.

Contact:* *hulya.orall@gmail.com

Keywords: biomimetic design, network systems, agent-based design

Interactive Structures in Nature Inspired Design

B. Arch. Hülya Oral, R. A.

Department of Architecture, Istanbul Bilgi University, Istanbul, Turkey

e-mail: hulya.orall@gmail.com

Msc. Arch. Erhan Karakoç, R.A.

Department of Architecture, Istanbul Kültür University, Istanbul, Turkey.

e-mail: erhankarakocitu@gmail.com

Premise

Adapting to change which is embedded in nature has become much more important under the changing conditions of our world. Especially, the orientation of the plants' roots according to the water and leaves according to the sun, which is called tropism is ensured the adaptation of the plants to the changing environment. Thanks to tropisms, the structure of the plant which consists of the xylem is bending, lengthening or widening if it is necessary for adaptation. By this means, the structure of the plant which consists of the nodes and links between them yields the survival of the plant in the extreme conditions.

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Model has future potentials which can answer different architectural needs in the micro and macro scale. Structures are obtained which vary in size and shape owing to the human interaction of the algorithm. The various structures can be integrated with the functional needs of any kind of the building and used as a part of the design process. By designating the less and more densified spaces in a building, the algorithm can generate the structure of it. Besides, the macro scale adaptation of the algorithm, urban plans, green areas and infrastructures can be designed. In conclusion, nature inspired interactive structures can be used in different design phases thanks to its potentials and opportunities which serve to the designers.

– 1. Introduction

Network systems are interdisciplinary systems which are utilized by several scientific fields like biology, computer science, geography, engineering etc. in order to model complex systems. A network is an abstract organizational model, in its broadest sense concerned only with the structure of relationships between things, be they objects or information, which can be applied to the organization of anything from friends lists to genetic algorithms to global military operations [1]. These relational networks are used in both for modelling hierarchical and emergent systems. A network system which defines the complex material or energy system includes performative parameters in itself. These parameters are in relation with flexibility, self-organization and adaptation [1]. In self-organizing networks, a micro-scale behaviour affects whole the system and creates performance based structures which response to the changing environment according to stimuli.

In a self-organizing data network, behaviours can be analysed by agent-based systems. For example, in plants as an example of natural agent-based systems, the water and nutrition which are carried by the xylem are the agents of the network system. Through these agents, new connections in response to the need of water and nutrition are set in the structure of the plant while keep its own structural rigidity. As it is shown in Figure 1, *Luffa cylindrica* has a fibre network structure which is formed after drying. This network system is hierarchically organized to host the inner seeds and to protect the plant. The connections of structure change in time by creating emergent patterns, while plant grows. Thus, the system shows self-organizing structural behaviour which can be adapted to the architecture and urbanism as an information based interactive model.

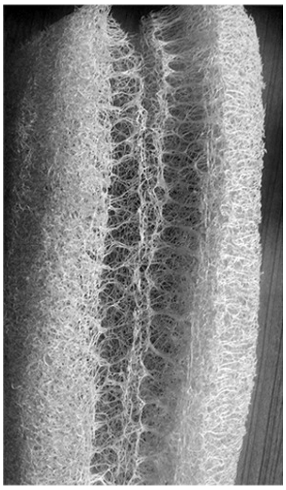

Figure 28: Luffa cylindrical after drying.

In this paper, firstly, the tropism movement in plants as a network system will be analysed in terms of biology and its applications in architecture. Next, a model will be proposed by using a nature inspired method in relation to plant tropism movements within a network system.

– 2. The Movement Systems in Plants

Plants obtain the water and minerals from the soil by their roots while convert light energy to nutrition and oxygen by their leaves. While they satisfy their need, they make change of state according to stimuli in a way that directional or non-directional. These movements are called tropic and nastic movements [2]. Tropic movements are in relation to the direction of stimuli, whereas nastic movements does not depend on it. Thus, nastic movements are not analysed in this paper, because the response to stimuli independent from the direction of it like Venus flytrap which captures pray [3].

2.1 Tropism

Tropism is the growth or turning movement of a biological organism, usually a plant, in response to an environmental stimulus [4]. If the tropism occurs at the same direction of the stimulus is called positive tropism, at the opposite direction is called negative tropism. Some of these movements are phototropism (in response to illumination), geotropism (in response to gravity), haptotropism (in response to touch or physical contact), chemotropism (in response to chemical), traumatropism (in response to one-sided injury), and hydrotropism (in response to water or moisture) [2].

Tropisms which are activated by stimulus play an important role in the growth of plants. According to this tropic movements, a plant can sense the direction of the growth by means of pressure changes and response to it. For example, traumatropism occurs if a plant is injured. The growth of cells in that area of the plant gets slower and nutrition needed for growth is translated to the healthy areas of the plant. Thus, the plant leans toward and creates a curvature which differs in every stimuli.

In plants, these movements occurs according to the change of the agents in the environment. Besides, these movements in the plants are neither totally chemical nor mechanical. All the tropisms, except the behaviour of the Venus flytrap occur by means of the cell growth. For example, roots of the plants in order to find water by turning a corner, make a cell growth at the small area of the plant and the plant leans toward to negative direction of the cell growth [5]. Thus, the plant can survive in extreme conditions with this kind of tropism called hydrotropism.

Figure 29: Hydrotropism of the roots of the wheat plant [6].

As it is shown in Figure 2, roots of the plants lean toward stimulus which is called positive tropism. The body of the plant in contrast to the roots, grows to the opposite direction of the gravity, which is called negative tropism. Thus, the structure of the plant change in time while staying stable.

Both in hydrotropism and gravitropism and also in other several tropisms, plants bend while growing. This is because the concentration of a plant hormone called auxin inhibits the growth at one side of the plant [7]. One side grows much more than the other side of the plant and taller side starts to bend over the other. Different angles are created due to the elongation at different levels. Thus, plant can adapt to the environment and survive in changing conditions.

– 3. Biomimetic Approaches in Architecture

Agent-based systems can be observed in different scales - from building to city as similar as tropisms in plants. These systems are used to model and to analyse the human behaviour in order to understand and simulate the relationship between people and their environment. They are generally applied to ensure the organization of space, to plan the infrastructures, and to model the circulation and guidance elements. In these systems, every agent is in a relation with its environment and responsive to stimulus. Thus, they can be analogically associated with the tropism in plants as they adapts to the change.

A network system defined by nodes and links between them according to algorithms is the one of agent-based systems. In digital design, these nodes may represent a region in an urban pattern or a joint in a structure. As an example for urban network systems, Urban Sprawl Condenser by Sugar Inc. is shown in Figure 3. This project is designed by using a network system which defined by nodes and links and used the method of biomimicry by applying the principles of plants network systems and fibre structures. The model starts with a single node and aggregates according to the algorithms while creating circulation systems and public nodes. These network clusters grow and spread by getting organized. Eventually, an urban plan is created [8].

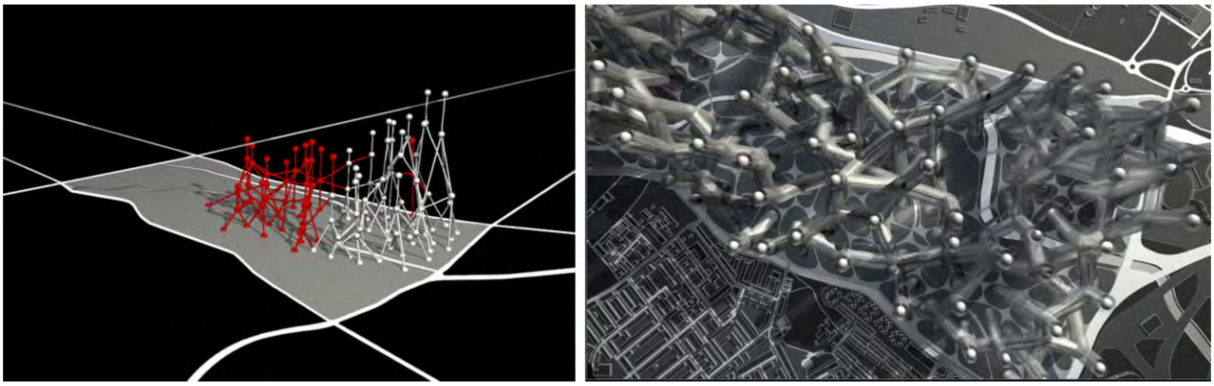

Figure 30: The pattern which is created by aggregation of various urban and circulation nodes [8].

Next, these nodes are designated to host various functions while links between them form the structure of the network as similar as a structure of a plant (Figure 4).

Figure 31: Urban Sprawl Condenser: Inspired by fibre structures of plants [8].

A structural example for network systems is Hylomorpic Project by O-S-A. In this project, various structures with different nodes and links are obtained after several iterations according to the algorithm. Next, they are analysed regarding the stability and materiality for choosing appropriate ones (Figure 5) [9].

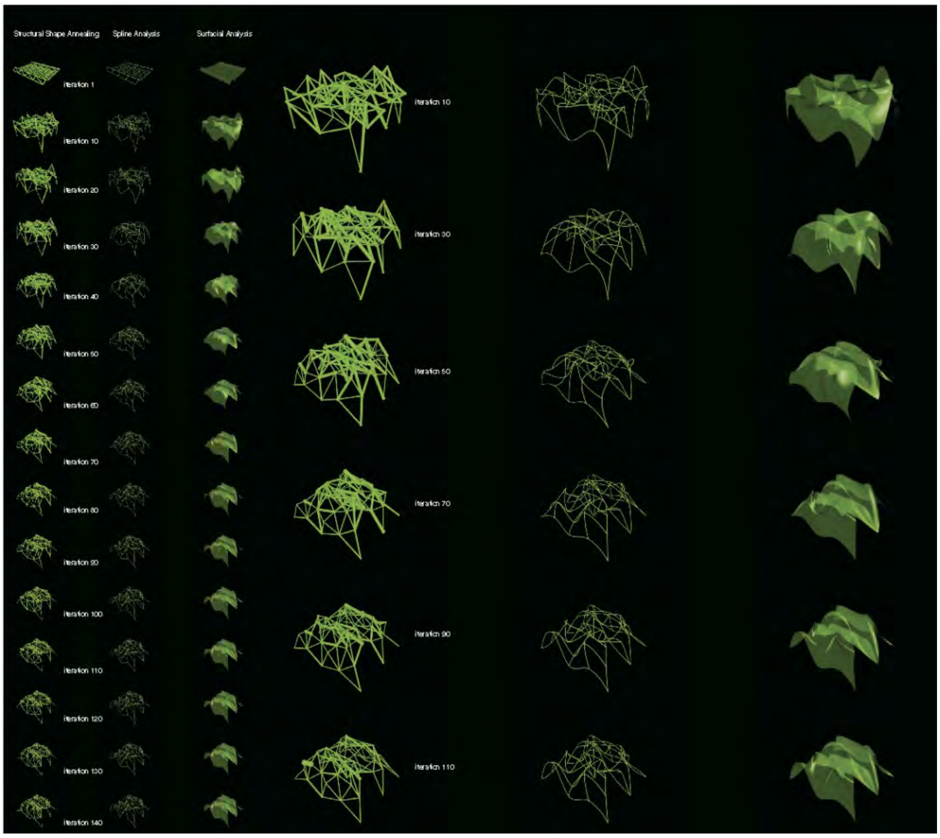

Figure 32: Hylomorpic Project by O-S-A [9].

Both projects uses the network systems to produce the output. It is attempted to adapt the growth of the plants based on the aggregation of nodes and creation links between them in the first example, while in the second example, to generate different kind of structures to be chosen according to criteria of stability. In conclusion, first project gives one design solution in a time, while second one generates several structures according to the algorithm. The model which is created for this paper, the method of the second project is used in order to generate several outputs while inspired by tropisms in plants.

– 4. A Model based on Tropisms in Plants

– 4.1 The Concept of the Model

– Agent-based interactive structure which is inspired tropisms in plants, takes as an input, the movement and density of the people. The structure which itself a regular network system in the beginning, adapts to the changing conditions by creating new nodes and links between them, according to the location and density of people within the structure. The structure can be formed by stimulus due to its self-organizing character. By means of this model, the idea of the constant structure is surpassed by the interactive structure which responses the changing character of today's world.

–

– 4.2 The Parameters and Design of the Model

– The inputs which affect the form and tropism of the structure are the movement and density of the people defined by a code written on Processing [10] and adapted by writers for this paper. This structural organism lengthens and shortens in the manner of plants by changing the nodes and links within the system. Thus, spaces are created based on the structural change due to the interaction with human.

– As it is shown in Figure 6, several additional libraries are used in Processing code. “Particles” class is used in order to model and represent the movement of people and “Attractor” class is used to represent the gathering point. The density of the people is controlled by the cardinality of “Particles” class and the position of the “Attractor” is determined by the mouse pointer. As “Particles” follow the “Attractor” their coordinates change.

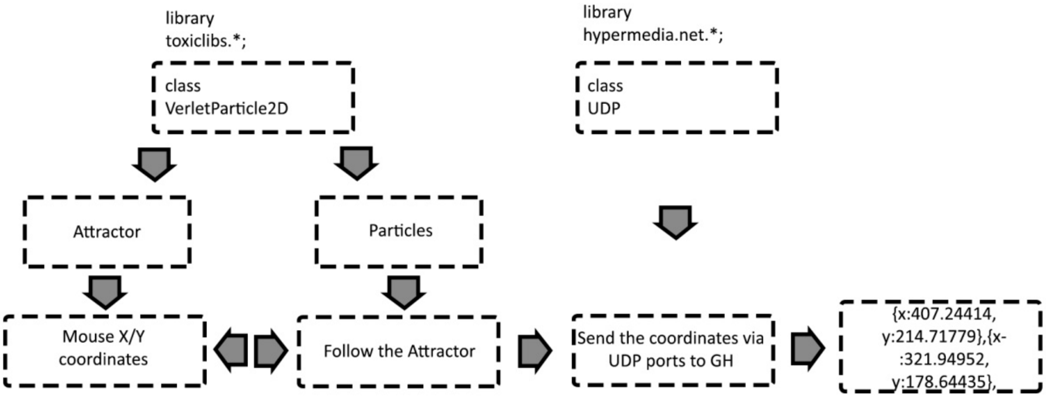

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Figure 33: Flow chart of the “Processing” code.

– As it is shown in Figure 7, the behavior of the people which is simulated in Processing, is transmitted to the Grasshopper by using a port and used as inputs which affects the coordinates of nodes of the structure. People follow the attractor point which can be in different numbers by changing the parameter. Thus, the structure changes dynamically as people move and increase in number. Structural change is constant and creates an event based building system which deploys the internal flow to the outside world and the structure becomes a representation of inner circulation which communicates with its environment. Besides, structure becomes a fragment of a city due to dynamic relation with its residents and orient itself according to this relationship. Thus, the form of structure takes its appearance directly from the present.

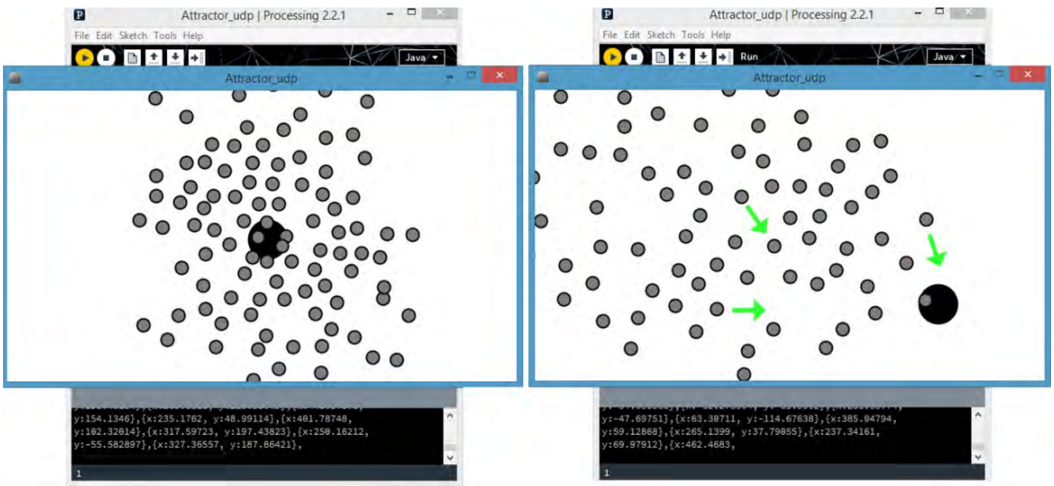

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Figure 34: The diagram which shows the gathering point (Attractor) and the movement and density of the people (Particles).

Various structures can be obtained by means of the formation of the initial network system by applying the algorithm which is shown in Figure 8. These structures are created by linking the X and Y coordinates obtained in Processing and transferred to Grasshopper, according to the radius limitations between two points. Owing to "Exoskeleton" plug-in in Grasshopper, the network system which is obtained, can turned out to be a skeleton with a thickness which can be adjustable. In Figure 8, first line of code shows the skeleton of network derived from arrangement of the point cloud and the second line of code shows the transmitted X and Y coordinates and density of people imported from Processing.

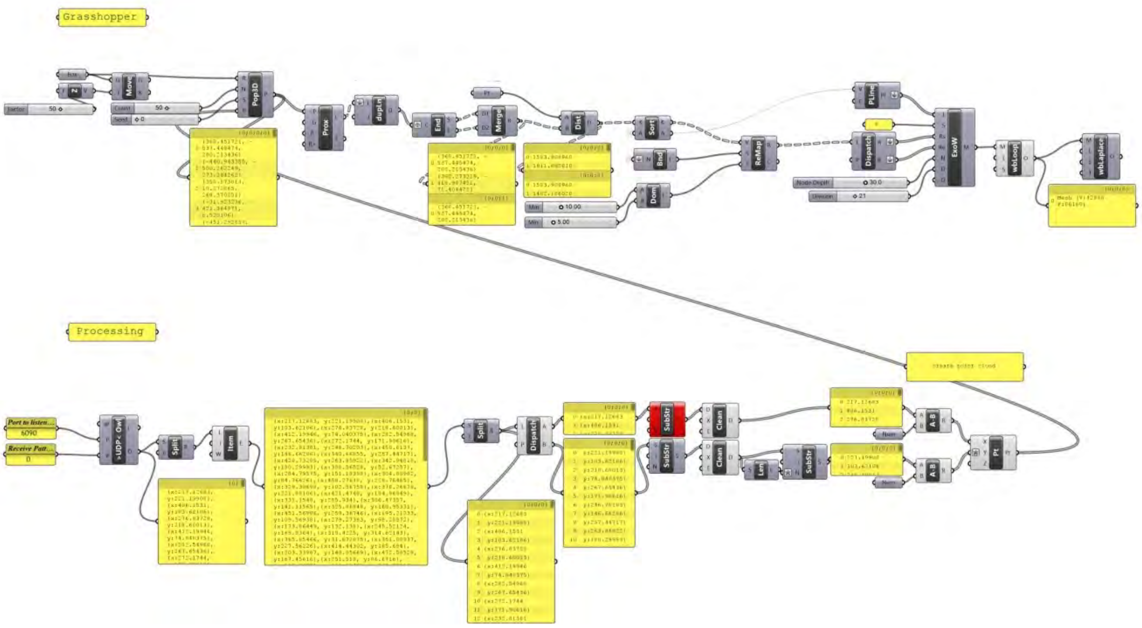

Figure 35: Flow chart of the Grasshopper code.

The structure lengthens as the people approach and shortens as the people move away from the nodes of the structure which are affected. The initial state of the model is shown in Figure 9. In this state, the nodes create almost a regular pattern which is created by a defined box with adjustable dimensions. And, nodes and links created due to the default component algorithm for the initial network.

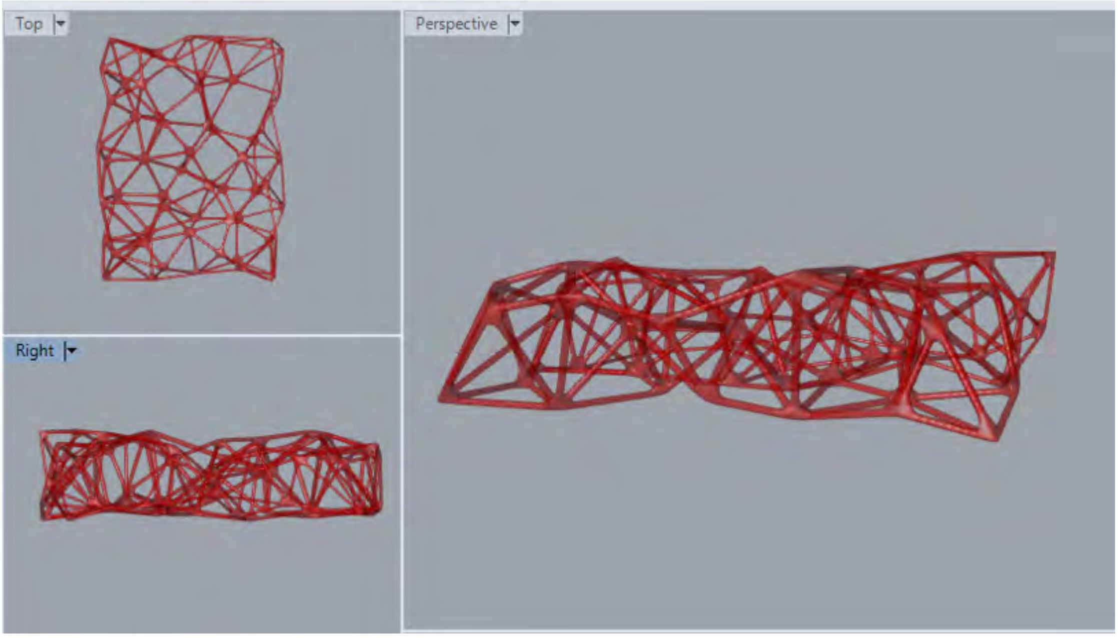

Figure 36: The initial state of the system.

– In Figure 10 and 11, on the right, the movement of people is shown as a Processing code; on the left, the changes in the perspective and elevation of the structure based on the movement are shown. In Grasshopper, the cluster of the people is shown in green as a point cloud. Two programs work in simultaneously as it is depicted. So, dynamic relation of programs creates an adaptive network systems.

– After the code is compiled, if the cluster of people is at the borders of the structure, nodes at these region create a console like structure (Figure 10). If the cluster of people is at the middle of the structure, nodes create openness in the structure like a long span beam to form a bigger space depends on number of people (Figure 11). The model creates emergent structures even it shows some predictable behaviors.

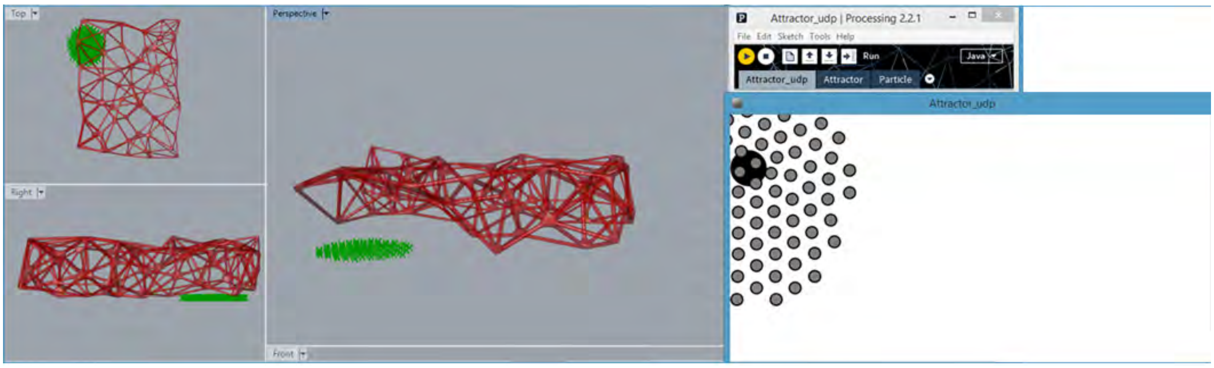

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Figure 37: The diagram which shows the position of people at the border of structure.

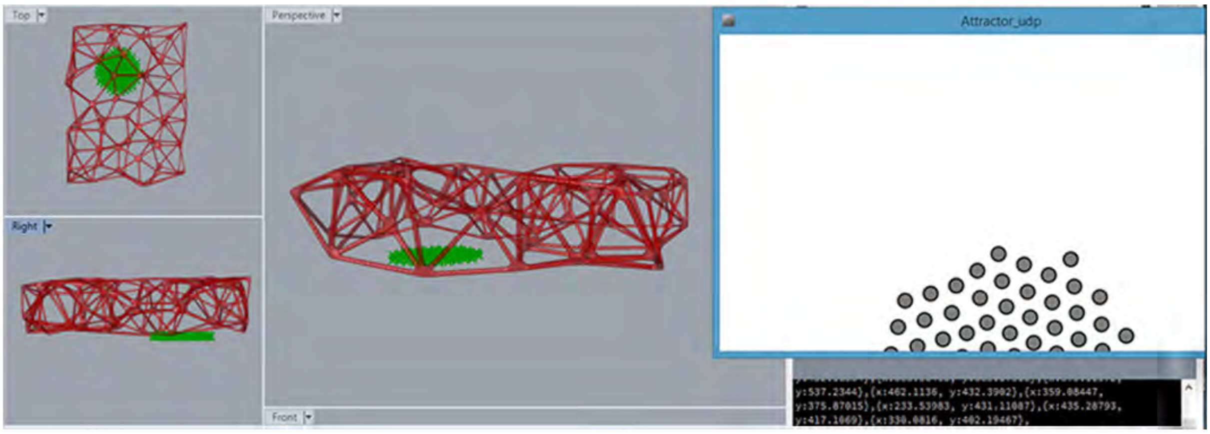

Figure 38: The diagram which shows the position of people in the middle of the structure.

Various forms emerges as people wander inside or close to the structure. These forms can be chosen by the designer and used in first stages of the design or with the structural analysis forms can be chosen according to results. Structural systems which have the different network types are shown in Figure 12 and much more of them can be generated thanks to the algorithm. Changes in position and number of people directly affect the structure and changes nodes and links. As it is shown in Figure 12, some of the structural networks are closed and define a mass while others are open and creates pillars. This network language which created by the digital model can be integrated with functionality and used as a form finding machine. Or, for future applications, structures which are generated, eliminate by analysing static behaviour of each output.

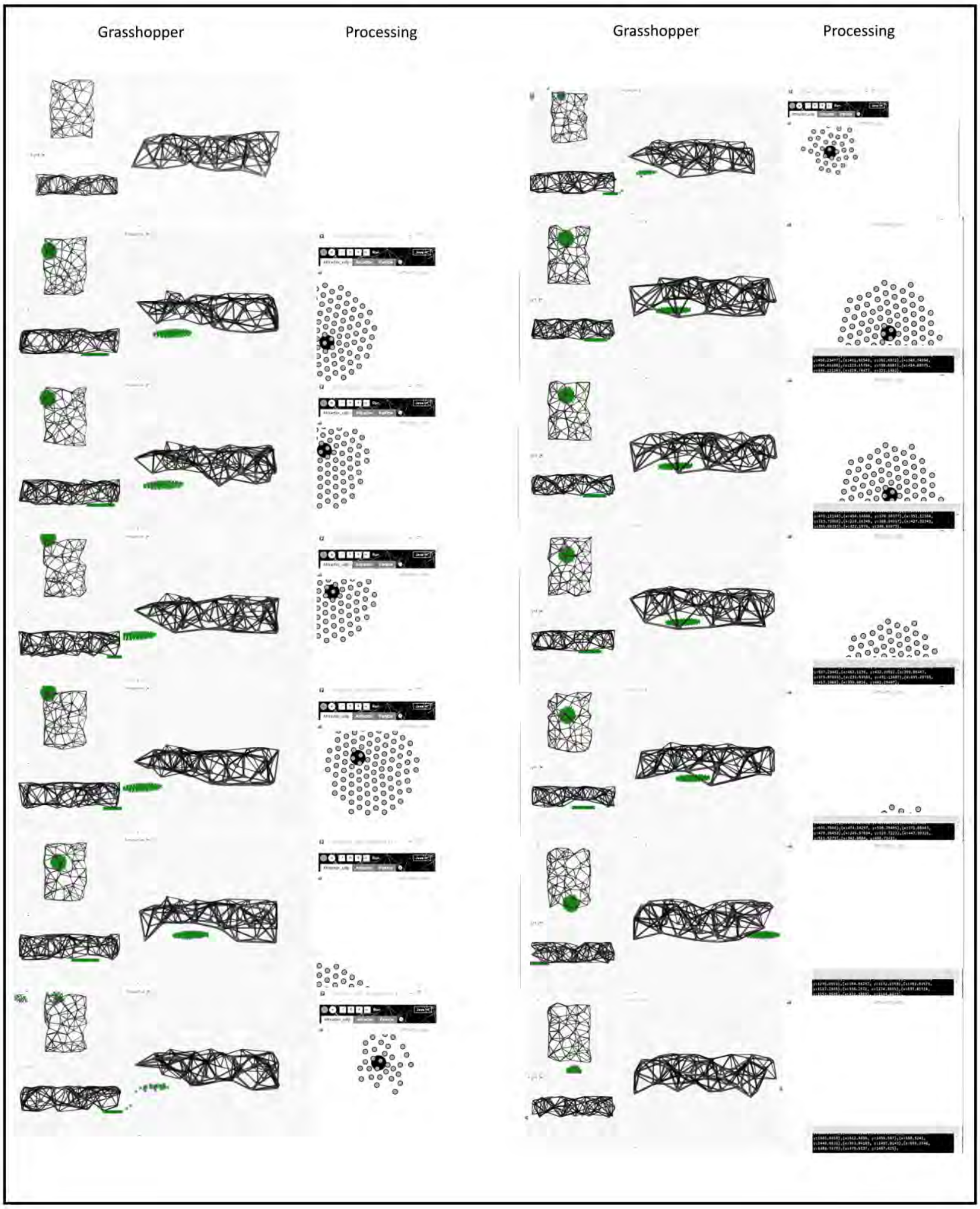

Figure 39: The interaction of density of people and structure.

– 5. Conclusion

The model which is created for this paper has potential to response the architectural needs in the micro and macro scale. Owing to the human interaction of the algorithm, various structures can be created. These structures can be the part of the design process by integrating the functions of the building to the structural element. It is possible to design the structure according to the density and circulation of people in the building. So, the building becomes an interactive entity as it takes people behaviour as an input. The form of the structure is directly in relation with present which makes the structure an event based model defined by dynamic data flow of location of it. Thus, the building can act as a fragment of city which is also derived from data. Despite of the information based character of the model, some emergent structural networks are generated due to ambiguity of the algorithm like in a city.

For future applications, as the result of applying the model to macro scale, various public spaces, circulation networks, infrastructures, green areas and city centres can be designed in the urban scale owing to the network based model. Also this structural network have the ability to adapt to its environment and to sense of the people and bend toward to them as in the plants. In conclusion, nature inspired interactive structures can be used in several stages of the design thanks to its potentials serving to the designer. Besides, the model which is created for this paper, can be analysed regarding stability and material possibilities and improved according to the data which is obtained, for future applications of the model.

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Arne Eigenfeldt.

Generating Affect: Applying Valence and Arousal values to a unified video, music, and sound generation system

Multimedia Generative Art

Authors:
J. Bizzocchi[1], A. Eigenfeldt[2], M. Thorogood[1] [1] School of Interactive Art and Technology, Simon Fraser University, Surrey, Canada
[2] School for the Contemporary Arts, Simon Fraser University, Vancouver, Canada

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[1] Hevner, K. (1937). "The affective value of pitch and tempo in music." The American Journal of Psychology, 49(4), 621-630.
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Abstract:
Art can clearly affect viewers and listeners in very emotional ways; however, artists will often reject the claim that the emotion is *in* the artwork itself, and instead insist that emotions felt are solely within the viewer/listener. How does one reconcile these seemingly opposing views? Efforts have been made to discover the relationship between emotion and music [1] as well as moving image [2]; however, these studies have limited direct application for the generative artist.

Russel's circumplex model [3] introduced two very significant parameters for describing features that may produce emotional responses in listeners: *valence* (pleasant/unpleasant) and *arousal* (eventful/uneventful). These objectives measures can be used both analytically as well as for generative purposes.

Within our multimedia installation, *Seasons*[1], we are using these measures to drive the music and soundscape generating systems based upon an analysis of the video system's current output. The artwork uses visually evocative nature shots, and its goal is to support an ambient user experience that is calming and contemplative; as such, the values for valence and arousal in the video are relatively moderate.

Seasons combines three very different generative systems: video, music, and soundscape. In order to maximize aesthetic coherence and flow, the artwork relies on a chain of valence/arousal assessments and communications. The chain starts with the database of video clips. The video sequencing system uses a set of content tags to select and order the stream of clips. Each clip has also been assessed and tagged by the artists for its valence/arousal values. This assessment is based on the artists' subjective evaluation of each of the shots.

The valence/arousal values for each selected shot are then sent to the two audio systems. The music system uses artificial agents (called "Musebots") to compose and create an original generative music track that reflects the valence-arousal values of the images. The soundscape system uses both content tags and the valence-arousal values from the video stream to select and mix a sound effects soundscape that is consistent with the video and the music. Future modifications of our system will include the development of software that can generate valence-arousal values based on computational feature extraction and analysis.

1. https://vimeo.com/136362499

Contact:
Jim Bizzocchi, jimbiz@sfu.ca

Keywords:
affect, emotion, generative video, generative soundscape, generative music

Applying Valence and Arousal Values to a Unified Video, Music, and Sound Generative Multimedia Work

Arne Eigenfeldt

School for the Contemporary Arts, Simon Fraser University, Vancouver, Canada

arne_e@sfu.ca

Jim Bizzocchi, Miles Thorogood, Justine Bizzocchi

School of Interactive Art and Technology, Simon Fraser University, Surrey, Canada

jimbiz@sfu.ca, mthorogo@sfu.ca, justine@sfu.ca

Abstract

We describe our research-creation across multiple generative systems, using the parameters of valence and arousal as unifying parameters. A variety of methods have been explored that translate emotional responses in viewers into objective measures; however, most of these are not useful for artists, especially generative artists. However, valence (pleasantness) and arousal (eventfulness) are two parameters that do suggest generative potential. We describe three generative systems – a recombinant video system, a soundscape generation system, and a multiagent music system – and how they individually use valence and arousal for generative purposes. Finally, we describe an artwork in which these three generative systems operate collaboratively to produce a multimedia installation.

1. Introduction

Art can clearly affect viewers and listeners in very emotional ways; however, artists will often reject the claim that the emotion is *in* the artwork itself, and instead insist that emotions felt are solely within the viewer/listener. How does one reconcile these seemingly opposing views? Efforts have been made to discover the relationship between emotion and music [1] as well as moving image [2]; however, these studies have limited direct application for the generative artist.

For example, many psychology studies have focused upon a stimulus response model, in which subjects are asked to rate musical excerpts using a set of adjectives, such as “cheerful, gay, happy; fanciful, light; delicate, graceful; dreamy, leisurely; etc.” [3]. Other studies have used fMRI analysis to determine subject’s neural responses to “pleasant” and “unpleasant” music [4]. While such studies may produce interesting data regarding listener experience, they leave few cues for artists: Dvorák’s *Slavonic Dance No. 8* in G Minor may be considered “happy”, but how can that inform a compositional practice?

Russell’s circumplex model [5] introduced two very significant parameters for describing features that may produce emotional responses in listeners: *valence* (pleasant/unpleasant) and *arousal* (eventful/uneventful). These objective measures can be used both analytically as well as for generative purposes, primarily because such objective measures can be considered during the creative process. Artists can readily translate these measures within their medium: in music, for example, eventfulness can be translated as activity, and pleasantness can be translated as tension.

The circumplex model overlays emotional states on the two-dimensional scale (see Figure 1); significantly, these emotions result from the relationship between the two measures of arousal (or eventfulness, also called activation/deactivation) and valence (or pleasantness). Therefore, an artist, generative or otherwise, can create an artwork that has low arousal and high valence – two objective measures – and be confident that it will be perceived as "calm and relaxed", two subjective responses.

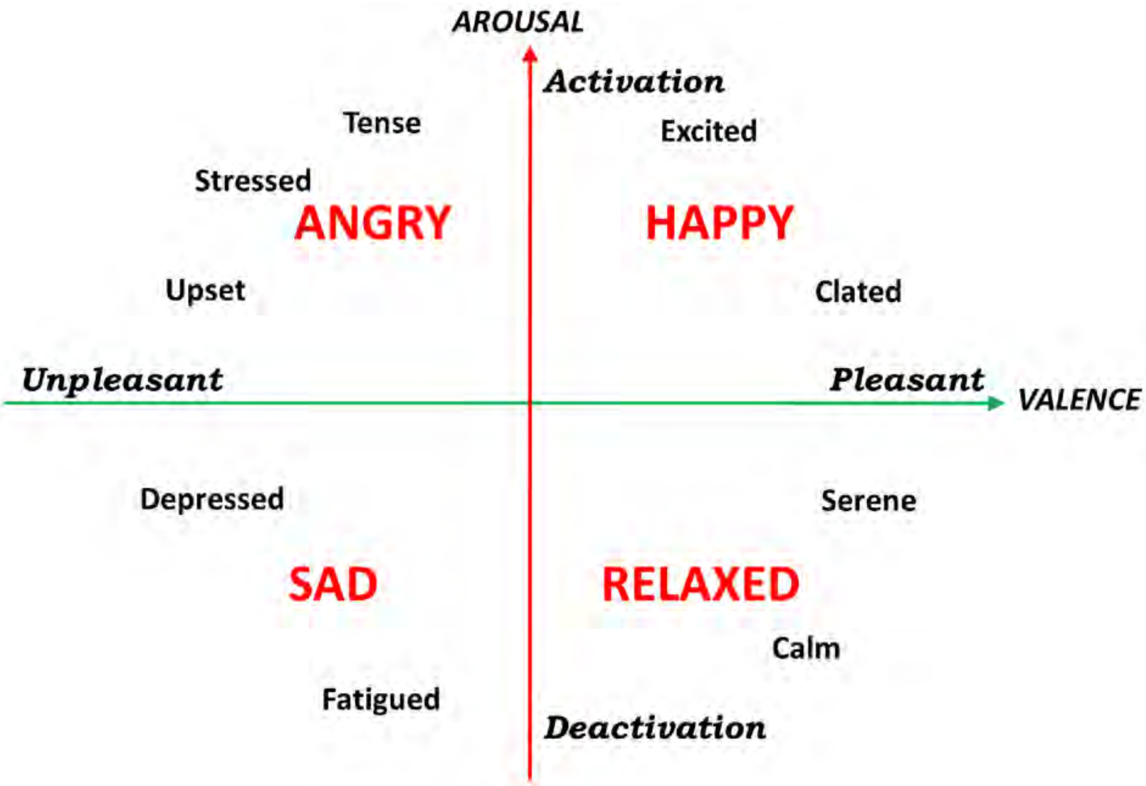

Figure 1. Valence / Arousal model

1.1 Generative Systems

Generative engines are systems that provide various, expected or unexpected patterns by using a series of rules. The use of systems, rather than intuition, for artistic creation has a long tradition, and for this reason, Galanter suggests that generative art can be considered as old as art itself [6]. A contemporary approach to generative art has arisen: metacreation. Using tools and techniques from artificial intelligence, artificial life, and machine learning, metacreation develops software that is creative on its own. In other words, software is a metacreation if it exhibits behaviors that would be considered creative if performed by humans [7].

While the potential of codifying artistic decisions may be alluring to many artists, the challenges are many: for example, can the notion of creativity be extended to machines, or can they (should they?) only remain as tools for the creative artist? The growing field of metacreation explores these questions, and is populated by psychologists, art theorists, cognitive scientists, artificial intelligence researchers, machine learning specialists, and, perhaps most importantly, artists. As such, it is not merely an academic pursuit: it is, and has been, a fertile creative domain for artists exploring new avenues of production.

Many examples of metacreative works in sound, music or video can be found, but the authors have not been able to discover any that combine these into a system where the elements interact and generate a blended audio-visual work in real-time. Some generative and metacreative systems that were inspirational to our work are described in a previous paper [8].

Some production systems, particularly in music, have investigated the potential for affective generation, including the use of valence and arousal. Wallis *et al.* created an Emotional Music Synthesis system in which valence/arousal were mapped to various musical parameters [9]; however, such heuristic and ad hoc mappings will always depend upon the desired musical output, and are seldom generalizable. For example, Wallis *et al.* decided that the phygrian mode constitutes a minimal valence, whereas the lydian mode constitutes a maximal valence. Such straightforward mappings limit the harmonic potential of the generated music to modal melodic material, despite any experimental user studies that may suggest correlations between a generated melody's intended and perceived valence/arousal.

Oliveira and Cardoso [10] use machine learning to discover these mappings objectively. 80 participants rated 96 musical excerpts from film music, albeit MIDI versions of the music, for valence and arousal. Classifying this data using 146 musical features, the more salient musical parameters for affect were derived. Of note, the experiments suggest temporal and density features are superior for predicting valence, countering the more intuitive notion that harmony is its main determinant; this might result from their study's limited harmonic features, as it suggests that the most important harmonic feature for valence was minor versus major scales, a somewhat simplistic notion.

As artists, generative or otherwise, have known for centuries, the affective power within an artwork is dependent upon its context; an image, melody, or sound will be perceived by viewers and listeners differently, given its circumstance. While it may be possible to determine that certain features relate to valence and arousal percepts, the application of this information is still reliant upon artists for its effective use.

2. Seasons

Seasons is an audio-visual journey through our natural environment across the span of a year. The work is situated within the genre of "Ambient Video" - artworks that provide ongoing visual and emotional pleasure without requiring our attention in any particular moment. The primary goal of the work's creative team is to work within this tradition to produce a successful generative artwork that fully satisfies our artistic sensibilities. Its generative underpinnings are integral to its appreciation, while its metacreative aspects are clearly important, yet secondary to its artistic intentions.

The system comprises video sequencing and transitions enriched through their interaction with music and soundscape. The full work is a real-time and ongoing cybernetic collaboration between three independent but communicating generative systems: video (*Re:Cycle*, see Section 3), soundscape (*AuMe*, see Section 4), and music (*Musebots*, see Section 5). The work runs continuously using a variety of computational processes to build the audio-visual output for a single large-screen display and multi-channel sound system.

Within this multimedia installation, we are using measures of valence and arousal to drive the music and soundscape generating systems based upon an analysis of the video system's current output. The artwork is intended to support an ambient user experience - one that is calming or contemplative. The visuals consist of a series of evocative nature shots that are consistent with this goal (see Figure 2). The values for valence and arousal in the video are therefore relatively moderate.

Figure 2. Example evocative nature shot from *Seasons*

In order to maximize aesthetic coherence and flow between the three very different generative systems, the artwork relies on a chain of valence/arousal assessments and communications (see Figure 3). The chain starts with the database of video clips. The video sequencing system uses a set of content tags to select and order the stream of clips. Each clip has also been assessed and tagged by the artists with text cues for sound as well as for its valence/arousal values, an assessment based on the video artists' subjective evaluation of each of the shots.

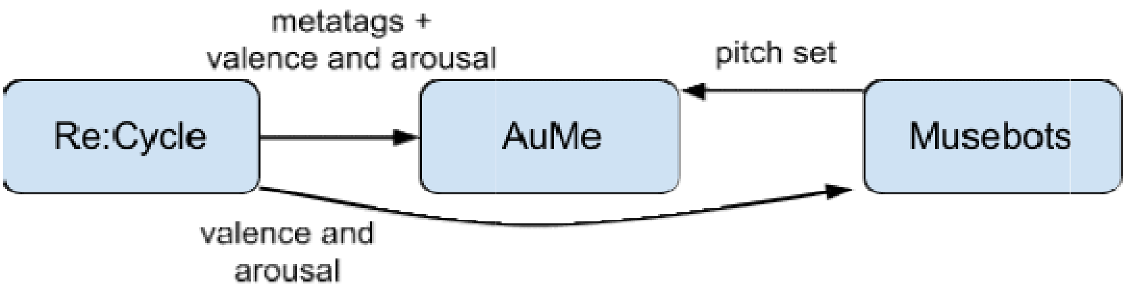

Figure 3. Metatag and Valence/Arousal pipeline between the video system (*Re:Cycle*), the soundscape system (*AuMe*), and the music systems (*Musebots*)

The valence/arousal values for each selected shot are then sent to the two audio systems. The music system uses artificial agents (musebots) [9] to compose and create an original generative music track that reflects the valence/arousal values of the images. The soundscape system uses both the text cues and the valence/arousal values from the video stream to select and mix a soundscape that complements the video and the music and will achieve the artists' overall aesthetic goals.

3. Video engine

The video system is an extension of Bizzocchi's computational video sequencing and presentation system entitled *Re:Cycle* [11]. This system relies on a recombinant process to combine and sequence shots and transitions drawn from the system's databases, currently consisting of over 250 shots. *Re:Cycle* uses metadata tags to nuance its selection process with an enhanced semantic coherence. As *Seasons* strives for an "Ambient Video" aesthetic [12], the content consists of imagery drawn from nature and landscape; therefore, the tags reflect the content of the individual shots: for example, "trees", "water", "mountain", "snow". Short sequences of shots are selected and presented based on these content tags. This very simple computational process significantly increased the visual flow and unity of the piece.

Creative use of tags determined by the artists for the video clips drives the selection and sequencing of the visuals, as well as providing triggers for the selection, processing and playing of the music and soundscapes. As shown in Figure 4, these commentaries form part of a pipeline that communicates video, mood, and tonal metadata between the subsystems of *Seasons* using the Open Sound Control (OSC) protocol [13].

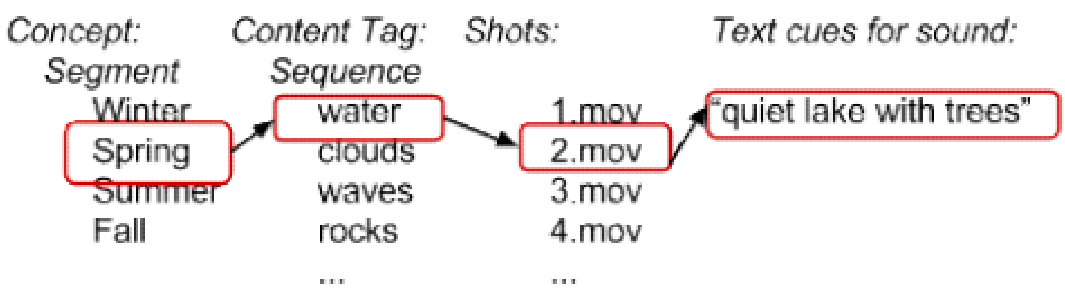

Figure 4. Video sequencing logic

There is a hierarchy to the tagging and sequencing logic. During performance, an initial *concept* is chosen, which gives coherence to an visual *segment*. In *Seasons*, concepts consist only of the four separate seasons (see Figure 4). These season segments are cycled through in the same order. Within each season, *content tags* are chosen from those available within that concept subset. The system then filters all shots in the seasonal subset of the database that contain that content. From this collection, the system uses random operations to select the shots for this *sequence*. Each shot, which lasts 55 seconds, has a unique description associated with it, which is used by the soundscape engine (see Section 4). For *Seasons*, the system has been set so that each segment contains four content-defined sequences, and that each content sequence has three video clips.

The system runs indefinitely, going through the seasonal segments as it proceeds. For this work, there is no beginning and no end; shots do repeat, but not in the same order or context. The effect of this method is the automatic generation of a series of coherent shot sequences nested within a larger thematically-based video segment. The artist's creative use of both the initial settings and the segment and content tags drives the resulting generated video thematic progression and viewer experience. There is still an element of randomness in the sequencing selections, which builds in an ongoing variability and helps to maintain viewer interest over multiple viewings. At the same time, the tagging and selection mechanisms maintain ongoing content coherence and visual flow. This unifying connection of sequencing decisions produces an experience that is often 'read' by the audience as a traditional linear video built upon human-produced visual and semantic integrity.

3.1 Valence/Arousal in video engine

The video sequencing drives the soundscape and music generative processes. At the moment, each shot in the database has been hand-tagged with a subjective valence/arousal measure. This in itself was a difficult process, and methods had to be determined as to how to apply these measures in as objective a way as possible. While there are a number of studies which are working to establish some objective measures of visual elements correlated to valence and arousal in photos or videos [14], they are not sufficiently advanced in their results to be able to be implemented by the artists for this work.

A method of scaling had to be determined: would the least "pleasant" of the shots be considered a low valence, and how would that be determined? The clips are assessed individually, although it is likely that affective perceptions by viewers of a particular shot would actually be skewed by its context in a sequence (the montage effect). Further, elements of the shot may change over the length of the clip. Finally, the videos for this piece were selected with the ambient video aesthetic in mind. They purposefully seek to be both calm and pleasant. This naturally limited the full range of valence and arousal values that might be found in randomly acquired images.

For *Seasons*, the assessments were done primarily as an intuitive and creative exercise, with an attempt to utilize some consistent guidelines. The subjective assessments combined both content references and more abstract visual elements. For example, close-ups of brightly coloured flowers were assessed as high on both valence and arousal. This reflects the intuitive sense that spring flowers are 'happy' and 'stimulating'. Fast-moving, rushing water was assessed as high in arousal (eventful), but could be low or high on valence depending on the surrounding elements (dark skies and rain compared to bright sunny day or flocking birds).

The result in the view of the artists' was remarkably successful. The music and soundscape work very well with the ongoing dynamic video sequences. However, there is much more work to be done in applying these affective measures to moving visuals and then understanding how best to utilize them to create a blended audio-visual work.

4. Soundscape engine

A generative system – Audio Metaphor (*AuMe*) – autonomously creates the soundscape by processing metadata communicated from *Re:Cycle*. *AuMe* takes a modular approach for analyzing the valence/arousal tags related to videos, retrieving and segmenting audio files, and processing that information to generate a representative soundscape. Each generated soundscape consists of multiple layers of background and foreground sounds related to the concepts found by semantic analysis. Described in greater detail elsewhere [15], the arrangement and processing of those sounds is controlled by a mixing engine, making decisions based on a set of soundscape composition rules. The duration of a soundscape correlates with the duration of a video clip, and the transition from one soundscape to the next happens by interweaving sounds as a video transition occurs.

4.1 Valence / Arousal in soundscape engine

AuMe uses a database of curated soundscape recordings that has been analysed for measures of valence and arousal [16]. Recordings are automatically annotated with these measures by a machine-learning algorithm trained with example recordings labeled by human listeners during a listening study. For the study, we were interested to observe if a correlation exists between low-level audio signal features and how listeners perceive a soundscape, in terms of valence and arousal. Having established that indeed such a correlation exists, we were then able to model a machine for classifying soundscape recordings based upon audio signal features.

Each soundscape generated by *AuMe* utilizes the machine-learning model to be sympathetic to the sentiment content of a video. For *Seasons*, *AuMe* selects segments of soundscape recordings using the valence and arousal tags associated with the current video clip. If a clip contains a high degree of arousal, then the soundscape will be comprised of sounds that have a similar degree of arousal. Furthermore, the mixing engine will also respond to this measure by mixing the sounds to convey a more active scene. The same approach is taken for valence, where a higher degree of valence will result in a perceptually more pleasant soundscape. Similarly, if the video is tagged as having a low valence or arousal, then *AuMe* will generate a soundscape to convey those measures.

In its implementation for *Seasons*, *AuMe* generates a new soundscapes at every cycle of the year by creating slight variations in its search space, based on a Gaussian probability distribution. *AuMe* is influenced by this search space variation. As different sets of audio files are given for mixing, the behaviour of the *AuMe* system is altered. Thus there is a slight variation of the generated soundscapes even as the video clip tags remain constant.

6. Music engine

An agent-based production system creates the music through generative means based upon information received from *Re:Cycle*. The music engine is comprised of independent musical agents – musebots – that act autonomously, yet collaboratively with one another. Described in more detail elsewhere [17], each musebot generates a particular aspect and/or function within the music – for example, a bass line; however, it does so in relation to other active musebots. The musebots, of which there are currently dozens, function within curated ensembles, and communicate via messaging. Within *Seasons*, one musebot will generate a harmonic progression, and send this information to other musebots for their interpretation. A *Conductor* handles the tempo, as well as serving as an overall relay station for musebot messages and initiating each successive musebot ensemble. New ensembles are launched for each new season; because a season consists of four sequences of three clips, each of which lasts 55 seconds and contains a 22 second transition, an ensemble's duration is currently locked at 6 minutes 36 seconds. Tempo is consistent for a given ensemble: for *Seasons*, tempo varies between 40 and 60 beats per minute.

6.2 Musebot reaction to Valence/Arousal

Because each musebot is autonomous, yet sensitive and reactive to its ensemble partners, the music can vary substantially over the course of a season's duration. Each musebot has its own defining parameters, although several more general parameters overlap. For example, "density" is a common element which can be interpreted as the number of events over a given time period: the greater the number, the higher the perceived musical density. Incoming arousal (eventfulness) messages are mapped directly to a musebot's density parameter; however, each musebot may interpret density in a nonlinear way, depending upon its previous states, and other active musebots. In other words, a given valence will not produce a fixed response from a musebot ensemble.

Valence is even more subtle, and can be interpreted in a variety of ways. Pleasantness can be mapped to musical consonance, which in turn can be mapped to "simple" versus "complex". While each musebot can interpret complexity in a variety of ways, one of the most audible is by the harmonic generating musebot: simple chord progressions use simple chords (i.e. triads) and the root movement is predictable, whereas complex chord progressions use chords with extensions and alterations (for example, as found in jazz) and more unpredictable root movements. Similarly, melodic musebots can prefer stepwise melodic movements (high valence) or more disjunct melodic movement (low valence), and rhythmic musebots can emphasize simple metric divisions that enforce the beat (high valence) or complex subdivisions that subvert the beat (low valence).

Within the current implementation of *Seasons*, musebots will alter their generation subtlely with each new clip, as new valence/arousal measures are sent when clips initiate their incoming transitions. As such, the musebots behave very much "in the moment", without any sense of the future. For example, the given clip may have a high valence / low arousal tag, and the musebots will exhibit a "relaxed" emotion, but without knowledge of the next clip's tags, they will lack any real sense of movement or progress. Within the aesthetic of ambient art, such lack of musical motion is acceptable, and even preferred; however, as will be discussed in Section 8, a pre-computed structure, complete with detailed vectors for time-varying valence/arousal, will be necessary for the musebots to anticipate changes in shot, segment, and concept.

7. Installations

Seasons has been shown in two different installation environments. In August 2015, as part of ISEA 2015, it was shown in an enclosed room in which the walls had thick black curtains that created an isolated viewing and listening environment. A high-quality four channel sound system was used, along with a large 60" LED monitor; a bench was provided for audiences, inviting them to experience the work in contemplative surroundings. Based upon our own experiences within the installation and watching audiences anecdotally, we found that viewers stayed within the space for anywhere from five to twenty minutes, with the latter time allowing them to experience multiple seasons. Responses were extremely positive, however anecdotal they might be.

A second installation was presented as part of a large exhibition, coexisting with several other generative installations. The event was held over four weeks, and audiences had docents present tours, explaining each work. In this case, *Seasons* was displayed in an open gallery context – replete with extraneous public noises and competing soundscapes and music from other installations. Although we did provide the possibility of headphones, as well as the soundscape and music being heard through the monitor's built in speakers, the lack of comfortable seating did little to motivate audiences to spend more than a few minutes with the work. While the audiences were more informed about the nature of the work and collaborative effort, due entirely to the docent's explanations, the tour format, which necessitated timely movement through all exhibits, sadly negated this benefit.

8. Conclusion and Future Work

We feel that *Seasons* is an effective installation, if presented in a situation where viewers can experience its ambient nature properly. The interaction between the three generative systems is not immediately obvious, and, somewhat paradoxically, requires some critical viewing and listening on the part of its audience. However, we prefer to consider this as rewarding the audience for active viewing/listening, as the ambient aesthetic of indirect interaction is still supported.

Each generative system operates successfully as an independent entity, while also following the unifying features of valence and arousal. The subjective, rather than purely objective, interpretation of these features allows for a considerable amount of variation; for example, a single video shot, with its set valence/arousal rating, will elicit different reactions depending upon its context.

Larger issues within generative art, specifically large-scale structure, are happily avoided within *Seasons*, as these are determined by the imposed structure of the seasons themselves. The approximate six minute duration of a single season can be treated as one coherent gesture; any longer, and sectional changes and more direct development of material would be required by the three systems.

Several improvements are still planned for *Seasons*. The first of which would be the selection of all shots by the video engine in advance, allowing for the season's complete valence/arousal measures to be communicated prior to commencing. This would allow the music and soundscape engines to sculpt their selections better, as it would provide a target shape for the longer section. Another modification will include the development of software that can provide feature extraction and analysis of video. This would lead to a computational assessment of valence/arousal, and could also provide additional cues on how to build certain shot sequences.

Our next project will be to create a generative documentary in the tradition of the early “City Films” such as the Ruttmann 1927 classic silent film *Berlin: Symphony of a Great Metropolis*. We will deconstruct selected films in this genre in order to guide our plans for shot creation and for visual sequencing. We will then adapt our system of segment/sequence/shot selection to create a contemporary video montage in the spirit of these classic city films. This new project will allow us to more deeply explore the dynamics of valence/arousal values within the design and the experience of our work. A city documentary will have a much more varied emotional palette than the relatively constrained ambient aesthetic, so the variance in the valence/arousal values in the elements of this work will be much broader. The soundscape and music systems will therefore generate appropriate accompaniment material that reflects the more complex affective range of a complex urban environment.

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James Basson and Frederic Eichelbrenner

TITLE of proposal : Generative solution to planting design
TYPE of proposal: *Paper*

Topic: Planting design-generative approach

Authors:
James Basson
University of Greenwich, UK BA Hons in Garden Design
Resident in France
www.scapedesign.com
Fred Eichelbrenner
Master's Degree in Numerical Analysis from University of Paris 6
www.ellipsofacto.com

Main References:
www.generativeart.com

Abstract:
Computational ecology and computer aided mapping systems facilitate the input of data, coping with the variables on a deeper level, there are so many factors to consider when creating planting designs, climate, soil type, aspect, natural water fall, flowering season, height, width, colour (both flower and foliage) that the human brain can only process a limited number of variables creating what could be argued as staid and non-adventurous planting schemes worldwide, to take this medium to the next level -using computer based tools makes perfect sense.

Rather than be based on a real time study, computer data is potentially rich enough to give us new planting schemes, constantly refreshed plant associations at each turn thus avoiding the danger that planting design will become uniform and stagnant.
Having studied the game of life and other algorithmic automated growth programs we have created a programme that by entering variables into a computer model will demonstrate how we can predict planting patterns and therefore chose the best possible planting scheme for each outside space. Taking into account the wealth of information available to us that we can input whilst still posing the question just how ‘good’ is the quality of this information?
Is generative art and computational ecology the way to formulate the planting plans of the present going into the future in order to produce sustainable, ecological interesting yet realistic planting design?

Example: Matrix planting Cote d’Azur

Contact: james@scapedesign.com

Keywords: ecology, sustainability, planting design, future

A Generative Solution to planting design.

James Basson, BA hons Garden Design, MSGD, FFP

University of Greenwich, Scape Design

www.scapedesign.com *james@scapedesign.com*

Frederic Eichelbrenner, Masters Numerical Analysis

University of Paris 6, Ellipso Facto

www.ellipsofacto.com frederic.eichelbrenner@ellipsofacto.com

Abstract

Computational ecology and computer aided mapping systems facilitate the input of data, coping with the variables on a deeper level, there are so many factors to consider when creating planting designs, climate, soil type, aspect, natural water fall, flowering season, height, width, colour (both flower and foliage) that the human brain can only process a limited number of variables creating what could be argued as staid and non-adventurous planting schemes worldwide, to take this medium to the next level -using computer based tools makes perfect sense.

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Is generative art and computational ecology the way to formulate the planting plans of the present going into the future in order to produce sustainable, ecological interesting yet realistic planting design?

Introduction

The world of architecture has long been taking inspiration from organic forms of the natural environment, and yet planting design has been slow to take up the mantle.

Unlike Architecture, Planting design is dependent on so many variables, both physical (climate, soil type, aspect etc.), human desire (colour type, style of planting etc) and the complexity of nature (plant competition – aggressivity of growth, time etc). The task of trying to come up with a natural, organic planting solution is far from easy. The idea of a human brain computing all the information required to come up with a truly inspirational, unique and natural planting design becomes impossible, we need to look to computational technology to offer us an alternative to the reductive lists currently available on plant databases and search engines to create an auto-generative list of plant possibilities that are suitable for a specific given environment and list of desires. A model could then in turn demonstrate the eventualities of these generated plant lists predicting how they would develop over time allowing us to choose the plant community that not only suits our personal aesthetic requirements but that will thrive in it's given location, all the while producing a solution that fits harmoniously within its natural location.

Architecture

Frank Gehry's Guggenheim museum in Bilbao is an excellent example of the world of architecture embracing organic forms and using computer aided design software to turn a concept into a reality. He designed the building concept by simply rolling up pieces of paper and taping them together, in 1997 technology was just starting to be able to cope with such forward thinking design…

"As the proposed curves exceeded the capabilities of conventional construction, Gehry turned to CATIA software (developed by the French aeronautical firm Dassault) to translate his concept into a built reality. Essentially, CATIA digitises points on the edges, surfaces and intersections of Gehry's hand-built models to construct on-screen models that could then be manipulated in the manner of animated cartoons.

The computer has enabled Gehry to generate formal and spatial complexity that would have been inconceivable only a few years ago. The notion that uniqueness is now as economic and easy to achieve as repetition, challenges the simplifying assumptions of Modernism and suggests the potential of a new, post-industrial paradigm based on the enhanced, creative capabilities of electronics rather than mechanics." [1]

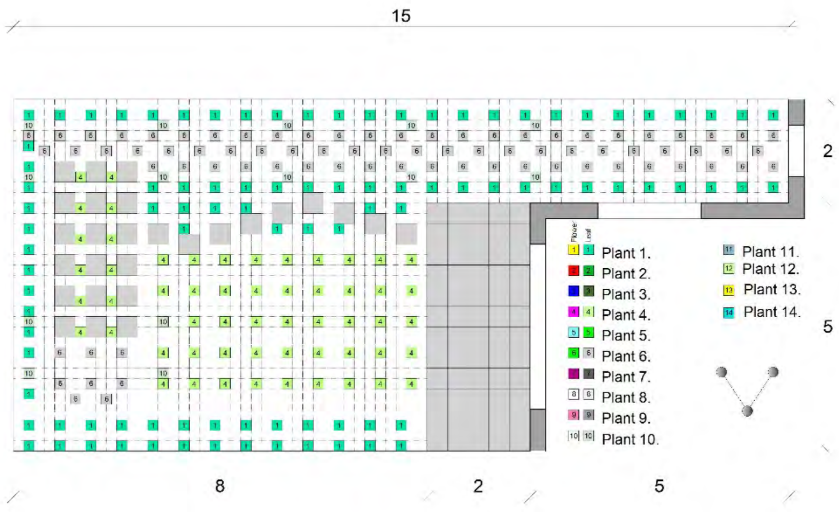
The natural world

However when we move from the static material of 3D buildings into the natural world, things get even more complicated. How could one replicate the murmurings of a flock of starlings? How can one create a garden that is a stable ecology by designing a planting solution that replicates the habits of the natural world yet satisfies the desires of the client at the same time?

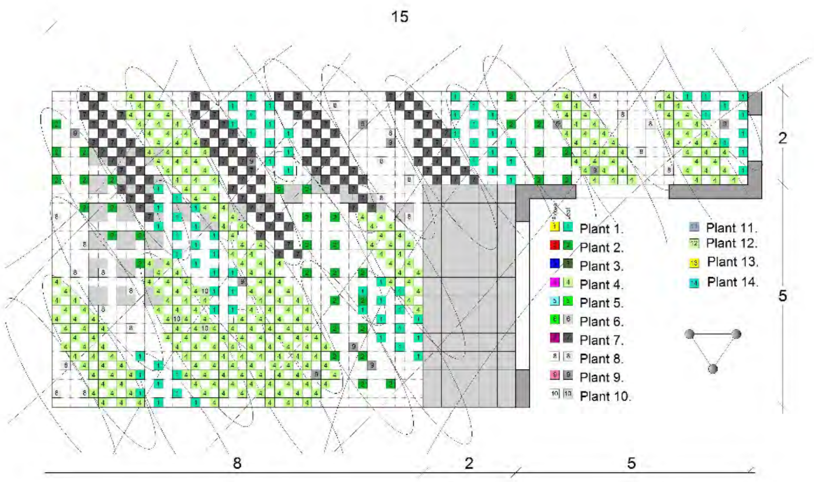
Planting design today

At present in order to create a plant list to implement a garden design we use a range of search engines and enter criteria such as: shade or sun, colour of desired flowers, flowering season, soil type and sometimes style. More often than not this generates a list of 1 or sometimes 0 plant possibilities. Nature is obviously not this reductive there are plants that can thrive in sun AND shade, or that will work in sandy AND clay soils, yet technology is such that inclusive lists are not currently an option.

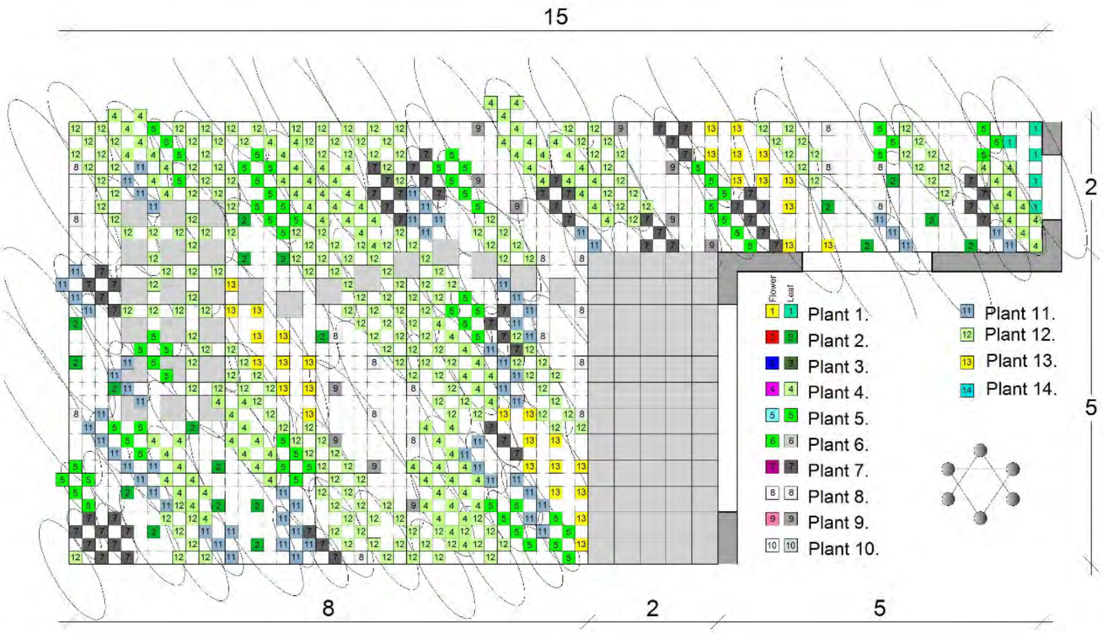
For this reason over the last few decades garden designers and Landscape architects have tended to stick to a palette of a few select tried and tested plants and use them in a variety of permutations.



Block planting (above) and mass plantings (below) whereby each plant has 3 possible interactions with other plants.

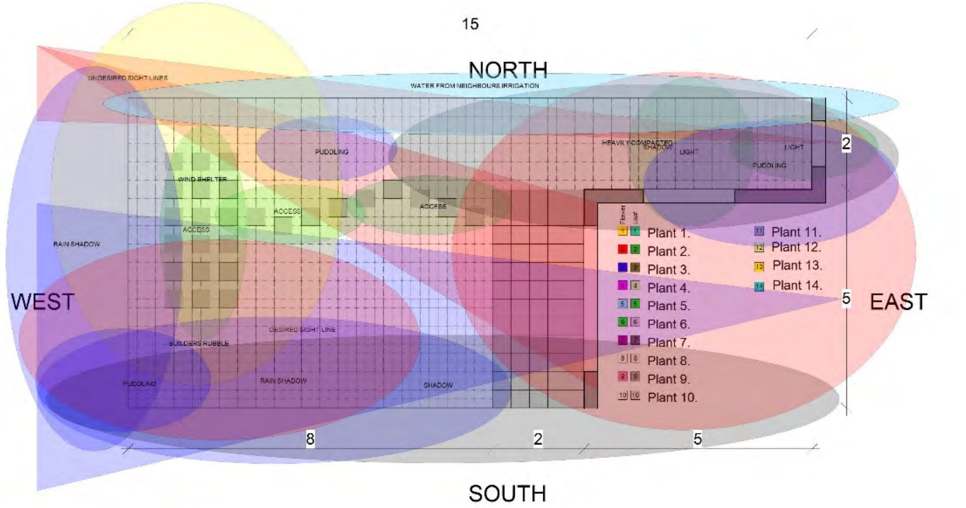


Moves towards a more naturalistic planting design where there are more possibilities of interaction (see below) have only recently started to become more developed and used. An excellent example of this approach is London’s Olympic park planting.



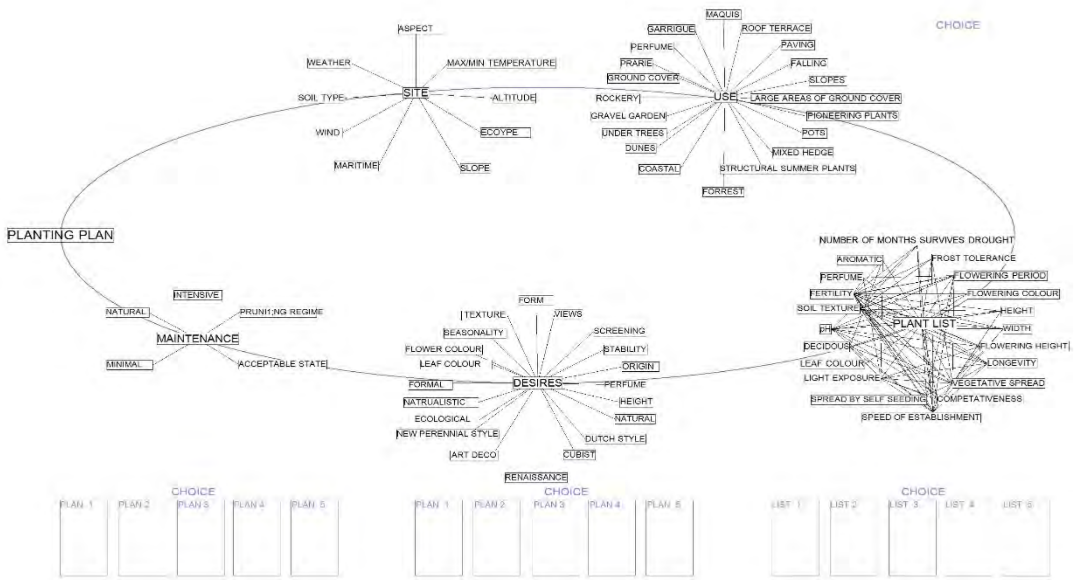
“The planting was led by two of the most innovative, cutting-edge plantsmen in the world: Professors James Hitchmough and Nigel Dunnett of the Department of Landscape, University of Sheffield. Their research-based approach to planting has produced landscapes that are both ecologically functional and jaw-droppingly beautiful. Hitchmough and Dunnett pioneered a unique approach to urban planting, which combines native and non-native plant species in low-input systems based on semi-natural vegetation types, such as meadows, woodlands and wetlands. This approach has come to be known as `The Sheffield School´ of planting design.” [2]

This type of planting was considered cutting edge and indeed was unlike anything seen previously. But we wanted to know how this could be taken further, in one square metre of natural countryside there can be as many as 100 or more plant species, how can man possibly take this inspiration and use it to produce even more naturalistic planting combinations, whilst taking into account all of the physical restraints shown below that have to be considered when created a private garden or landscape project…



…As well as the desires of the client previously mentioned? The answer, in short is we can't!

If we put all the variables into one flow chart we can see the amount of interchanges that have to be dealt with and this is where we need to look to generative computer aided modelling.



Computer Model 1 – Inclusive 'Big Data' plant lists

At this point we want to take all our restrictions and desires and create an inclusive plant list. One that takes into consideration all the grey areas and that is intelligent enough to take the data that is potentially held on an open source database that is geo-specific to generate a series of plant list options that would work on our given site.

Once we have these options of plant lists we can select one that appeals to us, happy in the knowledge that the plants selected will work in the environment in which we want to use them. But then what? How can we be sure that the end result will be what we are looking for in 5 or 10 years, how do we maintain the garden?

Computer Model 2 – Creating patterns.

Once we have chosen the plant list that appeals to us for the above reasons we can equally apply a style to create the kind of 'ambiance' we are looking for in a landscape, this again could be aided by machine learning.

Machine learning is a subfield of computer science[4] that evolved from the study of pattern recognition and computational learning theory in artificial intelligence.[5] Machine learning explores the study and construction of algorithms that can learn from and make predictions on data.[6] Such algorithms operate by building a model from example inputs in order to make data-driven predictions or decisions,[7] rather than following strictly static program instructions. a good example of this is the photo to painting application.

In the same way we could apply a style of planting 'new perennial' 'post modern' 'naturalistic' etc and generate the feel of the garden we are looking to create.

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Computer Model 3 – Maintaining stability

By applying the information we have amalgamated from the previous 2 models in our planting design process we now need to apply a third layer to dictate when we stop the evolution of the garden according to desired end effect. Using our simulators instead of creating a random generative pattern we are able to create a physical workable possibility.

We want our garden reach a stable ecological state, but we need to know how it will develop in order to do this.

James Conway's 'Game of Life' uses cellular automaton to create a simulated evolutionary process

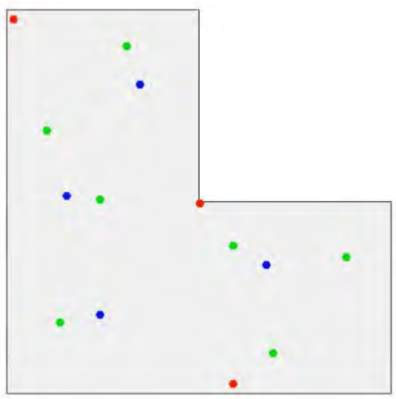
"Conways genetic laws are delightfully simple. First note that each cell of the checkerboard (assumed to be an infinite plane) has eight neighboring cells, four adjacent orthogonally, four adjacent diagonally. The rules are:

1. Survivals. Every counter with two or three neighboring counters survives for the next generation.
2. Deaths. Each counter with four or more neighbors dies (is removed) from overpopulation. Every counter with one neighbor or none dies from isolation.
3. Births. Each empty cell adjacent to exactly three neighbors--no more, no fewer--is a birth cell. A counter is placed on it at the next move." [3]

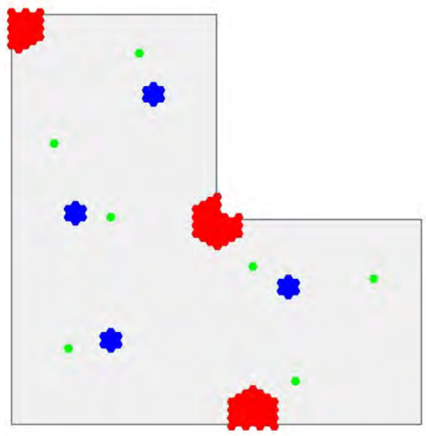
By using a few simple mathematical rules Conway was able to create a single generation evolution developed from a generative pattern.

In planting design by integrating factors or as in Conway's case 'rules' such as plant aggressivity/competitiveness in pushing out other plants, growth patterns and time to reach a mature specimen we are able to simulate a planting ecology to see which one over time delivers the result we are looking for. We start with say 5 randomly placed plants and set the generative program in action to see how those plants will interact and develop. For example :

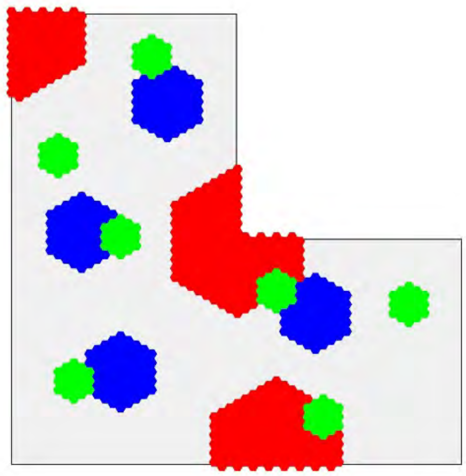
Stage 1



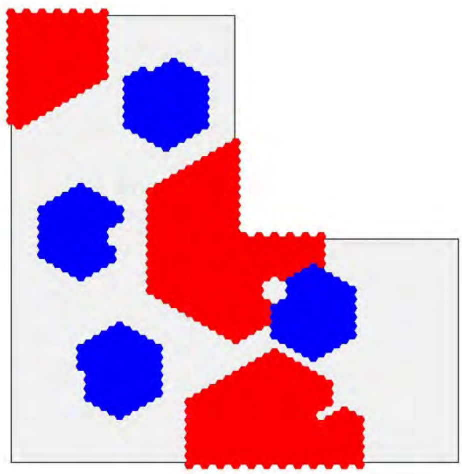
.Stage 3



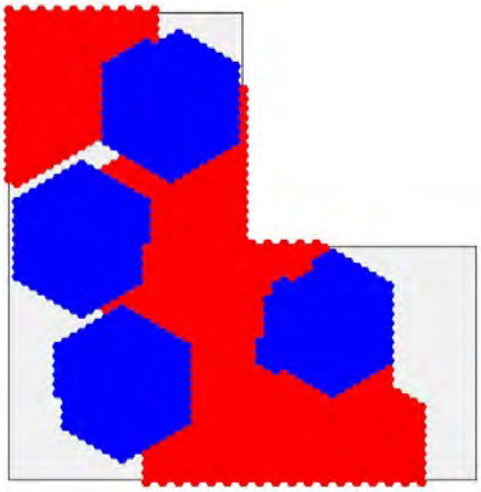
Stage 8



Stage 11 – the green plant has now been outgrown by red and blue



Stage 17 – Dominant plant is established



Once we have established the plant list we will use, the ecological stability we require and the style of the planting. We have to address the question of maintaining this stable ecology. There are many ways nature deals with this issue, wind naturally keeps shrubs low, periodic fires maintains woodlands and allows subshrubs, perennials and annuals to breathe and grow.

Conclusion

The simulators we have been looking into are just the tip of the iceberg there are endless factors that have related questions that need inputting to make a more efficient realistic simulation for example:

- “Health", depends on :
  - available resources : at the moment, we consider that required resources are guaranteed
  - health on previous iteration
  - age : plant is supposed to be weak when very young, then strong when adult (or mature), then weak again when reaching its maximum age
  - a random factor can be introduced to take into account unexpected events such as disease.
  - currently, the simulator doesn't manage health, only death of plants when exceeding the maximum age limit of the species
- "Resilience", depends on :

        - health status
        - plant species own resilience
        - season / period of the year
        - distance to the trunk (more resilient near trunk)
        - a random factor could be introduced to allow for unexpected events
        - currently, the simulator only takes into account resilience associated to the species, distance to the trunk, and a random factor
- "Growth", depends on :
    - plant species own growth rate
    - health
    - distance to trunk or stem of surrounding vegetation
    - age
    - season / period of the year
    - a random factor can be introduced to take into account unexpected events
    - currently, the simulator considers a constant growth rate associated to the plant species
- "Sociability" depends on :
    - plant species own sociability
    - distance to the trunk
    - health
    - season / period of the year
    - currently, the simulator only takes into account sociability associated to the species, distance to the trunk, and a random factor
- "Seeding", depends on :
    - plant species own seeding rate
    - season / period of the year
    - health
    - distance to trunk
    - currently, the simulator doesn't simulate seeding

All of the above are further considerations that undoubtedly will be able to be incorporated as technology develops with machine learning progressing rapidly.

The world of planting design has reached a plateau, as Penelope Hobhouse, one of Britains most respected garden designers once said “You have to be old to be really good at garden design”. Undoubtedly it cannot be denied that age and experience will influence the confidence of the designer but with generative programs and open sourcing databases surely we can take planting design to the next level. Opening a new world of possibilities of plant combinations, that can compete with nature in terms of complexity, that can be stabilized to create self-sustaining ecologies that from a conservational viewpoint will be more and more important in the near future as water becomes scarcer, and climates more unpredictable. Yet at the same time satisfying the client to create an aesthetic piece of natural art, could this field be a logical cross over point for generative art to produce practical solutions for environmental concerns and development?

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Tripti Singh

Digital Art Fabric Prints: Procedure, Process and Progress
(Paper and Artwork)

Topic: Digital Art Fabric Prints: Procedure, Process and Progress

Authors:

Dr. Tripti Singh

Faculty, IIT Mandi, HP, 175001, India

Teaching Fellow,

Indian Institute of Technology, Mandi, HP, India.

Abstract:

Digital tools merging boundaries of different mediums as endeavoured artists exploring new areas. Digital fabric printing has motivated artists to create prints by combining images acquired by photograph, scanned images, computer graphics and microscopic imaginary etc to name few, with traditional media such as hand drawing, weaving, hand printed patterns, printing making techniques and so on.

It open whole new world of possibilities for artists to search, research and combine old and contemporary mediums for their unique art prints. As artistic medium digital art fabrics have aesthetic values which have impact and influence on not only on a personality but also interiors of a living or work space. In this way it can be wear, as fashion statement and also a interior decoration.

Digital art fabric prints gives opportunity to print almost everything on any fabric with long lasting prints quality. Single edition and limited editions are possible for maintaining scarcity and uniqueness of an art form.

These fabric prints fulfil today's need, as they are eco friendly in nature and they produce less wastage compared to traditional fabric printing techniques. These prints can be used to make unique and customised curtains, quilts, clothes, bags, furniture, dolls, pillows, framed artwork, costumes, banners and much, much more.

This paper will explore the procedure,process, and progress techniques of digital art fabric printing in depth with suitable pictorial examples.

Contact:
tripti@iitmandi.ac.in

Keywords:

Digital Art, Fabric Printing, Digital Fabric Printing, Fabric Design

Digital Art Fabric Prints: Procedure, Process and Progress

Dr. Tripti Singh, PhD.
Teaching Fellow,
School of Humanities and Social Sciences,
Indian Institute of Technology, Mandi,
175001, HP, India.

House no 51, Lakhanpur Housing Society,
Vikas Nagar, Kanpur, U.P. 208024. India.

Contact No. 8005438410
tripti@iitmandi.ac.in, tripti.in@gmail.com

Abstract:

Digital tools, merging boundaries of different mediums as artists [1] are exploring new areas. Digital fabric printing has motivated artists to create prints by combining images acquired by photograph, scanned images, computer graphics and microscopic imaginary etc to name a few, with traditional media such as hand drawing, weaving, hand printed patterns, printing making techniques and so on.

It has open whole new world of possibilities for artists to search, research and combine old and contemporary mediums for their unique art prints. As artistic medium digital art fabrics have aesthetic values which have impact and influence on not only on a personality, but also interiors of a living or work space. In this way it can be worn, as fashion statement and also an interior decoration.

Digital art, fabric prints give opportunity to print almost everything on variety of fabric with long lasting print quality [2]. Single edition and limited editions are possible for maintaining scarcity and uniqueness of an art form.

These fabric prints will fulfill today's need, as they are eco friendly in nature and they produce less wastage compared to traditional fabric printing techniques. These prints can be used to make unique and customised curtains, quilts, clothes, bags, furniture, dolls, pillows, framed artwork, costumes, banners and much, much more. Future prediction for digital fabric prints is full of possibilities as it is growing day by day. [3]

This paper will explore the procedure, process, and progress techniques of digital art, fabric printing in depth with suitable pictorial examples.

Keywords: Digital Art, Fabric Printing, Digital Fabric Printing, Fabric Design.

1. Digital Fabric Printing [4]: I had worked as, Head of design and market development of an Hi fashion company so in this paper I will share about the technology, design process and possibilities. Digital fabric printing is a very new technology with varied applications. Most available printed fabrics are rotary screen printed, single print run is several thousand yards. The high cost is due to time required to prepare screens, as each color in a design require a separate screen. But digital printing has advantage as it has the ability to do very small runs of each design (may be even less than 1 yard) because screens are not needed. Digital printing was first patented in 1968, in the 1990s, inkjet printers mostly been used for paper printing applications. The development in technology has now specialized wide-format printers which can handle a variety of substrates – everything from paper to vinyl to canvas and fabrics also.

2. Fabrics: The words cloth [5] and fabric are used in textile [6] assembly trades as synonyms for textile. Cloth may be used synonymously with fabric, but often refers to a finished piece of fabric used for a specific purpose (e.g., table cloth). Fabric refers to any material made through knitting, weaving, crocheting, bonding, or spreading that may be used in the production of further goods (garments, etc.). However, specialised usage of term textile refers to any material made of interlacing fibers.

2.1. Natural fabrics:

Natural fabrics derived from the fibres of animal, plant, stems and leaves, and silkworm cocoons. They are breathable, soft and less discolouration. There are many natural fabrics but some are mentioned here as they are best fabrics for digital fabric printing.

2.1.1. Cotton is one of the best natural fabrics. Cotton is strong, soft, unlikely to cause allergy. It easy to wash and flame retardant. And it is the most popular natural fabric used in making clothing.

2.1.2. The silk is the strongest natural fabric in the world, it is obtained from the cocoons of silk worms. Silk is, beautiful, luxurious. It is warm in the cold or cool in the heat. Silk is used in clothing, home furnishings and medical textiles.

2.1.3. Linen is protects against sun radiation and does not cause an allergic reaction. It is comfortable and luxurious. It is good absorbent of water as it can absorb up to 20 times its own weight in liquid and it is strong. Linen is obtained from the flax plant. It is used for apparel, painting canvases and rugs etc.

2.1.4. Ramie is stronger than linen or cotton. It is obtained from the ramie plant. Ramie is strong, absorbent and can be dyed easily. Its uses include clothing, pillow cases, tablecloths, sacks and cable insulation etc.

2.1.5. Hemp is quite unusual in that it is both very durable and soft. It can be used for many things from work clothing to home decoration, sheets and dish towels. It has a great lustre and dyes easily.

2.1.6. Wool is durable and soft fabric. Wool comes from goats, sheep, and rabbits. There are various types of wool such as flannel, chenille, tweed and melton etc. Wool absorbs moisture and it is warm. Wool is used in blankets, carpets and clothing.

2.2. Poly based fabrics: The synthetic fibres, polyester [7] fibres, are long chained polymers derived from water, coal, air and petroleum. They are formed through chemical reaction between an alcohol and acid. In this reaction, two or more than two molecules combine to make a large molecule whose structure repeats throughout its length. These molecules are very stable and strong. Fabric blends are made of different types of fibres twisted together. This can result in an item that is, care for or more comfortable and easier to clean.

2.2.1. Types of Polyester

The polyester fibres are generally available in two varieties- PCDT (poly-1, 4-cyclohexylene-dimethylene terephthalate) and PET (polyethylene terephthalate). PCDT has more elasticity and resilience and PET is the most common production. It is stronger than PCDT. PET can be used alone or blended with other fabrics for making stain resistant and wrinkle free clothing.

2.2.2. Polyester viscose [8] is a blend of viscose, it is a form of rayon, mixed with polyester, which increases the viscose's wet strength and durability to handle washing and drying by machine. The blend makes the fabric stronger, but it retains feel of standard viscose rayon and the same drape.

2.2.3. Cotton comes from a naturally grown plant were as polyester is a synthetic material. Cotton that provides good moisture absorption and is a very soft material, while polyester is a more durable material that when combined with cotton, allows for the production of more durable clothes, linens, undergarments and other industrial fabrics.

2.2.4. Silk can be blended with wool to result in a subtle texture, for example in making ties.

2.2.5. Ramie blended with acrylic results in a soft fabric which is easy to care.

2.3. Width and length of the textile bolts: The length is usually either 100 or 40 garden, but it may varies depending on the fabric being referred to, e.g., a bolt of cotton is traditionally 39 garden. The width of a bolt is usually 60 or 45 inches, but it may vary from fabric to fabric according to need.

2.4. Shrinkage: When fabric reduces the size than its original size is called shrinkage. Shrinkage happens due to high tension during preparation of fabric which result in excess stretch or squeeze of the size of the yarn. Two types of shrinkage are lengthwise and widthwise. Digital printing process include washing, drying and padding etc. which results the shrinkage

Shrinkage is determined as: Shrinkage Length % = (length of fabric before wash)-(length of fabric after wash))/ (length of fabric after wash) *100

Normally shrinkage is acceptable less than 5% but there is a difference in shrinkage between natural fabric and poly-based fabric. For natural fabrics shrinkage is higher around 10% and for poly-based it is around 5%. The shrinkage ratio also differs by the length and the width of the fabric.

3.1. Design Process:

Designs can be created by using graphic design software such as Photoshop and Illustrator as these softwares are the most popular. Artwork, photographs and designs can be scanned and then can be digitally manipulated to make a pattern. Designs are seamless pattern that is repeated across the fabric.

Patterns [9]: Patterns are ideas which merge difference techniques and different skills. Artistic patterns are unique through it can be driven and can be improved according to artist’s taste. Some of the popular patterns are mentioned here.

Table 1. The Types of Patterns								
Art movements	Art Deco	Art Nouveau	Anthemion	Cartouche	Ethnic Art	Gothic	Ancient Art	Optical Art
Geomatrical	Celtic Knot	Diaper	Fret Pattern	Greek Key	Zillij	Arabesque	Foulard	Henry John Woods
Animal prints	Tiger	Leopard	Peacock	Cheatah	Cat Patterns	Dragon fly	Figurative	Snake
Abstracts	Airbrush	Optical Art	Stylized	Minimalist	Colour-Related	Light-Related	Curvilinear	
Strips	Awning	Bayadere	Barcode	Bengal	Pencil	Chevron	Guilloche	Hairline
Eyes effect	Bird's Eye	Fish Eye	Bull's Eye	Pheasant's eye				
Floral	Botanical	Boteh	Liberty Style	Palmette	Anthemion	Calico	Tapestry	Toile De Jouy
Onamental	Paisley	Anthemion	Arabesque	Islamic	Architecture	Herati	Ogee	
Over all	Neats A neat	Liberty Style	Basketweave	Calico	Coral	Chintz Glazed	Madder camouflage	Ditzy A ditzy
Technique	Batik	Collage	Tie and Die	Dry-brush	Hound's tooth	Watercolor	Spray	eccentrics
Check	Gingham	Hound's Tooth	Tattersall	Pincheck	Windowpane	Glen	Shepherd	Dupplin
Pattern	Dotted Swiss	Stylized	Seamless	Ikat	Greek Key	Herringbone	Twill Weave	Chevron
Mathematical	Frieze Pattern	Fractals	Flexagon	Symmetric union	Polygon	Snowflakes	Golden spiral	Tetradodeca
Repeat	Composite	Croquis	Foulard	Frieze	Guilloche	Half-drop	Henry John Woods	Irregular

Anthemion: A classical motif based on a stylized honeysuckle plant or a radiating, fan-shaped palm leaf (palmette) commonly found in Greek, Egyptian, Assyrian, and other ancient art.

Arabesque: An elaborate ornamental design of intertwined curvilinear floral or geometric motifs. Commonly comes from (or inspired by) Islamic art or architecture [10].

Art Deco: A style of decorative art typical of the 1920s and 1930s. The name was derived from the 1925 International Exhibition in Paris that showed "des Arts Decoratifs."

Art Nouveau: A design style of the late 19th century characterized by dynamic, flowing curves suggesting foliate motifs.

Cartouche: An oblong decorative figure resembling a frame, tablet, shield, or scroll bearing an inscription or emphasizing a design element. Used as a standalone or as part of a pattern's motif. On ancient Egyptian monuments, an enclosure for royal and divine names.

Celtic Knot: A knot formed by interfaced ribbons that lead seamlessly into one another. Same as everlasting knot.

Diaper: A small-scale geometric pattern in a set layout of interlocking or closely aligned forms. Also a weave forming a diamond (diagonal) pattern.

Ethnic Art: typical of a specific nationality or a design based on folk art.

Foulard: A small-scale pattern with basic block repeat, also called a set pattern or a tailored pattern. Originally, the term foulard referred to a soft, lightweight silk cloth. Classic foulards are small-scale, regular-shaped geometrics, usually in set layouts.

Greek Key Pattern A plane geometric pattern or a border interlocking that consists of lines that meet at right angles. Also known as fret pattern. Often used as an ornamental border design.

Optical Art An abstract artwork that creates the illusion of movement, vibrating effects, moire (moiré) patterns, an exaggerated sense of depth, or other visual effects.
Palmette: A classical motif based on a stylized radiating, fan-shaped palm leaf commonly found in Greek, Egyptian, Assyrian, and other ancient art.

Tracery: The ornamental framework of interlacing stone, wood, or cast iron ribs supporting (or implying the support of) glass in a Gothic window.

Zillij: The intricate geometric mosaic tilework created from sets of characteristic shapes, typically cut from enameled terracotta squares. Used as decorations outside and inside buildings. Another spelling is zalij.

Herati: A stylized rosette, enclosed in a diamond, with a serrated "acanthus leaf" along each side, often used as a motif in the rug designs from the Caspian region. The "leaf" may actually represent a fish and then the pattern is also called the mahi (fish) design. The name comes from the city of Herat in Northwestern Afghanistan (formerly the Persian empire).

Airbrush: Imitating effects produced with a painter's spray air gun. Often creates patterns with a light, soft, and modern look.

Stylized: A design with modified or abstracted elements that give the design a more decorative look.

A elatively wide, even, usually vertical stripes of solid color on a lighter g on awning fabrics.

Bayadere Stripes: Brightly colored stripes of various widths laid out horizontally (from side to side on the fabrics). The color effects usually range from lively to startling to bizarre. Often made with black warps and crosswise ribs (plain or twill weave). Mostly produced in India. The name is derived from the Bayadere dancing girl of India, dedicated to a dancing life from birth.
Bead and Reel A decorative motif consisting of oval or round shapes ("beads") alternating with elongated or cylindrical shapes ("reels").

Barcode: A stripe pattern consisting of lines of varying width as in a barcode.
Basketweave An allover pattern resembling the structure of a basket or a woven fabric. See also examples in weaving.

Bengal Stripes: Stripes of apparently the same width and alternating light and dark colors. Bengal stripes are usually wider than candy stripes, but narrower than awning stripes. Commonly used in wallpaper, upholstery, and shirtings. Originated in India and became popular during the Regency era in the United Kingdom. Also called Regency stripes and tiger stripes.

Pencil Stripes: A stripe pattern produced by lines that are about as thick as ones drawn by pencil. The distance between lines is often wider than the lines.

Chevron: A traditional, woven or printed design of zigzags in a stripe layout, also called herringbone.

Guilloche: A decorative repeat of interlacing curved bands, sometimes forming circles.

Hairline Stripe The thinnest stripe pattern possible, with stripe width of about the diameter of human hair.

Hairline Stripe: The thinnest stripe pattern possible, with stripe width of about the diameter of human hair.

Bird's Eye: A weave forming small-scale diamond shapes (diaper) each with a dot in the center, suggestive of the eye of a bird. Also a small-scale (typically geometric) design of a similar shape.

Bull's Eye: A pattern of concentric circles, often creating optical effects, such as movement or pulsation.

Pheasant's Eye: A weave forming diamond shapes that are somewhat bigger than bird's eye weaves.

Boteh: A stylized teardrop-shaped design originally on shawls from Kashmir and mass-produced in Paisley, Scotland.

Botanical: A pattern design showing realistic representation of herbs, garden plants, and other botanical objects. Also a design based on botanical illustrations.

Liberty Style: An allover, small-scale organic (usually floral and other plant-inspired) printed or dyed patterns, characterized by highly stylized, flowing curvilinear forms and subtle, artistic tones of Art Nouveau, developed by Liberty & Co. of London.

Palmette: A classical motif based on a stylized radiating, fan-shaped palm leaf commonly found in Greek, Egyptian, Assyrian, and other ancient art.

Calico: A small-scale allover floral design in bright colors originally from India. Later associated with American country-style.

Tapestry: A woven textile art with hidden warp (vertical) threads and visible colored weft (horizontal) threads usually depicting a floral design, geometric pattern, or historic or other pictorial motif. Commonly used for wall hangings, curtains, and upholstery.

Toile De Jouy: A decorating pattern on a scenic, pastoral, or floral theme usually printed in one color on a light or white ground. Originated in 18th century France. Often abbreviated to "toile."

Paisley [11]: A stylized teardrop-shaped design that originally appeared on kashmir shawls mass-produced in Paisley, Scotland.

Islamic Pattern: A pattern based on simple geometric shapes that uses symmetry [12] and repeatability to create an impression of the infinite; that emphasizes beauty, flow, and unboundedness; with cultural or historic connections to Islamic art.

Ogee: An onion-shaped motif.

Neats A neat: Is an allover, small-scaled, spaced pattern with floral or geometric motifs usually printed in one or two colors on a white or colored ground. Inexpensive to produce and economical for dressmaking

Basketweave: An allover pattern resembling the structure of a basket or a woven fabric. See also examples in weaving.

Coral: An organic allover pattern suggestive of coral growth.

Chintz Glazed: Usually printed in bright florals and stripes, mostly used for drapery and upholstery, but also for apparel.

Madder camouflage: Patterns are frequently described as belonging to more than one class; for example, an abstract undirectional allover madder camouflage pattern, which has the simple shift symmetry [13] and the half-drop layout.

Ditzy A ditzy (ditsie): Is an allover design of small buds, circles, zigzags, and other elements that are simple, eccentrically silly, and may be funny.

Dotted Swiss [14]: A pattern of small, evenly spaced raised dots (usually on a thin, lightweight fabric).

Drybrush: Employing or imitating effects produced with a brush holding a small to negligible amount of paint. Characterized by a scratchy, textured look.

Batik [15]: A design with a tie-dyed appearance created by coating the parts of cloth not to be dyed with removable wax. Colors often include indigo, dark brown, and white. Certain patterns have historic meanings and can only be worn by nobility.

Collage: A collage pattern is one assembled by gluing paper scraps, photographs, cloth, or other objects onto a flat surface. Also an imitation of such a technique. Derived from the French "collar", to glue.

Hound's Tooth: A pattern of small broken or jagged checks created by four-pointed stars.

Watercolour: Imitating effects produced by painting with watercolors (aquarelles). Often creates patterns with light, soft, and transparent gradations.

Airbrush: Imitating effects produced with a painter's spray air gun. Often creates patterns with a light, soft, and modern look.

Eccentrics: An eccentric is a pattern of thin lines generating an illusion of a distortion or op-art effects. Another spelling is excentrics. The class is believed to be originated from the Lane's Net pattern.

Pincheck: A check pattern produced by intersecting pin-sized stripes that are one or two yarns thick.

Gingham Check: Fabrics woven in a block or check effect. An allover pattern of solid-color squares made by overlapping stripes of the same width.

Ikat Pattern: A pattern design created by tie-dyeing either warp or weft threads prior to weaving the fabric, or a design simulating such a technique.

Pincheck: A check pattern produced by intersecting pin-sized stripes that are one or two yarns thick.

Windowpane Check: A widely spaced check pattern resembling panes in a window. Commonly used on suits, shirtings, and accessories.

Shepherd's Check: The simplest of the district check patterns consisting of small, even-sized checks of two colors. Resembles the Gingham check. Was also known as “Spongebag."

Stylized: A design with modified or abstracted elements that give the design a more decorative look.

Seamless Patterns: Repeating patterns without visible boundaries between motifs. Created by elements of the motif that appear in a regular manner (as in set layout) or artfully extend beyond geometric boundaries of the repeating region (as in interlocking patterns). Blending of neighboring units is another way to achieve seamless repeats.

Twill Weave: A weave in which each weft thread passes over two (or more) warps and then under the same number of warps to produce diagonal ridges. Compare with plain and satin weaves.

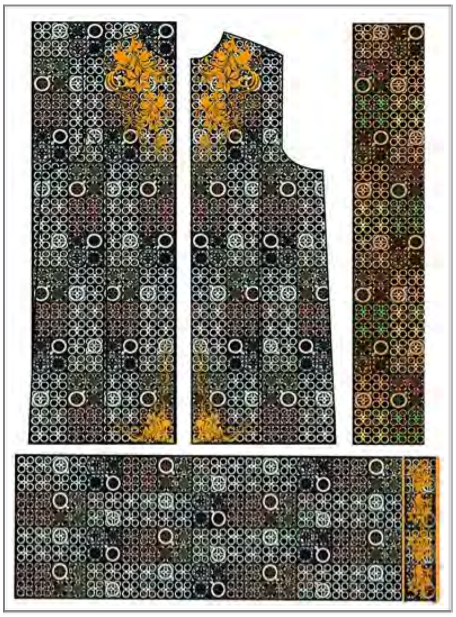
Fractals[16]: Some mathematical rule-patterns can be visualised, and among these are those that explain patterns in nature including the mathematics [17] of symmetry [18], waves, meanders, and fractals. Fractals are mathematical patterns that are scale invariant. This means that the shape of the pattern does not depend on how closely you look at it. Self-similarity is found in fractals.

Composite Overlay: Two or more patterns stacked on top of each other. A typical example is patterned background.

Composite Repeat: A combination of two or more symmetry types in one pattern. For example, rotational medallions put in a drop repeat. In Artlandia SymmetryWorks, created with replicas.
Contemporary A design with simple, extremely stylised motifs.

Croquis: A fully painted design that is not in repeat; same as sketch.

Irregular Repeat: A design based on the same principles as the half-drop and brick layout repeats, but in which consecutive units are not always moved by a fraction of the repeat size



4. Process for creating digital art fabric design:

.1. Garments :
Garments and clothes have historical roots often goes thousands of years back. Many common garment types throughout the world have different variations, different names and in different places.

Classification of garments [19] e.g. through layers, e.g. from inner to outer; through body areas they aim to cloth, cover, or, sometimes to reveal; through fabrics that are used; through purposes and events they are designed to serve; through ease of fabrication; by country; by culture; by ease of fabrication; by family, and so on.

4.2. Home Furnishing and Measurements: Types of possibilities in home furnishing.

(a) Bed Covers

1. Standard Bed Sheet sizes in inches

Single Bed fitted sheet	36" x 76" + 16"
Single Bed flat sheet	71" x 100"
King Single Bed fitted sheet	42" x 80" + 16"
King Single Bed flat sheet	79" x 106"
Double Bed fitted sheet	54" x 76" + 16"
Double Bed flat sheet	90" x 100"
Queen Size fitted sheet	60" x 80" + 16"
Queen Size flat sheet	97" x 108"
King Size fitted sheet	72" x 80" + 16"
King Size flat sheet	102" x 108"

(b) Cushion Covers,

30 x 30	12" x 12"
30 x 50	12" x 20"
40 x 40	16" x 16"
45 x 45	18" x 18"
50 x 50	20" x 20”
65 x 65	26" x 26"
40 x 110	16" x 43"

(c) Table Covers,

Sizing Charts: The table sizing charts to determine the best table shape and size. The charts below, a standard banquet table height of 30 inches is assumed. Therefore, a drop of 30 inches would indicate a floor-length table linen drop.

Round Table (inches)

Table 2. Table Diameter

	30	36	42	48	54	60	66	68	72
70	20	17	14	11	8	5	--	--	--
78	24	21	18	15	12	9	6	5	--
90	30	27	24	21	18	15	12	11	9
108	--	--	--	30	27	24	21	20	18
120	--	--	--	--	--	30	27	26	24
132	--	--	--	--	--	--	--	--	30

Round Tables

To find the tablecloth drop (the length tablecloth will hang down from the tabletop), subtract the table diameter from the linen diameter and then divide by two. For instance, for a 60 inch round table and which have a 120 inch round tablecloth. Subtract 60 from 120 (120-60=60) then divide by 2 (60/2= 30 inches). A 120 inch round tablecloth will cover a 60 inch round table and drop 30 inches off the table, all the way to the floor.

To calculate size of table cloth first measure table and length of a drop then, by multiplying the drop length by 2, then adding the table diameter. For example, for a 60 inch table and a 15 inch drop (halfway to the floor), multiply 15 by 2 (15x2=30) then add the table diameter (30+60=90) to get 90 inches, which means it is 90 inch round tablecloth.

Standard sizes for common round tables:

48 inch round table: 70 inch cloth
60 inch round table: 90 inch cloth for a drop that goes halfway to the floor, 120 inch for a full drop. For the "square-on-round" look, an 85 inch square tablecloth is used on to of a 120 inch round tablecloth.
72 inch round table: 120 inch cloth, or a 132 inch for a full drop

Square Table Linens (inches)

Table 3. Table Sides

	34	36	48	54	60	72
54	10	9	--	--	--	--
70	18	17	11	8	5	--
85	25.5	24.5	18.5	15.5	12.5	6.5

Square Tables
To find the tablecloth drop (the length of tablecloth will hang down from the tabletop), simply subtract the table length from the linen size and then divide by two. For instance, for a 48 inch square table and have a 70 inch square tablecloth. Subtract 48 from 70 (70-48=22) then divide by 2 (22/2= 11 inches). This means a 70 inch square tablecloth will cover a 48 inch square table and drop 11 inches off the table, just over a third of the way to the floor.

If the size of the table and length of a drop known, then to find out the tablecloth size by multiplying the drop length by 2, then adding the table length. For example, 36 inch table and a 18 inch drop (just over halfway to the floor), multiply 18 by 2 (18x2=36) then add the table length (36+36=72) to get 72 inches, which means 72 inch square tablecloth.

Rectangular

Rectangular Table Linens (inches)

Table W x L
30 x 48 (4 ft) 30 x 72 (6 ft) 30 x 96 (8 ft)

Table 4. Rectangular Table Measurements

60 x 102	15 x 27	15 x 15	--
60 x 126	--	15 x 27	15 x 15
70 x 120	--	20 x 24	20 x 12
90 x 132	--	30 x 30	30 x 18
90 x 156	--	--	30 x 30

Rectangular Tables

To find the tablecloth drop (the length of tablecloth will hang down from the tabletop), subtract the table length from the linen length and then subtract the table width from the linen width and then divide the differences by 2. For example, a standard 6 foot rectangular table, so the width is 30 inches and the length is 72 inches, and a 70x120 inch rectangular tablecloth. Subtract 30 from 70 to get 40 inches wide (70-30=40) and then subtract 72 from 120 to get 48 inches long (120-72=48). Now divide those numbers by 2, giving a 20 inch drop on widthwise and a 24 inch drop lengthwise (40/2=20 and 48/2=24).

To know the size table and length of a drop needed, then find out the tablecloth size by multiplying the drop length by 2, then adding the table width and length (for a non-uniform drop, individually calculate the widthwise and lengthwise drop lengths). For example, for an 8 foot table (30 inch by 96 inch) and a 15 inch drop (halfway to the floor), multiply 15 by 2 (15x2=30) then individually add the table width and length to get 60 inches wide by 126 inches long (30+30=60 and 30+96=126, respectively), which means a 60x126 rectangular tablecloth to get a uniform tablecloth drop of 15 inches.

Standard tablecloth sizes for rectangular tables:

6 foot rectangular banquet table: 60x102 tablecloth and 90x132 tablecloth
8 foot rectangular banquet table: 60x126 cloth and 90x156 tablecloth

(**d) Pillow Covers,**

Standard	19" x 29"
Superking	19" x 36"
Square	26" x 26"
Baby Pillow	12" x 16”

5. Curtains are made to fit these common window lengths:
24", 30", 36", 38", 45", 54", 63", 72", 81" or 84", & 95".

5. Machine Printing:

Digital printing [19] is a form of printing in which inkjet [20] printhead's micro-sized droplets of dye placed onto the fabric. The the data supplied in a cadmic_Textile digital image file interpret by printing system software. The digital image file data control the droplet output so that the colour control and image quality may be achieved. Digital textile printing referred as DTG printing [21], digital garment printing or direct-to-garment printing. It is a process of printing on garments and textiles using specialised inkjet technology. This is the recent development in textile printing industry and it is expanding very fast.

Inkjet printer prints [22] on fabric by using fabric sheets with a removable paper backing. Today, major inkjet technology manufacturers offer specialised services for direct printing on textiles, for sampling and also for bulk production. In early 1990s, inkjet [23] technology developed water-based ink (disperse direct ink or dye-sublimation) made possible to print directly onto polyester fabric. This is mainly related to visual communication in brand promotion and retail e.g. flags, banners etc. Reactive ink used for cellulose based fibers such as linen and cotton. Silk and nylon printed by using acid ink. Inkjet technology in digital textile printing allows, mid-run production, single pieces and even long-run alternatives to screen printed fabric.



Earlier in 1980 fabrics were printed by using dye-sublimation inks on a transfer paper then heat press was applied on fabric. In early 1990s the development of a dye-sublimation printer made it possible to print with low energy sublimation inks and high energy disperse direct inks directly onto textile.

6. Process of printing and finishing of the fabric: The use of the fabric is the most important starting point to identify what to produce as an end-product.


Most used fabrics for digital printing is a polyester based fabrics. The printing process should match with type of ink e.g. low energy sublimation (dye-sub), high energy sublimation (also known as disperse direct), reactive, acid and pigment. The ink chemistry should fit the requirements of the fabric (nylon, polyester, silk, cotton). On the bases of choosing fabric and ink combination, the process followed for heat-press sublimation, infra-red fixation or steaming.

Polyester fabric mostly printed with dye-sub or disperse direct ink, solvent inks, latex and UV [24]. Thesublimation ink colorants bond with the fibre during fixation or sublimation as the inks are absorbed by the fabrics, then other medium in which the ink remains with the coating and on top of the fabric, as with UV-curable formulations. Many times latex inks on porous textiles suffer crocking or ‘rub-off’ issues.

7. Advantages of digital fabric printing:

Printing with low energy sublimation ink is easier, but the disadvantage is colours fading, it is UV resistance [25], or light-fastness, is less resistant, than equivalents using high energy disperse direct ink. Dye-sub can also suffer from a ‘halo’ effect which results in less sharp images. The disperse direct ink is a ‘stronger’ ink than the dye-sub kind, and this is very important factor artwork to last longer.



Benefit of aqueous-based sublimation ink is that there are no hazardous components as it is found in UV-curable, solvent and in latex inks. Direct fabric printing using disperse ink on uncoated fabrics offers maximum advantages. These prints can be seen from both sides of the fabric which is an essential quality of digital printing. These prints get more profit, with an ‘eco-friendly’ label and with a higher quality. Other fabric and ink combinations cannot allow this.

The biggest advantage of direct printing on fabric is, it reduces waste as method hasn’t used transfer paper before calendaring (or heat-pressing). Reducing waste is an ecological and an economical factor in fabric print production [26].

8. Post-processing:

The qualities of the printed end product should best as it is the artwork. Longevity is an important factor for an antique print. Post-processing is very important as the printed material should be easily handled, confectioned or applied. Making a decision, if it need washing or if it need a finish (e.g.water repellent, fire retardant). A washed textile does not have coating or ink residues and it will have a better feel. It will be less prone to stains and it will last longer. But digitally printed fabric will fade out with repeated washings, so it should be labeled as “dry cleaning only”, and the best way is, washing by hand with cold water or using the washing machine with a gentle cycle and use a mild detergent [27].



9. Conclusion:

Digital art textile printing has immense possibilities to create artworks by combining other mediums. It gives artists’ possibilities to make modification and sampling. An artist can stick to single edition prints as well as opt for mass customisation. Digital Printing process produces subtle color tones and fine gradations. It is suitable for small production and it runs at low cost and high speed. This process consist of data files instead of plates used for analog printing. It minimises the environmental burden due to minimal wastage of dyes.

It combines many disciplines contributing to digital textile printing e.g. design, fabric, measurements, ink chemistry, pre and post-treatment of fabric, and lots more. Infect it is a combination of many hired services from different sectors of the digital fabric printing factories [28].

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Silvija Ozola

TRANSFORMATION OF TRADITIONAL WOODEN LOG HOUSES IN MODERN LATVIA

Abstract:

In the lands populated by the Baltic tribes one could encounter only wooden buildings till the 13th century: the principal types of wooden constructions were pile building, structure of horizontal beams and filled framework building. These three building types of wooden houses can be found in the archaeological evidences of the ancient settlements and also nowadays in building of several European nations, but the performance technique, scale and quality have changed.

In the Curonian, Prussian, Semigallian, Liv and Estonian as well as Lithuanian society the smallest unity was the family. A house was built for its settlement, round which a fence was built, but due to the necessity of other rooms, separate buildings were built near the house, creating a fenced group of houses which was called a farmstead. The most important wooden structures were concentrated in building complexes on the mound peaks and farmsteads, where buildings were mostly made out of logs.

When looking at the log houses nowadays, one can see that the wooden construction has not lost its peculiarity and it has remained unchanged in its constructive essence through lots of centuries. Developing the constructive solution of log houses, new building types have been created nowadays and a completely new way of application has appeared – public buildings and relaxation complexes are being built in the ancient constructions. The traditional construction inspires creation of new architectonic structures for provision of modern functions.

The main goal of the research is to find out qualitative features in the modern architecture of Latvia.

Topic: Architecture

Author:

Silvija Ozola

Riga Technical university Liepaja branch

Latvia

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https://hdwallpapers.cat/wallpaper_mirror/lido_restaurant_in_riga_at_christmas_lights_hd-wallpaper-1239473.jpg

Image of LIDO restaurant in Riga

Contact:
ozola.silvija@inbox.lv

Keywords: architectonic structures, building of horizontal beams, traditions, wooden constructions, spatial environment

Transformation of Wooden Log Houses in Modern Latvia

Ozola Silvija

Riga Technical University

e-mail: ozola.silvija@inbox.lv

Abstract

In the lands populated by the Baltic tribes one could encounter only wooden buildings till the 13th century: the principal types of wooden constructions were pile building, structure of horizontal beams and filled framework building. These three building types of wooden houses can be found in the archaeological evidences of the ancient settlements and also nowadays in building of several European nations, but the performance technique, scale and quality have changed.

In the Curonian, Prussian, Semigallian, Liv and Estonian as well as Lithuanian society the smallest unity was the family. A house was built for its settlement, round which a fence was built, but due to the necessity of other rooms, separate buildings were built near the house, creating a fenced group of houses which was called a farmstead. The most important wooden structures were concentrated in building complexes on the mound peaks and farmsteads, where buildings were mostly made out of logs.

When looking at the log houses nowadays, one can see that the wooden construction has not lost its peculiarity and it has remained unchanged in its constructive essence through lots of centuries. Developing the constructive solution of log houses, new building types have been created nowadays and a completely new way of application has appeared – public buildings and relaxation complexes are being built in the ancient constructions. The traditional construction inspires creation of new architectonic structures for provision of modern functions.

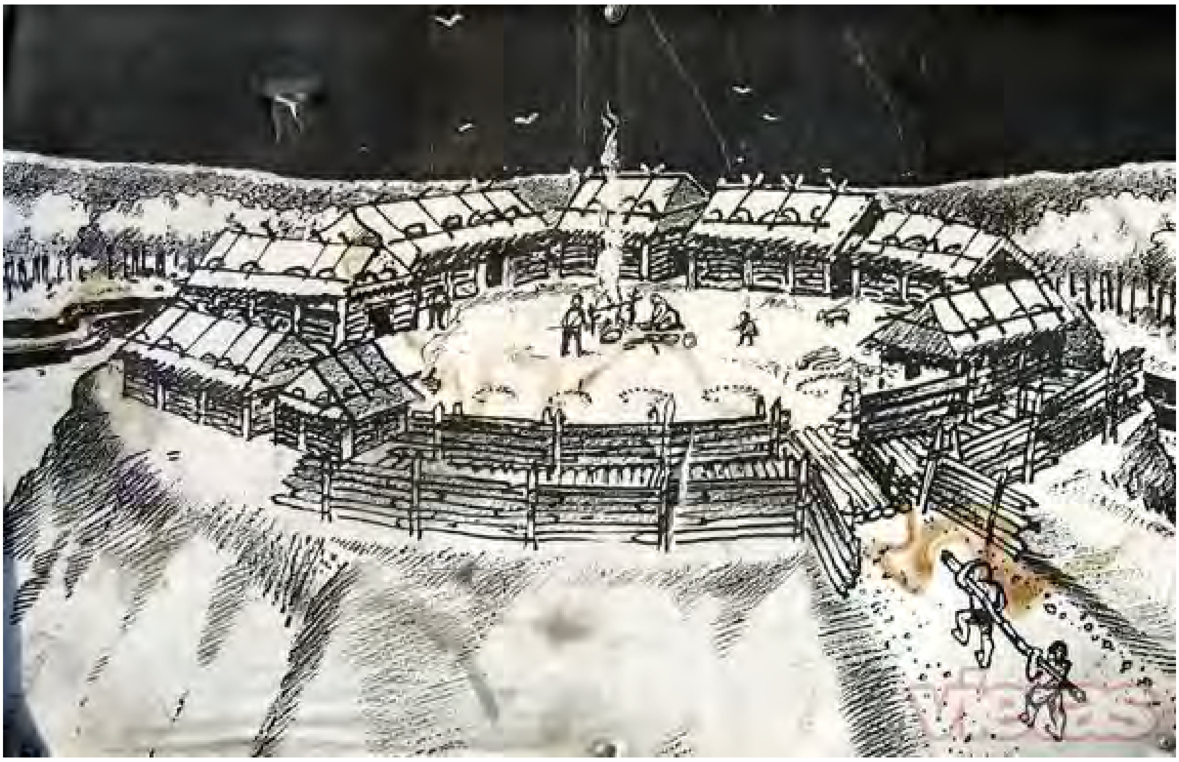
Keywords: architectonic structures, building of horizontal beams, traditions, wooden constructions, spatial environment.

Introduction

A long time ago large areas on the south-east coast of the Baltic Sea were covered by forests. Inhabitants used this natural resource in building of dwellings. By the 13th century only wooden buildings, mostly log houses were built on the lands populated by the Balts. The most significant building construction of log house was the beams' wall.

The smallest unity in the Curonians, Prussians, Semigallians, Latgalians, Livs, Estonians, as well as Lithuanians' community was the family. A house, surrounded by a fence was built for its shelter, but due to the necessity of other premises, separate buildings were built near the residential building. A group of buildings, surrounded by a fence, called a yard or farmstead, was made.

In the Baltic lands the diversity of populated areas was common: open settlements, where a group of buildings was surrounded by palisade and ditch, and settlements protected with natural obstacles. People began to build fortified settlements (Picture 1) on high natural hills with an adjusted plateau and steep slopes in order to protect themselves from predators and foreign tribe attacks. The most significant buildings were concentrated on the tops of the mounds, where fenced complexes (Picture 2) were made. Following the terrain features of the mounds, it was necessary to build houses of different configuration planning. Log houses were very appropriate for such conditions where it was possible to make combinations of rectangular, polygonal and free configuration walls out of the logs.

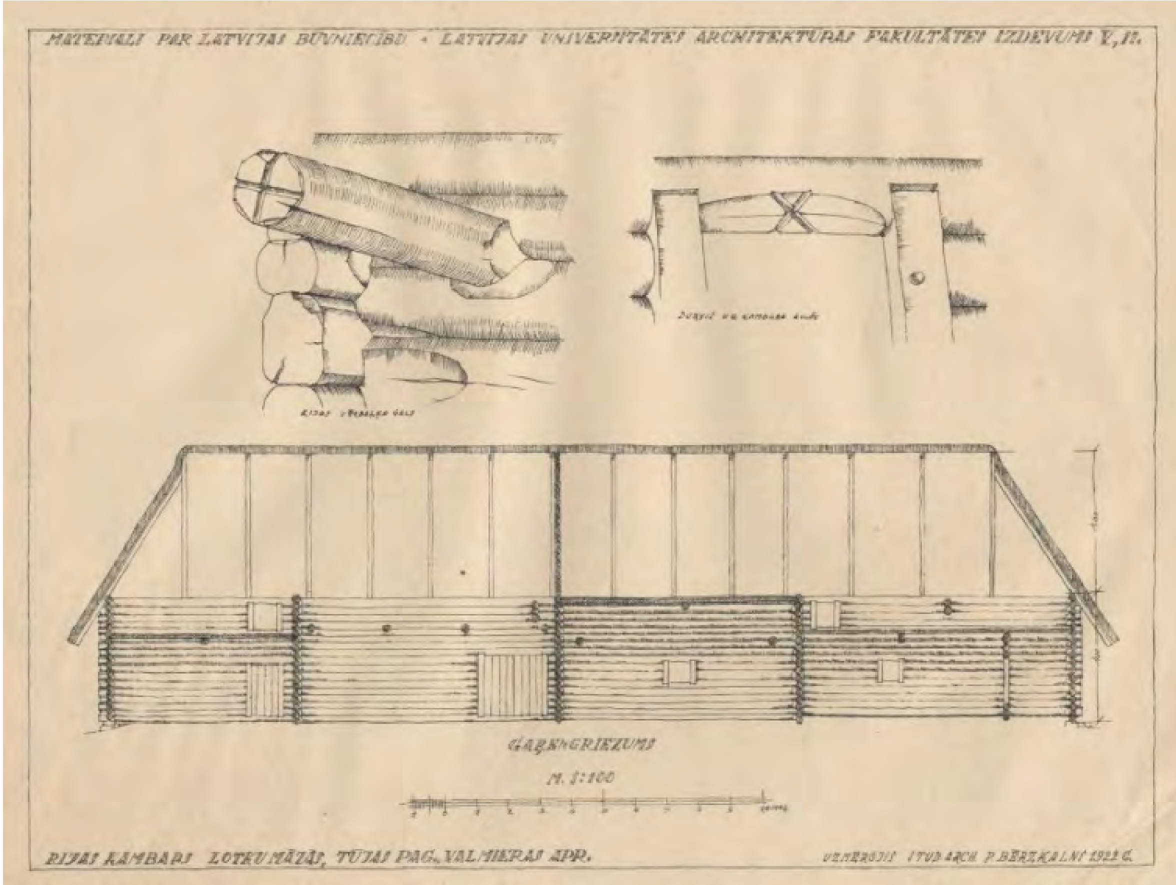


Picture 1. Semigallians' settlement on Tērvete Hillfort. Reconstruction. *[10]*

Picture 2. Semigallians' fortified place of residence on Dobele Hillfort. Exposition model of Jelgava history and art museum of Gedert Elias. [9]

1. Constructive Solutions of Log Houses

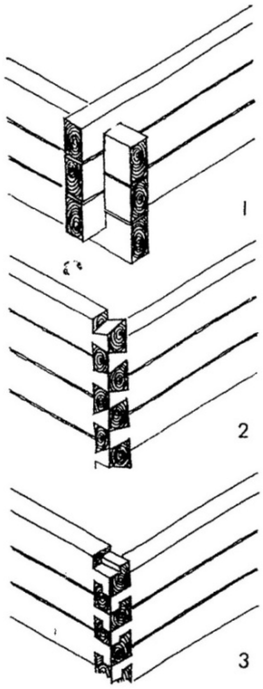
Log houses, which by their essence are archaic and solid wood buildings, were built in Latvia countryside and towns for lots of centuries. Nowadays they are considered as more elite and impressive than the log houses made of wooden pillars and panelled with wooden boards and insulated walls during the modern times. The microclimate stability in the room, the "breathing" wood surface and its artistic decoration and sense of safety are considered as the advantages of the solid wood buildings. A log house is made of round logs (Picture 3), bevelled logs with dovetail, full edged logs (Picture 4) without dovetail and of milled logs with several rebates.

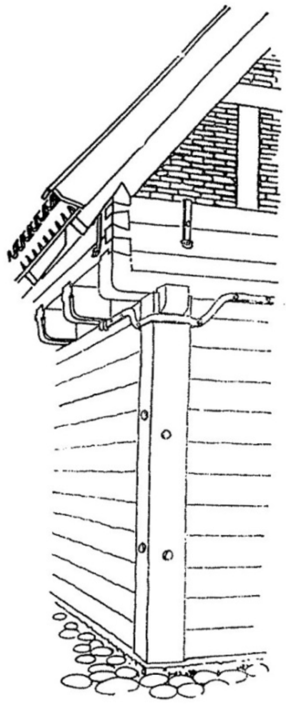


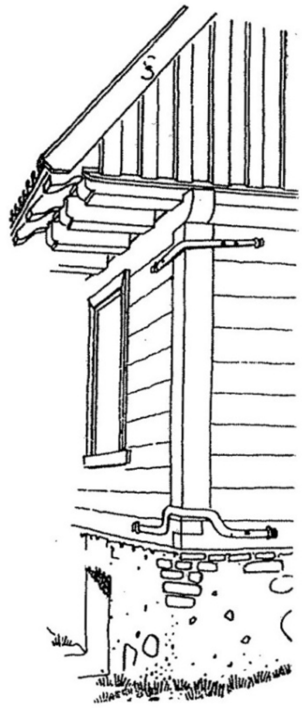
Picture 3. Drawing of the barn of the “Lotkas” House in Tūja Parish, Valmiera Region. Author: Pēteris Bērzkalns. 1922. [7]

Trees for timber were felled and taken home only in winters. To achieve a tight fitting of overlying logs they were hewn and provided with moss-cladding from inside, though earlier houses are known to have been built of untrimmed or only partly trimmed timber [8].

The logs were fastened in the corners of the buildings (Picture 4). A roundish notch was cut on the upper side of logs in about half of their depth, where the next log was put on, or also both on the upper and lower sides a notch was cut in about one quarter. Latvians called these about half-foot long ends of logs as corners [3, *22*].







Picture 4. Corner joints of horizontally edged walls: 1 – with corners (a cross corner), 2 and 3 – the smooth corner. [1]

Picture 5. A horizontally edged building with corners joined in a strut and overhang for the 18th century warehouse in Liepaja [1]

Picture 6. A horizontally edged building with deep eaves under the ends of the beams for the 18th century dwelling house in Liepaja [1]

A strut log house (Picture 5 and 6) is built of bevelled logs with dovetail, full edged and milled logs with several rebates. However, it is hard to make complicated wall combinations for such buildings, as the struts become too complex. In Courland the old warehouses of Liepaja Port, residential buildings, pubs and other buildings were built in log struts, the scheme of frames was applied: vertical struts tied the upper and lower row of logs. Struts were also placed on both sides of the door and window openings. A horizontal beam construction was applied for the space between the struts, placing the ends in the rebates of struts. A strut design log house cannot have a cross corner, as the external walls and corners of the building are smooth, therefore the processing of the parts has to be done precisely. Excellent logs are necessary only for the struts, as well as for the upper and lower row of logs [4, 32].

During the boom of new farms construction in the 20s and 30s of the 20th century thousands of farms were made: lots of buildings had to be constructed – most of them were built in forest parcels of former manors. Farmers themselves prepared 9 to 10 metres long logs on the building sites. An even corner or cross corner was used for the corner joining. Single-family dwelling houses were built in the new farms, applying local materials, thus the construction was comparatively inexpensive [6]. The floor height of a log house was 3,5 to 4,5 metres. Some upgrading was implemented: beams were built into 2,7 to 3 metres height, but above them some rows of logs were built to make a small *drempel*. The archaic log pediment was used on the ends of the oblique roofs.

For the sake of the stability of the log houses' walls the window openings were usually made no closer than 1,5 metres from the corner to provide the wall rigidity. Mostly vertically stretched window openings were made, even though the characteristics of continuous windows also appeared. Some openings of the solid wood log walls, e. g. the main entrance doors, whose sizes were bigger, were supported by division walls.

2. Artistic Expressivity of Log Houses

The architectonic value and artistic expressivity of log houses is determined by the constructive logic, which was cultivated and developed during long centuries, creating a tradition which is carried on till nowadays: due to common designers and builders' work balanced and tasteful houses are made. When the constructive logic and traditions are not observed, atypical and unsuccessful solutions to solid wood buildings appear – houses built of thin logs with badly made corners, too wide window openings for a traditional log house, leaving atypical and non-resistant “posts” of sill corners. Continuous window openings should be used in the log houses with struts or in the buildings of solid wood frame construction. When the logical and plain basic volume is supplemented with colonnades, balconies and bays, the building obtains a distorted construction volume. In the modern architecture preserving the constructive logic of construction, successful samples of log house application are found; in lots of contemporary buildings the contrasts between the log house and strut construction are emphasized [4, *35*].

Using smooth surfaces of milled logs, round log walls with cross corners and expressive exchange of the fat end and thin end, a different texture has been created for the external surfaces of log houses. In the ethnographic regions of Vidzeme and Latgale the houses had round log walls, but in Courland the log houses were built of hewed logs on two and even four sides. In the southern part of Courland the smooth log walls were embedded into smooth corners, but in the northern part of Courland cross corners with the roof overhang can be met [3, *22*].

3. Functional Diversity of Log Houses

By World War I mostly monumental one or one-and-a-half storey residential and social buildings, also railway stations, were built in Latvia countryside. In Vidzeme since 1739 till the end of the 19th century 130 church congregation houses were built – one of the most impressive was *Ceplis* Congregation House (Picture 7) built in 1817 by Lake Alauksts [4, *31*].

Picture 7. Brothers' worship house "Cepļi" in Vecpiebalga [11]

Sill or frame pediments were made above the sill walls of the ground floor. The sill floor included several blocks of rooms. Large size threshing barns (Picture 8) were specific, which were not built at the end of the 19th century any longer.

Picture 8. Barn in the ethnographic region of Vidzeme, Latvian writer Rudolf Blaumanis (1863–1908) memorial museum „Braki" (created in 1959). [12]

Not a long time before World War II banks in Latvia supported building of fireproof houses and farmers started to build stone buildings, therefore the construction of log houses decreased. Rural residential buildings obtained also flat roofs and they reminded of urban buildings. After World War II houses were built of bricks and concrete in order to regenerate the housing fund.

Lots of wooden churches were built as log houses – one of the most impressive is Church of Jesus in Riga [4, *31*]. Currently known oldest of church's buildings in Latvia, built as log house with smooth corners, is a sixteenth-century church in Vecborne (1537). This church is one of the earliest exhibits (since 1936) of the Latvian Etnographic Open-air Museum [2].

In the research by professor *Arturs Krūmiņš* (1879–1969) one can find descriptions about the technical solutions of churches built as log buildings – the churches built as log houses were coated with boards from the outside, but the pediments, towers and other parts built above the eaves were made in the ridge frame construction, thus the consumption of boards for such buildings was higher than other buildings [5]. In the plans of churches it is possible to notice the features typical for log house construction: the wall dominates over the opening, the window openings are distanced from the wall joints, and wall blocks of the log house provide the rigidity of the building that are placed in the corners of the building and served as towers or utility rooms. The rigidity of the long sill walls was provided by the posts built on both sides. Wider rooms with rows of columns were divided in the middle nave and side naves [4, *31–32*].

In the 18th century in Latgale, where all wooden churches used to be log buildings which were covered with boards from the outside nowadays Orthodox Churches are built like log houses: in Rēzekne right now St. Nicholas the Wonderworker's Orthodox Church (Picture 9) is being built like a log house.

Picture 9. The new building of St. Nicholas the Wonderworker's Orthodox Church in Rēzekne built as a log house. 2015. [9]

In Balvi the design initiator and concept author of the Orthodox Church of the Dormition of the Holy Mother of God (Picture 10) was Pastor Vladimirs Rubcihins. According to the northern traditions the church was designed as a log house of canonical forms with two Holy Tables. The image of the Orthodox Church had to be recognisable, but the symbolism of the church had to create a visual impression about the Universe – the worlds of the Earth and Heaven, about the God and His attitude to the world and people.

The construction of the church consists of different proportion volumes: the Heavenly World is symbolized with a cubic basic volume covered with a tent type four-edged roof, whose centre is crested with the big “Head” and cross – the Universe Church Ruler’s Symbol. The big “Head” placed on the octagonal base symbolizes the God’s Law. The belfry crested with the small “head” is lower. The plan of the church is made of the iconostasis and canonical enfilade of rooms – porch, anteroom, front church, middle-room, altar- directed towards the altar or from the “darkness of sins” towards the Reconciliation with God. In the middle of the church the side extensions form the cross plan. The basic volume of the church is emphasized by the windows above and big windows in the side extensions in order to give the space good lighting. In the anteroom the small windows create shadow. Engineers Arnis Asis, Aleksandrs Lukjanecs, Jeļena Šklevska, Juris Šataikins, Tatjana Kiriliva, Andrejs Libers, Alla Kere, Oļģerts Lukaševics, Olga Pilipenko took part in the projection. The projection was started in September 1994, but a year later the developed project was confirmed by Balvi Building Board and with the Head Office manager Juris Gertmanis’s agreement it was presented to the church congregation for free of charge.

Picture 10. The Orthodox Church of the Dormition of the Holy Mother of God in Balvi built as a log house (2012–2014). Author: architect Ludmila Kļešņina. 2015. [9]

In 1990 in Latvia after the restoration of national independence the interest in wooden buildings and also log houses increased. The restaurant “Lido” was built in Riga – the biggest log house by its size (Picture 11); its upper part was made in the strut design, the same way as the mill (Picture 12) of this building complex.

Picture 11. Restaurant „Lido” in Riga at the Christmas light. [13]

Picture 12. Restorāna „Lido” interjers. [14]

In Turaida the roadside restaurant “Kungu Rija” (*The Lords’ Barn*) is ambitious, spacious and beautiful, built from grand round logs with a big roof overhang with a wooden shingle roof (Picture 13).

Picture 13. Roadside restaurant „Kungu rija” in Turaida. [15]

The restaurant-guest house “*Medzābaki*” (Picture 14) built by Lake Lilaste has got a basement and plinth made of chipped stones, the ground floor is made of sills, but the roof of reeds. The guest house “*Puduri*” (“Clusters”) is a multifunctional recreation complex (Picture 15) on the bank of the River Daugava.

Picture 14. Restaurant-guest house „Medzābaki”. [16]

Picture 15. Guest house “Puduri” not far from Ķegums. [17]

The buildings made as copies of historic houses are very specific. Single-family residential buildings are an important group of new log houses that can be divided into two groups: the handcrafted log homes and milled (manufactured) log homes [4, *34*]. Nowadays lots of customers perceive log houses as something profound, natural and healthy.

– Conclusions

1. The traditions of wooden log houses construction continues in Latvia: transforming the characteristic and visually clearly perceivable construction volumes of Latvia ethnographic regions, nowadays complexes of impressive restaurants and guest-houses are being built as log houses in picturesque places by the water, whose planning and architectonic construction is usually complicated. In order to integrate the multifunctional buildings in the landscape, natural materials are used for the roofing.
2. In ethnographic region Latgale, where the building construction of log houses has been cultivated for centuries, nowadays new Orthodox Churches are built in compliance with the canonical planning and architectonically spatial structure.
3. In different ethnographic regions of Latvia the single-family residential buildings built as log houses are exclusive and unique.

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Zita Sampaio

BUILDING INFORMATION MODELLING (BIM) TAUGHT IN ARCHITECTURE (*Paper*)

Topic: Architecture, Teaching theory

Authors:
Zita Sampaio
University of Lisbon,
Department of Civil Engineering and Architecture
https://fenix.tecnico.ulisboa.pt/departamentos/decivil/

Main References:
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Abstract:
Building Information Modelling (BIM) is changing the way projects are constructed. This emerging practice requires new mind-sets and technological know-how in order to achieve significant improvements in building efficiency. Universities must focus on the strategy of using BIM as an innovative technology to allow the acquisition of new skills by students and prepare them for their future activity in a more competitive world.
The management of all information, in its entirety, concerning the different phases of the life cycle of a building, from architectural design to post-occupancy maintenance, can be supported on a single common technological environment. This concept is the basis of BIM technology. There is now a growing interest in the adoption of this technology within the Architecture, Engineering and Construction (AEC) industry. At present, the professional architecture community is embracing new technology quickly, incorporating new opportunities to streamline the design process and to save time and money, whereas the academic community moves more deliberately and thoughtfully to incorporate new technology and to offer new courses. However, it is inevitable that Architectural education will move into a world which demands that students and new professionals are adept at using tools like BIM.
The mission of the school of Architecture is to prepare future professionals in those fields, and as such, must provide education on those topics relating to all aspects of those professions. As part of this, the school must focus on the changes in Information Technology (IT) tools, used in the project office which could be used in the realization of collaborative, interconnected and therefore more effective projects. For this reason, students need to acquire knowledge of basic BIM technology. The text describes how the BIM concept is being introduced in the Department of Civil Engineering and Architecture, at the University of Lisbon. The acceptance of a new approach in the presentation of issues, in particular those related to architectural design, requires awareness, on the teachers' part, of the benefits offered by the use of BIM. The paper first focuses on the current situation in teaching and reflection related to updating education in BIM, and latter presents the recent research at MSc and PhD levels, explore the training courses taught in the Department aimed at continuous training, as an extra-curricular service provided by the school and aimed at designers and architects who work in design offices. A final topic refers to recent proposals for of research projects in the BIM field.

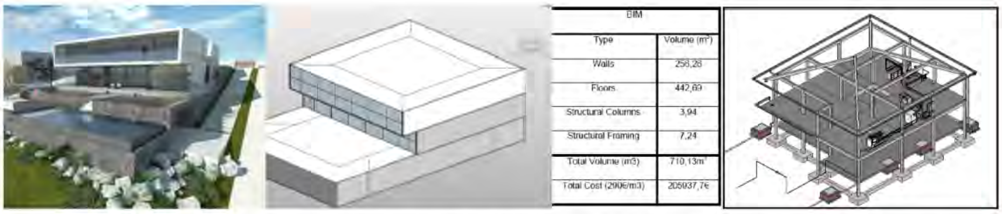


Figure . BIM tool capacities used in visualization, conceptual energy analysis, estimation of material quantities and conflate analyses.

Contact:
zita@civil.ist.utl.pt

Keywords:
BIM methodology, Architecture, Education, Training.

Building Information Modelling (BIM) taught in Architecture

Prof. Alcinia Z. Sampaio, BEng, MSc, PhD, CEng

Department of Civil Engineering and Architecture, University of Lisbon, Portugal

https://fenix.ist.utl.pt/homepage/ist12448

e-mail: zita@civil.ist.utl.pt

Abstract

Building Information Modelling (BIM) is changing the way projects are constructed. This emerging practice requires new mind-sets and technological know-how in order to achieve significant improvements in building efficiency. Universities must focus on the strategy of using BIM as an innovative technology to allow the acquisition of new skills by students and prepare them for their future activity in a more competitive world. Based on this perspective, the text presents some educational measures on offer at the Department of Civil Engineering and Architecture of the University of Lisbon. It focuses on the importance of teaching BIM: the involvement of students in research projects, PhD theses and MSc dissertations, and the dissemination of BIM through professional short courses and workshops addressed to the AEC community outside the school. Some of these have already been carried out in the school; others are presently being proposed or currently in progress. It is clear from this paper that school is an important driver for the growth of BIM knowledge and practice through the preparation of new and existing professionals.

– 1. Introduction

There is now a growing interest in the adoption of Building Information Modelling (BIM) technology within the Architecture, Engineering and Construction (AEC) industry. A BIM model is a parametric model, strongly associated with visual presentation (the geometric model), but it is, in fact, a model rich in information [1]. The immediate benefit of BIM is that the three-dimensional (3D) model is automatically generated from the 2D lines drawn and the properties of the elements within the software. But, there is more to BIM than visualizations, as each building element is an object with its own information and identity.

Although is still at an early stage of development and implementation, the BIM is one of the most promising technologies for the integration of teams working on the same project. The ability for interoperability, that still must be made possible by BIM, is the basis of the integration of collaborators in the project [2]. Today, it is being used by many in the construction industry to make efficiency savings and to improve the accuracy and coordination of documentation [3]. The implementation of this concept involves multiple actors from different sectors of the AEC industry [4]. At present, the professional architecture and engineering community is embracing new technology quickly, incorporating new opportunities to streamline the design process and to save time and money [5], whereas the academic community moves more deliberately and thoughtfully to incorporate new technology and to offer new courses [6]. However, as the pressures increase both to control costs and save time, it is inevitable that Architectural education will move into a world which demands that students and new professionals are adept at using tools like BIM.

The mission of the school of Architecture and Engineering is to prepare future professionals in those fields, and as such, must provide education on those topics relating to all aspects of those professions. As part of this, the school must focus on the changes in Information Technology (IT) tools, used in the project office which could be used in the realization of collaborative, interconnected and therefore more effective projects. For this reason, students need to acquire knowledge of basic BIM technology, both because it is innovative technology and because there is a growing interest in its application in the design office.

The text describes how the BIM concept is being introduced in the Department of Civil Engineering and Architecture, at the University of Lisbon. The methodology of introduction the BIM concept in school is based on proposals to students and professionals of topics to be developed as MSc and PhD research works, short courses and research projects. The next section, focuses on the current situation in teaching and reflection related to updating education in BIM, and later sections present the recent research at MSc and PhD levels, explore the training courses taught in the Department aimed at continuous training, as an extra-curricular service provided by the school and aimed at designers and architects who work in design offices. The final section refers to recent proposals for of research projects in the BIM field.

– 2. The importance of teaching BIM

BIM is one of the most recent acronyms to appear in the world of architecture and construction, the timing of its more formal appearance being difficult to establish. However, neither the concept, nor the nomenclature of BIM, is new. The concept can be dated back nearly thirty years and the nomenclature, around fifteen, with America claiming its origin in 2002 as a means of describing virtual design, construction and facilities management (Race, 2012) [5] while in 2008 the American Institute of Architects (AIA, 2011) [7] issued its first contracts which specifically refer to BIM. The term evolved from the expressions “Building Description System”, “Building Product Models”, and “Product Information Models”, finally merging them all to arrive at “Building Information Modelling”. However, as Kymmell (2008) [8], expresses it, “architects have been using BIM from the very first time information was exchanged in order to get something built”, so BIM should not be seen as something entirely new and different. In fact, as mentioned below, some applications with a small degree of interoperability have been in use since the late 20th century.

Engineering education always strives to follow the interests of the construction industry and currently BIM is a very attractive topic. Not only does BIM show a building at every step of its development and illustrate construction, design and materials in detail but the embedding capacities of BIM make it a dynamic platform that allows multiple groups in different locations to work on projects. Increasingly, the technical information in a BIM concept is rich and highly structured. The students in an Architectural school and the team in a design office must acquire adequate skills to be in a position to make use of this technical information, according to the design phase data the users intend to get from the model.

According to Sabongi [6] “the academic community moves more deliberately and thoughtfully to incorporate new technology and to offer new courses”, a number of undergraduate programs are now incorporating BIM in their curricula. The literature mentioned below illustrates the efforts to introduce this material into higher education:

- Construction Management Faculty at California State University organized a study to examine the effectiveness of BIM, as a construction visualization tool that integrates estimation capacities [9]. The results showed that BIM as a construction tool can improve estimating skills;

- Clevenger et al. [10] discusses the faculty motivation, summarizes student input, outlines academic material development, and presents preliminary student feedback for the strategy of including BIM in the Civil Engineering curriculum. The main objective of the changes was to introduce students to the techniques, and to arm them with basic BIM modelling skills;

- In the conference Building Innovation [11], Arto Kiviniemi, from the University of Salford, said "In 2012, we were the only University (in England) that had a graduate program in BIM. This year, there are five or six";

- Universities play a prominent role in the spread of technological change and, especially in the construction field, by the process of dissemination in training students in BIM base tools. Higher education teachers are supposed to be the key actors in education innovation and in the process of change [12]. Universities, consequently, must focus on the strategy of using BIM as an innovative technology.

– 3. Bologna Master's theses and PhD tutorials

At the Department of Civil Engineering and Architecture, the preferred target of education is the student as they are the future professionals. The student must acquire skills for using the advanced technology tools, as they will use BIM technology in their future activity; they will be thus more competitive. A school of Engineering and Architecture can be expected to constantly update computational resources in frequent use in the professions and to introduce innovative resources into the training of the student, leading to their adaptation for curricula in drawing and modelling disciplines.

Today, in carrying out research work within the studies leading to Bologna Master's theses there has been a wide acceptance and commitment demonstrated to BIM by the students, so that there is a widespread recognition that this innovative technology is strongly focused on their future. The proposals of topics of dissertation are aimed at different areas in Architecture and Engineering:

- The student must make an initial literature search regarding the BIM concept: evolution, applicability, advantages and disadvantages;

- The student learns to handle the basic BIM software most frequently used in design offices;

- In order to create adequate BIM models and afterwards to allow the accurate transfer of information between the different design phases the student must acquire knowledge of the standardized file formats, in particular, IFC and other open sources;

- The student must use his knowledge of this application in a case study in order to learn how to create a model and to analyse the degree of interoperability needed to create an effective BIM collaborative model.

As an expected result of the academic research the students, will inevitably improve their skills in an innovative technology of great relevance to the contemporary IT field applied to buildings.

3.1 BIM applied on building projects

In his recent dissertation “Application of BIM technology to building projects” the author, P. Neves [13], an MSc student, focuses on the differences between what the BIM presents and traditional 2D drawing and 3D modelling in the context of a small construction project.

The focus of the work goes towards the modelling effort (undertaken in Autodesk Revit). The dissertation reflects the differences between traditional 2D/3D CAD drawings generally used and the BIM parametric approach: the modelling procedure is greatly changed, producing a central 3D model which can be used to obtain different data (energy consumption, estimates and visualization for example) without the need to redo the model, with the associated loss of productivity. The results indicate that BIM would be suited to small construction projects, particularly when visualization, estimating and conceptual energy analysis are used. As a conclusion, the research work project confirmed the overall positive trend within the AEC industry regarding BIM adoption and its benefits.

Figure 1 show the 3D view of the project all modelled in Revit Architecture. The 3D viewing environment allows the user to turn the whole model in whichever direction is intended and it is also possible to obtain top view of different levels of the project.

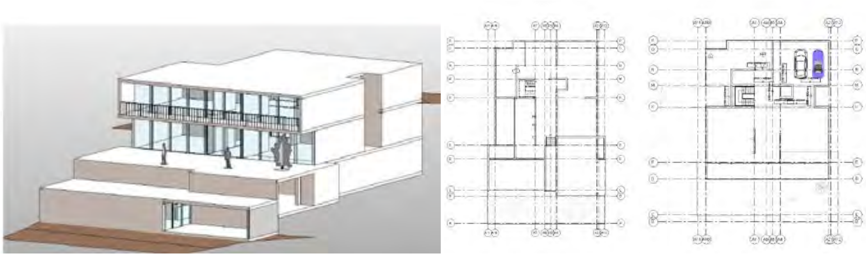
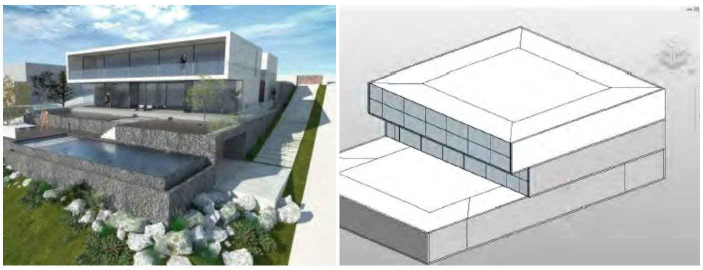
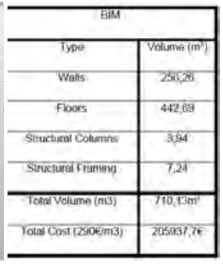


Figure 1. 3D model and plant views of the architectural project.

The energy analysis was conducted on a simpler mass model (Figure 2), using a sketch-like interface within Revit, where only the general shape, materials, percentage of glass surface and other properties of the project are defined. Using Autodesk Revit Architecture to produce a bill of quantities is a quick procedure that only depends on a well modelled project in order to achieve great accuracy.





BIM	
Type	Volume (m^3)
Walls	250,26
Floors	442,69
Structural Columns	3,94
Structural Framing	7,24
Total Volume (m3)	710,13m³
Total Cost (290€/m3)	205937,7€

Figure 2. Revit capacities used - visualization, conceptual energy analysis and estimating.

The study case showed that modelling in BIM is very straightforward, reflecting the material nature of building elements that was not present in 2D CAD. The use of information rich objects guarantees a more cohesive design and analysis process where different tools can be used to develop and study the project, all based on a primary model initially developed by the architect. Furthermore, modelling this small project showed that if the different stakeholders are aligned in the use of BIM technologies and behaviours, there are evident benefits to small projects that are often left out of the BIM discussion, given their simplicity.

3.2 Conflits analyses in a BIM based design

The aim of a Master study developed by Berdeja [14] was to evaluate the practical capabilities of the BIM concept in the conflict analysis between building services, namely, the water supply and drainage systems design, and the architectural and structural design. As such, it was case study the development of an architectural, structural and building service (Mechanical, Electrical and Plumbing, MEP) BIM models and their subsequent conciliation and clash detection. In this work, commercial software such as Revit 2014, Tekla BIMsight and Navisworks Manage were used, the latter two providing features for automatic collision detection. A BIM model concerning architecture, structures and MEP was developed. The BIM technology provides automatic clash detection during the development of the building design. So, using the software of automatic detection of conflicts between elements of the three building components a final solution to the MEP model was established (Figure 3).

This work contributes to demonstrate the advantages of BIM in the conciliation and coordination between different specialties, as well as the benefits of its application in conflict analysis in a building design.

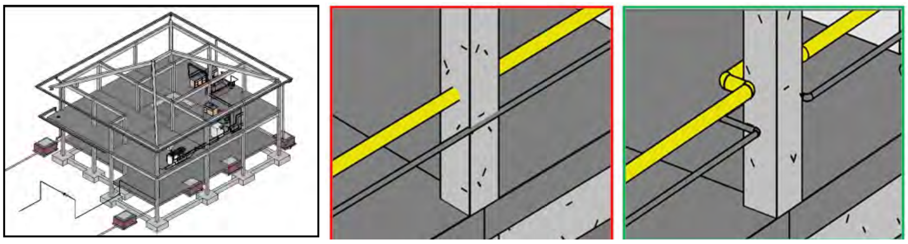


Figure 3. Analyses of clash conflits between structural and MEP components.

3.3 BIM applied to construction management

In addition to work carried out on the Master's program, the PhD program offered by the Department includes the tutorial module "Advanced Course in Information Systems Aided Projects", coordinated by the author, this within the field of IT in Construction. The PhD candidate, A. Costa [15] developed his report under the title "BIM applied to construction management".

The construction case studied by Costa aims to contribute to the assessment of the potential of the BIM software for 4D model simulation and its interoperability with planning software, such as Microsoft Project. The result of the work presents itself in the form of an application able to simulate the construction, through 3D models defined for each constructive step, according to the MsProject file, and was created on the basis of the plan established for the work. The methodology to support the implementation considered three main components (Figure 4):

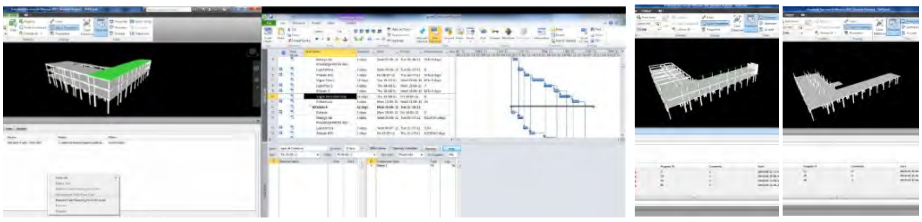


Figure 4. Animation of the construction process using Navisworks.

- BIM model generation in Autodesk Revit and additionally, at the end of the process of modelling, an IFC format file was created; this was required for the transfer of information between the Revit software and Navisworks;

- Construction planning established in MsProject. The schedule of construction work treats the whole construction process as two modules, for the purpose of an optimizing construction phasing; Autodesk Navisworks used to process simulation of construction. BIM model was imported to Navisworks based on the IFC format and the links between the model BIM objects and the timeline were established. The simulation was then performed automatically by the Navisworks software.

The main advantages of the applied methodology refers essentially to the great potential for future developments: the simulation does not require any programming; the interactivity of the BIM software allows greater flexibility to adapt possible changes in the timeline or in the geometric model; the simplicity of the software allows an application more widespread use, contributing to a well-deserved appreciation of the importance of virtual simulation in construction.

3.4 BIM applied on a Architectural project

The tutorial work of another student, Hawreen Ahmed, concerns the use of BIM technology to generate an architectural project [16]. Today Revit, available as Revit Architecture, is the most widely used tool for generating BIMs. It contains libraries of standard components, which can easily be copied and edited to create additional components. Door, window and wall schedules are easily extracted to spreadsheets, databases, and other estimating and scheduling packages (Figure 5).

Figure 5. Architectural BIM model.

When defining architectural elements in a BIM model some relationships between components must be established. Furthermore the students used templates for estimating and for the project schedule. Schedules could easily be created for other elements, such as walls or floors, showing lengths, areas, or volumes. By developing a simple case fully the student obtained enough skill to easily pick up the programs in the future and use them on a more complex project.

– 4. External training courses

The Foundation for Continuing Training in Civil Engineering (FUNDEC) with the aim of improving the skills of people engaged in Civil Engineering in Portugal, promotes, to this end, professional training and courses, studies and services. To achieve these objectives, the foundation counts on the participation of the Department of Civil Engineering and Architecture and its qualified staff to satisfy the needs of the Association. In addition, the operations to be carried out necessarily correspond to the needs felt by the technical and business stakeholders.

Following this strategy of the Department, the author is the coordinator for the professional short courses FUNDEC. The main aim of the courses is to disseminate BIM technology as a means of supporting the management life cycle of the building, particularly directed to the activities of design, construction and maintenance. The first course “Information technologies applied to buildings: BIM and VR technologies” was held in November 2012, and included the presentation of some case studies developed in BIM environments. The notion of the course was well accepted within the AEC community, the interested parties showing interest in the topic presented and identifying solutions and modes of action for future use in their activity.

A new course has been proposed for the present year: “Implementation of BIM Technology in the AEC industry”. This includes an introduction to BIM: concept, state-of-art, applications, benefits and limitations; analysis of interoperability between the various sectors of the AEC industry and presentation of some cases illustrating successful implementation. The course is aimed at various levels and sectors of the AEC industry. This second course focuses more directly on the problem of the implementation of BIM in the AEC sector and specifically on computer science knowledge concerning the BIM paradigm. Particular attention is paid to the MEP model, specifically, in the analyses of conflicts between BIM models. The use of 3D Scanner technology in BIM is also explored as a technology to capture building shapes for rehabilitation projects. The contents of this second course are list below:

- Introduction to BIM concept: Definition, State-of-art, application, benefits and limitations; Interoperability and standardization
- Computer-based BIM technology
- Limitations of the model BIM interoperability in building management
- BIM as a computer-aided design tool: Generation of architectural, MEP and structural models; Analyses of conflicts between models
- 3D Scanner technology applied in BIM.
- Full BIM model: a study case

– 5. Research project on BIM

This final section describes, a research project which has been submitted to the FCT (Foundation for Science and Technology), a national public organization, under the coordination of the author and with the participation of an exterior designer. The proposed research concerns the BIM domain "Maintenance of buildings supported on BIM" to be developed in the period 2013-2015 [17]. The purpose of this research project is to establish a BIM framework focusing on the issues of maintenance and visualization supported on VR technology for new or existing buildings. This research proposal aims to improve the solution of integrating maintenance information and system interfaces using advanced visual performances. The knowledge related to VR technology and maintenance planning, acquired in previous research projects [18] and educational research will be explored within the context of a BIM strategy. The project aims to explore the most recent investigation sub-issues for BIM: models supporting maintenance information and incorporation of visual representation of knowledge.

BIM allows the integration of corporate strategy, management, and IT throughout the project's entire life cycle. However, the reuse of BIM models in post-construction and post-occupancy phases is still in a very early stage [19]. Fully-integrated and sophisticated BIM implementation may effectively support some projects, but, the overall and practical effectiveness of BIM utilization is difficult to achieve. BIM implies mechanisms for optimization of data and issues for its efficiency. In this context, this project intends to provide guidelines for this optimization. File and data systems will be explored and organized with a focus on BIM-maintenance. Besides the effectiveness, an actual investigation sub-issue for BIM is the integration of visual data among different construction sectors [2]. Using visualization expands the usability of data/information/knowledge. With respect to presentation of maintenance information, BIM framework will include visualization of condition assessment data and visualization of 4D model simulating materials evolution of coatings and other building components. The capacity of visualizing and simulating the degradation in 4D model will give a more understandable overview of the life cycle performance and will enable effective use of resources, increasing better communication and supporting long-term planning of maintenance, repair and rehabilitation. Furthermore, visual knowledge representation and viewer interaction, supported on VR technology, are topics to be developed in this project in order to archive important benefits to maintenance. The research work must incorporate VR-based interactive techniques and input devices to perform visual exploration tasks.

6. Conclusions

BIM is currently being introduced into the construction sector at a very fast pace and tends to be seen as cutting edge technology and processes. However, the academic community acts more conservatively to incorporate new technology and to offer new courses, while recent studies in university reveal that some undergraduate programs are making the jump to incorporate BIM in their curricula. In this context, the education work developed in the Department of Civil Engineering and Architecture, at the Technical University of Lisbon aims to improve the knowledge concerning BIM aimed at the future AEC professionals.

The author as a teacher is committed to implementing this pioneer subject in academic programs motivating students to adopt this new technology. The author has supervised several MSc theses and tutorial PhD lectures concerning the field of BIM design and believes that in the future other students will be engaged in research developing BIM. Today, in carrying out research work within the studies concerning Bologna Master's theses, there has been a wide acceptance and commitment demonstrated by the students, so that there is widespread recognition that the innovative BIM technology is a strong focal point for their future. Following this strategy the author has organized short professional courses and workshops, which have been very well accepted within the AEC community, the participants showing interest in the topic presented and identifying solutions and modes of action which in the future will use in their activity, thus helping the spread of this innovative technology in their particular professional areas.

This paper demonstrates ways in which schools can be an important driver of BIM knowledge through the new professionals who will incorporate it in their future AEC activity, and supports the opinion that Universities must, as a matter of urgency, focus on the strategy of using innovative technologies to allow students to acquire new skills in the use of BIM software, and knowledge about the capabilities of BIM, to better prepare them for their future activity in a world that is ever more competitive.

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Pinar Calisir

NATURAL PERIODIC FORCES AND FORM FINDING STUDIES: THE SOUND MOTION STREAKS PROJECT

Abstract:

The aim of this paper is to investigate the effect of natural periodic forces on the embodiment of forms in nature and propose The Sound Motion Streaks Project where the sound can be used as a generative computational data and applied to digital form finding experimentations in the scope of architecture. This process relies on an idea that sound as a natural periodic force can produce or deform shapes according to its influence. The first phase of the process is to make physical experiments on the sound and see its influences on granular and fluid materials. We can say that, in these physical experimentations, there is a knowledge transmission from physical to digital medium that we can use as design parameters on a software. In digital software, sound can be a force field and manipulate digital matters such as particles, curves and meshes. This form-finding method is constituted by all physical and digital experiments, and applied in an urban area to discuss its architectural potentials. The ultimate form emerging in this process depends on time; therefore, we can track the whole process along the form and this brings kinetic properties to spaces created in the Sound Motion Streaks Project. The contribution of this kinetic process to the architectural space is its changeability and endless topology. Moreover, in this animated space, users discover sound with their eyes and become aware of the sound-scape of the area. Through this kinesthetic experiences, users can not only hear the sound in the environment but also see and touch therefore, the perceptual experiences are enriched and enhance. Briefly, this paper is based on the nature's way of form-finding with periodic forces and particularly focuses on sound in order to find out its potentials as a generative force in architecture.

Topic: (Architecture)

Authors:

Istanbul Technical University

Turkey

Architectural Faculty

Architectural Design Computing Graduate Program

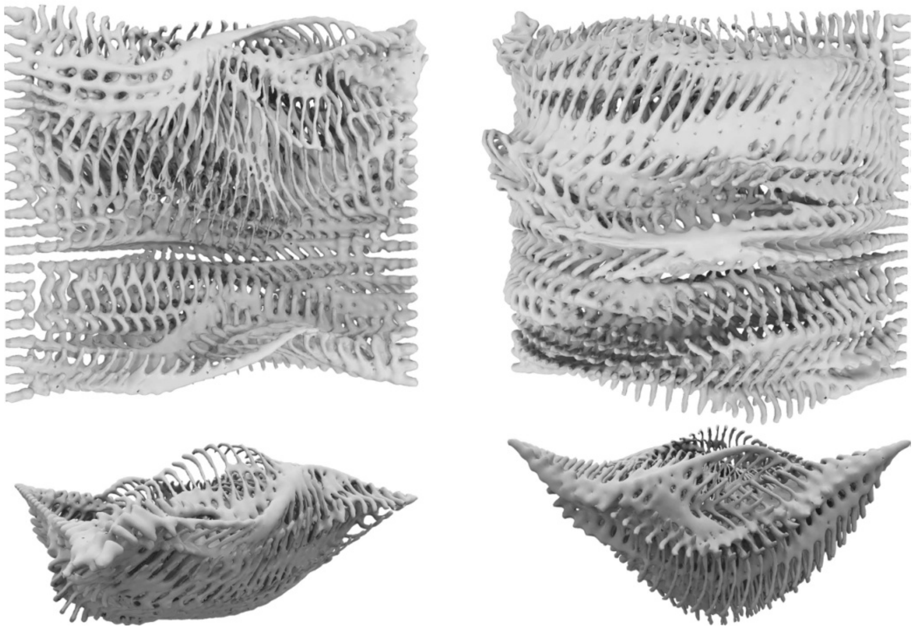

Figure 1: Elevations of the Sound Motion Streaks Project. In this test, a square boundary is created for the system. We can see the whole process of animation along the form.

Contact: ***pinarcalisir@amasya.edu.tr***

Keywords: Form-finding, Kinetic Form, Sound, Experimentation

NATURAL PERIODIC FORCES AND FORM FINDING STUDIES: THE SOUND MOTION STREAKS PROJECT

Pınar Çalışır, Arch, MSc.

Istanbul Technical University,

Institute of Science and Technology,

Architectural Design Computing Graduate Program, İstanbul, Turkey

e-mail: pinarcalisir@amasya.edu.tr

Abstract

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1. Introduction

Nature has a lot of novel forms and patterns and produces new ones without stopping a moment. Thus, it is not a coincidence that the novel ideas in architecture usually come from experimentation procedures copying the processes of nature. To do this, architects need to understand how nature finds her forms and what her rules during the process of form generation. Our motivation in this paper is a desire to create a form finding process which is called “the Sound Motion Streaks Method” in terms of experimentation on natural forces in order to find novel ideas in architecture. Sound is the force that we used in our study. The main objective of using sound is to see what sound looks like through interaction with matters. By doing this, we can produce a new notion of space which negates with the traditional Euclidian space and create a multi-sensory experience on users with the help of sound materialization. While reading this paper audience will see that there is no starting shape in this process, but there are different materials reacting to the sound influences. Therefore, this kind of formation processes will lead us to create a variety of topological geometry. Spaces emerging in this process are no longer static but dynamic, and this dynamism in the structure brings some kinetic properties to the form. In an animated form, the notion of kinetic reveals with a continuous motion through immovable structure of form. We can see the history of material movement under the influence of sound through transparent and overlapping structures of form. This illusion of movement called as “frozen moment” and the designer becomes a person who “orchestrates” the whole process [9]. The design process in this study is developed in four stages. First stage is to gain a general knowledge about the notion of form-finding process and physical sound properties. In this stage, as an addition to the literature review, we repeated physical sound experiments from the precedents - such as Cymatics (a discipline investigates periodic formation systems)- in order to strength our understanding of sound properties and material interactions. The second stage is to use this general knowledge coming from the first stage and constitute various digital experiments to examine the nature of digital materials and their reactions to the sound. Third stage is to generate our form-finding method and test it with different parameters in order to find a way for creating an urban scale prototype. Our final stage is to test this method in an urban area and discuss its architectural potentials through this way.

2. Form-Finding

In 1806 Goethe introduced the term “Morphology”. He has a unique understanding on how forms emerge in nature and how the constant formation and transformation of forms related to environmental forces [7]. According to him generative processes in nature affect both organic and inorganic systems with the help of natural forces. He invented “Ur-forms” in order to explain “the foundational programs” in nature. These programs determine differences and similarities between forms in nature which is to say that similar forms (Urforms) should share a common foundational program [1]. These foundational systems actually refer environmental forces which affect all forms in nature and cause a constant transformation throughout its lifetime. For instance, imagine different cracking systems in nature. The foundational program behind dry mud and dry paint is the same, therefore these cracking systems looks like identical. They are “Urforms”. Both are shaped by same environmental force which is “fluvial erosion” [1]. D’Arcy Thompson explained similar ideas with Goethe in his book “On Growth and Form” in 1917 [3]. He proposed that there are environmental (external) forces in nature affecting shape of things. More importantly, he believed that we can solve this process with mathematics [7]. Similarly, Philip Ball [2] stated that patterns and forms in nature are not only generated through biological coding, but also there are simple physical laws behind them. Therefore, we can repeat complex forms in nature by repeating these rules. From all these ideas, we can say that there are some natural forces in the world and they are acting on organic and inorganic things and determine their appearances. These external forces cause similarities and differences and we can repeat their effect on forms by repeating these physical forces. In the Sound Motion Streaks Project, our departure point is to use sound as an external force and find sound patterns and structure by means of form and force relations. Therefore, in the next chapter we examine some precedents works on sound phenomena and repeat some of their experiments in order to find the foundational program behind sound patterns and forms.

3. Sound in Cymatics as a Natural Periodic Force

Nature consists of complex systems constantly changing one assemblage of conditions to another, opposite one. These changing systems –animate or inanimate- create their own repetitive patterns and forms and their formation reveals hidden periodic forces which lay beneath them. A continual state of “vibration, oscillation, undulation and pulsation” give these forces periodicity [5]. On the basis of vibrational phenomena sound can be seen as another example. Taking information from its nature cannot be done with an eye or other senses except hearing. However, this does not give any visual data on the periodicity of the sound. Thus, since the eighteenth century, scientists have worked to make sound visible in order to explore its nature [5]. Ernest Chladni (1756-1827), who was one of the first physicist musicians, tried to simulate the vibrations of sound and make it visible. Chladni used a violin to vibrate metal plates covered with powder, and made the sound vibration process visible [5]. After Chladni, the most important person working in this area was Hans Jenny, a physician and natural scientist who founded Cymatics, which is the study of the vibrational character of sound and its hidden force on matters. Jenny’s experiments (Figure 1), by putting matters such as sand, fluid, powder or salt on a metal plate, showed the hidden force of the sound on materials. He observed that in a kinetic-dynamic process based on sound vibrations, all patterned formations are generated and maintained by sound periodicity [5]. Overall, according to Jenny [5], sound is physical force that can create vibrations and finally systemized pattern forms.

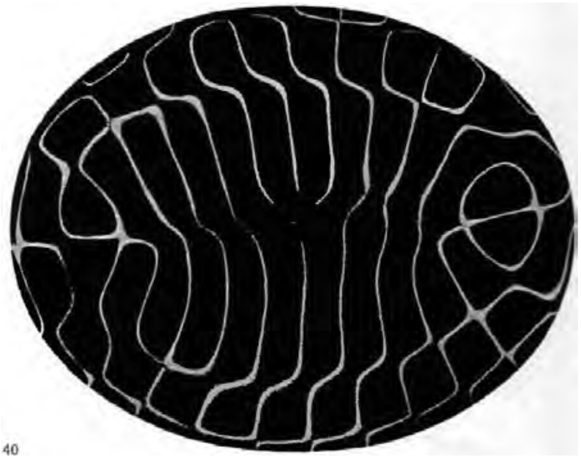

Figure 1: Chladni Experiments in Cymatics (Quartz Sand on a steel plate). A unique pattern emerges according to specific frequency. [5]

3.1 Sound Attributes

To understand periodicity of sound we should understand the properties that create rhythmic vibrations. Sound is a kind of wave which passes through the air effecting particles back and forth and change their equilibrium positions, but it is the disturbance which travels not the individual particles in the medium [11]. The frequency is the number of occurrences of a repeating event (period) per unit time. The amplitude is the measure of a magnitude (energy transported) of oscillation of a wave [12].If we find a sound analysis of a particular sound, we can see that, both amplitude and frequency reflects the periodicity of sound and rhythmicity.

3.2 Physical Experiments to Make Sound Visible

In this phase of the study, multiple physical experiments were generated from the Cymatics experiments, in order to deeply understand which parameters of sound actually create forms, deform shapes, or produce patterns. Water, non-Newtonian fluid made from water and starch and salt were used for physical experiments. In experiment 1 and 2 (Figure 2), 40x40cm steel plates were used in order to materialize sound wave patterns. The left image shows the 1mm thick plate and the right image shows the 0.5mm thick plate. These square plates were clamped by the center with a speaker connected with an amplifier. Salt was sprinkled onto the plates vibrating with the sounds in different frequencies starting from 20Hz and gradually increasing to 80Hz with the help of an amplifier. As the plate vibrates, the salt begins to travel along the surface and salt particles interact with each other until they reach points along the plate that salt particles are not vibrating. We can see these accumulation zones as white lines. When thickness of the plate increases, patterns on the surface blur, so that in the right image in Figure 2, we can see clearer patterns (0.5mm thick plate). Ultimately, every frequency has its own 2d pattern because of its unique vibrational character.

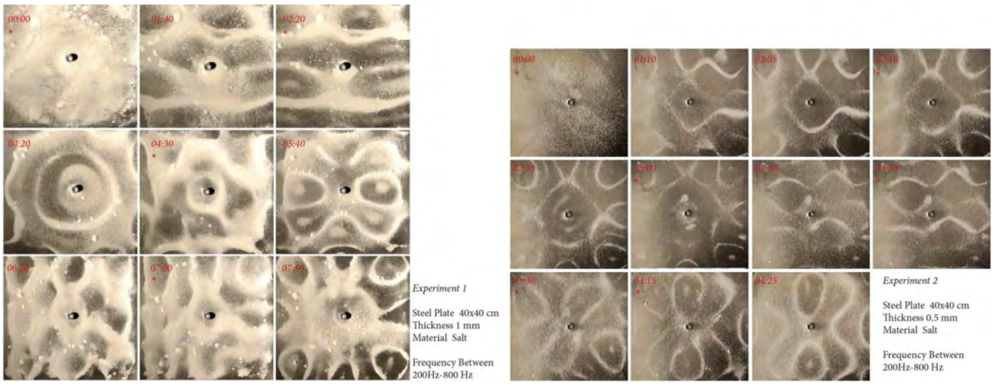

Figure 2: Experiment 1 and 2, Chladni Experiments. 1mm thick plate on the left and 0.5mm thick plate on the right. In both images, each pattern belongs to particular frequency.

In experiment 3 (Figure 3-left image), we used corn-starch and water to experiment on a viscous fluid affected by a sound vibrations. This Non-Newtonian fluid behaves against the gravity and dances with the frequency played on the speaker. By the means of material behavior, viscous nature of the fluid tends to provide its surface continuity but irregularity of fluid molecules help to create 3d forms and patterns. Thus, this material has the capacity to create volumetric forms and patterns. In experiment 4 (Figure 3-right image) we repeated previous experiment with water. Water maintains it surface continuity thus, it does not produce split patterns or 3d forms, instead the sound only can deform its surface. The higher frequency brings out the more complex wave-patterns.

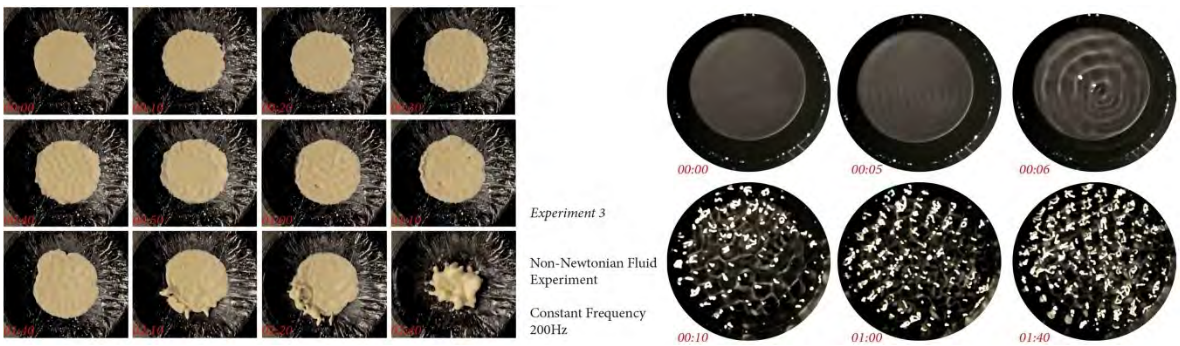

Figure 3: Experiment 3, Non-Newtonian Fluid on the left image. Experiment 4, Water on the right image. Both experiments illustrate different frequency patterns.

These experiments are important in order to understand different material behaviors against sound vibrations and find a process to materialize sound. For fluids, viscosity determines the embodiment of matter. On the other hand, granular materials are more interactive inside because of their particular nature. In the most general sense, sound frequency and amplitude stimulate matters, which cover a plate connected to a sound generator. However, the time and material features are also minor effects in producing the overall shape. Because materials have either viscosity or a granular system, they continue to change through more complex and heterogeneous formations over time until the process is over. From these physical experiments, three fundamental issues can be observed. First one is the behavior of natural force, the second one is material behavior and the third one is material capacity. The digital medium is a place for representing natural world, obviously with the control of a human. Therefore, digital materials are always open to manipulation and sometimes we cannot foresee material behaviors. Thus, in order to build a form-finding system digitally, we have to create simulations and understand same principles in physical experiments in terms of digital matter. Therefore, findings coming from physical experiments become a guide for digital ones.

4. Digital Experiments to Simulate Physical Data

From physical experiments, we know that sound spreads in the environment as a wave. Also, sound source produces rhythmic and periodic forces when it meets a surface. If there are particles upon the surface, they react to the sound force. These findings help us to constitute digital models of physical experiments in Autodesk/Maya. In order to create an influence of sound amplitude or frequency as a dynamic force field in the Autodesk/Maya, the AudioWave node, which can read sound amplitude per second, was used. A dynamic force field is a force that manipulates digital matters such as particles, fluids, or polygons by pushing, pulling, splitting and so forth. Through the HyperShade, which is a relationship editor on Maya, dynamic connections between materials and forces in the scene can be controlled during the time. Unlike physical experiments, both particles and fluids can be simulated through this process at higher level because the unpredictable behaviors of both materials can be kept under control. Hence, the digital process allows further evolution of forms and assemblies. From this understanding, the first digital experiment (Fig 4-left) was built in Autodesk/Maya. There was a sound source in a container producing sound waves according to sound amplitude and particles in this container reacted to this periodic force as well as each other. Therefore, this system produced well-organized and regular patterns. The more interaction between particles and the higher amplitude caused more complex patterns. Second experiment (Fig 4-center) illustrates the surface deform behavior of sound from physical experiments and applies it upon continuous surfaces such as a sphere. Thus, sound active surfaces emerge. Third experiment (Fig 4-right) demonstrates the form generator features of the sound wave and produces volumetric forms within the harmony with sound amplitude.

Figure 4: Digital experiments. Left image: Sound becomes a Pattern Generator when it interacts with particles. Center image: Sound becomes a Surface Deformer with a continuous surface. Right image: Sound becomes a Form Generator with viscous fluids. We can see sound effects on different digital matters.

According to these experiments, we can say that in the digital medium (Maya) sound can generate patterns and become “Patterns Generator”; deform existing shapes and become “Surface Deformer” and finally generate forms and become “Form Generator”. Analyzing and synthesizing both physical and digital experiments help to create our own system which is the sound Motion Streaks Project.

5. Sound Motion Streaks Method

Learning from physical experimentation provides a deep understanding of sound and its nature. On the other hand, digital simulations of physical experiments provide a deep understanding of how digital matters react the sound when it is simulated by a dynamic force field as a wave. From these experiments, we construct knowledge on digital material behaviors and capacities and create our form-finding tool with the integration of different kind of digital materials. There are several ways to create forms by taking information from sound and manipulating time. For instance, the AudioNode can be connected to particle emitters in order to change the quantity of particles released per second or manipulate their directions and scale. On the other hand, this process can be stated in terms of the logic of constructing linear elements produced by particle tracing and apply particle releasing based on curvatures. In order to get more control over the particle systems, each particle converted into polygonal meshes, therefore, this new converted matter creates multiple structural formations. This mesh form is much more characteristic than the other, which is only created by particles. In the Sound Motion Streaks Method, three different digital tools are regulated together: the particle system, the linear curve system and the polygonal mesh system. Together the entire system fulfills its performative capacity with regard to these three systems. Spatial conditions have different levels of density. More articulated and characterized spatial shapes can be produced. Additionally, for the larger scale, architectural systems have the ability of response to multiple functional requirements in the site context. As hinted above, there are several ways to simulate sound driving forms in software applications, and it is a broadly acknowledged fact that software applications can cause coincidence results during the design process. To prevent this, it is necessary to understand the logic of the tools used and parameters that affect digital models. Hence, the following will focus on settings for ‘the sound motion streaks method’ in order to deeply understand the system, its architectural quality and make it a design tool.

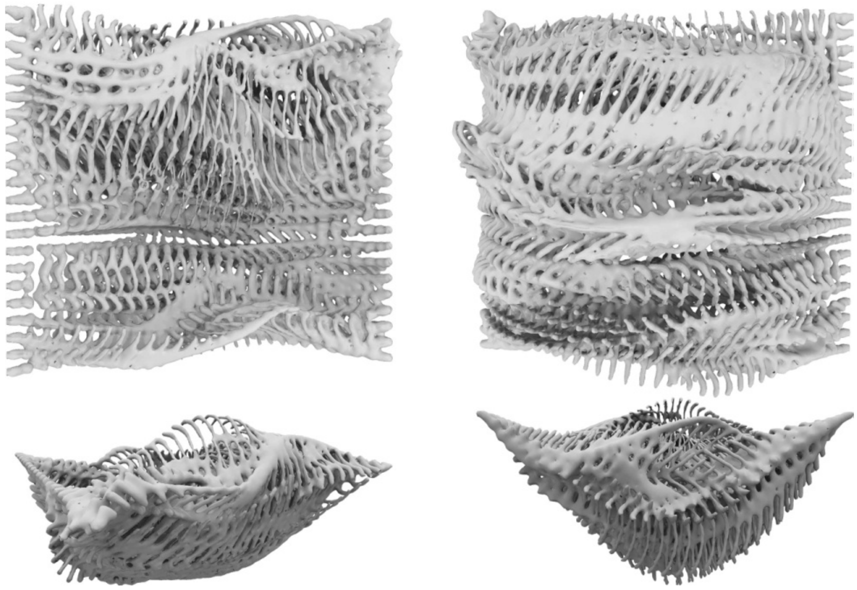

Figure 5: Elevations of the Sound Motion Streaks Project. In this test, a square boundary is created for the system. We can see the whole process of animation along the form.

5.1 Settings for Form Generation Method

As introduced above, the sound motion streaks method is based on three criteria: particles, curves and polygonal mesh. Particles are basically points that represent a collection of dots behaving like granular systems. Force fields such as air and gravity manipulate and organize this system based on the expressions or parameters. Similarly, a curve system lets one create dynamic curves so that natural movements and collisions can be created. Finally, polygons are a geometrical type that can be used to create three-dimensional structures in order to produce surface or architectural skin covering the systems. The whole system behaves like natural forms and like all forms in nature, they assemble themselves and also have the ability to gather their matter and interact with the environment under gravity or different fields. On the other hand, in order to produce these forms, the system must be run in a simulation. Simulations are essential for laying out complex architectural systems, in software applications and examining their behavior over extended periods of time. Also, simulations provide generative design processes [4] and take advantage of motion movement and time. We can control dynamic relations between digital matters, dynamic force fields and time through HyperShade Editor (Figure 6). In order to discuss the potentials of the Sound Motion Streaks Method by the means of space and form we apply this method in an urban area.

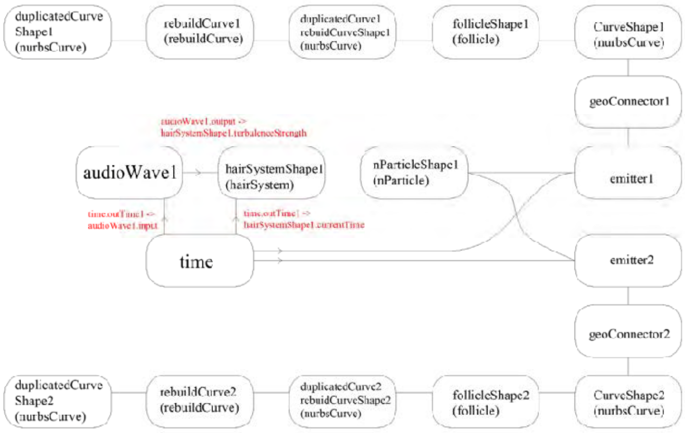

Figure 6: Connections on HyperShade-Dynamic Relationship Editor (Connections for the Sound Motion Streaks Method on Autodesk Maya). We can change relations between digital matters and dynamic force fields through HyperShade.

6. Prototype

Figure 7: An Urban Scale Prototype Area, Limehouse-London.

For an urban scale prototype, an old bridge in Limehouse in London was chosen. The bridge is a kind of extension for Dockland Light Railways(DLR) but now is neglected and separated from DLR from a barrier. The whole area is affected by the rhythmic noise of DLR. In order to make visible the sound-scape of this area-a sound that is unique to an area- and produce sonic awareness, the sounds of this particular site in London were recorded and translated into an architectural proposal. The idea is to "see what the sound looks like in a particular place". The proposal is an urban path/a connector between two different "sound areas", and making use of an abandoned rail bridge which crosses a busy road to a quiet area behind the new railways. To make possible the sound visualization, the sound was captured and recorded on real time. It means that the sounds used in this proposal, present the exact differentiation of the noise/calm areas as they were captured along the path. For the urban prototype we do not fix curves in the space, instead, the sound curves travel following the path, and are influenced in accordance to the area they are passing. This form extends in a linear site, and unfolds as a canopy that varies with the urban sound. The resulting form is dynamic with differentiation of spaces, densities and textures. The linearity is broke were the sound is higher because higher sound creates voids between the layers that could be used to accommodate internal spaces. The spaces are articulated with the continuity of the shape, as a linear and kinetic space, encourages the user to flow along it. The sound as the creator of the space is frozen in time and allows the user to witness and become aware of the acoustic environment. Wall, roof, and floor are all blend together, giving a sense of continuous space and enhanced perceptual experience. Nothing in this form is predictable, everything is opened to be discovered by the self-experience.

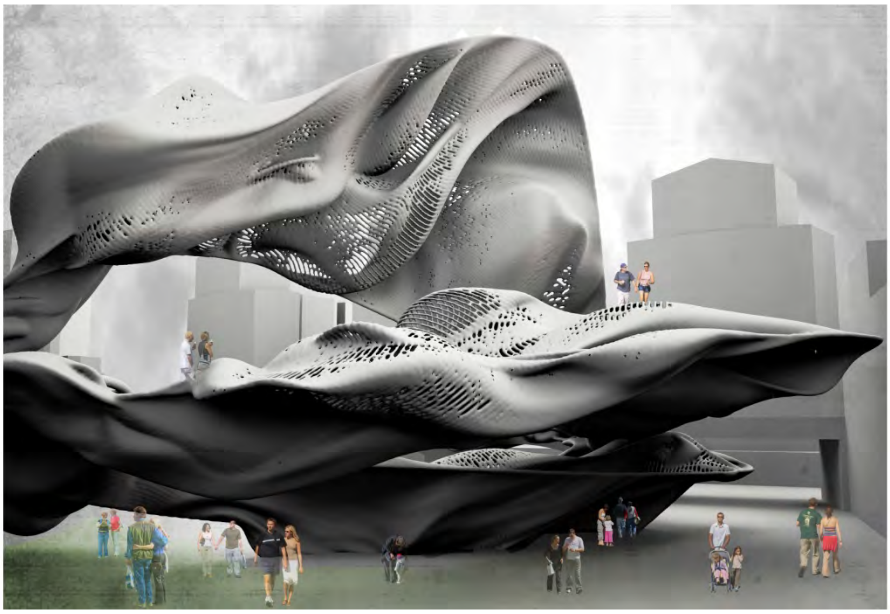

Figure 8: An Urban Scale Prototype. Voids break the linearity of the path and create internal spaces.

Figure 9: An Urban Scale Prototype. Elevations. Different elevations shows the whole path adaptation to the different sound areas. Linear parts are in the calm areas and volumetric parts reflects areas with higher voice.

6.1 Architectural Consequences

It became clear that all kinds of patterns and forms are being manufactured by not only frequency and amplitude but a generative design method which also incorporates time and the site context. All these parameters pose advance settings for digital control systems which evoke three-dimensional and responsive architectural forms [6]. Therefore, this kind of digital production of form is more sufficient and yields a variety of topological geometry. Also, what is worth noting here is the creation of kinetic space in addition to time and to give more architectural features to the form. Before going further, it is necessary to define the term kinetic. Kinetic is a term that can be expressed with the word motion in most cases. The term "motion" is a process of changing position or place over time [9]. According to Terzidis [9] , "while time is involved in motion as a measurement of change, the form itself does not involve time. Thus, the kinetic form represents a motionless boundary and an extension of the notion of architectural form."

Figure 10: This image illustrates 3 different phases of form evolution. Time manipulation gives us a chance to freeze the moment and materialize a specific time.

6.2 The Term "Kinetic" in Art and Architecture

Before architecture, the kinetic had a long history in the art, especially after the 1950s when it was used in the movement of kinetic art [9]. The history of kinetic art begins with the realist manifesto published in Moscow in 1920 by Gabo and Pevsner. They proposed that the traditional elements of plastic and pictorial arts are denied and that in these arts, a new element, the kinetic rhythms, will be claimed as the basic forms of our perception of real time [8]. Marcel Duchamp's sculpture Mobile wheel and his painting Nude Descending the Staircase can be given as examples. These art pieces are not three-dimensional but four-dimensional which is time as an interpretation of the actual movement [8]. In architecture, on the other hand, the representation of motion is usually achieved with an abstract formal arrangement which depends on the relation between "cause and effect". Cause and effect relations can be created by different digital tools and simulations. Digital tools can be animated in simulations which are essential for not only designing kinetic processes but also for designing complex material systems and for analysing their behaviour over extended periods of time. Air, sound, wave and nuclear physics are commonly available simulations [4]. Another simulation that has been mentioned so far is sound. The movement in the sound motion streaks process is provided by AudioNode and its connection with time. Small variations in the AudioNode in each sequence may produce changes in the development of each component at many different scales. Hence, as time goes on, architectural form continues emerging through much more complex and articulated space. Terzidis [9] posited that in this complexity of form, users' eye can catch the virtual movement and the physical stimuli which forms have. Furthermore, from all digital experiments, it can be said that apart from the complexity of kinetic form, all shapes driven by sound have in common rhythmicity, motionless boundaries and changeability over time, no matter their different materials, causes or functional mechanisms. Therefore, in this design process, form is literally a product of matter. It is actually an abstract entity to which process gives certain geometric and kinetic characteristics [9]. Kinetic form evokes generative processes and the concepts of interactivity, modifiability and continuous evolution with the help of time [10]. In terms of time, kinetic forms produced by sound change over time and this motion either freezes the moment or makes complete. In both ways, kinetic form has great architectural value because it consists of agitated surfaces, compressed planes and penetrated spaces in both ways. Even though movement is frozen, the unique characteristic of architectural space remains; that is both dynamic and static [9]. According to Terzidis [9], it is dynamic because the design process provides an elastic essence and manipulation of entities. It becomes static when it has to freeze in order to be built. Therefore, it contains a large collection of forms from which architects find the most suitable in terms of function, architectural space and environmental context.

7. Conclusion

This paper proposed a method to create forms and patterns in a dynamic-kinetic process by using sound as a periodic force. To create this method, first physical, then digital experiments are done to understand the sound phenomena and its influence on materials. After these phases, we construct our method with 3 different tools in Autodesk Maya-curves, particles and polygonal mesh-. Sound affects this hybrid material system and we manipulate time-sound and material properties through HyperShade. The ultimate form emerging in this process depends on time therefore we can track the whole process along the form and this brings kinetic properties to spaces created in the Sound Motion Streaks Project. The value of this kinetic process is its changeability and endless topology. Moreover, in this animated space, users discover sound with their eyes and become aware of the sound-scape of the area. Through this multi- sensory experience, users can not only hear the sound in the environment but also see and touch therefore, the perceptual experiences are enriched and enhance.

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Peter Beyls

Towards Emergent Gestural Interaction

Paper and Live Performance

Topic: (Music, Sound Performance)

Authors:
Peter Beyls
Universidade Católica Portuguesa, Porto
Centre for Research in Science and Technology for the Arts

http://artes.ucp.pt/citar/en

Main References:
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[2] Mudd, T, Dalton, N. Holland, S and P. Mulholland, Dynamical Systems in Interaction Design for Improvisation, *ACM Proceedings*, Vancouver 2014

Abstract:

This paper develops an approach to live performance through the impact of spontaneous live gestures on complex, non-linear sound producing algorithms. DSP algorithms include chaotic systems and sample-based granular synthesis. A performer provides gestures in 2D and 3D space; gestures are interpreted as control trajectories influencing autonomous behavior in a free running algorithm. The system aims blending explicit gestural control with unpredictable but coherent generative behavior. Consequently, performance is seen as dynamic exploratory engagement with many simultaneous musical processes driven by emergent gestural interaction (EGI).

EGI is a live performance system integrating a number of ideas on musical gesture, interaction and spontaneous play into an open, modular software-defined experimental system. Musical performance is viewed as the acquisition, management and interpretation of user-defined gestures in real-time. A number of principles underpin the present work, including the principle of influence (rather than control), implicit generative behavior, online exploration of the system's affordances and open improvisation.

Musical experiences with EGI explore the relationship between embodied gestures and their multimodal impression; dynamic visualization of gestures appraises the listening process and provides hints as to the perception of implied movement and progression. Therefore, the performer and listener both participate in a dynamic exploratory, improvisational climate where musical meaning crystalizes as islands of understanding of connectivity in multimodal perception. We acknowledge the intensity, quality and depth of the aesthetic experience of music to be informed by a process of anticipation. EGI implicitly investigates oscillatory modes of music production through continuous evaluation of causal associations between gesture and sound. EGI is implemented in SuperCollider.

Contact: *pbeyls@porto.ucp.pt*

Keywords: Emergent behavior, Gestural interaction, Complex dynamical systems, Granular synthesis, Live sampling

Towards Emergent Gestural Interaction

Peter Beyls
Centre for Research in Science and Technology for the Arts
Rua Diogo Botelho 1327
4169-005 Porto, Portugal
pbeyls@porto.ucp.pt

ABSTRACT

This paper develops an approach to live performance through the impact of spontaneous live gestures on complex, non-linear sound producing algorithms. DSP algorithms include chaotic systems and sample-based granular synthesis. A performer provides gestures in 2D and 3D space; gestures are interpreted as control trajectories influencing autonomous behavior in a free running algorithm. The system aims blending explicit gestural control with unpredictable but coherent generative behavior. Consequently, performance is seen as dynamic exploratory engagement with many simultaneous musical processes driven by emergent gestural control (EGI).

Author Keywords

Emergent gestural control, complex dynamical systems, granular synthesis

ACM Classification Keywords

H.5.5 [Information Interfaces and Presentation] Sound and Music Computing.

INTRODUCTION

EGI is a live performance system integrating a number of ideas on musical gesture, interaction and spontaneous play into an open, modular software defined experimental system. Musical performance is viewed as the acquisition, management and interpretation of user-defined gestures in real-time. A number of principles underpin the present work:

1. Gestures aim the expression of *influence* on the implied sonic behavior of an abstract audio process. The notion of precise and discrete instrumental control is hereby avoided; the orientation is towards the exploration of the effect of continuous gestures.
2. We develop a systemic (rather than instrumental) orientation towards software. A synthesis algorithm is seen as a black box with a number of normalized control inputs. Most units carry 3 inputs, accepting a scalar value (0.0 to 1.0) conceived of as a single point in 3D space. The algorithm defines a private behavioral scope as a complex dynamical system and is free running.
3. Complexity and relationship motivate our design. A continuous evaluation cycle drives performance; the effect of gestural data on audio complexity is assessed – we evaluate the relationship between the visual representation of a gesture and its impact on audio synthesis. Insight develops within the interaction process itself.
4. Gestures are seen as initial basic structures subject to evolution and change. EGI merges ideas of explicit gestural control and implicit generative behavior in an integrated organism.
5. Many sequentially acquired gestures are accommodated in a memory structure. Sampling from an online database provides structural and behavioral integrity to the system.

6. Parallelism is implicit, many simultaneous abstract gestures are linked to many parallel audio producing software components in a network of arbitrary complexity – all components manage private receiving and transmission channels.
7. Scalability is intended musical functionality. Control may extend on the micro-sample level up to musical gestures lasting several seconds.
8. Musical improvisation is at the core of the present system. We explore the affordances implied in the system through a process of real-time incremental optimization. Performance becomes a self-propagating process of anticipation, exploration and discovery. Performance unfolds the systems potential as a sequence of complex, intimately related emergent musical phenomena.
9. EGI is a playground for sound, it suggests a simple, fixed framework – a two-dimensional space – however, allowing for spontaneous movement within these constrains [1].
10. A sound becomes musically communicative and significant if it changes over time. EGI implements arrays of responsive, slowly fluctuating control sources to this effect.

IMPLEMENTATION

EGI contains two basic software components; (1) graphic user interfaces to capture and visualize real-time gestural user input and (2) a collection of Digital Signal processing (DSP) modules of significant diversity.

Gestures capture

Figure 1 shows the standard graphic user interface to capture two-dimensional gestures drawn using a mouse. A 2D trajectory displays as a sequence of colored dots, color maps to the distance between any two consecutive dots. While the dots represent XY values in 2D space, the intervals (changes in distances) may represent a third Z dimension. Beyond a mouse, 3D acceleration sensors are equally accommodated and easily interfaced.

Gestures express numeric influence in 2 or 3 dimensions on a DSP algorithm; four families are implemented so far: (1) generative sound file playback using granular synthesis, (2) audio synthesis using non-linear complex dynamical systems, (3) multi-channel live audio sampling and playback and (4) processing of live audio using complex, composite algorithms.

Gestures are of a fixed, limited capacity: for example, while dragging the mouse, a new coordinate is added and the oldest datum is removed from the list. The XYZ object holds a task stepping through the list of xy-coordinates at a rate between 20 milliseconds to 5 seconds time intervals. The articulation of the gesture maps immediately to the audio generated. Additional methods towards the synthesis of control signals include: (1) *Fly*; the xy-data point is randomly flying and bouncing off the walls in a 2D control space, (2) *Trn*; circular movement around a center point defined by the user’s last mouse location, (3) *Rnd*; a single xy-location jumping in 2D space and (4) *Pts*; a small collection of points that slowly move in 2D space while the number of points equally evolves over time. These behavioral modes receive parametric tuning from 3 continuous controllers. As seen in the interface of figure 1, three sliders support the specification of the *rate* (relative speed of change), *range* (for example, the radius of the spinning dot in the *Trn* mode) and *delta* parameters.

A second row of buttons (labeled *Muta* to *Rem*) relates to switching on/off an additional set of independent processes; the delta parameter specifies a probabilistic weight for action to be taken or not. *Muta* mutates the current data vector of the gesture typically involving small displacements. The *Shift* process displaces the gesture as a whole, therefore, a fresh interpretation of its data follows while the shape of the gestures remains guaranteed. *Pick* selects a gesture from memory, an earlier gesture then shows up again potentially creating a significant moment of musical expression. *Add* and *Rem* are complementary functions; gestures may either grow or shrink within limits and according to parametric specification from the delta parameter.

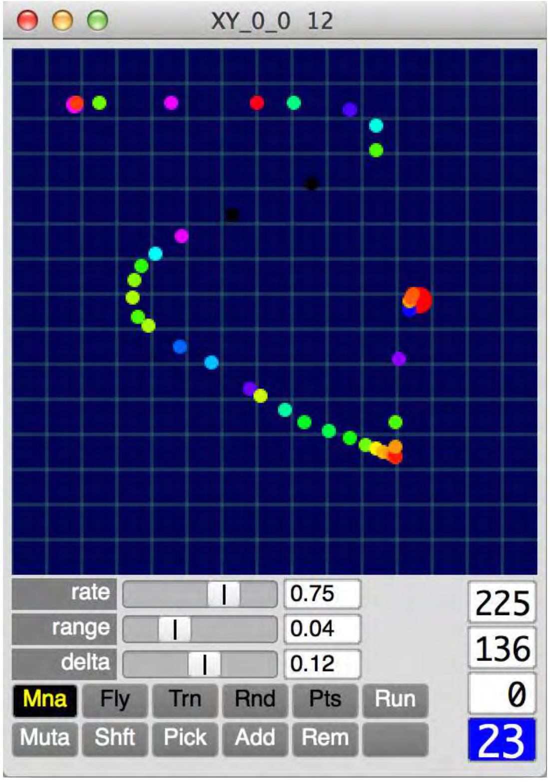

Figure 1. XYZ object.

The blue background number box allows for adjusting the transmission channel of the XYZ control source, the channel is important in the specification of the OSC transmission protocol.

Audio synthesis

Granular synthesis is based on SuperCollider's *GrainBuf* object [10], it accommodates four control signals, (1) a trigger to start a new grain, (2) duration or size of the grain, (3) the playback rate of the sampled sound and (4) the playback position for the grain to start (0 is beginning, 1 is end of file).

The GUI of a four channel live sampling program is seen in figure 2, it supports continuous recording and playback using 5 specific handcrafted generative functions, all of then accepting control information on 3 channels, labeled x, y and z. The latter values map internally as to take effect according to the DSP logic embedded in the five playback functions. XYZ values can be tweaked either using the faders (blue labels) or accept external control signals. In addition, a task (the fader *xyzTask* sets its tempo) may step-wise modify the values independently as to create a smoothly shifting set of control parameters. Other faders specify recording duration (0.5 to 10 seconds), recording- and pre-recording levels (their values relate to how much audio is recorded in a buffer on top of existing audio content). Most DSP playback functions contain combinations of low frequency noise generators (their impact equally conditioned by the XYZ parameters) to articulate dynamic audio playback.

Figure 2: *Loops*, live sampling object

Buttons on the left side in figure 2 are instrumental in switching between recording and playback. The *selTask* slider specifies the tempo of an automation task randomly or sequentially selecting combinations of playback algorithms. Note that one may also load sound files from disk, the musical performance potential of field recordings may then be explored. The semantics and identity of a predefined family of acoustic samples may then blend with the spontaneous nature of live audio sampling.

Complex dynamical systems

Our global design approach views abstract gesture as a trajectory through an n-dimensional control space, while a gesture discloses a particular path through the behavioral scope of a given DSP algorithm. However, the path remains unknown until the moment it is first exposed as audio. User gestures become devices to explore the anticipated complexity of an algorithm since gestural activity is driven by discovery and surprise. This improvisational approach integrates notions of intimate physical embodiment with gesture, non-linearity in the process of discovery and exploration and acknowledges the chaotic interplay and friction of the relationship between gestural complexity and issuing audio complexity [3].

Various complex dynamical systems were implemented in software, for example to model macroscopic language and music development [2], to generate music on the MIDI event level [4] and on the audio sample level [12]. Di Scipio introduced the acoustic properties of a given physical space in the feedback loop towards the creation of sonic ecosystems [5].

Complex systems develop a range of complex behavior; from point attractors, to quasi-periodic to chaotic behavior to strange attractors. Most probably, such systems suggest particular musical potential because they incorporate an uncommon and singular control perspective; a relatively continuous control spectrum that is nonetheless modulated by sharp discontinuities – in addition, the history of the user's input is accumulated in the control structure.

Networks

EGI is implemented as a flexible set of audio processing modules of variable connectivity, modules mutually communicate through the Open Sound Control communication protocol [9]. The number and nature of modules may change during performance, renewing musical functionality on the fly – conceptually, quite similar to musical live coding [13]. Control modules transmit on a specific, private transmission channel, 100 bi-directional channels are allocated in the current implementation. In turn, audio synthesis modules listen only to information arriving at their private reception channel. Future implementations will include sample-level audio applied as control signal in addition to control-rate gestural control data.

DISCUSSION

A particular fascination for dynamical interaction with DSP algorithms is implied in our work. Sample-based instruments typically produce predictable results from triggering a sound file. However, through the continuous parametric articulation of a sound file (rather than instrumental triggering), intimate dynamic performativity and engagement develops between a given gesture and its musical impact. Then, performance oscillates between suggesting gestural patterns in 2D or 3D space, and judging their impact, for instance, on a granular synthesis algorithm.

In the long run, we may observe a gradual change in performance as the inclination evolves from exploration to exploitation, i.e. from spontaneous evaluation of the unpredictable to the deliberate configuration/selection of particular control gestures. Interestingly, qualitative feedback is operational inside the DSP algorithm and, on a much larges scale, in the iterative performance cycle. Incidentally, then, the question arises of how a concert audience might possibly engage in the experience of non-linear musical instruments. What is the relationship between what is seen and what is heard? From performances with the system documented here, the general conclusion is that a motivated non-expert listener wishes to engage visually as well as musically; the listener aims to decipher activity in the graphic user interface, actively trying to create a mental image of the mapping process.

Musical experiences with EGI explore the relationship between embodied gestures and their multimodal impression; dynamic visualization of gestures appraises the listening process and provides hints as to the perception of implied movement and progression. Therefore, the performer and listener both participate in a dynamic exploratory, improvisational climate where musical meaning crystalizes as islands of understanding of connectivity in multimodal perception. We acknowledge the intensity, quality and depth of the aesthetic experience of music to be informed by a process of anticipation [6]. EGI implicitly investigates oscillatory modes of music production through continuous evaluation of causal associations between gesture and sound.

CONCLUSION

We discussed EGI, a modular generative system that blends explicit gestural control and autonomous behavior, a systemic rather than an instrumental approach to spontaneous live performance. Gestures are trajectories activating degrees of freedom in musical algorithms conceived of as complex dynamical systems. Since the sound production process and the control mechanism are unrelated and independent [11] design of mappings between gesture and sound is core in most work in musical interaction with electronic instruments [7]. Composition extends into the creation of sensible relationships between instrumental musical intention and sounding result. However, we suggest the notion of *instrument* to blur toward *process* – a mode of human-machine engagement where musical ideas develop in common effort and through shared initiative. The current implementation of EGI deliberately supports simple mapping schemes though interfacing with distributed, self-organizing control algorithms is straightforward to implement [8]. A particular rewarding musical experience results from the dynamic confrontation of exploration and discovery – that is, from the relationship between a tentative gesture and the complexity of its entailing impact. That relationship is partly unpredictable, so its uncovering into conscious causal understanding underpins a rewarding musical experience.

EGI thus develops a distinct behavioral approach to human machine interaction. It differs from responsive instrumental music control systems since the relationship between gesture and sound remains afloat: from evident causal correlation to uncertain opaque connections.

A global performance challenge remains to further develop hybrid architectures supporting a *control continuum*: (1) from precise and nuanced instrumental action to, (2) blending physical instrumental gesture and generative interpretation and, finally (3) performance with independently coexistent systems interaction using the principle of mutual influence. Ideally, such a structure of scalable complexity and engagement – and its implied potential for performative shifting of focus, intention, process and detail – could also mediate new modes of cultural sensibility and exiting new forms of general musical perception and understanding.

ACKNOWLEDGEMENTS

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Pinar Calisir

Gulen Cagdas

A Computational Model For Urban Design: An Amasya Case

Topic: Architecture

Authors:
Pinar Calisir
Istanbul Technical University,
Institute of Science and Technology,
Architectural Design Computing Graduate Program, Turkey

Prof. Dr. Gulen Cagdas
Istanbul Technical University,
Architectural Faculty,
Turkey

Abstract:

This paper presents a hybrid method for an urban design in an existing city. A city is a complex system which has many forms and structures affecting each other spontaneously. Even if, we shape cities certain areas with laws and planning decisions, through time, it reorganizes its parts and formation with bottom-up forces. Therefore, an urban system which creates the city may seem complicated and hard to understand. In this complex structure, while designing new spaces, designers must understand the inner nature of the city in order to design coherent structures with city's existing culture, social-economic structure as well as its architectural tissue. In this context, this paper proposes Cellular Automata (CA) as a generative urban design tool to create an urban model depending on environmental and urban data in the scope of sustainable design in an existing city.

In the phase of collecting information from the city, Data Mining techniques will be used in the context of Information Technologies in order to investigate and define urban patterns and their relations to each other. Then, we can produce a specific CA rule system for a sample city based on Data Mining results. Cellular Automata may provide a simple rule system that helps us to understand the complex city formation in terms of social, economic and physical way. The data generating the rule system for CA can be produced by Data Mining methods. By doing this, we can not only produce our own rule system for CA but also we can extend the boundaries of CA basic rules according to different urban relations.

In the first phase of the study, the sample city, Amasya, and the selected part of it, Hatuniye Neighbourhood will be identified. After explaining the methodology of the study, the Data Mining concept will be explained in the scope of Knowledge Discovery in Databases. Then, the case study will be presented. In the case study, digital maps are provided by Amasya Municipality and cleaned in AutoCAD in order to get rid of unrelated urban layers. Then, the clean drawing file is exported to ArcMap. Furthermore, Building Info Form is prepared to complete missing information on digital maps. The Data in Info Forms are translated to Arcmap Attribute Table for buildings and prepared for Data Mining software which is RapidMiner- an open source platform. In RapidMiner, different clustering tools and Correlation Matrix are used in order to reveal hidden patterns and relationships in Hatuniye Neighbourhood. The results coming from RapidMiner are interpreted in order to produce a specific CA rule system for this neighbourhood.

In the final section, we produce a model in the neighbourhood to discuss the potentials of this hybrid method in terms of investigating urban patterns and defining their relations to each other for urban design studies embracing locality.

Contact:
pinarcalisir@amasya.edu.tr
glcagdas@gmail.com

Keywords: Urban Design, Cellular Automata, Data Mining.

A COMPUTATIONAL MODEL FOR URBAN DESIGN: AN AMASYA CASE

Pınar Çalışır, Arch, MSc.

Istanbul Technical University,

Institute of Science and Technology,

Architectural Design Computing Graduate Program, İstanbul, Turkey

e-mail: pinarcalisir@amasya.edu.tr

Prof.Dr. Gülen Çağdaş, PhD

İstanbul Technical University, Faculty of Architecture

İstanbul, Turkey

e-mail: cagdas@itu.edu.tr

1. Introduction

In the last decade, there has been an increasing demand on tourism and construction activities in historic cities in Turkey. Thus, there is a high pressure and treat on the historic parts of cities. In this study, we propose a design method in historic towns with Cellular Automata (CA) by understanding urban dynamics and characteristics with digital tools. Urban system which creates the city may seem complicated and hard to understand. Especially in historic towns it is very important to sustain the tissue of the city. To achieve that, we should understand the system of the city and its independent parts deeply. In 1965, Christopher Alexander published an article named "A city is not a tree" in which he made a distinction between artificial and natural cities. According to Alexander [1], a city is a semi-lattice system. While we plan a new city which is artificial we only copy the appearance of the old one (natural city) and forget the essence which gives life to the old city. To overcome this, designers need to understand the structure of the city and its parts. The city consists of interdependent parts which all work together unconsciously as a whole. In natural cities, parts of the whole usually overlap and fuse with each other and create a complex living system [1]. Therefore, decomposing and realizing these parts are very important to reveal the inner nature of this complex system which gives a characteristic to the city.

– 2. Methodology

For a sustainable design in an urban environment, designers must have strong ideas about architectural, social and economic dynamics of the city in addition to history and local values.

Therefore, design area and its surroundings need to be analyzed with both qualitative and quantitative research methods. The results coming from various analyses may help designers to reveal systems of cities. After, they can clearly see repetitive patterns, random behaviors and different factors affecting each other in the city's structure. Thus, we have to collect as much as information from cities. Then, we need to find appropriate methods and techniques which can resolve the complex structure of urban systems. In this study, in order to compile and collect different sources of information from cities GIS software will be used and in an analysis phase of this information, we will benefit from various Data Mining techniques. For Data Mining studies, Rapid Miner –open-source software- was used. Collecting data for Data Mining was carried out in ArcMap/ESRI and cleaning digital data was done in AutoCAD/Autodesk. After analyzing phase of urban information, we created our local CA rules in Autocad/Maya/Mel according to Data Mining results (Figure 1).

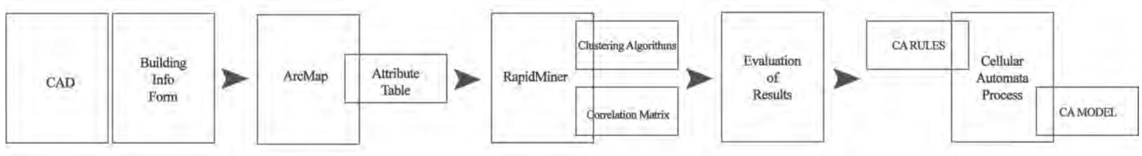


Figure 1: Stages of the Study

– **2.1 Geographic Information Systems**

Geographic Information System (GIS) provides visual and non-visual information of spatial locations. GIS tools can collect, store, process and visualize geo-spatial data. Different disciplines take advantage of GIS, such as urban planners, architects, historians, sociologists, economists, cartographers, local governments and so on. In this study, the main point of using GIS software is to collect, store and visualize geo-spatial data. Through a database made by the GIS software, collected information become unique to the neighborhood. There are many open-source and commercial GIS software. Even if they don't have an opportunity for dynamic modeling, they can assist designers to supply, preprocess and transform urban data. In this study, we can create a database through the GIS software and preprocess and visualize this data for Data Mining techniques. Also, GIS software can reveal the formation process of the neighborhood according to a timeline.

2.2 Data Mining

Data Mining is an important part of the process called Knowledge Discovery in Databases (KDD). KDD process "makes sense of the data [4]" stored in digital Databases. Every day, heavy load of information is uploaded into Databases and this raw data cannot be analyzed with manual methods. KDD gives us computational techniques and tools to evaluate, interpret this data and construct meaningful hypotheses according to our interest. This process of transformation from raw data to knowledge helps us to analyze the current situations, make predictions and decisions for the future. Data Mining is the main part of this process which is "the application of specific algorithms for extracting patterns from data [4]". Data Mining contains different mathematical techniques for producing patterns from transformed data in databases for further interpretation and evaluation. If we consider the city as a large database collecting raw data, we can use Data Mining techniques in order to produce knowledge by collecting, selecting and evaluating data in order to produce useful patterns and structures focusing on our design problems in cities. Our aim of this study is to use Data Mining methods in a similar manner. For this purpose, in Amasya, we chose historic Hatuniye Neighborhood and started creating a Database for this neighborhood with GIS software. After having a large collection of information about this neighborhood, we can use Data Mining techniques in order to see a complex structure of this part of the city. We can detect interesting or dominant patterns, relationships between city elements and evaluate these results to find the essence of the Hatuniye Neighborhood which gives form to it.

2.3 Cellular Automata

The generative design model proposed in this paper, is based on Cellular Automata (CA) developed by John von Neumann [9] in 1940s. CA is a mathematical approach where simple forms follow neighborhood relations as rules in order to be arranged and produce complex systems. CA can produce highly complex behaviors from simple rule sets [7]. Therefore, it has been used in different disciplines where complex phenomena are studied, such as physics, geography, urban studies and so on [5]. Batty [2] states that rule based procedures like CA can reveal how complex systems work and which conditions they are dependent. Similarly, according to Wolfram [10], people usually assume that the underlying system of complex structures should be as complex as the structure itself. But as we seen in CA, very simple rules can effect simple forms inside a primitive grid and produce highly intricate structures. In a basic CA world, there are 5 major components: transition rule, time, lattice (or grid), neighborhood and cell state [6]. The most important component is the transition rule, because it determines cells that stay alive or die in the next generation and designates the general form of the cells. Thus, in order to produce a sustainable and regional design method for Hatuniye Neighborhood, construction of transition rules are very crucial. In this study, CA will be used to generate an urban design model based on environmental and urban data coming from GIS database and Data Mining techniques. The database will be composed in GIS software and consists of various data from the Neighborhood. Data Mining techniques will help us to understand raw data by turning them into useful knowledge about the underlying structure of this urban unit. After analyzing and interpreting the raw data we can produce our own-local CA rules and construct a method to produce new areas in Hatuniye Neighborhood.

3. Case Study

Figure 2-3: Location of Amasya and view from Hatuniye Neighborhood [8].

Amasya is a historic city in the Black Sea Region, Turkey (Figure 2). It is located in a valley created by Yeşilırmak (Iris) River and between the Kırklar and Sakarat Mountain. A Case study is carried out in Hatuniye Neighborhood which is situated along the river and leans its back to the Kırklar Mountain. At the peak of the mountain, Harşena Castle, above it 5 Pontic tombs and the urban structure of the neighborhood with the river create "a poetic urban experience [3] " (Figure 3,4). The neighborhood has 4 bridges and two of them draw the periphery of the neighborhood. We chose this neighborhood for a case study, because it has clear geographic borders and has a unique urban form despite changing social, economic and cultural dynamics. The neighborhood consists of 14 street blocks, 204 parcels, and 206 buildings in total. Most of the waterfront houses in the Neighborhod are from the Ottomans in the 19th century. There are also few houses and monuments built in the 18th and the 17th century.

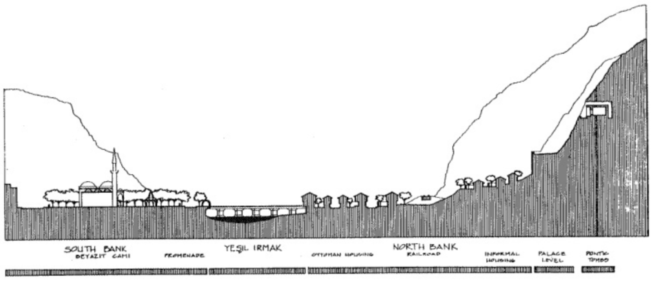


Figure 4: Diagrammatic Section of Amasya, Hatuniye Neighborhood contains the Ottoman Housing [3].

Until recently, most of the houses were neglected in the neighborhood, but still you could have an idea about how the Ottoman town looks like in terms of urban character, scale and environment [3]. Today, some of the buildings contain the remains of older ones and in the urban layout, the roads of the old town is still protected [3]. Amasya exists in a very narrow valley, therefore, the city forms as a linear structure parallel to the river. Unlike the modern urban areas in the city, old settlements were built in sloping areas in order to give space for agricultural activities and to have a protection from floods. Nowadays, the city is evolving through flat agricultural areas [11]. Also, all historic neighborhoods of the city are under the pressure of the high demand of tourism and construction activities. Thus, there is an urgent need for a design method to produce new spaces in historic parts of the city in order to protect the city's self-evolved structure through time respecting local climate, topography and culture.

Figure 5: Google Earth image of Hatuniye Neighborhood.

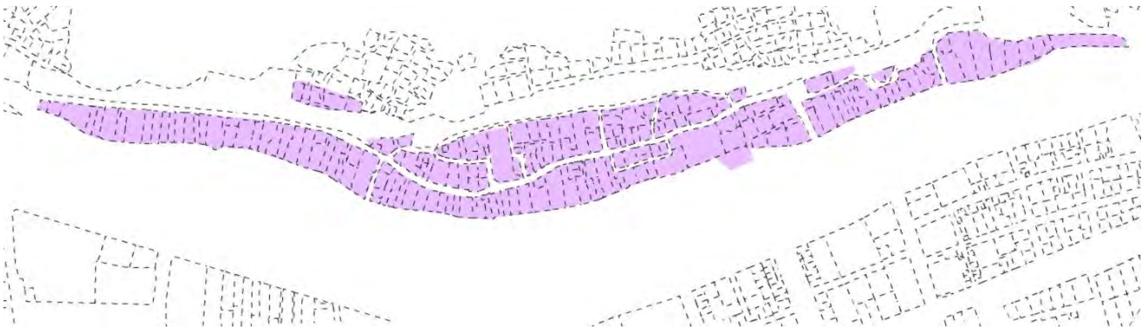


Figure 6: ArcMap Visualization of Hatuniye Neighborhood. Pink areas represent street blocks, Dashed lines represent parcels

Figure 7: ArcMap Visualization of Hatuniye Neighborhood. Pink areas represent street blocks, Blue represents buildings

Figure 8: ArcMap Visualization of Hatuniye Neighborhood. Pink areas represent street blocks, Blue represents buildings and marked areas are courtyards

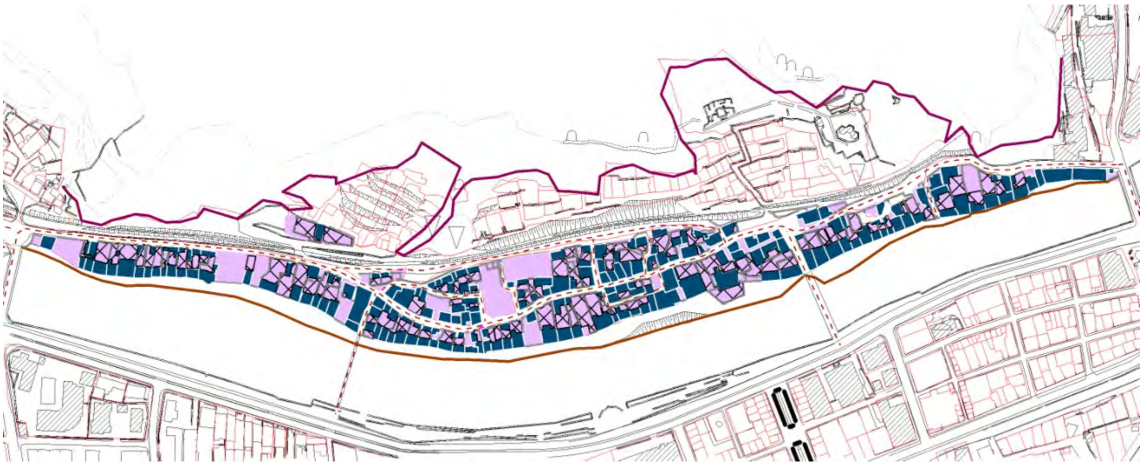


Figure 9: ArcMap Visualization of Hatuniye Neighborhood contains all urban entities.

3.1 Application of Data Mining Techniques

Digital data is provided by Amasya Municipality and cleaned in AutoCAD. This available data was poor, so that for every building in the area, a Building Info Form is filled. In total, 21 attributes were determined as a start. Also, numeric values for blocks, parcels and buildings were automatically calculated in GIS. In Table 1, we can see all attributes in the data set and their numeric and nominal values. Also, in Figure 10, we find a schematic explanation of some attributes.

Table 1: Attribute Table shows attribute types and values

	Name	Type	Value
1 (id)	*Block_ID (Ada_Kimlik)*	Polynominal	A,A1,B,C,D1,D2,E,E1,F,G,J,H
2 (id)	*Building_ID (Bina_Kimlik)*	Polynominal	Building Numbers
	Attribute_Name	Value_Type	Attribute_Value
1	Ground Floor Area (Taban_Alani)	Numeric	
2	*Conservation (Koruma_Durumu)*	Binominal	Registered, NotRegistered
3	*Building Function (BinaFonk)*	Polynominal	Residential, Accomodation,Empty, Governmental,Leisure, Mixed-used, Social, Education,Monumental
4	*Ground Floor Function (ZeminKatFonk)*	Polynominal	Residential, Accomodation,Empty, Governmental,Leisure, Mixed-used, Social, Education,Monumental
5	*First Floor Function (1KatFonk)*	Polynominal	Residential, Accomodation,Empty, Governmental,Leisure, Mixed-used, Social, Education,Monumental
6	*Basement (Bodrum)*	Binominal	Exists, NoBasement
7	*Floor (KatSayisi)*	Numeric	1,2,3,4,5
8	*Building-Street Relation (Yapi_Sokak_iliski)*	Polynominal	Building_Entrance, Courtyard_Entrance, AdditionalBuilding_Entrance
9	*Building-Parcel Relation (Yapi_Parsel_Durumu)*	Polynominal	DetachedHouse, CornerBuilding , AttachedHouse
10	*Courtyard (Avlu)*	Binominal	Exists, NoCourtyard
11	*Courtyard Location (Avlu_Konum)*	Polynominal	FrontCourtyard, SideCourtyard, BackCourtyard, MiddleCourtyard, Front/BackCourtyard
12	*Orientation (Yapi_GirisKapisinaGore_Oryantasyon*	Polynominal	N_S, E_W, NW_SE, NE_SW
13	*View Area (Bina_Bakis_Yonu)*	Polynominal	River, Mountain, Street
14	*AdditionalBuilding (EkYapi)*	Numeric	0,1,2
15	*Building_Width (Bina_en)*	Numeric	
16	*Building_Height (Bina_boy)*	Numeric	
17	*Courtyard_Area (Avlu_Alan)*	Numeric	
18	*Building_Form (Bicim)*	Binominal	L-Shape , Rectangular
19	*Distance_to_Center (Meydan_Mesafe)*	Numeric	0-100, 100-200, 200-300, 300-400, 400-500, 500,600
20	*Material_(Malzeme)*	Polynominal	Wood/Brick, Concrete, StoneMasonry
21	*Construction (Yapım_Teknigi)*	Polynominal	WoodFrame, Concrete, StoneMasonry

Information coming from the Building Info Form and cleaned digital data from AutoCAD is transformed into GIS software (ArcMap) to produce a map for all urban attributes. In this map, all quantitative and qualitative data can be joined together and represented both cartographically and in a database form. After creating this data set, we can export it for Data Mining studies to Rapid Miner (an open-source data mining software). In the mining stage of this raw information, the main aim is to identify clusters and groups, find out the dependency of urban attributes to each other and look for significant patterns in the urban tissue. The process of gathering information and creating a database is still running so that some initial studies are made at this stage to test the Data Mining methodology of the study.

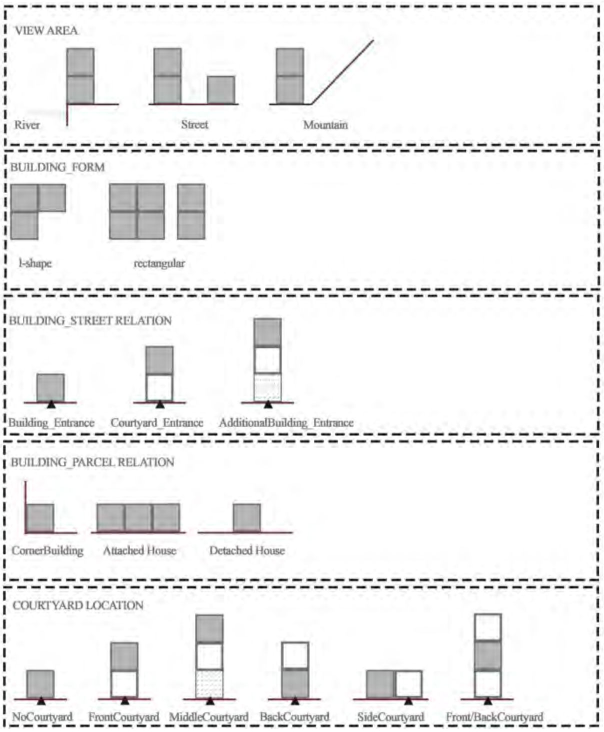
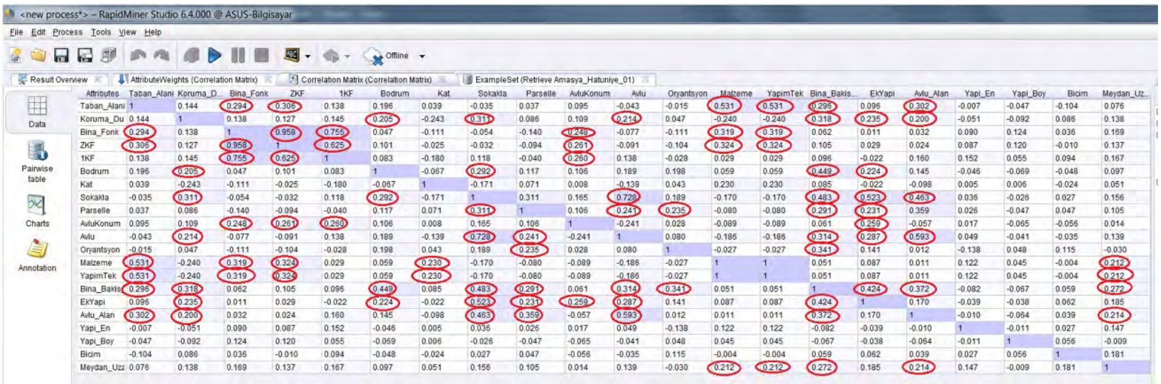


Figure 10: Diagrammatic representations of urban attributes and their values

3.2 Data Mining Results

The data table from ArcMap is imported in a data mining application software-Rapid Miner as an Excel sheet. Before doing anything, the software analyzes numeric values such as parcel and building areas in terms of maximum, minimum and average values. According to this analysis, while the smallest street block is 66,468 m², the biggest one is 9144 m². The difference between these blocks can be clearly seen from the map (Fig.6). For the size of parcels, while the smallest one is 19,591 m², the biggest one is 946,342 m². The average value of parcels is 153,646 m². Monumental buildings also added into the calculation, therefore, their influence on the average should be considered during design experiments. Similarly, the smallest building size is 21,196 m² while the biggest one is 336,655m² with average 86,634 m². In this way, Rapid Miner can give us statistical results about maximum, minimum and average values for the building envelopes and open spaces for further design studies. Next, 170 main buildings were classified with K-means clustering algorithm according to the building area. K-means clustering was chosen because of the small size of the numeric data. 5 groups of buildings emerged due to building size: [1] 21-58 m² [2] 59-94 m² [3] 96-130 m² [4] 150-203 m² [5] 253-336 m². The first group of buildings mainly contains additional structures and the fifth group contains monumental ones such as mosques and baths. In the data table, there are mainly nominal values for attributes. In order to find out their dependency to each other, Correlation Matrix was used. In Correlation Matrix, dependency is computed between -1 and 1. If an attribute has a negative effect on the other, the result appears as -1. 0 means no relationship at all between clusters and 1 means an attribute meets itself in the matrix. The table below represents results generated through Correlation Matrix (Table 2).

Table 2: Correlation Matrix shows dependent and independent urban attributes



Attributes	Taban_Alani	Koruma_D...	Bina_Fonk	ZKF	1KF	Bodrum	Kat	Sokakla	Parselle	AvluKonum	Avlu
Taban_Alani	1	0.144	0.294	0.306	0.138	0.196	0.039	-0.035	0.037	0.095	-0.043
Koruma_Du	0.144	1	0.138	0.127	0.145	0.205	-0.243	0.311	0.086	0.109	0.214
Bina_Fonk	0.294	0.138	1	0.958	0.755	0.047	-0.111	-0.054	-0.140	0.248	-0.077
ZKF	0.306	0.127	0.958	1	0.625	0.101	-0.025	-0.032	-0.094	0.261	-0.091
1KF	0.138	0.145	0.755	0.625	1	0.083	-0.180	0.118	-0.040	0.260	0.138
Bodrum	0.196	0.205	0.047	0.101	0.083	1	-0.067	0.292	0.117	0.106	0.189
Kat	0.039	-0.243	-0.111	-0.025	-0.180	-0.067	1	-0.171	0.071	0.008	-0.139
Sokakla	-0.035	0.311	-0.054	-0.032	0.118	0.292	-0.171	1	0.311	0.165	0.728
Parselle	0.037	0.086	-0.140	-0.094	-0.040	0.117	0.071	0.311	1	0.106	0.241
AvluKonum	0.095	0.109	0.248	0.261	0.260	0.106	0.008	0.165	0.106	1	-0.241
Avlu	-0.043	0.214	-0.077	-0.091	0.138	0.189	-0.139	0.728	0.241	-0.241	1
Oryantsyon	-0.015	0.047	-0.111	-0.104	-0.028	0.198	0.043	0.189	0.235	0.028	0.080
Malzeme	0.531	-0.240	0.319	0.324	0.029	0.059	0.230	-0.170	-0.080	-0.089	-0.186
YapimTek	0.531	-0.240	0.319	0.324	0.029	0.059	0.230	-0.170	-0.080	-0.089	-0.186
Bina_Bakis	0.296	0.318	0.062	0.105	0.096	0.449	0.085	0.483	0.291	0.061	0.314
EkYapi	0.096	0.235	0.011	0.029	-0.022	0.224	-0.022	0.523	0.231	0.259	0.287
Avlu_Alan	0.302	0.200	0.032	0.024	0.160	0.145	-0.098	0.463	0.359	-0.057	0.593
Yapi_En	-0.007	-0.051	0.090	0.087	0.152	-0.046	0.005	0.036	0.026	0.017	0.049
Yapi_Boy	-0.047	-0.092	0.124	0.120	0.055	-0.069	0.006	-0.026	-0.047	-0.065	-0.041
Bicim	-0.104	0.086	0.036	-0.010	0.094	-0.048	-0.024	0.027	0.047	-0.056	-0.035
Meydan_Uz	0.076	0.138	0.169	0.137	0.167	0.097	0.051	0.156	0.105	0.014	0.139

Attributes	Oryantsyon	Malzeme	YapimTek	Bina_Bakis...	EkYapi	Avlu_Alan	Yapi_En	Yapi_Boy	Bicim	Meydan_Uz...
Taban_Alani	-0.015	0.531	0.531	0.296	0.096	0.302	-0.007	-0.047	-0.104	0.076
Koruma_Du	0.047	-0.240	-0.240	0.318	0.235	0.200	-0.051	-0.092	0.086	0.138
Bina_Fonk	-0.111	0.319	0.319	0.062	0.011	0.032	0.090	0.124	0.036	0.169
ZKF	-0.104	0.324	0.324	0.105	0.029	0.024	0.087	0.120	-0.010	0.137
1KF	-0.028	0.029	0.029	0.096	-0.022	0.160	0.152	0.055	0.094	0.167
Bodrum	0.198	0.059	0.059	0.449	0.224	0.145	-0.046	-0.069	-0.048	0.097
Kat	0.043	0.230	0.230	0.085	-0.022	-0.098	0.005	0.006	-0.024	0.051
Sokakla	0.189	-0.170	-0.170	0.483	0.523	0.463	0.036	-0.026	0.027	0.156
Parselle	0.235	-0.080	-0.080	0.291	0.231	0.359	0.026	-0.047	0.047	0.105
AvluKonum	0.028	-0.089	-0.089	0.061	0.259	-0.057	0.017	-0.065	-0.056	0.014
Avlu	0.080	-0.186	-0.186	0.314	0.287	0.593	0.049	-0.041	-0.035	0.139
Oryantsyon	1	-0.027	-0.027	0.341	0.141	0.012	-0.138	0.048	0.115	-0.030
Malzeme	-0.027	1	1	0.051	0.087	0.011	0.122	0.045	-0.004	0.212
YapimTek	-0.027	1	1	0.051	0.087	0.011	0.122	0.045	-0.004	0.212
Bina_Bakis	0.341	0.051	0.051	1	0.424	0.372	-0.082	-0.067	0.059	0.272
EkYapi	0.141	0.087	0.087	0.424	1	0.170	-0.039	-0.038	0.062	0.185
Avlu_Alan	0.012	0.011	0.011	0.372	0.170	1	-0.010	-0.064	0.039	0.214
Yapi_En	-0.138	0.122	0.122	-0.082	-0.039	-0.010	1	-0.011	0.027	0.147
Yapi_Boy	0.048	0.045	0.045	-0.067	-0.038	-0.064	-0.011	1	0.056	-0.009
Bicim	0.115	-0.004	-0.004	0.059	0.062	0.039	0.027	0.056	1	0.181
Meydan_Uz	-0.030	0.212	0.212	0.272	0.185	0.214	0.147	-0.009	0.181	1

Due to interesting dependency results, some questions were asked to find out patterns in the urban tissue. Therefore, DBSCAN algorithm was used for classification on nominal attributes dependent to each other.

- Does having a courtyard/or not determine the relationship between the building and the street?

In correlation matrix, this dependency measured as 0.728. After clustering analysis, the biggest cluster consists of 88 entities which have a courtyard and one main entrance to it. The second biggest one was with 52 buildings with no courtyard and have a direct entrance to the building hole from the street. Thus, if a building has a courtyard, second entrance usually doesn't exist. And most of the buildings have a direct relationship with the public street.

-Is there a relationship between view area and building-street Relation?

DBSCAN algorithm was applied because the correlation matrix result was 0.483. DBSCAN gives us 7 clusters. The most crowded one was with 52 buildings looking through River and have a courtyard between the building entrance and the street. Other 6 clusters were not well decomposed, but still we identified riverside buildings with a courtyard and without an additional entrance.

- Can Building Function and Courtyard Location be related (Figure 11)?

In Correlation Matrix, dependency between building function and courtyard location measured as 0.265. Although this number means there is a weak dependency, we still applied DBSCAN algorithm due to find out the obvious pattern seen from the visual map which consists of houses with a front courtyard. Indeed, clustering algorithm shows us there are 73 urban entities which represent houses with a front courtyard. Another 2 clusters contain 16 entities which are neglected houses with front courtyard and 16 entities are empty buildings with a front courtyard. The algorithm produces another 9 clusters, but they are not decomposed very well. From these numbers, we can say that in the neighborhood majority of the buildings are originally houses with a front courtyard.

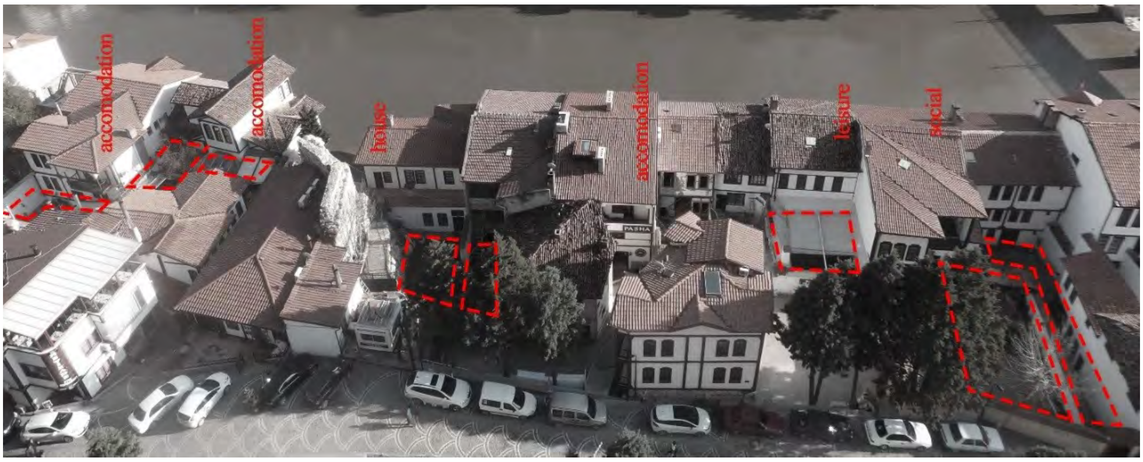


Figure 11: View from Hatuniye Neighborhood. Courtyards and Buildings with different functions

- Does having an additional building/or not determine the relationship between the building and the street?

The result was 0.523. After DBSCAN algorithm for these two attributes, we found 2 major clusters with 68 entities. One was without an additional building and one entrance to the courtyard from the street, and the other one was without an additional building and one direct entrance to the building hole from the street. So, there is no obvious pattern of having an additional structure. Even houses have a big courtyard; they usually don’t have an addition. According to Building Info Form, additional buildings are usually used for toilet, store and kitchen. This means that they probably built in recent times in the courtyards for extra functions.

-Can we tell whether or not a building has a basement according to its view (Figure 12)?

The result was 0.449. Therefore, having a basement and view area seem related to each other. DBSCAN algorithm for only these two attributes shows that there are 51 entities which have not a basement and look through the Street. Another cluster contains 29 entities with no basement and in the Mountain area. Other 44 entities look through River and have a basement. Another 3 clusters have small numbers of members which are not well decomposed. According to these results, it is clear that if a building has a view through the river, it has a basement, otherwise, with a high probability it does not.

Figure 12: View from Hatuniye Neighborhood. Basements and the Pontic Wall which creates a base for riverside buildings

-Does view area determine the situation of the building on the parcel?

The result was 0.291. So we can say that there is very weak dependency between these attributes and no need for DBSCAN. But, there is a strong visual pattern seen in the map so that we applied DBSCAN algorithm and find an important pattern which has 67 attached buildings with river view.

Therefore, we can say that at the riverside majority of the buildings are attached houses. Here, also we can detect few detached buildings which break the monotony in the block structure.

- Is there a relationship between view area and building orientation?

The result is 0.341. As in the previous paragraph, there is 1 cluster out of 7 with obvious structure which has 72 entities oriented towards North-South on the riverside. Similar to previous analysis we can say that if a building is situated on the riverside, this building should be orientated towards North-South.

-Is there a relation between having an additional building and the distance to the center of the neighborhood?

Throughout the study there is no obvious cluster for having an additional building. But, according to neighborhood map, we can see that most of the additions are far from the neighborhood center. Therefore, we applied DBSCAN to see results. At the end, only 6 out of 39 buildings which are 100 meters away from the center have an addition. Similarly, only 2 out of 45 buildings which are 200 meters away from the center have an additional building. We can say that because of the smaller parcels near to the neighborhood center, buildings usually don’t have any additional buildings.

4. Designing CA Model

In the designing phase with CA, we have to create our rules from Data Mining results. For this study, Autodesk Maya/Mel is used to generate a design procedure based on local CA rules. A design procedure (Figure 13) should follow this order: Firstly, we should model our neighborhood according to GIS database. Then, the CA procedure in Maya should read the database, create attributes and assign attributes values to the buildings on the scene automatically (ideally). Secondly, we need to construct our CA rules for the Neighborhood according to Data Mining results. In this stage of the study, we should find an empty parcel for implementation of the procedure. CA procedure should calculate the 8 closest neighbors of the empty parcel and carry on procedure by considering only these 8 closest neighbors. The Mel procedure should group values of the same attribute for 8 neighbors in an array for further array evaluations and operations. Before evaluation phase, we should also evaluate attribute arrays to find out which attribute element is the most and the least repeated according to a specific rule. By doing this, rules can work by taking information from attributes array. Finally, we should animate the system in order to freeze different building forms emerging as a result of the CA procedure.

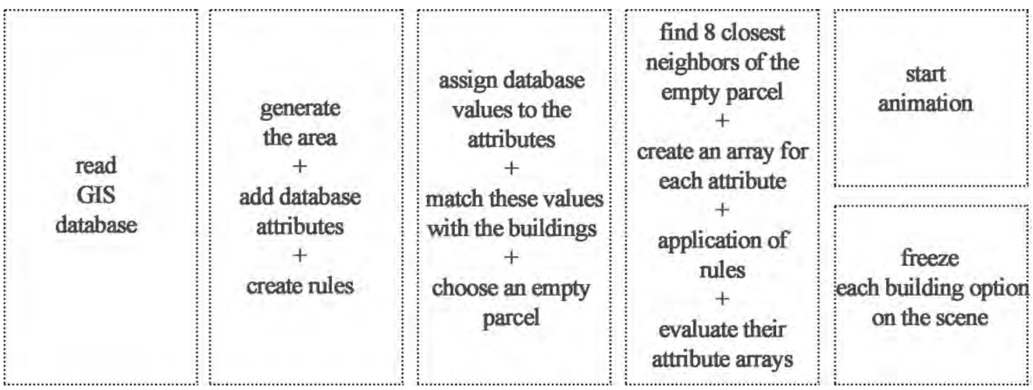


Figure 13: Flow of the Mel Procedure

As a start, we choose a small part of the neighborhood (Figure 14) and try to construct our CA world. This area contains 9 buildings with different functions and an empty parcel locating at the riverside.

Figure 14: Chosen Area

In this stage of the ongoing study, we could not read values from GIS database automatically in Maya; thus, we simply modeled the area and added 15 attributes and their values by hand. Then, we constituted arrays to hold information about 15 attributes for further CA rules operations. For an initial test, we assigned some attribute values before the procedure starts. For instance, for the empty parcel, viewArea is “river” and we’ve already known its parcel area and distance to the Neighborhood Center. Other attributes are left empty, because Mel procedure should find out these values according to CA rules (figure 16). In this phase Data Mining results are mixed with CA rules. Therefore, we have 9 rules in total but only one of them (Floor) is randomly working because of limitations of Data Mining results (Figure 15).

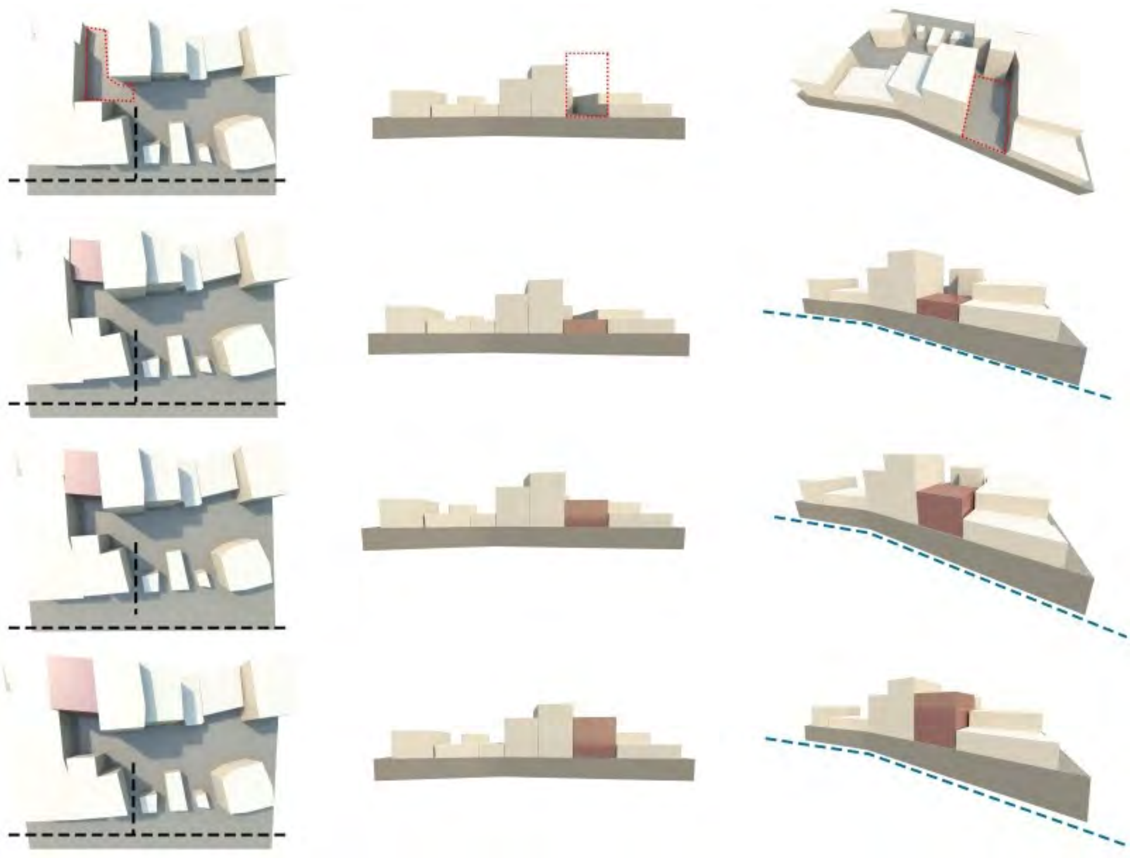


Figure 15: Above we can see an empty parcel at the top and different floor options below, but other 8 attributes values are same for each option.

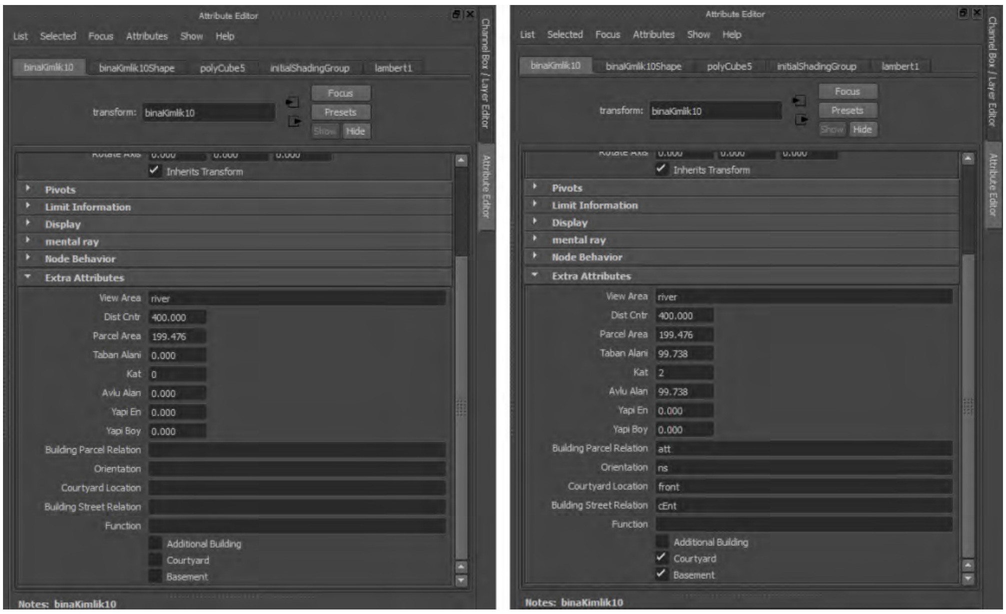


Figure 16: An attribute editor of the Empty Parcel // before and after the Mel procedure.

– 5. Conclusion

This study presented an approach for a generative design model based on CA with the help of data mining techniques and GIS tools. Experiments carried out in this paper are preliminary for further studies, therefore, a small part of the Hatuniye Neighborhood- was chosen for CA application. In the framework of the study, first, a database was prepared in GIS tools by getting information from Amasya Municipality and Building Info Form by visiting the area. After, this data set was used for Data Mining to investigate patterns and relationships among urban entities. Through this, we aimed to transform raw data in our data set into knowledge about urban characteristics. Finally, CA rules were determined according to Data Mining results and an initial model was generated in Autodesk/Maya. The process of construction the building database is still running, but obtained results in this paper showed that Data Mining presents various useful techniques to analyze raw urban information. For instance, numeric attributes can be classified according to its function and we can determine lower and upper size limits of urban entities. The most important pattern emerged at the riverside contains attached houses oriented towards North-South with a front courtyard and a basement. Therefore, houses use a fortress wall for a base, create a semi-private area to protect privacy and have a river view from the South façade. Another finding is about additional buildings. Having an additional structure seems like an independent choice of users, however, far buildings from the neighborhood center are more likely to have an additional building due to larger parcels in that area. In the Street and Mountain area buildings usually don't have a basement and again, they turn their façade to the North-South orientation. Most of the buildings having a front courtyard don't need an extra entrance to the building. These results can be promising for understanding the nature of the neighborhood structure and designing a CA model for a start, but still we need to collect more information and expand our data set to find more intricate relations between urban entities in the scope of further design studies. Additionally, procedure in CA model should allow for designers to enter some pre-existing information with a user interface and calculate more relations determined by CA rules automatically. By doing so, we can achieve our ultimate aim that is to generate a design procedure with digital tools to let designers generate sustainable and regional new designs in historic towns.

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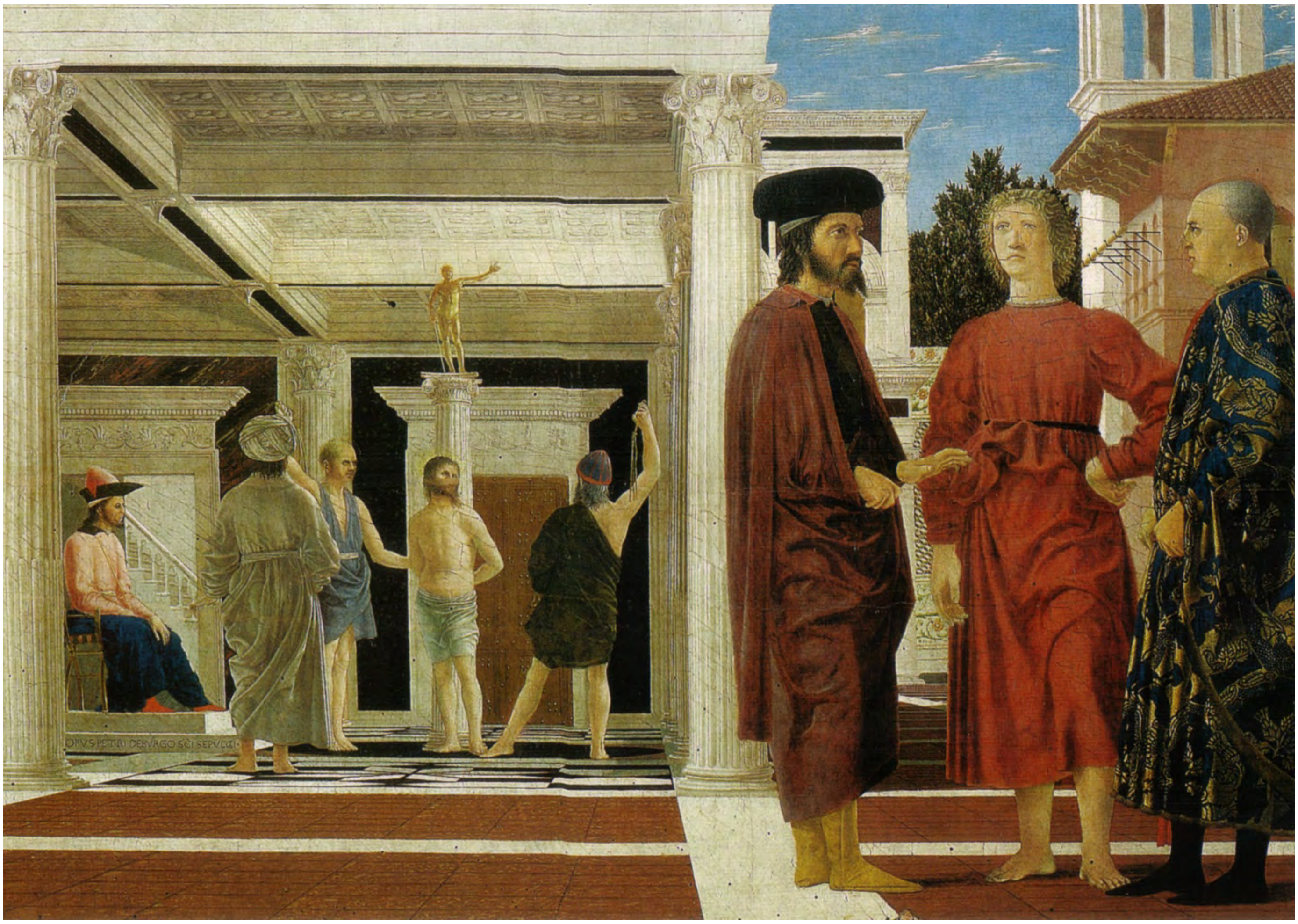
XVIII Generative Art
artworks
installations
posters



Piero della Francesca, Flagellazione

Yoshiyuki Abe

NN2015

Artworks, Live Performance

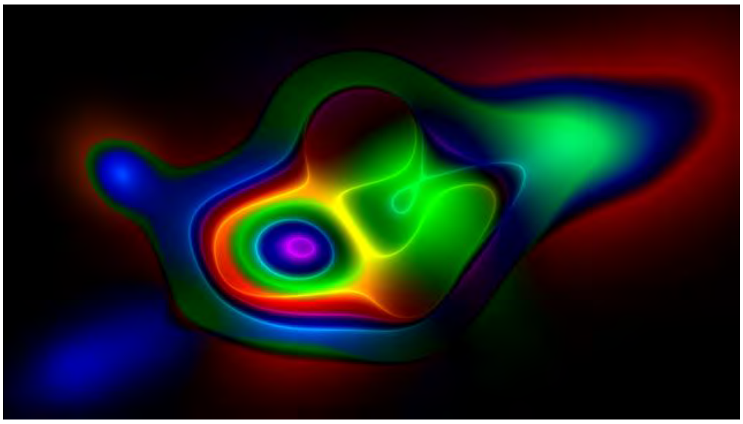
Abstract:

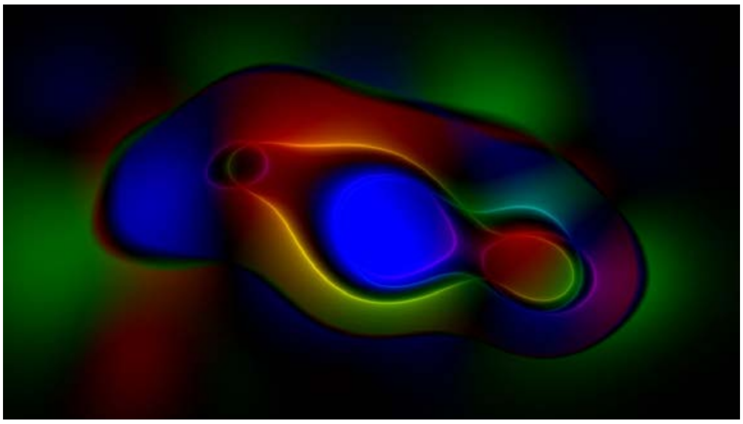
NN2015 is a project of movie making with light drawings on a screen placed in the virtual studio. The goal is the real abstract movie not possible to foresee its form, colour and movement. A production of Light! Computer! Run!

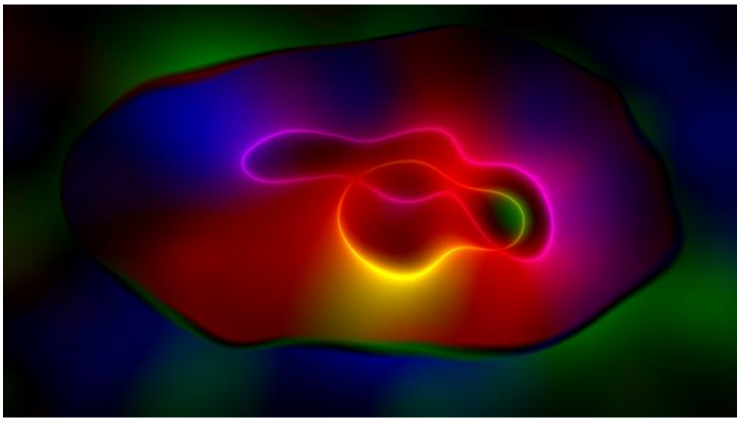
Printworks: image size: 360x640mm inkjet, 3pcs picked from the movie sequence.

Movie: HD video approx 25 minutes (in progress)

Sound: Akemi Ishijima in London and Igor Czerniawski in Warsaw.







Topic: Movie

Author:

Yoshiyuki Abe

artist

Japan

www.pli.jp

Main References:

A. Ishijima, Y. Abe, "Image driven sound generation", GA2003,

GDL Pub., December 2003, Milano

Contact: email
y.abe@ieee.org

Keywords: absolute abstract, light drawing

GA2015 – XVIII Generative Art Conference

Zoya Shokoohi

Art generation to creation of public sentience of spread the knowledge boundaries

Topic: Paper

Authors:

Zoya Shokoohi

Accademy of fine arts Florence department of painting

www.accademia.firenze.it

Main References:

[1] Charles Ogilvie, "Circling the square", Max planck institute, http://charlesogilvie.co.uk/portfolio_page/circling-square/, 2015

Abstract: One of clear function of art and especially visual arts is creation subconscious effect in people and finally increasing public sentience in society. In this case we can unaware produce a deep rooted sentience due to the placement of people of society to a Visual art work. In this study I try to present an image of enunciation "expanding the boundaries of knowledge" by present of a visual art work in depth community. Express of this enunciation and produce public sentience of expanding buondries formed by the following relation :

Generating new science and new knowledge → creating a new objective component in the intelligence space → knowledge observing by artist→ transforming the objective component to a subjective component as consciousness by artist→ generating art and visual art work → creating public sentience of science, knowledge and their expanding their boundaries.

This sentience for this reason is important that, true and comprehensive public sentience of progress and spread of knowledge train adequate and homogenous professional groups for different professional societies. Actually sentience of spread of knowledge boundaries and intelligence, train needed sciences career and in the other hand artists of art community during an art phenomena with a new comprehension of the unaffected of the audience, find and follow a dynamic path to creating the consciousness sentience.

Finally in addition to increasing the public sentience of knowledge and their boundaries, during a cyclic process, becoming, progressing level of art of the artist and art work in this hand and developing scientific society in the other hand.

Artworks of Charles Oglivie are one of the perfect examples of this circulatione! They are a result of the long standing collaboration between artist and mathematician explores the contrasting role of the riddle, as a problem in mathematics vs. Its various cultural forms.

Circling the square, Charles Ogilvie

Contact:
Zoya.shokoohi@gmail.com

Keywords: art generation , visual arts, public sentience, knowledge boundaries

Art generation to creation of public sentience of spread the knowledge boundaries

For GA2015

Zoya shokoohi

department of painting, academia fine arts of folrence

www.accademia.firenze.it

zoya.shokohi@gmail.com

Abstract

One of clear function of art and especially visual arts is effect on subconscious people and finally increasing public sentience in society. In this case we can unaware produce a deep rooted sentience due to the placement of people of society to a Visual art work. In this study I try to present an image of enunciation “expanding the boundaries of knowledge” by present of a visual art work in depth of community.

The express of enunciation and production of public sentience of expanding boundaries are formed by the following relation :

Generation of new science and knowledge → creation of a new objective component in the intelligence space → observation of knowledge by artist→ transformation of the objective to a subjective component as consciousness by artist→ art and visual art work generation → public sentience of science, knowledge creation and expanding their boundaries.

This sentience for this reason is important that, true and comprehensive public sentience of progress and spread of knowledge train adequate and homogenous professional groups for different professional societies. Actually sentience of spread of knowledge boundaries and intelligence, train needed sciences career and in the other hand artists of art community during an art phenomena with a new comprehension of the unaffected of the audience, find and follow a dynamic path to creating the consciousness sentience.

Finally in addition to increasing the public sentience of knowledge and their boundaries, during a cyclic process, becoming, progressing level of art of the artist and art work in this hand and developing scientific society in the other hand.

Keywords: art generation, visual arts, public sentience, knowledge boundaries

introduction

In history of human civilization, art always have had specific place (allocated specific place to itself). Position that in every era with geography have borned and continued or changed. Prehistoric people have used as a magic; then, The art was used for the application. At this time the actor is someone who performs the work of art. Now, The goal is not explain and interpret the history of art and only I wish to express the fact that we rely on the function of art.

We must consider that art has capacity to effect on mind. According to a research worked out by an artist show that frontotemporal dentia people able to(have the ability to) receive, sentience, processing as well as visual creativity[1].

on the other hand, I must pay attention to art therapy, power of art along with its capacity to influence on human[2]. In art therapy, person inspires by object which it has been treated. Then, his or her creativity is exploited and converted to artwork and all of these processes are worked by person who is treated. This procedure gives self-awareness, besides knowledge in the field of treatment. As a result, it leads to cure.
The symbolism is another method that used in addition to the above-mentioned method or independently [3]. In this case, patient is cured with symbols gaming, as well as knowledge, along with people‘s belief in symbols by using of art. .
Another issue that I would like to talk about it is the birth of conceptual art with its functions. This type of art is often visible and depends to politics, as well as society significantly [4]. This means that in an interaction, conceptual art relates to social, besides society. Subsequently, the birth of art provides feedback in society with politics and created feedback of artist‘s artwork is visible; afterwards, this rotary process will continue and political-social space. .
Having considered the preceding the paragraph, I want to study of awareness increasing, along with public sentience related to extending of knowledge boundaries. Additionally, I want to draw picture of knowledge boundaries transferring through a visual artwork in a society.

Method and elements

To express and illustrate that how the influence of art production to increase public sentiment about the knowledge boundaries, First of all we will see some example how to change society's attitude towards and increase their knowledge about the ambient and their world by visualization and visual expression.
The first example that I want to describe is about the discovery and general acceptance of the proposition that the earth is spherical. Exploration to date that,is 900 BC by the Greeks. But it is remarkable that before visual acceptance of spherical earth, different people have been different ideas and images from the earth that can be imagined as a wonderful example of Indian people. They thought the earth is surface on the shoulders of an elephant. While the acceptance of spherical earth have been different outputs of different nationalities. For example, in The Divine Comedy, Dante accepted assumption that the earth is round and by this default writes the Divine Comedy. Iranians are noteworthy example in the traditions that in some their traditional they emerge an apple into a container of water that is actually a symbol of the roundness of the earth and its movement. to Search art works and paintings with images of the Earth in the Middle Ages can be found some imagine that show a scientific exploration .

figure 1. John gower world vox clamantis detail [5]

figure 2. Hildegard von bingen ‘werk gottes’ [6]

Another example that I want to talk about it, the law of gravity and Newton's discovery. The discovery in scientific history dates back to 1687 and appointed to Newton. Keep in mind that there is evidence that people had thought before Newton's law of gravity, and some believe that the discovery of gravity by Newton and the falling apple is an exaggeration! Also I must focus on that public expression of gravity has been by newton because newton by gravity illustrate same as falling an apple have been get a deep sentiment a bout gravity to people of society. clearly seen how a visual art express expanding the knowledge boundaries

Finally, an example of one of the existing art collections available to increase public understanding of science. the Max Planck Institute in order to increase conceptual understanding of a complex study on the matter at this institution, prepared by Charles Ogilvie [7].

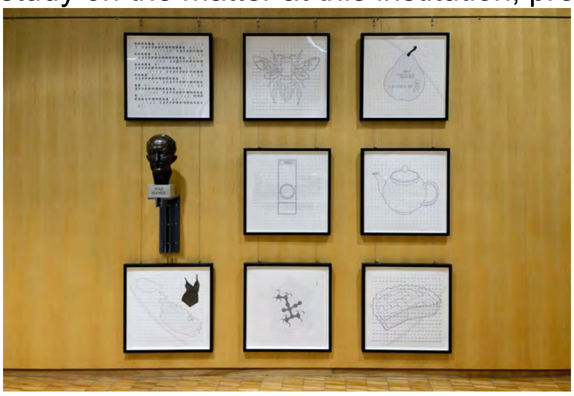


figure 3. Charles Ogilvie art works to express research of max plank institute[7]

Art collections that showcase academic achievements by artistic and conceptual expression are good examples for our discussion. I emphasize that the purpose of the above examples are merely examples of public expression of the expanding knowledge boundaries and its impact on society.

We have to consider that modern society, want modern art. To make an impact in the area of knowledge should use the new tools of art, and depending on the importance of academic achievement, should be the new artistic capacity (scale, color, material) [8].

Conclusion

In view of the above examples as elements of induction, transfer and create the public sentience of expanding the knowledge boundaries in the form of a relationship we define. examples mentioned in the exploration and production of knowledge is a scientific process and through the production and exploration of a new objective concept form. This concept by artist (as a element to analysis of phenomena and concepts) observed and artistic production transform the objective component to a subjective component that increase the quality and scope of public understanding of its world, becomes. This relationship can be expressed in the form of algorithm.

Generating new science and new knowledge → creating a new objective component in the intelligence space → knowledge observing by artist→ transforming the objective component to a subjective component as consciousness by artist→ generating art and visual art work → creating public sentience of science, knowledge and their expanding their boundaries.

Discussion

in such a society persona borne with capacity of creative seeing and expressing. but usually education systems didn't allow to mature these capacity[9]. Termite algorithm we can to use capacities to increase sentience about knowledge boundaries and its spread. In this society, professional groups in different fields grow up with deep understanding and in fact this society generate brainy and intelligent scientists with true and measured understanding of world. In addition, the artists receive feedback from the community as the audience and on the other hand are chosen path and will continue to monitor the spread of knowledge and its boundaries. Finally, in addition to increasing public sentience of science and spread the boundaries of knowledge, within a cyclical process, the artist and the artwork on the one hand and advancing the scientific community on the other hand will be achieved.

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Angela Ferraiolo

Artwork: **Three Hollywood Grammars: Chase, Shootout, & The Conversation**

Topic: Visual Grammar

Artist:

Angela Ferraiolo

Visual Arts Faculty

Sarah Lawrence College, Bronxville, New York, USA

http://www.slc.edu/faculty/ferraiolo-angela.html

www.angelaferraiolo.com

Abstract:

Three Hollywood Grammars: Chase, Shootout, & The Conversation

(Angela Ferraiolo, USA, 2014, generative image sequence,18 mins, Color/Sound)

Three Hollywood Grammars is a generative video made by deconstructing three classic scene structures from 1970s Hollywood cinema: the A/B walk and talk conversation schematic of police procedurals, the shootout of the classic neo-noir thriller, and the iconic street chase scene of 70s urban realism. Each of the scenes were edited, color graded, and exported as single frames. For exhibition, these frames are reconfigured through the use of context free grammars and sequencing algorithms to generate video montage. Sound is distorted through the use of granular synthesis.

The result is an emphasis on the structures and routines of the Hollywood narrative construction and cinematic design rather than the forward progression of story. What is viewable is the deep structure of the story rather than the traditional narrative. The results are in some ways familiar but in other ways a little startling, and therefore informative of what patterns might reside as archetypical in popular imagination. Beyond this, the visual repetitions and pattern making revealed by algorithmic recombination make these experiments arresting visual statements in their own right.

Example: Angela Ferraiolo, Chase (2015), frame enlargements.

Contact:

aferraiolo@sarahlawrence.com

aferraiolo@gmail.com

Keywords: context free grammar, visual grammar, generative video

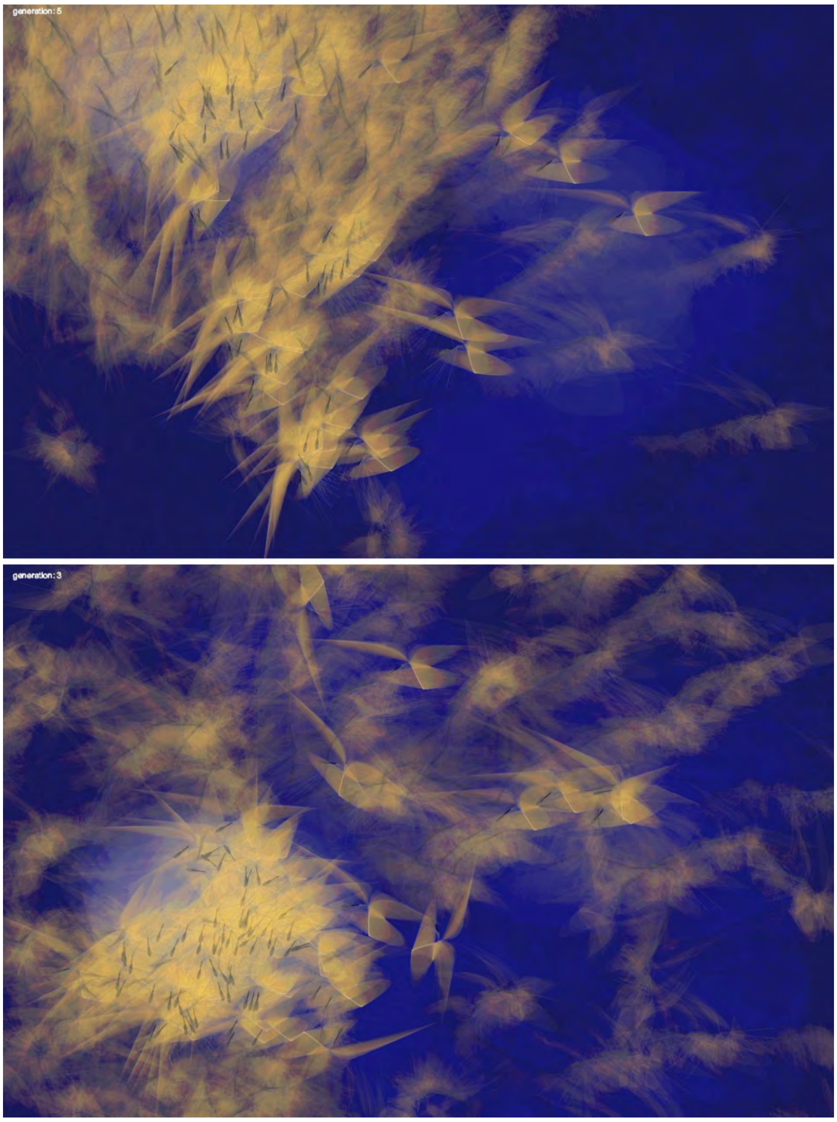
Daniela Sirbu

A-Biopoiesis

Interactive Art/ Installation

Abstract:

A-Biopoiesis is an interactive piece of genetic artwork that metaphorically emulates in the artificial world the natural biopoiesis process of life emerging from non-living matter. Artificial creatures are formed from primitive geometric shapes which then live, adapt to an environment structured in non-deterministic ways and evolve in interaction with external input to aggregate traces of their bodies in motion into visual worlds organized by design principles. A heuristic analysis of the artificial ectropy in these emerging worlds reveals processes of a-biopoiesis in the arising of the a-life creatures from abstract forms and code structures and in emerging visual compositions that continuously evolve.



A-Biopoiesis. Still frames from the time based interactive art piece. Author: Daniela Sirbu, 2015

Topic: Interactive Art

Author:
Daniela Sirbu
University of Lethbridge,
Faculty of Fine Arts,
Department of New Media
Canada
http://www.uleth.ca/finearts/new-media

References:

[1] Reas, Casey and Chandler McWilliams. 2010. *Form + Code in Design, Art, and Architecture*. New York, NY: Princeton Architectural Press.

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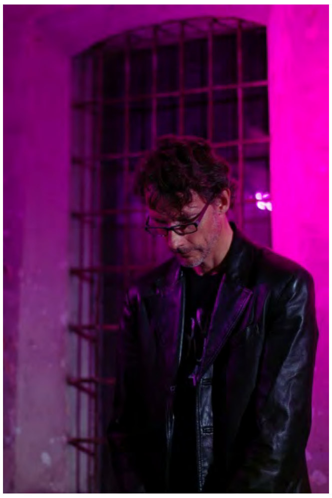
Contact:
daniela.sirbu@uleth.ca

Keywords: software art, evolutionary computing, artificial life, generative art, artificial creativity, interactive art.

Arne Eigenfeldt

Musebots Chill-out Session: A Continuously Running Generative Music Installation
Sound Installation



Topic: Music

Authors:
Arne Eigenfeldt
School for the Contemporary Arts,
Simon Fraser University,
Vancouver, Canada
arne_e@sfu.ca

Oliver Bown
Faculty of Art and Design
University of New South Wales
Sydney, Australia
o.bown@unsw.edu.au

Main References:
[1] Bown, Carey, and Eigenfeldt. “Manifesto for a Musebot Ensemble”, International Symposium on Electronic Art, Vancouver, 2015
[2] Eigenfeldt, Bown, Carey. “Collaborative Composition with Creative Systems: Reflections on the First Musebot Ensemble”, International Conference on Computational Creativity, Park City, 2015.

Abstract:

Musebots are pieces of software that autonomously create music, collaboratively with other musebots. The goal of this project is to establish a fascinating creative platform for experimenting with musical autonomy, open to people developing cutting-edge music AI, or simply exploring the creative potential of generative processes in music. Not simply a robot jam, but individual virtual instrumentalists coming together, like a band, to autonomously create (in this case) downtempo EDM. For this European premiere of the musebot ensemble, we have contributions from Europe, Australia, and North America.

The aim of the Musebot project [1] is to establish a playful and experimental platform for research, education and making, that will stimulate interest and advance innovation in musical metacreation (MuMe). Above all the Musebot project is a collaborative, creative experiment: **we invite others in the generative music community to join us in making autonomous software agents that work *together* to make original music**. These software agents will run on a either a single computer, or network of computers, creating music together in a “musebot ensemble” for a public audience.

Each software agent corresponds roughly to a single “instrumental part” in a piece of music, like a bassline or a drumbeat. If we make these agents smart, then the resulting music will be coherent and continually evolving in interesting ways.

There has been a lot of research in MuMe systems, and the results are impressive. But a lot of the creative work is in standalone systems that compose or perform live with human improvisers. This is a daunting task and the results can be opaque. It is hard for people to share their ideas or their code, or work out ways that their systems might be incorporated into creative workflows. Musebots, by contrast, are small modular units that are designed to be shared and studied by others. By making collaboration central, the Musebot project forces us to be transparent in how our systems work [2].

Musebot home page: http://metacreation.net/musebots/

Musebot example video (screen grabs): http://metacreation.net/musebot-video/

Contact:
arne_e@sfu.ca

Keywords:

Generative music, electronic dance music, installation

Musebot Chill-out Session: A Continuously Running Generative Music Installation

Arne Eigenfeldt

School for the Contemporary Arts, Simon Fraser University, Vancouver, Canada

arne_e@sfu.ca

Oliver Bown

Faculty of Art and Design, University of New South Wales, Sydney, Australia

o.bown@unsw.edu.ca

Artistic Statement

Musebots are pieces of software that autonomously create music, collaboratively with other musebots. Our hope is to establish a creative platform for experimenting with musical autonomy, open to people developing cutting-edge music intelligence, or simply exploring the creative potential of generative processes in music. Not simply a robot jam, but individual virtual instrumentalists coming together, like a band, to autonomously create (in this case) downtempo EDM. For this European premiere of the musebot ensemble, we have contributions from Europe, Australia, and North America.

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References

[1] Bown, O., Carey, B., and Eigenfeldt, A. "Manifesto for a Musebot Ensemble", International Symposium on Electronic Art, Vancouver, 2015

[2] Eigenfeldt, A., Bown, O., and Carey, B. "Collaborative Composition with Creative Systems: Reflections on the First Musebot Ensemble", International Conference on Computational Creativity, Park City, 2015.

Jim Bizzocchi *et al.*

SEASONS
Installation

Multimedia Generative Art

Authors:
J. Bizzocchi[1], A. Eigenfeldt[2], M. Thorogood[1], P. Pasquier[1], M. Horrigan[2], J. Fan[1], L. Fang[1], J. Bizzocchi[1]
[1] School of Interactive Art and Technology, Simon Fraser University, Surrey, Canada
[2] School for the Contemporary Arts, Simon Fraser University, Vancouver, Canada

Abstract:
Seasons is an audio-visual experience that models and depicts our natural environment across the span of a year. The system comprises video sequencing and transitions enriched through their interaction with music and soundscape. The full work is a real-time cybernetic collaboration between three generative systems: video, soundscape, and music. The work runs continuously using a variety of computational processes to build the audio-visual output for a single high-definition and multi-channel sound system.

The generative video sequencing engine uses a recombinant process to combine and sequence shots and transitions drawn from the system's databases. It runs indefinitely, and very seldom repeats its sequencing. The video engine uses metadata tags to provide semantic coherence to the ongoing stream of images and sequences. The aesthetic is that of "ambient video"[1], gently inviting the viewer to enter an experience of sensory engagement with our natural environment.

Each video clip also has been hand-tagged with a subjective measure for valence and arousal: these values, combined with the video's metadata, are sent to the soundscape [2] and music systems [3], which generate appropriate accompanying material. The soundscape engine, *Audio Metaphor*, uses techniques from natural language processing, machine learning, and cognitive modelling to autonomously create an ambient soundscape from metadata tags. The music engine, *PAT*, creates melodic, harmonic, and rhythmic material attained through machine-learning from a corpus.

The team includes individuals with expertise in moving images, film, music composition, performance, installation, machine learning, sound art, software development, and multi-agent systems. Applying sound and music analysis and generative concepts to video, and vice-versa offers a rich opportunity for innovation in generative art and technology.

Many examples of generative works in sound, music or video exist, but we have found very few that combine these into a system where the elements interact and generate a blended audio-visual work in real-time. An earlier version of the work, *Mediascape*, has been documented [4].

Link for sample video
Seasons is a work in progress at the time of this submission. Two early examples can be found here:

https://vimeo.com/136362499

https://vimeo.com/136361163

Main References:
[1] Bizzocchi, J. The Aesthetics of the Ambient Video Experience, Fibreculture Journal, 2008, Issue 11.
[2] Thorogood, M., Pasquier, P. "Computationally Generated Soundscapes with Audio Metaphor", ICCC, Sydney, 2013.
[3] Eigenfeldt, A. "Generative Music for Live Musicians: An Unnatural Selection", ICCC, Park City, 2015
[4] Eigenfeldt, A., Thorogood, M., Bizzocchi, J., Pasquier, P. "MediaScape: Towards a Video, Music, and Sound Metacreation", CITAR Journal 6(1), 2014

Contact:
Justine Bizzocchi, jbizzocchi@shaw.ca

Keywords:
generative video, generative soundscape, generative music, multimedia

Seasons: A multimedia generative artwork

Jim Bizzocchi[1],
email: jimbiz@sfu.ca

Arne Eigenfeldt[2], Miles Thorogood[3], Philippe Pasquier[1], Matt Horrigan[2], Jianyu Fan[1], Le Fang[1], Justine Bizzocchi[1]

[1] School of Interactive Art and Technology, Simon Fraser University, Surrey, Canada
[2] School for the Contemporary Arts, Simon Fraser University, Vancouver, Canada
[3] Faculty of Creative and Critical Studies, University of British Columbia, Kelowna, Canada

Artist Statement

Seasons is a meditation on our natural environment, inviting viewers to savor the passing of time over the course of a year. The system comprises video sequencing and transitions enriched through their interaction with music and soundscape. The full work is a real-time and ongoing cybernetic collaboration between three independent but communicating generative systems: video, soundscape, and music. The work runs continuously using a variety of computational processes to build the audio-visual output for a single large-screen display and 8-channel surround sound system.

Computational generative artists strive to instantiate the dynamics of artistic practice within the structure of code and algorithm. The creative team behind *Seasons* have been working independently for many years within separate generative art domains (video, music composition, sound art). Within their respective specialties they have developed generative work as a means to further their artistic goals. They have now come together to explore their shared ideas within an interdisciplinary context. Their common goal is to understand how generative methods can be applied to the aesthetic challenges and opportunities within multimediated works of audiovisual art.

1. Visuals

Seasons is conceived as an example of “Ambient Video”. Bizzocchi has been exploring and working within this form for over a decade. He has been inspired by Brian Eno’s description of ambient music, which “must be able to accommodate many levels of listening attention without enforcing one in particular; it must be as ignorable as it is interesting.”[1] Bizzocchi’s “ambient video” art is designed not to require viewer attention, but rather to reward viewer attention whenever it occurs. Bizzocchi sees this form of video art as an appropriate medium to communicate his deep love for natural places, and an effective expression for his deep love of visual pleasure and cinematic flow. In these works, he applied three creative tactics:

- gathering high-definition moving images imbued with filmic expressivity of visual composition, cinematic patterns and textures, and the ongoing play of color, light and shadow;
- treating time as plastic - slowing the editing pace through extended shot times and manipulating the time base within the shots to slow down certain features (such as water flow) or speed up other features (such as clouds floating across the sky)
- building a complex aesthetic of visual layering and complex shot transition to both confound our sense the “real” and to push back against the traditional cinematic norm of simple hard cuts

His linear videos were relatively short pieces - ranging from 8 minutes to 20 minutes in length. Bizzocchi began exploring generative methods in order to build a system that would create an ongoing ambient video flow that never stopped, yet always presented varying visual connections and sequences. His first generative work *Re:Cycle* used simple rules for sequencing shots and incorporating algorithmic visual transitions to approximate the aesthetics of his linear video art. With *Seasons*, he has incorporated more sophisticated sequencing rules to increase visual coherence, and refined the transition strategies to maximize visual flow. He is also excited to collaborate with his colleagues to develop tactics that incorporate the power of music and soundscape with the visual expressivity of the video.

Bizzocchi has written in more detail about his ongoing exploration of Ambient Video in many articles [2] and completed five works in this style. His website (http://www.ambientvideo.ca) links to articles and includes sample videos.

2. Music

The music in *Seasons* is generated by an ensemble of musical agents, called musebots. A musebots is a "piece of software that autonomously creates music collaboratively with other musebots".[3] Within *Seasons*, fourteen different musebots are combined into eight different ensembles, which rotate with each subsequent season, and are launched and coordinated by a Conductor. Musebots are designed to generate and manage specific musical functions; for each, one musebot generates a harmonic progression based upon the incoming arousal and valence values, and transmits this to other active musebots. Other musebots may generate rhythmic material, while others generate harmonic material (based upon the progression generated by the harmony generator). Musebots transmit their states, as well as their intentions, allowing other musebots to coordinate their musical actions.

The ambient aesthetic within *Seasons* suggests slower tempi; therefore, each ensemble ranges from 40 to 60 beats per minute. Several musebots create longer sustained textures (named "Chord", "BassDrone", "Drone", "Texture", "Pad"), while others generate more rhythmic elements (named "Figurate8", "Figurate16", "Mallets", "Ostinati", "Tinkle"). One musebot uses a corpus of machine-learned melodies derived from Pat Metheny ("MethenyMelodies"), while another uses instrumental samples and embellishes neighbor tone melodies ("Neighbor").

Musebots use sample-based audio generation and synthesis, including granular synthesis. Many of the samples are utilitarian (for example, "Harp", "Electric Piano", "Celesta"), while others are quite evocative on their own (for example, "Chord" uses "Bowed Guitar" and "Bowed Vibe" samples).

While the musebots are autonomous, they were designed by a composer, and "inherited" the composer's musical aesthetic. This is, perhaps, most clearly reflected not only in the types of musebot designed, but also curated into the ensembles for *Seasons.* Eigenfeldt has created over three dozen musebots that function in a variety of styles; however, most of those used within *Seasons* were created specifically for the work.

3. Soundscape

Thorogood and Pasquier developed the Audio Metaphor system [4] to generate live performances of soundscape composition. The system is designed to utilize natural language cues combined with audio analysis, segmentation and recombination to create evocative sound art performances. In its initial implementation, the system took its cues from Twitter comments and searched online audio clips for source sound material.

For *Seasons*, the inputs to the system derive from metatags manually assigned to each video clip and access to an audio clip database which has been curated to support the Ambient Video aesthetic. Initially, the tags used were often the same as the tags used by the Re:Cycle engine to select and sequence the video. This was an attempt to select source material that correlated closely to the content of the videos (lakes, forests, snowy mountains). However, it became clear that some of the audio sources returned sound that did not reflect the pleasant and calm aesthetic sought. This is due mainly to the unregulated tagging system (text added by those who contributed sound clips). Furthermore, some of the video tags were more visually oriented and would not often be used to describe sound clips. One solution we adopted for the first installation of the work in August 2015 was to adjust the settings in the system that composes the soundscape clip to create a less representational or natural soundscape in favour of a more abstract but evocative track.

Additional methods have also now been implemented. In the first case, a system to identify and eliminate certain sound clips from the database used by the system for *Seasons* has been implemented. For the second issue, a separate set of text cues for the sound was created. These help to differentiate between two shots that contain similar elements, but convey different environments. For example one shot of a lake or stream might be very calm and quiet, while another displays pounding waves. Finally, settings in the system that composes the soundscape clip were adjusted to create a less representational or natural soundscape.

4. Installation

The ideal setting for *Seasons* is in a separate space which allows viewers to take the time to absorb the slow pace of the video and fully enjoy the multi-layered sound track. This is not always possible in a gallery situation, particularly with respect to the sound. In such cases the work may be displayed by video projection or on a large high-definition monitor, with headphones provided for listening.

Sample video can be viewed here:

https://vimeo.com/136362499

https://vimeo.com/136361163

References

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[2] Bizzocchi, Jim. (2008) The Aesthetics of the Ambient Video Experience, *The Fibreculture Journal*, Issue 11 2008 dac conference. http://eleven.fibreculturejournal.org/fcj-068-the-aesthetics-of-the-ambient-video-experience/

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[4] Thorogood, M., Pasquier, P. (2013). ”Computationally Generated Soundscapes with Audio Metaphor.” Proceedings of the Fourth International Conference on Computational Creativity, Sydney, 256–260.

DamlaSoyer

Synth Fashion: Generative design experiments for creating digital fashion products *(Media Art Video / Print)*

Topic: Digital Fashion and AR

Authors:

Damla Soyer

Hongik University, IDAS

(International Design for Advanced Studies)

Department: Design Studies

Korea

www.idas.ac.kr

Abstract:

The Synth Fashion project is a fashion and media art project that explores a design process that overlaps between the physical world and computer environment. Synth uses a process of designing fashion products by immersion and synthesis of mixture of environments of augmented reality.
The project consists of three stages:
1. Digital Sketch: First, a model's photos or videos are taken in a chosen environment. The images are used used to create computer-generated imagery that exactly fits into the shot by data with a match-moving software. The generated data creates the base for design sketching.
2. Form Production: Final output of the sketches are designed as 2D forms and then converted into 3D shapes through 3D computer graphics software.
3. Manufacturing: 3D models of the designs are prepared for the use of augmented reality or prepared for laser cutting and 3D printing process to be manufactured.
Project's method is the use of data synthesizer to create a platform to digital sketch as a starting point for a design product. The process it follows starting form real life and the creating data form a real world and turning into virtual into real at the end.
https://vimeo.com/91242743
https://vimeo.com/91848981
http://digitalfashionn.blogspot.kr/
http://augmentedfashion.blogspot.kr/

Contact:* *damlasoyer@gmail.com

Keywords: Digital Fashion, Augmented Reality

Françoise CHAMBEFORT

Village Doc
Installation

Topic: Animation in real time

Authors:

Françoise CHAMBEFORT
(University of Franche-Comté, UFR STGI, Master Produits et Services Multimédia
http://stgi.univ-fcomte.fr/
In 2015-2016, PHD at University of Franche-Comté, Laboratoire)ELLIADD, équipe OUN
ELLIADD
OUN

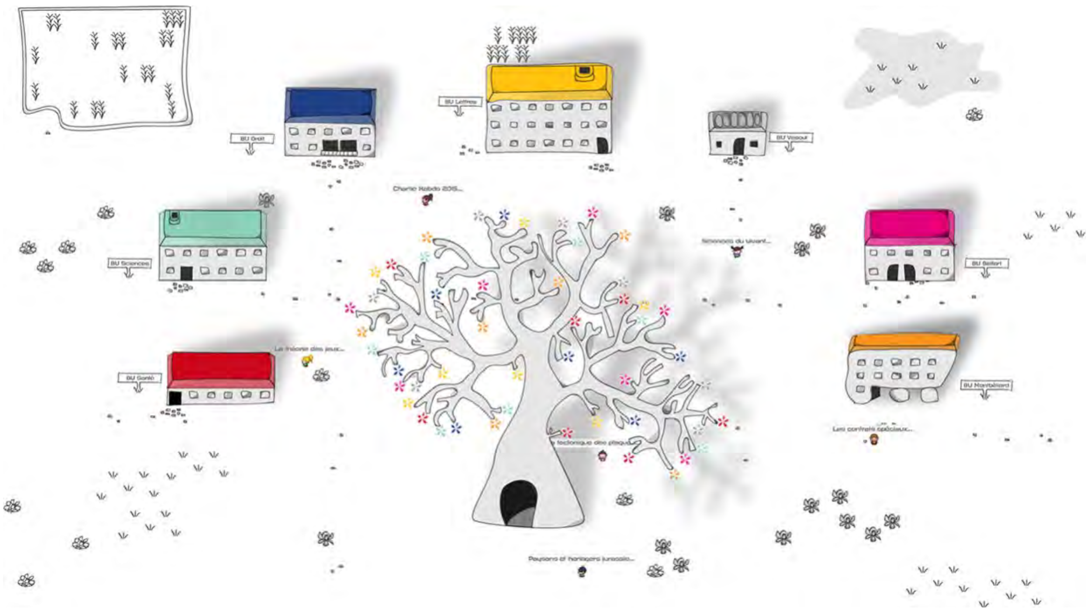
Main References:
2015-2016 UQAM Figura international intern hosting grant recipient ($4000 for a 2 month internship at the beginning of 2016)
Village Doc presentation on Behance

Abstract:

'Village Doc' is a generative work of art, built from the real-time data of document loans made in the libraries of the 'Université de Franche-Comté'. This work is both vision and sound related, with curiosity as the drive of its poetical universe.

A town square. In its center, the tree of knowledge. Around it, the buildings of all the libraries included in the network. A soft and meaningful tune puts the viewer in a contemplative mood. When a loan goes through in one of the libraries, in real-time, a small character emerges from the building where the loan took place and moves on the stage. His or her real first name is displayed briefly above him, along with the title of the borrowed document. As the libraries function, the landscape gets livelier. Gradually, the tree grows flowers of many colors. The crowd of readers circulates and exchanges, goes from throng to lonesome individual, in a never-ending choreography. The sounds are also enhanced.

Viewer is invited to first watch, and then understand, what is happening on the screen. The mind travels between fiction (the town) and reality (the libraries and their activity). The viewer will grasp the readers community in all its diversity : variety of first names and abundance of knowledge. Real-time experience will work its magic and generate in each viewers unexpected sensations and feelings, bound to change how he or she perceives libraries and the acquisition of knowledge in general.



Village Doc screen

Contact: francoise,chambefort@univ-fcomte,fr

Keywords: Digital Art, Generative Art, Real-Time Data, Integrated Library System

Village Doc, Generative Artwork built from Real-Time Data

Françoise Chambefort, University Librarian, PhD Student.

OUN Team (Digital Objects and Usages), ELLIADD Lab.,

Franche-Comté University, France

https://www.tumblr.com/blog/fchambef

e-mail: francoise.chambefort@univ-fcomte.fr

Abstract

'Village Doc' is a generative work of art, built from the real-time data of document loans made in the libraries of the 'Université de Franche-Comté'. This work is both vision and sound related, with curiosity as the drive of its poetical universe.

A town square. In its center, the tree of knowledge. Around it, the buildings of all the libraries included in the network. A soft and meaningful tune puts the viewer in a contemplative mood. When a loan goes through in one of the libraries, in real-time, a small character emerges from the building where the loan took place and moves on the stage. His real first name is displayed briefly above him, along with the title of the borrowed document. As the libraries function, the landscape gets livelier. Gradually, the tree grows flowers of many colors. The crowd of readers circulates and exchanges, goes from throng to lonesome individual, in a never-ending choreography. The sounds are also enhanced.

Viewer is invited to first watch, and then understand, what is happening on the screen. The mind travels between fiction (the town) and reality (the libraries and their activity). The viewer grasps the readers community in all its diversity : variety of first names and abundance of knowledge through real-time experience.

– 1. The data flow

In 2009, Pierre Berger wrote that a generative artist must first and foremost program what is uncertain. That uncertainty can be obtained through pseudorandomness algorithms, through the use of external ressources or through a variety of mathematical calculations. Using a data flow is one way of exploiting an unpredictable source. Most of the time, artists use data flow coming from the web. In this project, the flow of data is very specific, and not public, being the flow of transactions (withdrawals and returns) in a network of university libraries. Every day, hundreds of readers borrow and return books in those libraries. As they practice that activity using their name, it is an individual process. But as all these individual transactions are combined in this data flow, a global view of these exchanges becomes possible, and allows for the living community of readers to emerge.

– 2. Working in real-time

Handling data flow in real time means inscribing the work into time and into reality, it means interpreting reality as it forms itself. From the viewer's perspective, it may generate questions along two lines :

- from the human towards the flow, real actions performed by real people triggers the data flow,

- from the flow towards the human, the combination of the data into a flow creates, through metonymy, a human community which can be seen on the screen. This community will be reinterpreted, fictionalized.

The viewer can therefore apprehend the human interactions behind the system. His or her own actions can be interpreted by the work. The system is not interactive as the interaction must exist in reality itself. This approach of rooting the work into real time can be compared to a performing arts approach : every moment is unique and will not happen again in exactly the same way.

– 3. Overall structure

The program is using :

- HTML for display

- PHP files and AJAX technique to send SQL requests every two seconds to Oracle database,

- Phaser javascript game framework

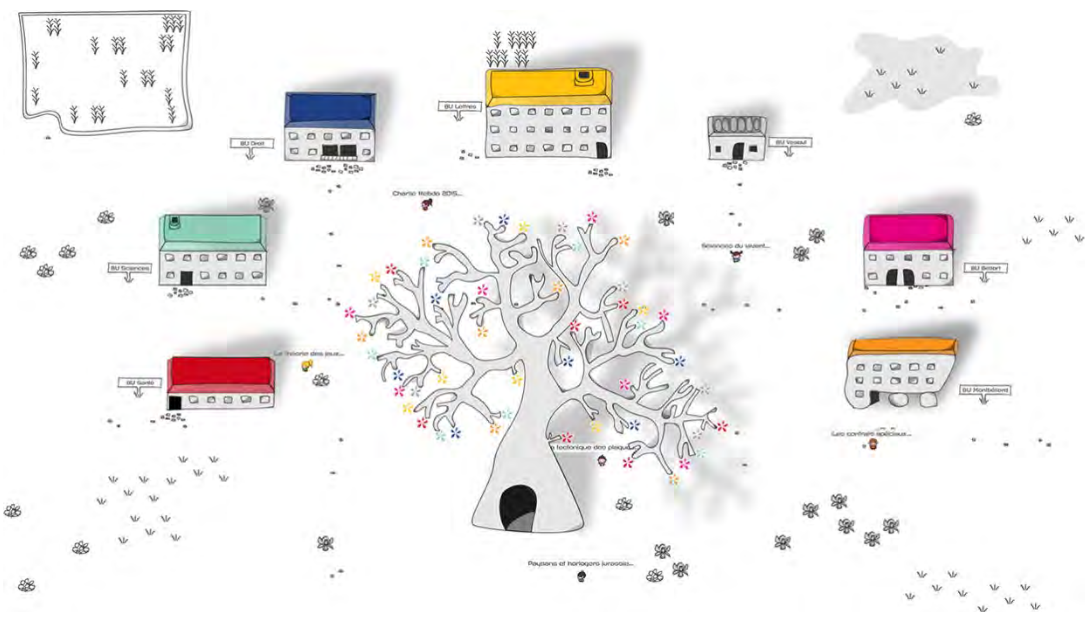


Figure 1. Village Doc screen.

3.1 Graphic elements

I took my inspiration from the Legend of Zelda games, produced by Nintendo since 1986. My goal was to quickly immerse the viewer in a fictional and fun world. In this world, readers are shown as children, beings that never stop learning. I used a strong contrast between black & white and color. I created the various elements, with the exception of the characters sprite sheets, made by KG Spriter, which are copyright-free.

3.2 Animation programing

Sprite sheets were used for basic elements animation (characters, flowers, magic...).

- Character travels

The goal was to give the impression of a swarm but also to favor colliding between characters. I chose to use the moving pattern from the game Zelda : characters move in 4 directions (right, left, up, down). Lines of circulation are therefore either horizontal or vertical. Characters exit the stage through its rims or they disappear inside the tree. Some elements of the landscape work as obstacles. When a character collides with them, he finds himself redirected at random.

The tree is always placed at the forefront. Characters move behind it and its colorful flowers, which grow with every loan. This gives some depth to the scene. The gateway into the tree works as a magnet : every character entering the area under the door is redirected towards it and disappears inside.

- Colliding between characters

When two characters meet (which can be detected through their coordinates on the stage), they exchange words (a whispering sound is triggered, chosen at random between two possible sounds) and a magical aura shines around them (a magic dust animation in the form of a sprite sheet).

3.3 Sound environment

The use of sound brings a lot of depth to what can be perceived of the device, in terms of both time and space perception. This is what Michel Chion calls the added value of sound : “the informative and expressive value with which a sound imbues a given image can lead to thinking (…) that this expression “naturally” comes from what we can see”.

I chose to use only sounds that I had recorded myself, although I reworked them subsequently. I had to record the sounds, possibly re-synthesize them, apply filters, mix and then compress them. I composed the music from a few arpeggios and guitar chords. I blended brute sounds with their counterparts reworked with a granular synthesis application. I then produced the sounds that were destined to be programmed (forest background, door sounds, footsteps, whispers, tree sounds).

Sound spatialization received particular attention :

- When a character walks across town, his footsteps go from one hear to the other, according to how he moves on screen. This spatialization is managed through API Web Audio, as a simple panoramic.

- For the doors, which are static, the sounds were spatialized using another method : SPAT, IRCAM's spatializer. That tool allows for the control of source positioning in a 3D environment and is ideal for a headphone experience. Its interface renders possible the positioning of one or several sounds in relation to a centrally placed listener (angle, distance).

– 4. Multimedia metaphor

Village Doc is based on a metaphor which connects the libraries network and a town : said network becomes the town, reading becomes walking, knowledge becomes a tree... This metaphor was developed in every detail of the conception, and gives the work its coherency. It unfolds jointly with every media used, whether discreet or continuous : static image, animated image, punctual sounds, looped sounds.

– 5. Conclusion

We live in a world of profuse data, but sometimes, we don't know what to do with that huge amount of information, apart from financial ventures and jeopardizing individual freedom.

With Village Doc, I wanted to use these data in a benevolent way to create a new type of metaphor. I believe in its efficiency, formidable in my point of view, as in an infinite loop, every instant is an opportunity for reality to generate fiction and for fiction to induce the viewer to reconsider what he thinks of reality.

– References

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Chion, Michel. *L'audio-vision: son et image au cinéma*. Armand Colin, 2005.

Ernest Edmonds

Shaping Form
Artwork

Topic: Art

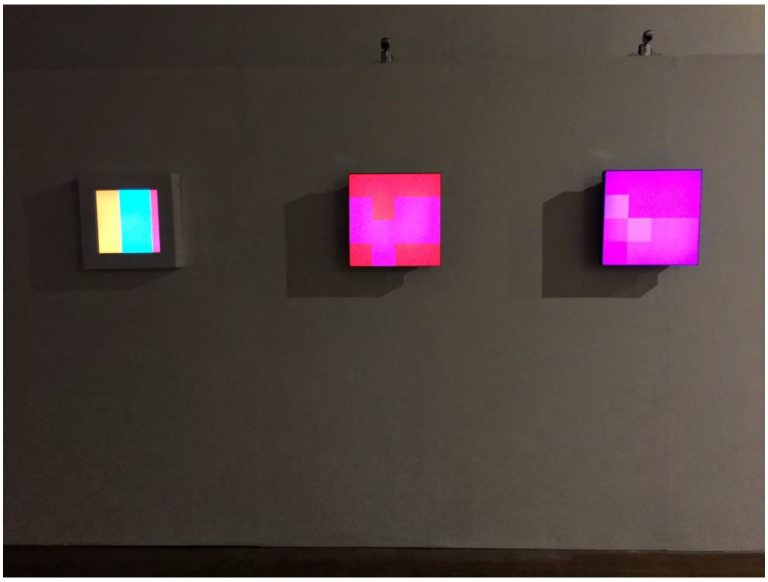
Authors: Ernest Edmonds
University of Technology, Sydney Creativity and Cognition Studios
Australia
Creativityandcognition.com
and
De Montfort University, IOCT
UK
ernest@ernestedmonds.com

Main References:
[1] Candy, L and Edmonds, E. A.(editors) *Interacting: Art Research and the Creative Practioner*, Libri Publishing, Oxfordshire, 2011.
[2] Boden, M. A. and Edmonds, E. A. (2009) What is Generative Art?. *Digital Creativity* Vol. 20 Nos 1-2, pp 21-46.

Abstract:

Shaping Form generative artworks consists of unique abstract interactive artworks that are each generating colours and forms in time from a set of unique rules. They also take data from a camera and continuously calculate the amount of activity seen in front of the work. The computer software then steadily modifies the rules. The artwork and its development over time are influenced by the people who look at it: the audience help to shape the work. *Shaping Form* is a representation of computed life, moving and changing of its own accord but maturing and developing as a result of the movement of audiences. Each work interacts gently with its environment. The *Shaping Space* installation is in a darkened room where there are two changing images in space creating a field of colour. The screens show a living matrix of colours that sometimes change very slowly and at other times burst into life. The colours use a small, but changing, pallet of hues. Images are generated using rules that determine the colours, the patterns and the timing. These are generative works that are changed by the influence of the environment around them. People can readily detect the immediate responses of the work to movement, but the changes over time are apparent only when there is more prolonged, although not necessarily continuous, contact with it. The shaping of the form is a never-ending process of computed development.

The work to be shown will use one square monitor, a MacMini and a webcam (all provided by the artist)



Three Shaping Forms in Primary Codes, Rio de Jenerio 2015

Contact: ***ernest@ernestedmonds.com***

Keywords: Generative, interactive, art, installation, influence

The Shaping Form Series:

Four Shaped Forms, Venice

Ernest Edmonds

University of Technology, Sydney, Australia

and

De Montfort University, UK

ernest@ernestedmonds.com

Keywords:

Generative, interactive, art, installation, influence

The *Shaping Form* generative artwork series consists of unique abstract interactive artworks that are each generating colours and forms in time from a set of unique rules. They also take data from a camera and continuously calculate the amount of activity seen in front of the work. The computer software then steadily modifies the rules. Each artwork, and its development over time, is influenced by the people who look at it: the audience help to shape the work.

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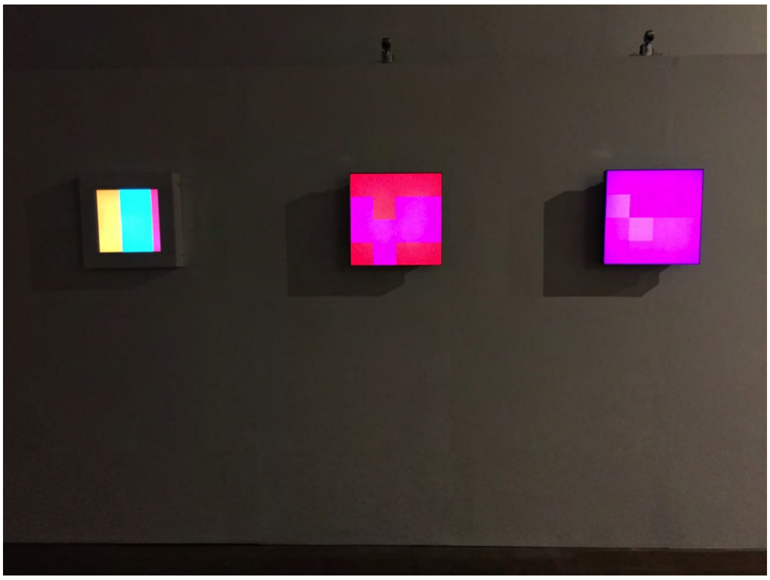

Fig 1. Three *Shaping Forms in "Primary Codes",* Rio de Jenerio 2015

These are generative works that are changed by the influence of the environment around them. People can readily detect the immediate responses of the work to movement, but the changes over time are apparent only when there is more prolonged, although not necessarily continuous, contact with it.

The shaping of the form is a never-ending process of computed development.

The work shown at GA2015 – the Generative Art Conference – is *Four Shaped Forms, Venice*. This is a digital print on aluminium, based on four instances of a Shaping Form. It can be seen as a composite of stills from the changing, time-based, artwork. It is a still image containing moments from a generative evolving *Shaping Form*.

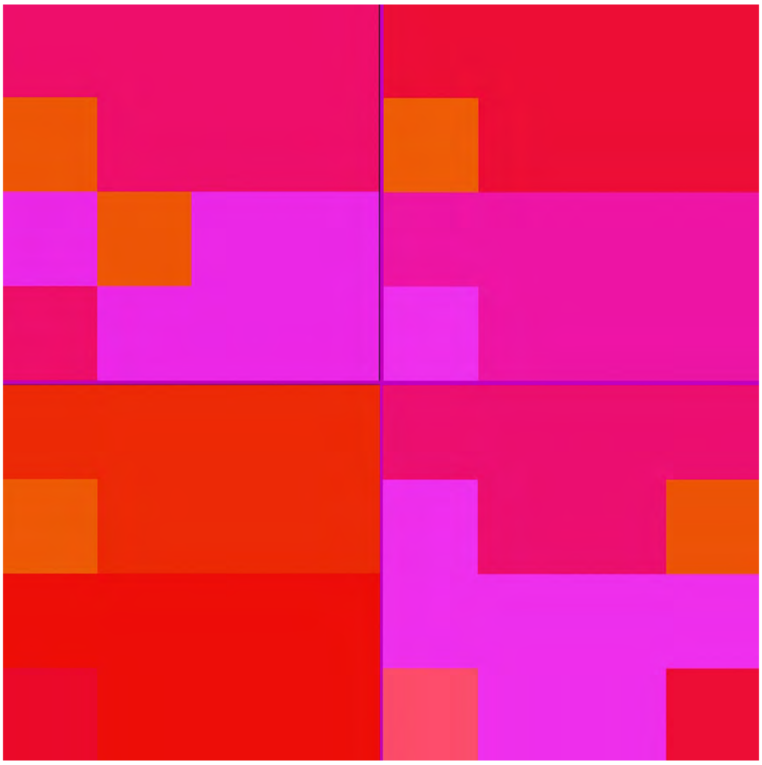

Fig.2: *Four Shaped Forms, Venice*, 2015. Ernest Edmonds

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[1] Candy, L and Edmonds, E. A.(editors) (2011) *Interacting: Art Research and the Creative Practioner,* Libri Publishing, Oxfordshire.

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[5] www.generativeart.com

Celestino Soddu

Sardinia Stone Age Futuring Past

Topic: Art, Architecture, Stone Age Art

Author:
Celestino Soddu
Generative Design Lab
Politecnico di Milano
Italy

Main References:
www.soddu.it
Archeological discover of Nuraghi models of 2nd millennium B.C. in Sardinia.

Nuraghes are the famous architecture of Stone Age in Sardinia. Nowadays 7,000 nuraghes are already discovered but their number is surely bigger. My generative project on Nuraghes was born by interpreting the recent discovery of a series of stone statues of "giants" together with a series of stone models of Nuraghes at small scale, made around two millennia B.C. in Sardinia, Italy   These models introduce a new significance of Nuraghe shape for the reason that we discovering how was the top of nuraghes that is destroyed in all their ruins. This was very impressive for me in performing my interpretation of the total space of these neolitic ancient architectures. For designing the code for generating variations of Nuraghes with my software Argenia I followed the generative process "Futuring Past". Futuring Past is a generative design process able to gain complex recognizable variations of the same idea/code constructed by an interpretation of the past time" C. Soddu, E. Colabella, 1998. The generation of Nuraghes was therefore directed to find again not only the characters but also the logical structures of these constructions.

As for other generative projects of mine the references are not only the existing architectures or artworks but their representation in the works performed by artists that have lived and interpreted the events of their own time. In this case these artists had constructed these "scale models" in stone. The Featuring Past result is a series of 3D scenarios of futurible nuraghes strongly connected to a logical interpretation of the discovered models and of their possible history.

In the images: Variations of Generated Nuraghes in an existing nuragic site, with the presence of the "models" discovered in Cabras new archaeological site.

celestino@soddu.it

Keywords: Futuring Past, Generative Design, Logical Interpretation

Enrica Colabella, Celestino Soddu

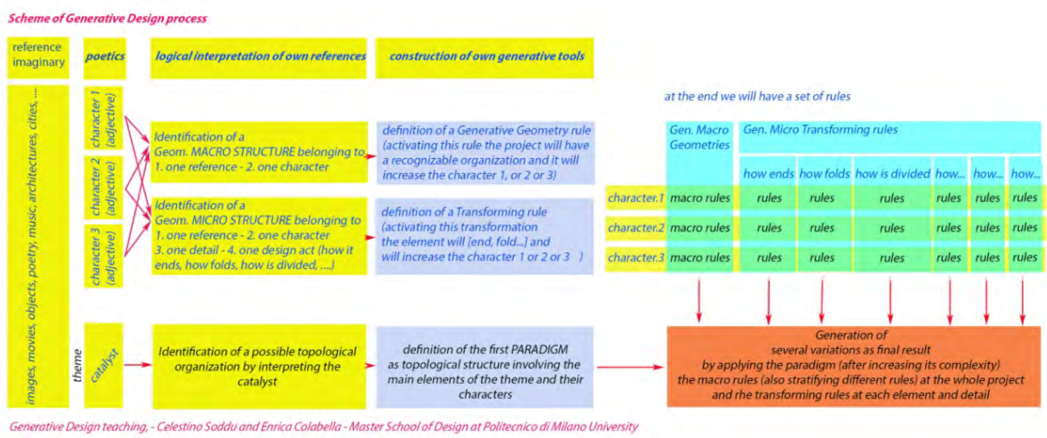
Venice more Venice than before

Topic: Poetic Logic, Generative Design

Authors:
Celestino Soddu
Enrica Colabella
Generative Design class, Master School of Design
Politecnico di Milano
Italy

Main References:
[1] C.Soddu, E.Colabella, "*Il progetto ambientale di morfogenesi, codici genetici dell'artificiale*", Progetto Leonardo, 2002, Bologna
[2] *www.generativism.com* (the website of the students of C.Soddu and E.Colabella with *teaching materials* and *Generative Design Manual*)

Abstract:
The master students of the Generative Design course present these posters as works in progress of their studying process. Our course started in October and the main aim of the first part is to increase the identity of each student as designer, by constructing a proper active background through a recognizable vision. As first step of the generative process, students identify some design characters as aims to gain. Then by focusing their singular vision and by performing one lecture' direction, students interpret their imaginary of reference by performing active connections as *poetic logics*. This year we asked students to discover their references inside the vast, complex and fascinating artworks by *Piero della Francesca.*The objective of these first 5 lessons of teaching activity was to build their own design tools as rules of transformation, as algorithms, able to define their own peculiar vision. For the reason that most of the previous design experiences followed only an analytical approach and not an interpretative one, the didactic difficulty was in the identification and development of a singular poetic logic, able to control the construction of their design tools. Once performed their design characters and their poetic logic, the GD process brings each student to create a paradigm of organization as a code able to control each part of their project. In this way students can generate a first series of scenarios following their prefixed characters as aims. This year a main collective aim was: *Venice more Venice than before*. Following each poetic logic, students can try to improve the dynamic identity of Venice where their projects will be located, *connecting past toward a generative vision.*
The master students are: Erika Lisa Marianne Axhed , Che Shengran , Chen Meng Jie , Daniela Anaid Contreras Camara , Giuliano Modesto Guarini , Francis Savio Kuruvilla , Meghana Thakkar , Nastazja Niedziela , Sara Victoria Velazquez Martinez , Pietro Cardinetti , Marwah Al-Sakkaf , Menghan Li , Xu Yang , Zeng Jiayu , Alessandro Zotta , Hong Li , Jing Guo , Siyu Zhan , Tianci Zhu, Anqi Ye , Xinyi Wang , Yixin Li , Qianzhu Ou , Zhijing Yuan , Haoran Lu , Chatziprodromou Georgios.
Scheme of Generative Design teaching process:

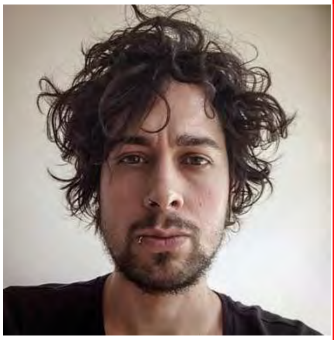


Contact: email: soddu@polimi.it

Keywords: Generative Design, Poetic Logic, Logical Interpretation

Fabio Morreale

Generative Everything 2083
Installation



Art, Music

Author:

Fabio Morreale

University of Trento
interAction Research Lab
Department of Information Engineering and Computer Science

Generative Everything 2083 is an interactive installation whose auditory and visual contents are generated in real time by two algorithmic agents.

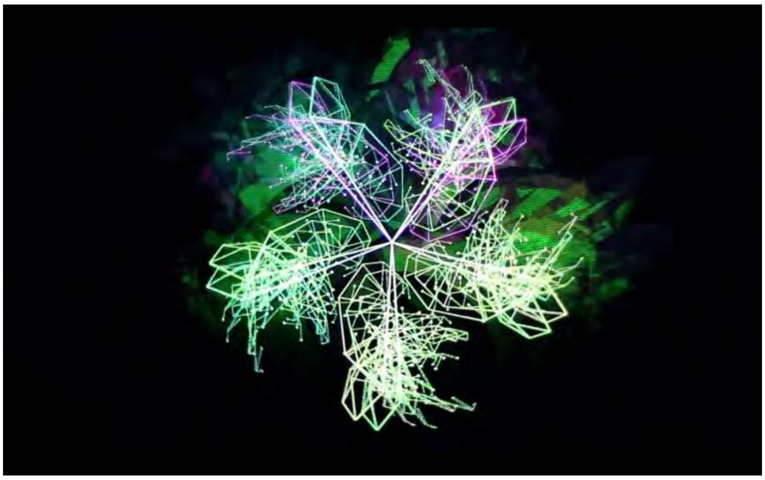
The musical agent composes and plays a tonal music in ambient style. This agent is based on Robin [1], an algorithmic composer that was taught with compositional rules of classical music. At each new performance, Robin applies such rules to mould a number of stochastic processes, which determines the melody, harmony and rhythm of the composition.

The visual agent generates visual compositions that are inspired by fractal geometry and that follow the musical cue. Complex musical patterns result in chaotic movements whereas calm and melancholic melodies result in tender dances of stars and flowers.

The evolution of the composition is determined by a random walker, which randomly roams throughout a multidimensional emotional space in which dramatic, romantic, and chaotic situations alternates. Following the related word in the psychology of music [2], this emotional space is represented in music using five parameters: tempo, mode, octave, volume and pitch contour. On the visual side, alteration of the emotional space will determine the color, dimension, speed, harmony and complexity of the visual elements.

The a-linearity and the non-determinism of the installation allow the system to generate completely new and non-replicable performances. Besides the purely aesthetic experience, Generative Everything 2083 encourages reflections and speculations on possible future scenarios of art, when the artwork will be co-created by the artist and forms of artificial intelligence. In this context, the artist role is "downgraded": once they had taught the rules to the machine they are precluded to control the actual evolution of the artwork.

https://youtu.be/puA5FtLbG3A



Main References:

[1] Fabio Morreale, Raul Masu, Antonella De Angeli. “Robin: an algorithmic composer for interactive scenarios.” In *Proceedings of SMC 2013*.

[2] Patrik N. Juslin, and John A. Sloboda. “*Handbook of music and emotion: theory, research, applications.”* Oxford University Press. 2010.

fabio.morreale@unitn.it

Keywords: Algorithmic music, procedural art

Karim M. Ibrahim

Classification of Arabic music genres
Poster

Topic: Music

Author:
Karim M. Ibrahim
Nile University,
Department of Software Engineering
Egypt
www.nu.edu.eg
Mahmoud Allam
Nile University,
Department of Software Engineering
Egypt
www.nu.edu.eg

Main References:
[1]] G. Tzanetakis and P. Cook. Musical genre classification of audio signals. IEEE Transactions on Speech and Audio Processing, 10(5), July 2002.
[2] A Comparative Study on Content-Based Music Genre Classification

Abstract:

The problem of music genre classification is a well-known problem with several attempts and approaches to solve it. There has been a noticeable progress in this particular task with satisfying results. However, most of the approaches are designed for the western music genres which are well-known and well defined. In the case of Arabic music styles, it didn't receive the same attention. The genres are not well defined and the Arabic music content on the web lacks both accurate description "Tagging" and classification "genres", making it harder to explore. In this paper, we provide both a reference for the most well-known Arabic music genres and also a method for automatic classification of those genres using content-based features and neural networks to reach an accuracy of around 85% of automatic classification between 4 of the most popular Arabic music genres.

Contact:
Karim.m.ibraheem@gmail.com

Keywords:

MIR, Music Genres, Classification, Arabic Music, multi-class classification, feature extraction

Zinka Bejtic

***Displacement* – Architectural Authenticity of Urban Space**
Video Installation, Loop (indoor or outdoor, screen based or projected)

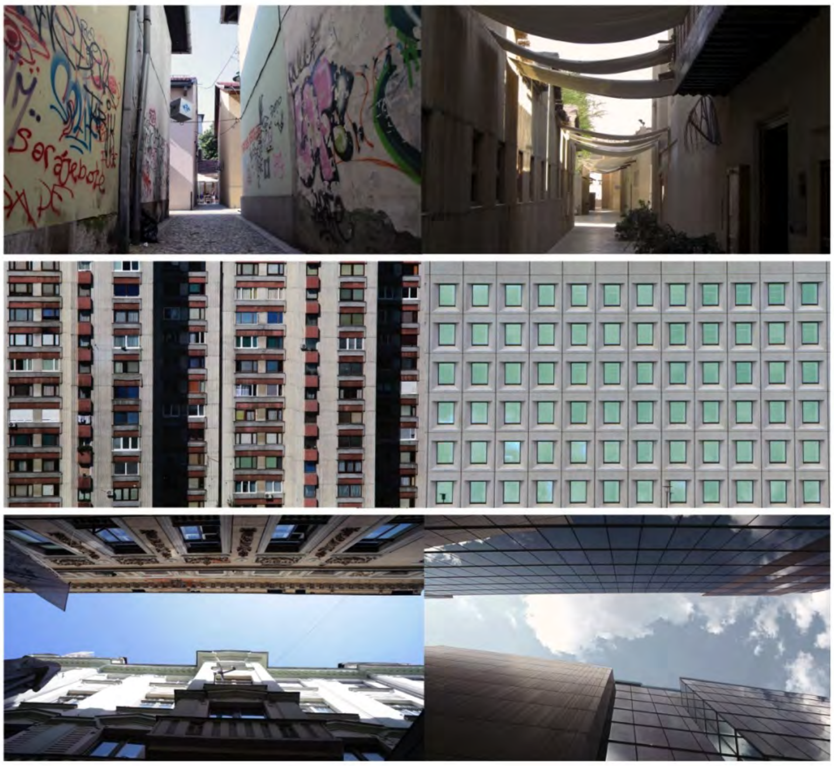
Topic: Art & Architecture

Author: Assistant Professor Zinka Bejtic
American University of Sharjah, College of Architecture Art and Design
United Arab Emirates
www.aus.edu
www.zinkabejtic.org

References/Screenings
[1] Zinka, Bejtic "Split" Aesthetica Film Festival, York, UK, 2015
[2] Zinka Bejtic, "*Split*", Currents New Media, Digital Media Festival, New Mexico, US 2015
[3] Zinka Bejtic, "*If I Don't*", Miami Fashion Film Festival, Miami, US 2014
[4] [3] Zinka Bejtic, "*Fragments*", SIKKA Art Fair, Dubai, UAE 2014
[5] Zinka Bejtic, "*If I Don't*", Columbia George International Film Festival, Los Angeles, US, 2014

Abstract:

The qualities of specific experience related to unique geographical location have always been very significant. Considering the advances in digital technologies, facilitation of communication and global influence of advertising, we are today more than ever inclined to look for specifics that make something different or unique - whether it's a product, service or an environment. The architectural elements that define a specific man-built space and make it authentic are integrated in the spatial yet interpreted in social and cultural context. As we are witnessing the globalization and the diminishment of borders in cultural aspect these location specific experiences are becoming extremely valuable. What are the specific architectural attributes that make an environment authentic? Through contrasting and comparing of cities Dubai and Sarajevo, two very distinctive locations that cannot be more different in geographical, cultural and social sense, extreme similarity of formal visual elements is suggested while the interpretation relies on the cultural context. The installation challenges the idea of architectural displacement and questions the diminishment of authenticity in urban spaces. Images run parallel to each other as a part of simultaneous installation.



Example: Three still frames from installation

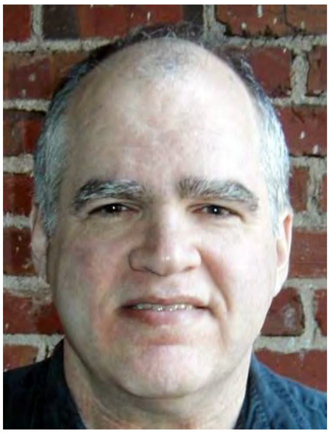
zbejtic@aus.edu

zinkabejtic@gmail.com

Keywords: Architecture, Visual Language, Cultural Authenticity, Installation, Globalization, Video Art,

Philip Galanter

Artwork: **Animated Line Drawings**



Topic: Fine Art

Author:

Philip Galanter

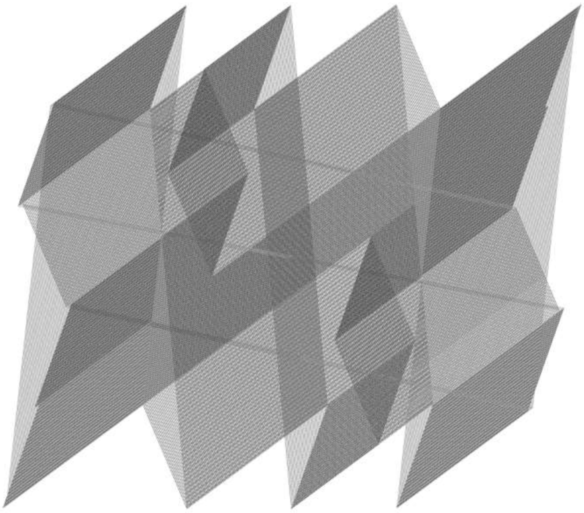
Texas A&M University
Department of
Visualization

USA

http://www.viz.tamu.edu/

Abstract:
Animated Line Drawings is a series of computer animations designed to run in real time for display on a very high-resolution display. Each is made of thousands of straight black and grey lines on a white background. Any given moment in time in an animation could be frozen as a static line drawing. But as an animation the screen displays a constantly morphing design.

This series of formal studies is strongly influenced by the Algorist school of computer art as practiced by Jean Pierre Hebert, Georg Nees, Herbert Franke, Vera Molnar, Frieder Nake, and others. Thanks to higher resolution displays and greatly improved compute power, these works extend into the dimension of time with dynamic form. The results are complex undulating forms that frequently expose multiple layers of Moiré patterns resulting in moving waves and flashing patterns.



Please Note Regarding Installation: I can potentially bring everything needed, BUT it would be extremely helpful if the conference could supply a flat screen display that can be wall mounted.

Contact: email

Keywords: Animation, generative graphics, drawing

Anthony Viscardi

Tracing Time to Measure Space: New Drawings and Constructions

Topic: Art Architecture and Design

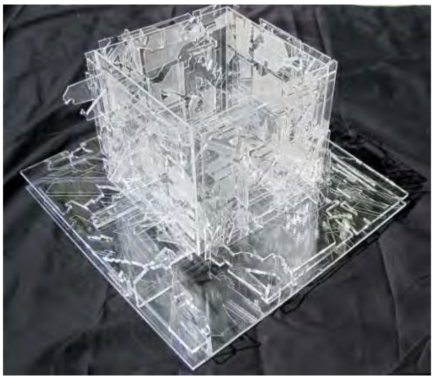
Author:
Professor Anthony Viscardi
Lehigh University
Department of Art Architecture and Design
USA
www.lehigh.edu/~av03

Main References:
Anthony Viscardi Tracing Time to Measure Space: New Drawings and Constructions
www.generativeart.com

MEDIATING BETWEEN REALITIES

Liberating architecture from the practical constraints of building, American artist Anthony Viscardi examines the space between art and architecture through explorations of solid/void, presence/absence, static/dynamic, and material/ephemeral continuums. Using drawing, a practice common to both art and architecture, Viscardi employs Rapidograph, ink wash, and graphite to reveal intricately detailed examinations of shadow and void. These shadow mappings have been the basis of the artist's twenty-year practice and pedagogy, and most recently, are the subject of this compelling exhibition Tracing Time to Measure Space which articulates the artist's process through drawings and three-dimensional constructions. Generated from time-based interactions during three periodic intervals of day — morning, noon and night — the ephemeral play of shadows is made static through sequential tracings that collapse space and time into one singular composite drawing. The resultant drawings, referred to by the artist as primitives, visually map the process that is both the basis for Viscardi's practice and the subject matter of his work. Viscardi's process is derived from traditional architectural drawing methods that privilege the hand and eye.

While contemporary architectural practice has indeed shifted from handcraft to digital design, the process by which external factors (formulas rather than light) affect or influence the built form is still prevalent today. In this way, Viscardi's practice is very much relevant to contemporary discourse while also remaining true to the craft of handmade fabrication with its attention to detail. This intimate process of drawing as a multisensory and intuitive experience is fundamental to all of Viscardi's work. The drawings in this exhibition result from the collusion of phenomena: the physicality of the object casting a shadow, the quality of light in real time and space, and the negotiation between the materials and the artist's hand.



Contact: email

Keywords: Art, Architecture

Quelic Berga Carreras

Babel Quàntic
Generative installation (Processing projected on screen + high resolution digital prints)

Topic: Generative Art, Portraits

Authors:
Quelic Berga Carreras
Universitat Oberta de Catalunya, Department of informatics, telecos and multimedia.
www.uoc.edu

Main References:
[1] Video: http://vimeo.com/7905471
[2] More information: http://quelic.net/babel-quantic/

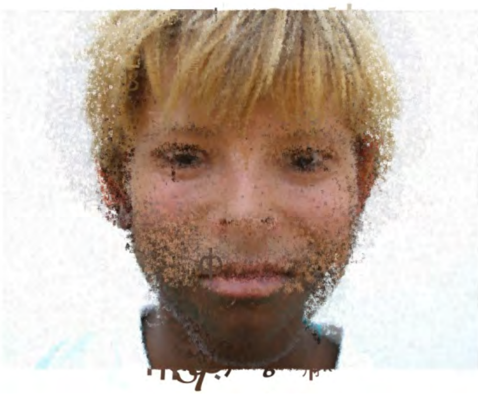
Abstract:
Babel quàntic (2009) uses most of the alphabets and several pictures from people from the world to create new human faces and new words. Impossible words give shape to impossible faces: some rather monstrous, some of incredible beauty.
It is a generative artwork that creates endless faces and though, it is a celebration of diversity. Human creativity (through language) combines with the laws of genetics (face characteristics) to produce never ending, new, realities.

Programmed with processing.

2009 Prize Jaume Graells on Digital Art

Image detail of print quality:

Images of 3 generate portraits:



Contact:
qberga@uoc.edu

Keywords: generative art, processing.org, hi-res prints, open-source

Presentation of Babel Quantic

Prof. Quelic Berga Carreras

Department of Informatics, telecommunication and multimedia,

Universitat Oberta de Catalunya, Barcelona, Spain

www.uoc.edu

www.quelic.net

e-mail: qberga@uoc.edu

Figure 1. Portrait of one of the generated and then printed faces of Babel Quantic

Premise

Babel quàntic (generative installation 2009) uses thirteen different alphabets from the world to create new words and new human faces. Impossible words give shape to impossible faces: some rather monstrous, some of incredible beauty. It is a generative artwork that creates endless faces and though, it is a celebration of diversity.

Human creativity (through language) combines with the laws of genetics (face characteristics) to produce never ending, new, realities.

The piece is a continuation of the work *Salt Quàntic* (2006). It uses the scripting language of processing.org and it was programmed by the artist.

1. Context

Babel Quàntic is the continuation of the artwork Salts Quàntics *[1] from the same artist. Both are strongly related to the hometown of the artist that has around 80% of immigration rate. The richness of the human and cultural landscape of the village was always inspiring the artist in his aim to envision the ideal future city with mixed cultures and ethnics.* Salts Quàntics (2006) *is an interactive sound-reactive artwork that mixes faces every time people sing, shout or make any noise. In this case, the artist invites people to use words and sounds, to communicate, express and dialogue, with the aim to reinforce the social network that daily grows in the city through human interaction.*

Babel Quàntic *was done during a long trip to Singapore where the artist was exposed again to a very mixed society. In this case the exposure of the artist to a very different culture helped him focus on to the linguistic part of the multicultural fact, hence he explored ways to integrate the concept of culture in this work.*

Figure 2. Detail of the lips of one of the resulting faces.

2. Description of the process

This artwork uses Processing [2] open software to mix parts of faces from a database of 40 different pictures of faces of people from several parts of the world (Europe, South-America, Africa and Asia) pictured in Salt (Spain) and Singapore.

Once the image is composed in the memory of the computer it plots letters to random positions from different alphabets or ideograms choosing the colour that corresponds to the position of the image composed previously. The resulting effect is an image composed by letters and ideograms instead of squared pixels.

The software plots about 20.000 new ideograms and letters per frame and changes the parts of the composed face every 10 seconds approximately. See an online render of the working artwork at vimeo platform [3]. The resulting effect is a morphing face, sometimes very defined, sometimes fuzzy, but always changing.

It uses the technique of overlapping letters and ideograms constantly to create a complex texture as the skin of the portrait.

Because typography is vectorial the quality of the image can be scaled to a potentially infinite size which allows very high resolution prints. See an example of the quality of the texture in the Figure 2*.*

3. Concept

The artwork reflects on the idea that culture and genetics evolve and recombine constantly. It is a celebration of fuzzy frontiers between identities and languages where boundaries become links of unity to create a new mankind out of union, mix and randomness.

Conceived to be contemplated, the viewer becomes the observer of the mixing never-ending unique faces.

4. Exhibitions and prizes.

4.1 Collective exhibitions

- **WORK IN PROGRESS***. Centre de Cultura "Les Bernardes" de Salt (Girona), Spain, July 2012*
- **OFFF BARCELONA***, Spain, June 2011.*
- **SENYALS I INTERFERÈNCIES***. Fundació Atrium Artis, Girona, Spain, May 2011*
- **TENS 5 MINUTS PEL CONSUM CULTURAL***. Espai Gironès, Salt, Spain, May 2010.*
- **FESTIVAL SURPAS'09***. Portbou, Spain, Sept 2009*
- **LABFABRICA, LABORATORI DE NOVES TECNOLOGIES DE CELRÀ***, Spain,* July 2009
- **NANYANG POLYTECHNIC SCHOOL OF INTERACTIVE AND DIGITAL MEDIA**, Singapore 2009
- **FESTIVAL INTERNACIONAL DE VÍDEO I ARTS DIGITALS, VAD** *, Girona, Spain, 2007*

4.2 Individual Exhibitions

- **ART DIGITAL: Quelic Berga Carreras***. Sala Municipal d'Art de Igualada, Spain, Mars 2010.*

4.3 Prizes:

- **1st Prize "Ciudad de Igualada'09 Awards"** *for Digital Art for Babel Quàntic, Spain, 2009*

Figure 3. Portrait of one of the generated and then printed faces of Babel Quantic

5 References

[1] http://quelic.net/salt-quantic/

[2] http://www.processing.org

[3] Video http://vimeo.com/7905471

Quelic Berga Carreras

An online short-film editing machine with a fixed structure and pseudo-infinite combinations.
TYPE of proposal: ***Poster***

Topic: Audiovisuals, Generative Editing, Art

Authors:
Quelic Berga Carreras
Universitat Oberta de Catalunya, Department of informatics, telecos and multimedia.
www.uoc.edu
Juliá Minguillón
Universitat Oberta de Catalunya, Department of informatics, telecos and multimedia.
www.uoc.edu

Main References:
[1] Gifreu-Catells, A. (2011). “The Interactive Documentary. Definition Proposal and Basic Features of the New Emerging Genre”.
[2] Laskari, D. I. (2008). The Generative Audiovisual Narrative System.
[3]Manovich, L. (1999). Database as Symbolic Form. *Convergence: The International Journal of Research into New Media Technologies*
[4] *See the working project at: http://iam.caotic.net*

Abstract:

The online art project intends to reflect on the possibilities of generating automated, pseudo-aleatory cuts of a 25'' short-film.
The poster explains the main 3 parts of iAm artwork: How the shooting have been done, how does the software works and how have the data visualization been conceived.
It shows the structure given to the script, the shootings and the later XML classification of the footage.
It explains the software architecture and describes the process that is followed to generate a unique short-film.
It analyses how the data visualization have designed for this specific project.

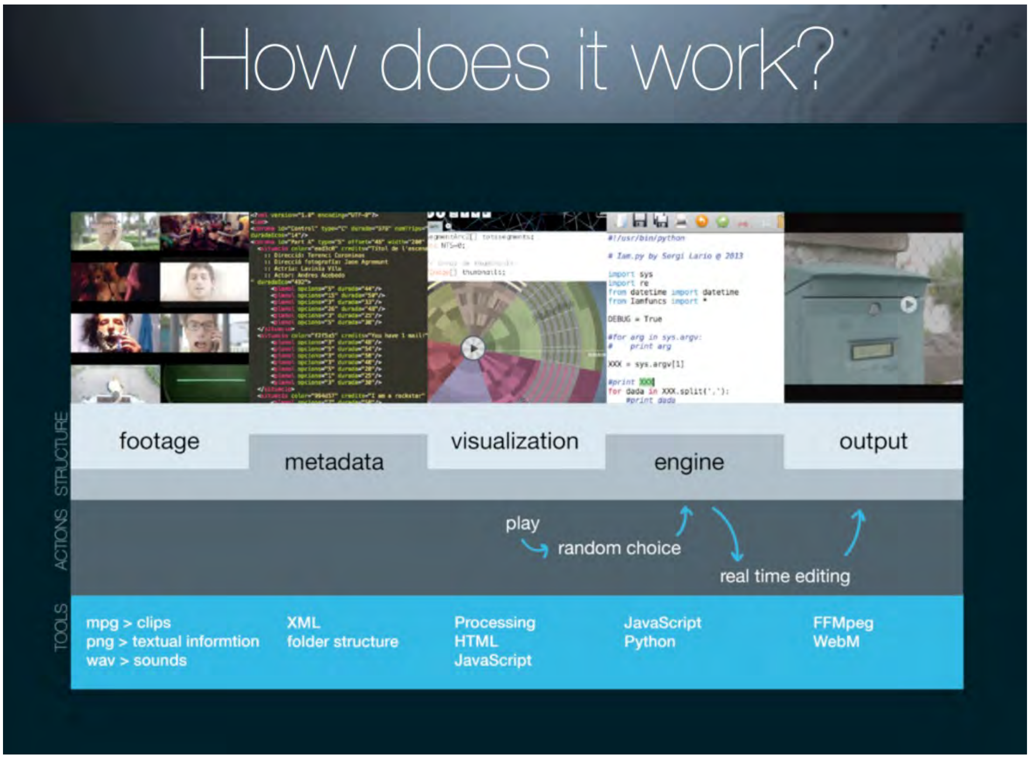


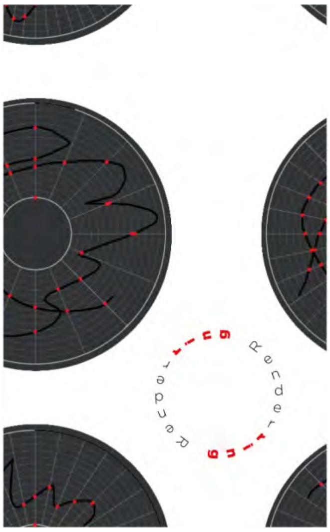
Image: Screen-shoot of a powerpoint presentation, part of the poster.

Contact: qberga@uoc.edu

Keywords: generative video editing, interface, data visualization, co-authorship, technology, patterns, processing.org, web-based, open-source

Chin-En kEiTH Soo

TITLE of proposal : *Render**ring** Installation*



(*Topic:* Interactive Art

Authors:

Chin-En kEiTH Soo

Senior Lecturer
Computer Graphic Design

Department of Computer Science

Faculty of Computing and Mathematical Science

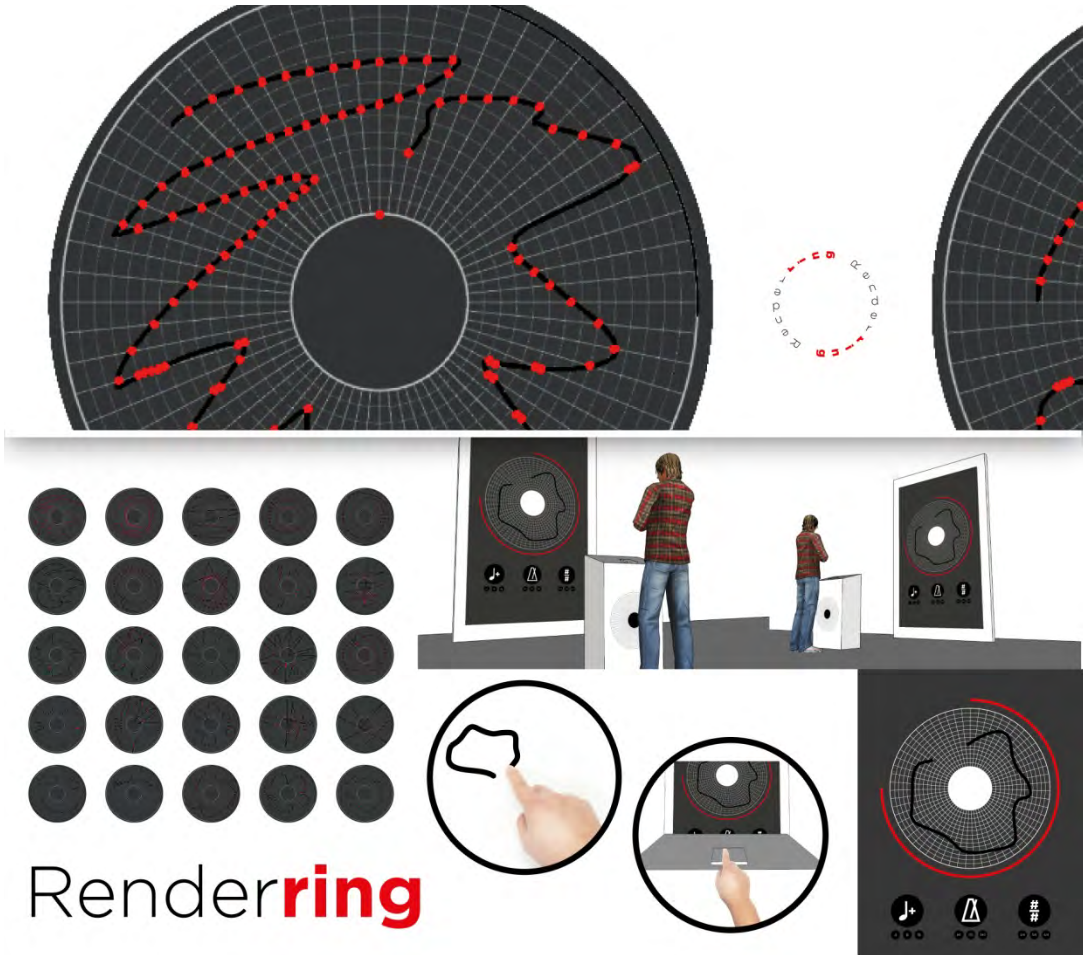
University of Waikato

http://www.cms.waikato.ac.nz/people/ceks

Abstract:

Renderring is a musical platform for intuitive composition. It enables users' interaction to provide opportunity for anyone to draw a unique circle and translates the drawing into a piece of melody. Users are able to set the composition variables before they start (Tempo, time signature and number of notes). The process involves two parts: First is a collection of user input by getting user to draw any unique circle in a provided space. Second is an interpretation using the program to decipher the drawing and identify point of intersections on the musical staff. After which, the program will produce a unique piece of melody with the user's drawing. The user can then proceed with options of redoing or saving the melody.

Renderring aims to bring new experience to create melody with a vision to simplify complexity. Transferring oneself energy from one form to another by converting visual to sound. The process enables creativity and empowers everyone to express his or her hidden inner potentials by making straightforward music.



Contact:ceks@waikato.ac.nz

Keywords: Intuitive, Composition, Music, Interactive

Slawomir Wojtkiewicz

Illusion of perception - artwork, performance, poster

Topic: Generative Art, theory, design, architecture

Author:

Slawomir Wojtkiewicz

Technical University of Bialystok

Faculty of Civil and Environmental Engineering

Poland

www.materialy.wb.pb.edu.pl/slawomirwojtkiewicz/

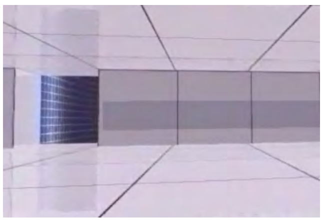
Main References:

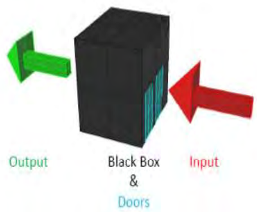
[1] Stiny G, Mithell W J, (1978).The Palladian grammar. Einvoronment and Planning B: Planning and Design 5 5-18

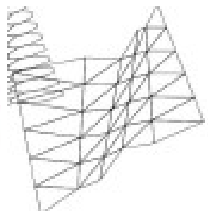
[2] Mandelbrot M., (2004) “Fractals and chaos” The Mandelbrot Set and Beyond”. Springer. New York, N.Y., U.S.A.

Abstract:

A Generative system is a structure of algorithms which are capable of generating a diversity of solutions. We can evolve those solutions by parameterization. Parameterization is not restricted to manipulating values or attributes. It extends to include algorithms. A system is synonymous to black box of algorithms. This box has doors (parameters), which allow us to handle maintenance of the algorithms. We design with rules all the time. There are many compilations of rules to provide a certain level of comfort and functionality in spaces we design.
Rules allow us to :
1. adjust sequencing of algorithms
2. control the treatment of parameters
3. guide responsibilities among designers
4. secure a convinced level of quality.
While artists and craftsmen typically do not express their process in writing, or of formalized methodologies of work, many scholars managed to describe works of art in algorithmic terms. Algorithms can be expressed in diverse representations: graphic, verbal, pseudo code, and programming languages such as RhinoScript, or others.
In my artwork I consider the following example. I develop an algorithm to populate a series of square tiles on a surface. I call this process illusion of perception. In final art experiment I obtain a shape of cube in close relation of outdoor and indoor. In this approach I take an attempt to create my own generative and algorithmic art system combined experiments with space. The result I wish to present is a short 3d movie appears through experiments that I carried out.
The aim of the research project is to discover and describe the mechanisms governing the logic of the space and the composition in the art and architecture. An important element is the analysis of the stages of development of space and “work” taking into accounts the factors affecting its value. Showing the relationship between objective and subjective factors in design - individual elements in the pragmatic and emotional defining the concept of beauty. The final results of the project - 3d computer animation would explain patterns in the process of composition and relate to aesthetic concepts such as art, beauty, style. Then describe the language through grammar patterns and concepts affecting the emotional and realistic dimension. Thus my artwork is a graphical representation of the algorithm, parameters and rules.







Contact:
.wojtkiewicz@pb.edu.pl

Keywords: Architecture, generative art, algorithms, rules, parameters, 3d animation

Jay Hardesty

A music ecosystem based on algorithmic analysis and hybridization of existing music.

Poster

A music ecosystem based on algorithmic analysis and hybridization of existing music.

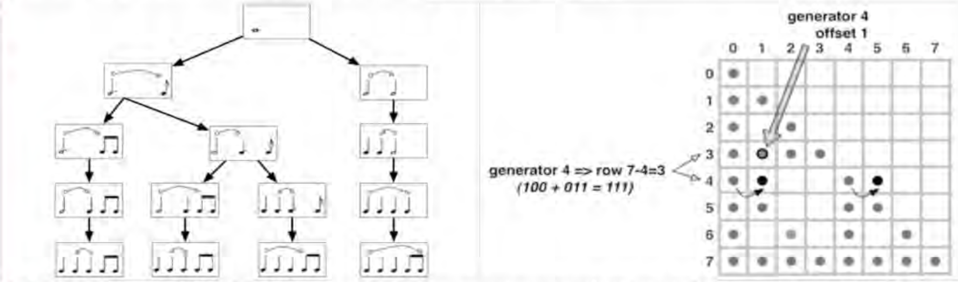
Jay Hardesty
Zurich, Switzerland
http://coord.fm

Main References:
[1] Jay Hardesty, *A self-similar map of rhythmic components*, Under submission.
[2] Arthur Komar, *Theory of Suspensions: A Study of Metrical and Pitch Relations in Tonal Music*, Princeton, Princeton University Press, 1971.
[3] David Huron, *Sweet Anticipation: Music and the Psychology of Expectation*, Cambridge, Cambridge, MIT Press, 2006.
[4] Fred Lerdahl and Ray Jackendoff, *A Generative Theory of Tonal Music*. Cambridge, Cambridge, MIT Press, 1983.
[5] H.O Peitgen and H. Jurgens, *Chaos and Fractals: New Frontiers of Science*, Berlin and New York, Springer-Verlag, 1992.

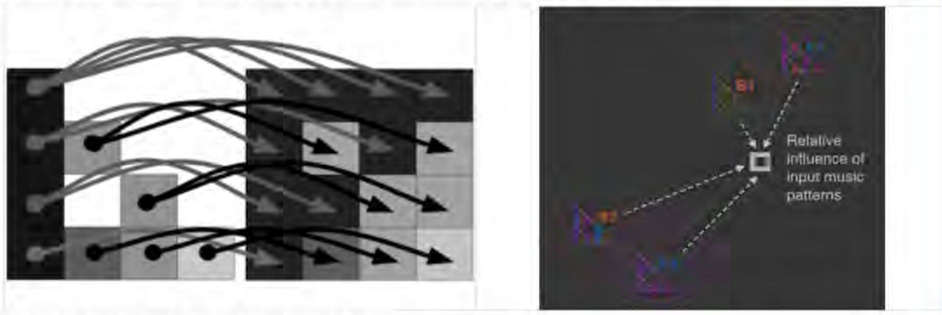
Abstract:

Music embodies varying degrees of balance between predictability and surprise, between coherence and immediacy. A particular intersection of number theory and music theory enables generative music production that navigates that balance, at two distinct levels.

Expectation in music is driven largely by interplay between repetition and meter. A map of that interplay facilitates algorithmic analysis and regeneration. That map consists of rhythms whose internal structure is entirely accounted for by parallel rhythmic anticipations. This nesting of simple, repetitive rhythmic relations within hierarchical meter gives rise to generative structure where self-similarity folds those possibilities into a tractable set that can be easily navigated. Music that is parsed into those rhythms can readily and meaningfully be mutated by other pieces of music which have similarly been analyzed.



A higher level at which this generative process plays a role is in an ecosystem of musical pieces produced by navigating the landscape of musical analyses described above. By factoring key rhythmic relationships within and between pieces of music, it is possible to compare, vary and hybridize material, creating new music that becomes a potential input back into the process. At this level a kind of musical natural selection takes hold. Preferred musical output is more likely to be re-used as a musical input, leading to further output. Music structure that is rich in possibilities for variation and mutation will produce more offspring and influence a greater portion of the resulting musical ecosystem.



A proposed poster session would:
1) Identify specific, simple elements of music theory that form the basis for the analysis and generation described here.
2) Outline the number theory that provides a concise mapping on all possible configurations described in item 1.
3) Demonstrate application of that mapping to algorithmic real-time music analysis, hybridization, and variation.
4) Create examples of music resulting from this generative process, thereby placed in a larger generative landscape where preferred results become the inputs to further generative composition.

Contact:
jayhardesty@gmail.com

Keywords:
Music, composition, algorithmic, prediction, generative, interactive

XVIII Generative Art
Live Performances

Piero della Francesca, detail

INIRE

Live Performance: Le corps sans qualités

Topic: Art

Authors:
INIRE

Krzysztof Pawlik
Małgorzata Dancewicz

www.inire.net

https://vimeo.com/inire video

http://culture.pl/en/artist/inire

References:

Gilles Deleuze, Félix Guattari, *Anti-Œdipe,* Éditions de Minuit, Paris, 1972

Gilles Deleuze, Félix Guattari, *Mille Plateaux*, Éditions de Minuit, Paris, 1980

Antonin Artaud, *Pour en finir avec le jugement de dieu*, recorded November 22-29, 1947 ***http://www.ubu.com/sound/artaud.html***

INIRE creative interests revolve around the links between performance art and new technologies. It blend traditional composing with reproducing, improvisation, recording and mastering. Their music is sonic exploration situated somewhere between sound art, field recording, noise and references to contemporary music. Audio and video analogue modular systems play an important role in INIRE's compositions, their emphasizes the blurred line between new and old media.

Audiovisual performance *Le corps sans qualités* is inspired by Deleuze and Guattari's theories and concerns of voice, speech and language system, considered as biological constructs involved in a musical context. Words are stripped here from their physiological shape, so that they lost both - their semantic functions, as well as a recognizable form. Linguistic approach, combined with biological and technological, deprives each other, body of language and language of body. *Le corps sans qualités* is a monochrome feedback loop, visual performance for voice and voltage controlled audio and video. Modular systems both, as audio as video are used here to construct the structure of tense electroacoustic harmony. Junction of analogue synthesis and digital techniques reveals common relationship of physical, abstract, analogue and digital variant shape of words, images and music.

Contact:
dancewicz@wp.pl
+48 505 057 027

Keywords:
audiovisual performance, virtual reality, virtual body, voltage controlled audio and video systems

Lance Putnam

TITLE of proposal: *Adrift*

TYPE of proposal: Live Performance (length 8 min. 35 sec.)

Topic: Music

Author:

Lance Putnam

Aalborg University, Department of Architecture, Design and Media Technology;

Art and Technology Program,

Denmark

http://www.create.aau.dk
http://www.art.aau.dk

Abstract:
Adrift is an audio/visual composition made for 3D immersive environments (currently being shown in UCSB's AlloSphere facility). The goal of the work is to allow one to intuitively experience what it could be like to be inside a mathematical space embodied through unified visual and aural sensations. The underlying algorithm is a recursive matrix multiplication that generates a continuous sequence of coordinates. Adjusting the matrix coefficients gives an endless variety of both regular and complex patterns. The work interpolates from one parameter set to another producing an evolving visual and sonic environment. The coordinates are graphed in space as oriented triangles and connected in sequence with light-like "rays" (Figure 1). Sound is generated by scanning along the rays and mapping the position information to the phases of several sine oscillators. The sound is spatialized according to the position of the viewer allowing local timbres to be emphasized and transition as the space is traversed.
The work will be run live from the performer's laptop. The room setup is shown in Figure 2. A more minimal setup of one projector and two speakers is also possible depending on available equipment. A preview of the work can be found online [1].

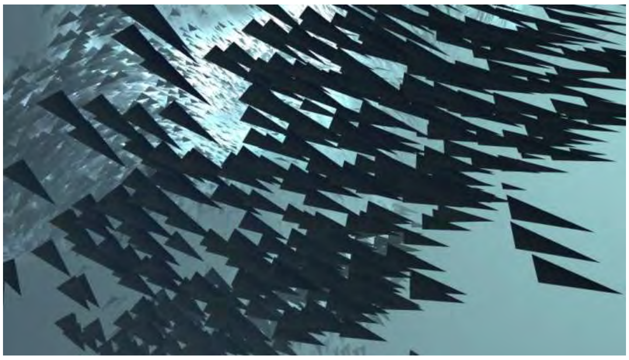


Figure 1. Still from *Adrift*.

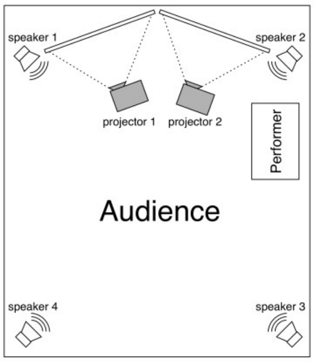


Figure 2. Two projector, four speaker setup for the performance.

Main References:

[1] http://www.mat.ucsb.edu/~l.putnam/adrift

Contact: lp@create.aau.dk

Keywords: Audiovisual composition, immersion, complex systems, mathematical art

Steffan Ianigro

Plecto – A performance using audio created by evolved Continuous Time Recurrent Neural Networks

Live Performance

Topic: Music

Author:

Steffan Ianigro

University of Sydney,
Architecture, Design and Planning
Australia
www.sydney.edu.au

Main References:

[1] Randall D Beer, "*On the dynamics of small continuous-time recurrent neural networks.*", *Adaptive Behavior*, 3(4):469--509, 1995

[2] Oliver Bown and Sebastian Lexer, "*Continuous-time recurrent neural networks for generative and interactive musical performance.*", Applications of Evolutionary Computing, pages 652--663. Springer, 2006 □

Abstract:

Steffan Ianigro is currently a PhD candidate at the University of Sydney Design Lab. Steffan's research revolves around the evolution of Continuous Time Recurrent Neural Networks (CTRNNs) to create novel audio artefacts. Steffan is also an active musician and has written works for and performed in a variety of events, such as 'Musify Gamify' as part of Vivid Sydney 2015, Ensemble Offspring's 'The Listening Museum', 'New Wave' as part of Vivid Sydney 2013, 'Tin Shed Spots' supporting German artist Schneider TM, and 'The Silent Hour' supporting Japanese artist Marihiko Hara.

This performance is part of Steffan's current research, which began in pursuit of an Interactive Genetic Algorithm (IGA) that affords unconstrained exploration of audio artefacts. Although there are many effective IGAs for the evolution of digital audio evident in the literature, they are designed around rigid audio engines, constraining evolutionary search by the sonic possibilities of their hardware and software components. CTRNNs on the other hand can exhibit boundless temporal behaviours and are a simple nonlinear continuous dynamical model, capable of approximating trajectories of any smooth dynamical system [1]. Various configurations result in smooth oscillations that can describe audio artefacts, providing a plausible method for the unconstrained evolution of digital audio. Their complex internal dynamics therefore expand the audio search space into virtually any possibility, and can be steered by the use of an IGA that modifies the CTRNN configurations [2]. Restrictive design factors are alleviated by the low level nature of this method, opening up a completely free timbral search space. To explore this method, Steffan has created Plecto, an online system for evolving CTRNNs to produce audio artefacts. Please see the following link to a version of Plecto (the software is still in development and I ask that the link should only be used for this application). Plecto - http://plecto-51107.onmodulus.net/

Within this performance, the author will only use audio samples created by Plecto. These samples will be manipulated live to create shifting soundscapes that range from intricate naturalistic textures to thick drones reminiscent of analogue synthesisers. This performance will be a premier of Plecto therefore no recordings exist, however previous performances by the author can be found through the links below.

https://vimeo.com/100571644 - Performance for electric guitar and live electronics.

https://vimeo.com/96659337 - Performance for gas cylinder bells and live electronics.

https://vimeo.com/78329351 - Performance for custom built light sensitive Arduino synthesisers and live electronics.

Contact:
steffanianigro@gmail.com

Keywords: Continuous Time Recurrent Neural Network, Genetic Algorithm, Web Based, Evolution, Audio Samples

Yuanyuan (Kay) HE

On the Fringe of a Whale's Tail
Live Performance

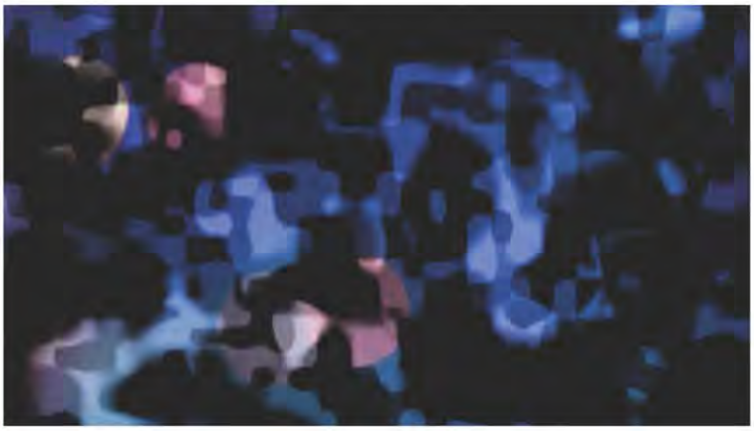
Topic: Music

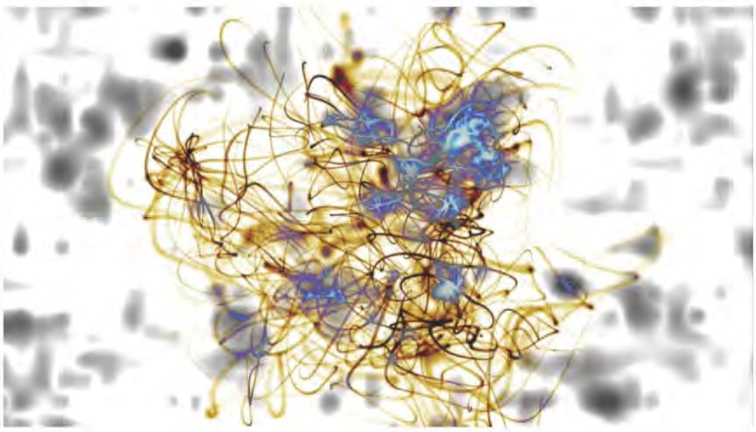
Authors:
Yuanyuan (Kay) HE
University of Texas at Austin
Butler School of Music
www.kayhecomposer.com

Abstract:

On the Fringe of a Whale's Tail for piano and electronics is written for pianist Josh Straub. The piece attempts to describe an artist's world. It is sentimental, unreal, and full of adventures, creativities and conflicts. Artist is not a manufactory profession, is an explorer with dreams. As artists, it is our responsibility to show our powerful emotion of our beautiful mind and imagination to the world, and also fight with the harsh and uninspiring reality. Imagination is the most powerful weapon.

The pianist is on the stage alone, creating much fascinating sound on piano. It is the lonely reality of how an artist individually exists in this world, just like standing on a whale's tail. The electronics (audio and video), based on pre-recorded sounds of the piano and generative visual art, is the little universe he/she created by his/her imagination. It is deep, dramatic, inspiring, exciting and colorful, like the ocean. Processed piano reveals this mysterious world, which sings simultaneously with the live piano. They are tangled with each other. The audience is unable to distinguish what is real and what is the imagination. Mic'd piano with live effects represents how creative passion evokes inspiration and imagination, which sometime contrasting with the reality.





Main References:

[1] Yuanyuan (Kay) He, "*On the Fringe of a Whale's Tail*", KHE Music Publishing, Austin, TX, 2014

[2] Live performance at UT Austin
video of performance

Contact:
kayhecomposer@gmail.com

Keywords:
piano, electronics, visual art, contemporary music, live performance

Davy Grégoire
Chung Yun

Xizhi *Live Performance*

Topic: Music
Authors:
Grégoire Davy
France
Chung Yun
Taïwan
www.spinzero.org

汐止 (潮汐所止)

Where the tide stop

Xizhi is a little town in north east of Taipei. In past, people gave this name after a big tide, increased by summer rains, reach this town distant from the coast.

Xizhi it's also the place where has been born our child, this august, during the super typhon days.

To be a bowl player,

no matter how tones like that,

all for prepare to arrive the "silent land"

to feel a strong and deep implosion.

C.Yun

The sound performance, dedicated to this event, will mix acoustic sounds of singing bowl, beans, leaves and computer synthetizer.

Contact:
aagregaas@yahoo.fr,
vena19861203@gmail.com

Keywords: fields recording, singing bowl, granular synthesis

Enrica Colabella
Celestino Soddu

Voiced syllables in the wind sound
Performance

Topic: Generative Art, Poetry and Music

Author:
Enrica Colabella
Celestino Soddu
Generative Design Lab, Politecnico di Milano University - Italy
www.generativedesign.com

Tenore SOS Emigrantes:
Marco Giobbo - Boche Orgolesa (Orgosolo)
Maurizio Pittalis - Boche Orunesa (Orune)
Istevene Pira - Bassu (Nuoro)
Alessio Pireddu - Contra (Bono)
Antonio Riviezzo – Contra (Nuoro)
Giancarlo Lovicu - Mesuboche (Oliena)
Sardinia

Abstract:

Light, 3 times and *now*
Il mio canto insegue un cuore di terra: / My song is running behind a ground heart:
Forte fragile fatto come di suono *leggero*, / Strong fragile, made as of *light* sound,
Vestito d'ombra, in pio splendore. / Dressed by shadow, in pious splendor.
Il mio canto è nel vento con ritmo *leggero*, / My song is in the wind with *light* rhythm,
Come sillabe in aperta soave ricerca, / As syllables in suave open research,
Intorno al senso eterno della vita umana, / Around the human life eternal sense,
Intenso e *leggero* come foglia di sole vestita, / Intense and *light* as sun dressed leaf,
Che il vento genera in continuo. / That the wind generates in continuum.
La cadenza del ritmo nel passo musicale/ The rhythm cadence in the musical step
Ritorna al suo luogo ancestrale di battito d'amore./ Returns to its ancestral site of love' bit.
Ora, sillabe di voce sagge come una parola di Dio, / *Now*, voiced syllabes,wise as a word of God,
Voi seguite lo splendore dell'orizzonte, / You follow the shining of the horizon,
In un sottile chiarore diffuso di bellezza. / In a diffused tiny lighting.of beauty.
E' *ora* che viviamo; vedi*, ora* …/ It is *now* that we live, you see: *now*…

The idea to design this performance rises after our visiting the Giants exhibition in last summer at Museum of Cagliari and of Cabras. The recent new discover of a vast archaeological site in Cabras is real impressive and mysterious. The starting point of the performance is a poetic text by *Enrica Colabella* about the art of connection between voice and wind. The voiced text interacts with Nuraghes images of 3D models generated by *Celestino Soddu*, in unique and un-repeatable variations. Following *Tenore SOS Emigrantes* start in performing songs. The structure of this way of singing, in 4 parts, *Tenore, Bass, Contra, Falsetto,* is one of the most ancient over the entire world. It is declared by Unesco patrimony of humanity. Firstly, *Tenore* starts alone the song. In second time *Bass* starts by generating syllables as a sound that tries to imitate the power of wind slow and strong searching words. Third step is for *Contra* by following Bass in contra. The structure of the meeting is an open research toward harmony. When harmony is gained the fourth voice starts in *Falsetto* as a sound in contra the Tenore incipit. This is a moment of performing a very impressive circularity. These four parts are strongly identifiable and this tradition explains a deep relationship between man and Nature. In fact, the relations are not only between human voice and wind, but also with animals. In fact Bass and Contra imitates the sounds of animals and for this unique aspect in the world Unesco declared it humanity Patrimony. This is a polyphonic structure, in fact *mottetto* is often used in Tenores performances. It is a great pleasure to see that this unique structure of sound is still alive in Sardinia, where is an actual great rediscovering of this wandering tradition in young generation. This is like an *Arcadia* still alive.

enrica.colabella@polimi.it
celestino@soddu.it
stefano.pira76@gmail.com
tenoresosemigrantes@gmail.com

Keywords: Generative Art, Poetic Logic, Generative Design, Futuring Past, Nuraghes, Stone Age, Sardinia Tenores Music, Polifonia, Mottetto, Hendecasyllabic, interactive voices and generated images

Each of the Generative Art 2015 Abstract books are jointed with a print of a Generated *Nuraghe* in anamorphic representation. Each one is different and unique and it is a gift for each participant to XVIII Generative Art conference: 56 different prints of different generated 3D models of *Nuraghes*. They were created by Celestino Soddu, using his Argenia software.

The generation of *Nuraghes*, the stone age architectures, existing in over 7,000 units in Sardinia, Italy, was performed referring to the last discovering of stone statues of *Nuraghes* models, carved around 2,000 years BC. The generation was done interpreting as algorithms these ancient statues. The representation was done using anamorphic reverse perspective with conic interface performed by C. Soddu with his personal software. This reverse perspective was created following the Florenskji interpretation of Russian icons. This perspective allows the possibility to represent external skins from different points of view connected in only one image. In this case the *Nuraghe*, in its conical structure, is represented from a 360 degrees sequence of dynamical points of view. The anamorphic structure performs these points of view inverting the structure of perspective and using the center of *Nuraghe* as "reversed" point of view and the original endless external points of view as "reversed" targets.

In the subsequent two pages the abacus of 56 images that is possible, using the A4 prints, to wrap into a cone for creating an anamorphic event.

Generative Art International Conference
Organized by
Generative Design Lab, Politecnico di Milano University
And
Argenia Association

www.generativeart.com