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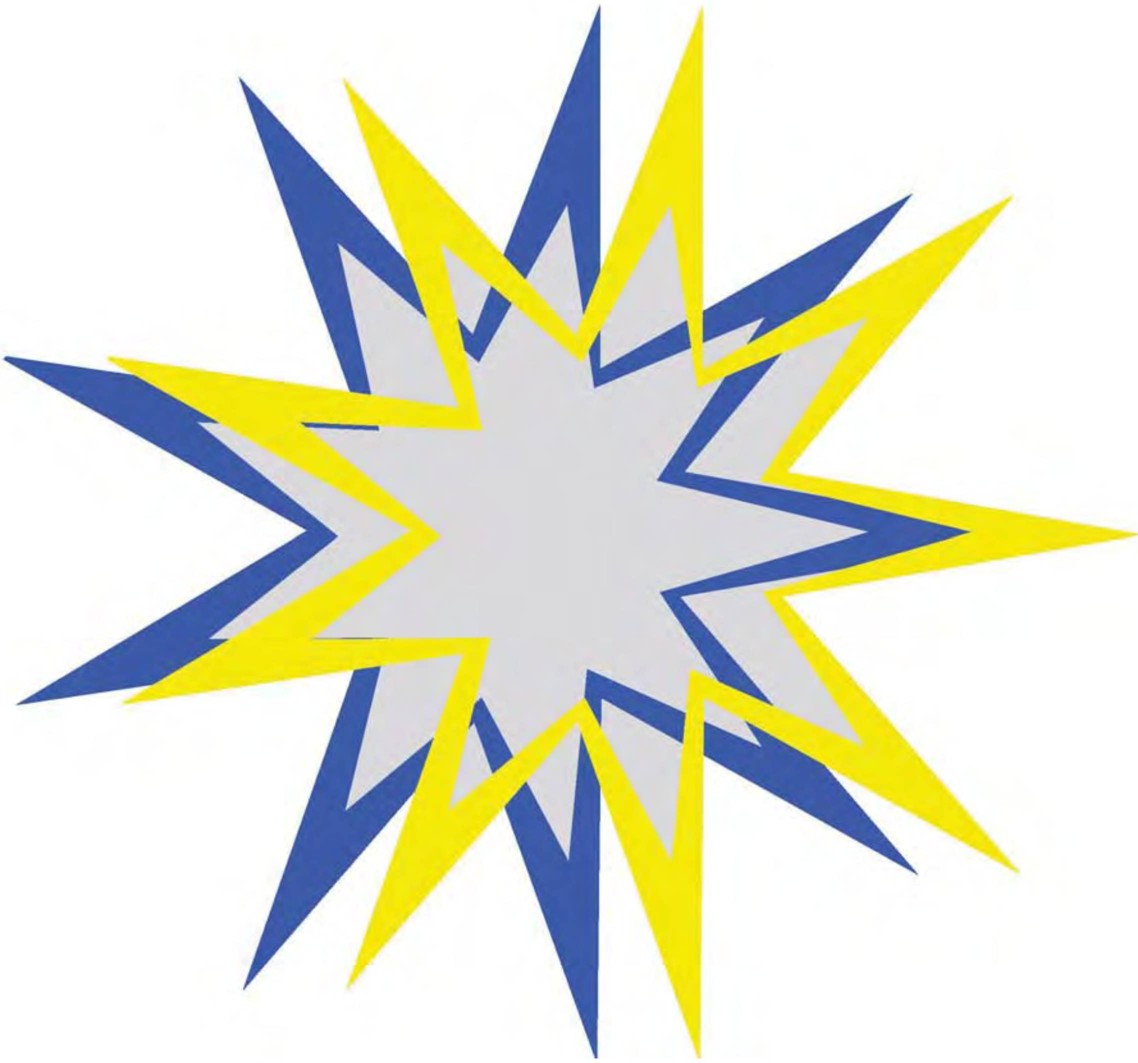

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PAPERS

Abir Acharjee

Paper: **Optimised Paneling Solution**

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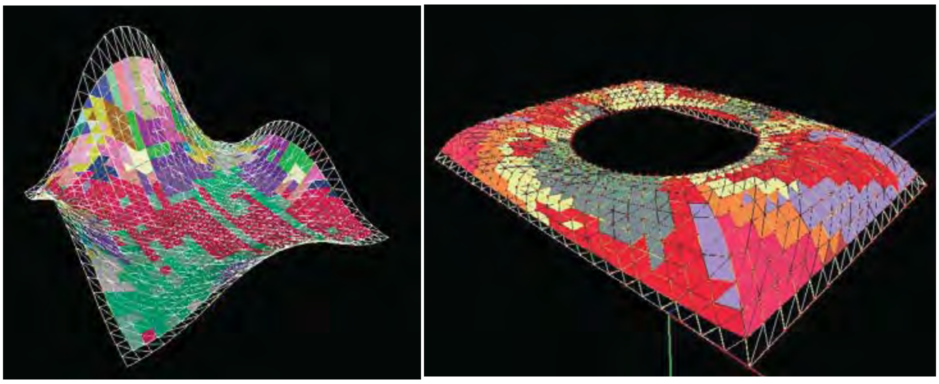
This paper will try to investigate ways in which a freeform surface can be rationalized to produce an optimised paneling solution. The research develops a generative algorithm combining dynamic relaxation and a particle spring optimization with paneling layout principles. The aim of the thesis is to minimise the number of panel variations that occur in freeform surface. Finally this leads to achieve a trade off between the rationalized geometry and its original counterpart.



Optimised Paneling Solution

Topic: Architecture

Authors:

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References:

[1] Fu, C. Lai, C. He, Y. Cohen-or, D., 2010. K – Set Tilable Surfaces, *SIGGRAPH, Technical Paper, ACM Transactions on Graphics*, Article No 44, Vol 29

[2] Eigensatz, et al., 2010. Panelling Architectural Freeform Surfaces, *ACM SIGGRAPH*

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Keywords:
Rationalization, Paneling, Geometric Optimisation, Freeform surfaces

Optimised Paneling Solution-
Design Rationalization and Optimised Paneling for Architectural Freeform Surfaces

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1. Abstract

Programmatic freedom and modeling software tools have led to a spectrum of geometrically challenging freeform surfaces. The problem lies on defining these freeform design surfaces in terms of constructible components. Different custom tessellation algorithms have thus been developed in response to this problem. These tessellations produce a large number of different panel sizes and there isn't any standard solution for rationalization of such surfaces. A paneling solution plays an important role in this rationalization process.

This paper will try to investigate ways in which a freeform surface can be rationalized to produce an optimised paneling solution. The research develops a generative algorithm combining dynamic relaxation and a particle spring optimization with paneling layout principles.

The aim of the paper is to minimise the number of panel variations that occur in freeform surface. Finally this leads to achieve a trade-off between the rationalized geometry and its original counterpart.

Keywords: Rationalization, Paneling, Geometric Optimization, Freeform surfaces, Particle-Spring System, Dynamic Relaxation

2.0 Introduction

With the emergence of large scale architectural freeform surfaces, the main challenge is to proceed from a geometrically complex design to a feasible and affordable way of production. This leads to the process of "*rationalization*" and achieving a "*paneling solution*". This process deals with the approximation of a design surface by a set of different sizes of panels that can closely approximate the design surface and can be fabricated at reasonable cost meeting the architect's perception. The main challenge in paneling these freeform surfaces lies in the complex interplay of various objectives related to geometric, aesthetics, structural and fabrication constraints that need to be considered simultaneously [1].

A smooth and continuous flow of the panel edge lines add to the rhythm, aesthetics and continuity of the structure. Quad meshes have lower node complexity. The triangular panels produce better surface approximation and continuity. Curved panels produce superior inter-panel continuity but the cost of these mould fabrication often dominate the panel cost. Planar panels are easiest to produce and cost effective. The cost of construction not only depends on the number of panels and the complexity of the paneling layout but also on the frequency of reuse of different sizes of panel, referred to as "panel types". The aim of this research is to investigate the issue of build-ability of a freeform surface to achieve a cost effective paneling solution which has minimum number of panel types that closely approximates the design surface. The research question is, therefore, what is the degree to which the reduction in the number of panel types affects the cost against the degree to which it deviates from the original surface?

3.0 Background

Dynamic relaxation and particle spring system are used in many cases for form finding. Dynamic relaxation is a numerical method which is often used in structural form-finding to find minimum surface for fabric structures of cable-nets. The aim is to find a geometry where all forces are in equilibrium. One of the early examples of the use of Dynamic relaxation in architectural design was the Great Court roof of the British Museum [2]. Particle system has received a lot of attention from the early pioneers of digital architecture and is used as a tool for form-finding using digital simulation of various architectural designs. Particle spring systems is used in the development of a three dimensional design and analysis tool which allow the user to find structural forms in real time [3]. A particle-spring approach to geometric constraints solving was presented by Thierry [4].

Parametric design approach has been taken since early twenty-first century for advanced surface rationalization. Using planar quad panels for covering general freeform surfaces with new ways of supporting beam layout was proposed for the computation of multi-layer structures [5]. This was extended to the covering of freeform surfaces by single-curved panels arranged along surface strips [6]. The concept of symmetrization was proposed to enhance object symmetry by controlled deformation of underlying meshing structure [7,8]. The idea of optimizing for repeated elements by altering the vertex positions of a given mesh is explored in the context of quad meshes [9]. A mathematical approach using discreet equivalence classes has been used for triangulated surface such that each polygon falls into a set of discrete equivalence classes [10]. This assumes a fixed topology and uses the k-means clustering of triangles. A related problem of panel mould reuse using different classes of panel geometries was proposed by using a novel 6-dimensional metric space to allow fast computation of approximate inter-panel distances [1]. This does not try to use small number of congruent shapes but address a related problem of what type of surfaces to use for minimizing construction costs.

4.0 Research Method

4.1 Overview of the algorithm

The methodology outlined in this section consists of six steps that need to be addressed in the generation of optimised paneling solution for a freeform design surface. The first phase of the algorithm defines the design surface by a mathematical construct and deals with tessellations which subdivides the surface into a series of triangles that forms the basic mesh. In the second step dynamic relaxation is used to get a better distribution of nodes on the surface [11]. The third step utilises a particle spring system. The particles are released from the surface to get the specified panel edge lengths for the respective edges falling under specified ranges. In the fourth step, panels are casted and laid down on this released surface to achieve a *“Panel Binning Solution”*. In the fifth step panels in each of the panel type are studied in details and *“Mother panel”* for all panel types are declared. In the sixth step, the panels in a panel type are replaced by the mother panel of that panel type.

4.2 Description of NURBS Surface

The basic surface geometry is defined by “*NURBS”,* which is industry standard tool for the representation and design of geometry [12]. NURBS stands for Non-Uniform Rational B-Splines. It offers a common mathematical form for both analytical and freeform shapes. The main components of a NURBS surface are the “*control points*”, its associated “*weights*”, “*knots*” and “*degree*”. Various surfaces can be generated by moving their control points and changing the density of tessellation. The control points have an associated polynomial equation named as the *“basis”* function. A rational B-Spline is defined as the ratio of the two basis function in *“u”* and *“v”* which are the two directions of the parametric space of the UV coordinate system [13]. Two polynomial equations i.e. basis-U (Ni,p) and basis-V (Nj,q), where the shapes of the basis functions are determined by the knots vectors xi, and defined by the following formula for the u-direction and alike for the v-direction [11,12].

$$N_{i,1}(u) = 1 \quad \text{if } x_i <= u < x_{i+1} \qquad (1)$$
$$= 0 \quad \text{otherwise}$$

$$N_{i,p}(u) = (u-x_i)\, N_{i,p-1}(u) / x_{i+p-1} - x_I + (x_{i+p} - u)\, N_{i+1,p-1}(u) / x_{i+p} - x_{i+1} \qquad (2)$$

Subsequently the final calculation of the NURBS curve is determined by a parametric equation which calculates the points on the curve for u and v respectively.

$$P(u) = \sum_{i=1}^{m} N_{i,p}(u)\, P_i \quad \text{and} \quad P(v) = \sum_{j=1}^{m} N_{j,p}(v)\, P_j \qquad (3)$$

Given *m* is the number of control points vertically and *n* is the number of control points horizontally. From (1) and (2), $N_{i,p}$ (u) and $N_{i,q}$ (v) are the B-spline basis functions with degree *p* and *q*; P_i and P_j are the array of m x n control points. From (3) the resultant P(u) and P(v) define the points on the surface for a specific u,v location. The code uses a double loop that calculates the NURBS equation for all the control points and returns a 3D vector containing the XYZ position of the points on the surface.

4.3 Description of Dynamic Relaxation

The aim of the relaxation process is to find a geometry where all forces are in equilibrium and to have a better distribution of nodes throughout the surface. The panel edge lengths are used as weights in the NURBS equation and determine the direction that gets the majority in the optimization. The relaxation process only affects the position of the nodes in the parametric space; therefore the nodes are free to move around on the surface through manipulation of their respective "*u*" and "*v*" coordinates.

4.4 Description of the Particle Spring System

The main aim for the inclusion of a particle spring system is to fix the initial panel edge dimensions to a fixed number of lengths before the panels are formed. This reduces the variations in panel edge lengths for the overall topology. Four variation of lengths (6, 8, 10, 12 variations) will be tested. The system consists of a series of particles which act as the nodal points for the original surface and a set of springs which connect the nodes via the specified tessellation pattern. The preliminary positions of the nodes are derived from the mentioned NURBS algorithm. At each iteration, the movement of the nodes are established depending on the ratio of the actual length to ideal spring length [14]. The spring lengths are compared against a series of ideal lengths, which are calculated prior to optimization. Each of the three sides of the panels are analysed individually. The springs are released from the surface one at a time and if their lengths are within a defined range then they are re-sized based on the ideal length of that range (Figure 1).

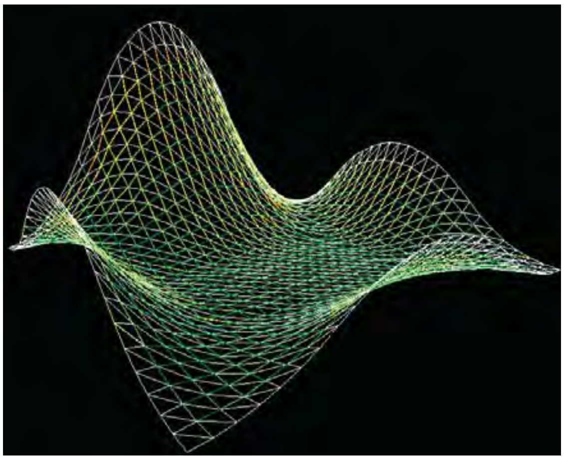


Figure 1. Surface after releasing with set number of lengths

4.5 Description of the Paneling Layout

"Panel types" refer to the different sizes of panels on the surface. Two panels with same panel types must have their respective edge lengths within specified *"tolerances"*. *"Kink Angle"* is the angle between these two panels (Figure 2).

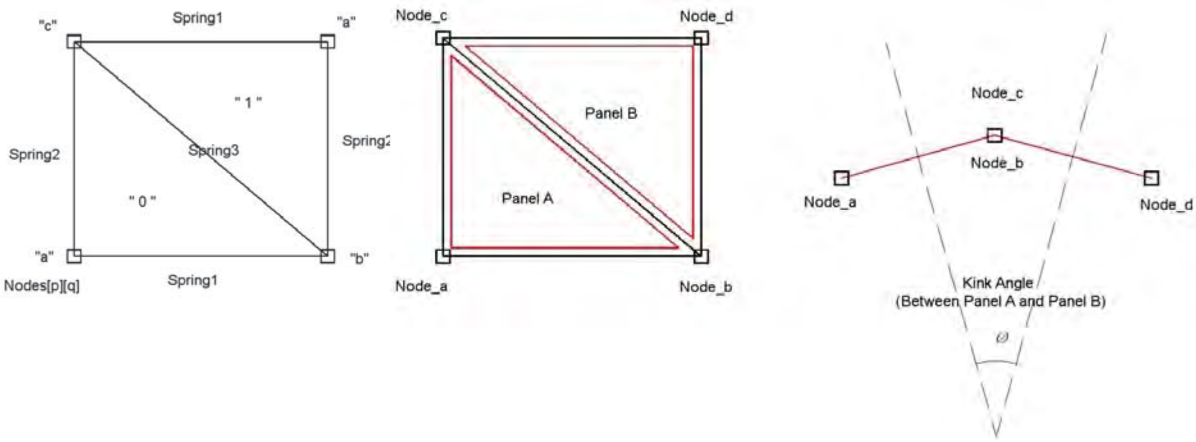


Figure 2. A node with two panels and the kink angle between them

4.6 Description of Panel Binning Solution

The *"Panel Binning solution"* is the process of extraction of the number of panel types. Two panels are selected and each of its edges are analysed. The respective shortest sides, medium sides and longest sides for these two panels are compared. If the differences in lengths are within the specified tolerance they are assigned the same panel type or if they do not match with the existing panel types a new panel type is declared. This is repeated with all the panels (Figure 3).

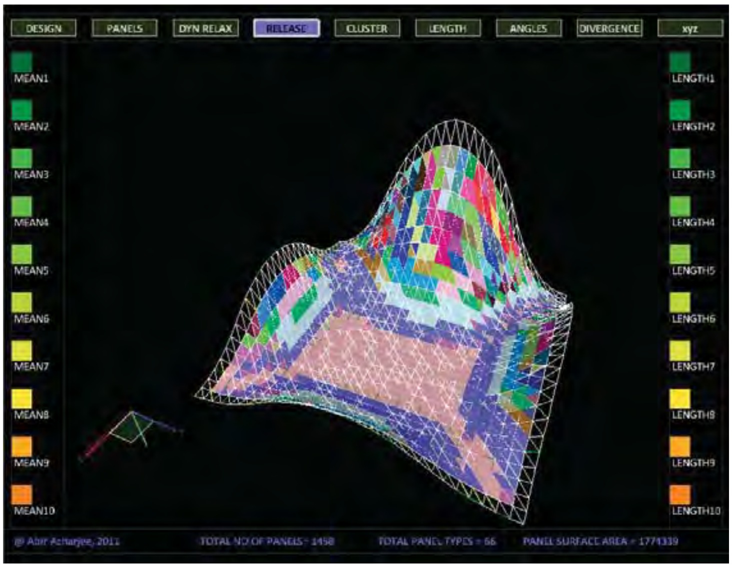


Figure 3. Panel type's extraction

4.7 Formation of Mother Panel and Description of Panel Mapping

Panel edge lengths and areas of each panel in a panel type are analysed and they are sorted with respect to their areas in that group. The minimum panel for each group is declared as a *"Mother Panel"* of that group (Figure 4). The panels in a particular group are replaced by the mother panel of that group. The mother panel dimensions can be used for fabrication purposes. A variable offset for every panel is calculated based on the panel's area, its panel type and the mother panel for this panel type. The tolerance used in the panel edge lengths contribute towards the divergences.

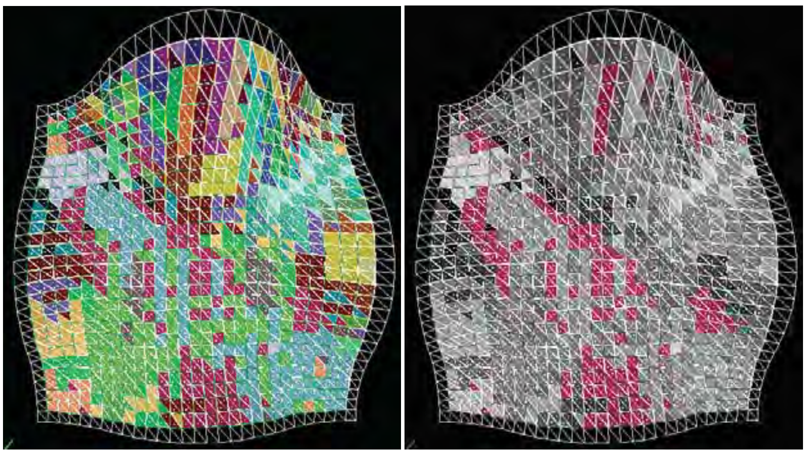


Figure 4. Showing all panel types (left), showing one panel type in red (right)

5.0 Experiments

5.1 Parameters for the Experiments

The experiments aim to pick up from the constructional phase of a design project and assume a defined topology which needs to be resolved for fabrications. Thus a single surface is defined as opposed to testing multiple surfaces. The system unit is defined as *"mm"* (millimetre) with a maximum tolerance of 0.1 mm. Seven categories of node samples, which are controlled by the density of triangular grid, are taken in total and the standard deviation of the panel dimensions for each node category help to determine the cost-effective density of the tessellation for initial experimentation.

The first set of experiments deal with dynamic relaxation to analyse the extent of its ability to reduce the variations in the panel edge lengths. After releasing the nodes using particle spring optimization the reduction in the number of panel types is analysed. The deviation of each node from the original surface is tested for understanding the overall deviation. The difference in the kink angle between two consecutive panels of the original surface and that of the optimised surface estimates the angular deviation. The change in structural efficiency is analysed by the change in structural stress. All these factors are tested for all the four different length variations and add up collectively to the success of the algorithm.

5.2 Analysis of Dynamic Relaxation

Dynamic relaxation settles down to a stable state after 300 iterations. Initial analysis of the spring lengths shows that out of total 2352 panel edge lengths there are 2071 different panel edge lengths. The performance of the algorithm is tested and it shows reduction in the range of panel edge length by about 27% and reduction in their standard deviation by about 12%. The maximum and minimum values are brought down by approximately 28% and 23% respectively (Figure 5).

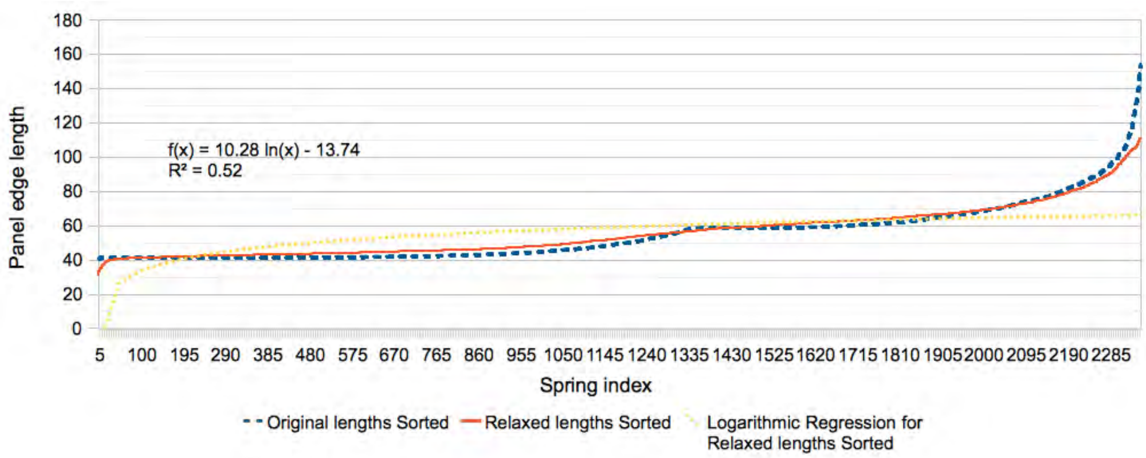


Figure 5. Reduction in panel edge length variation

Analysis of the node movements after relaxation shows that the nodes move differently to attain the equilibrium lengths (Figure 6). Analysing the difference in the kink angle between the original surface and the dynamically relaxed surface, helped to understand the effect of relaxation on the surface smoothness. A small change in the kink angle is observed (Figure 7).

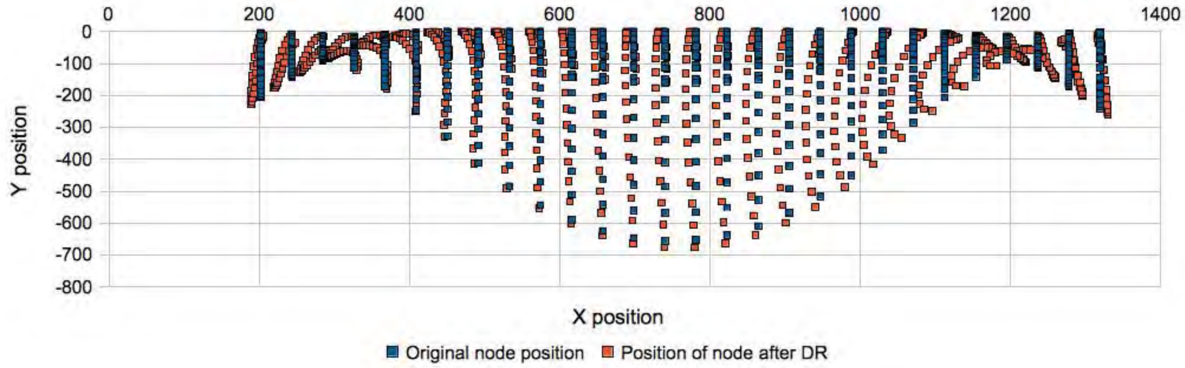


Figure 6. Movement of the nodes after dynamic relaxation

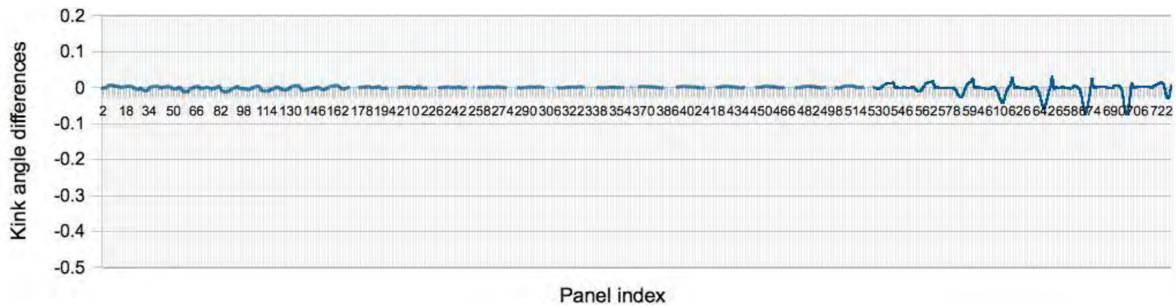


Figure 7. Difference in kink angle between the original Surface and the dynamically relaxed surface

Seven ranges of average kink angles are mapped to panel colours of the surface. The change in kink angle is mostly seen in the area near one of the saddle point (Figure 8).

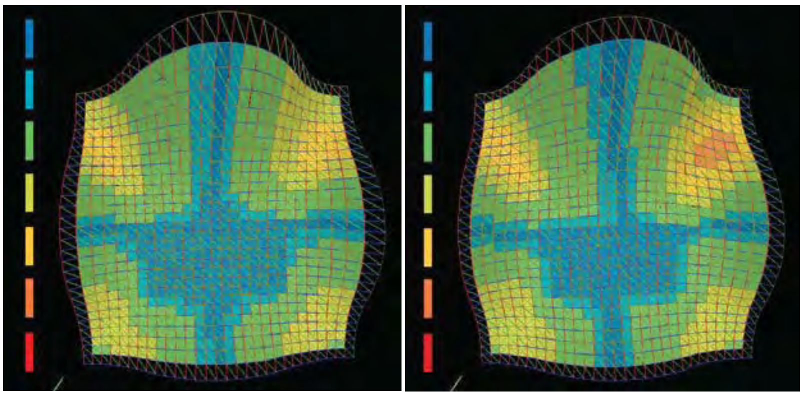


Figure 8. Mapped kink angle colours for original (left) and relaxed surface (right)

5.3 Optimization of Panel Edge Lengths and Release function

Having reduced the level of variations and total length range through dynamic relaxation, the following investigations are initialised from the relaxed position of the nodes, with all the four variations. The ideal rest-lengths are achieved through an analysis of all the panel edge lengths and dividing the actual range of spring lengths by the number of variations required. For each average value two ranges are assigned which serves as a guide for the springs (Figure 9).

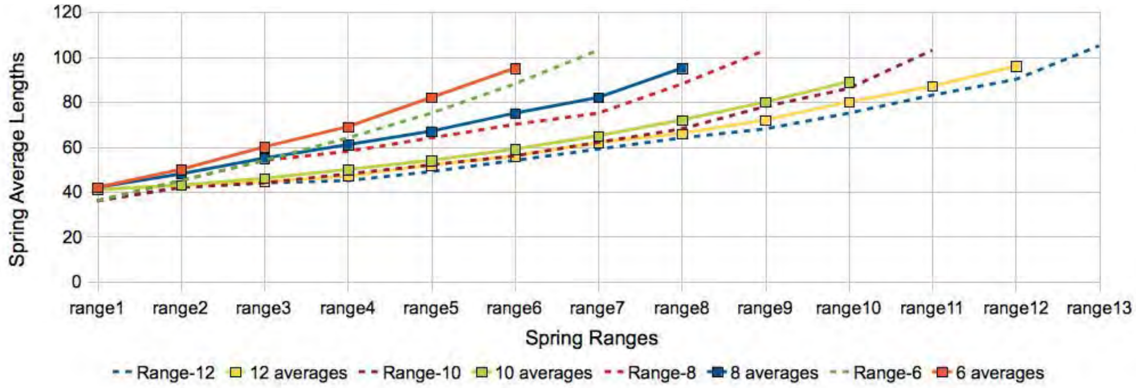


Figure 9. Average lengths for different variations in spring lengths

Spring 1 and Spring 2, which make the main quadrilateral of two panels, are released. They were constrained to various numbers of average lengths. For testing the accuracy of the optimization technique, the final rest lengths of the springs are analysed. Most of the springs are successful in achieving the averages (Figure 10,11)

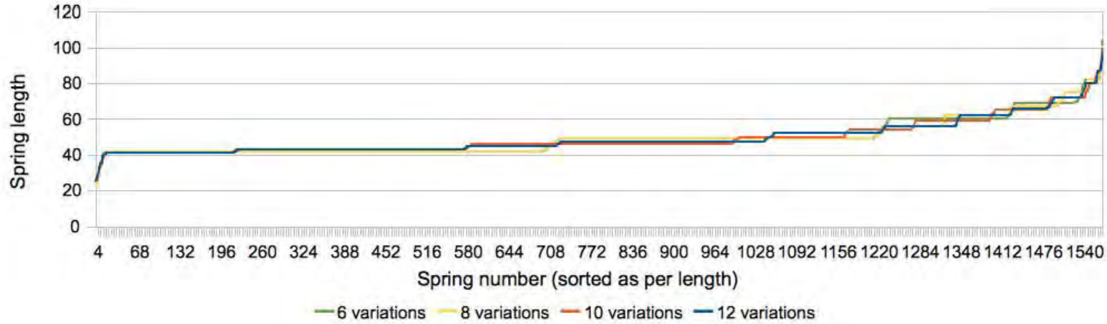


Figure 10. Final rest lengths for all the four variations

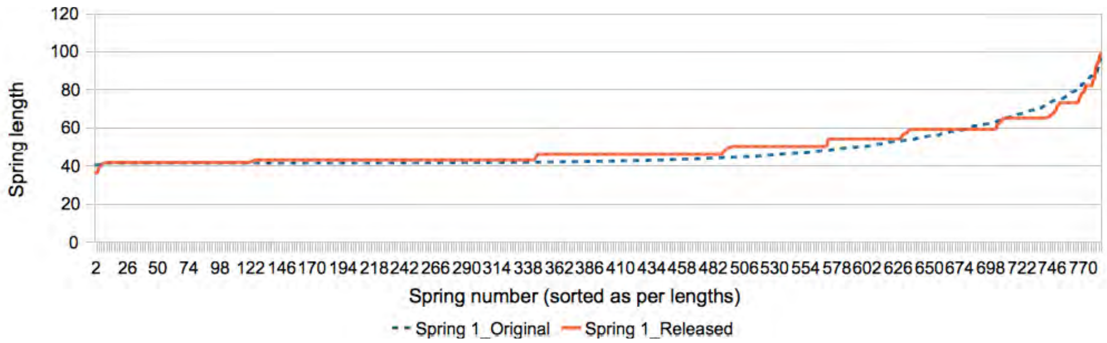
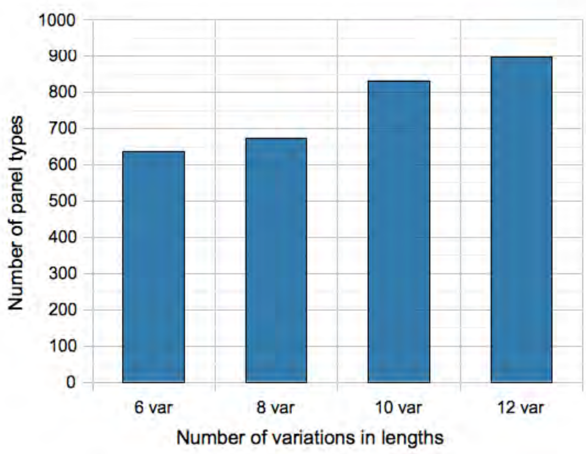


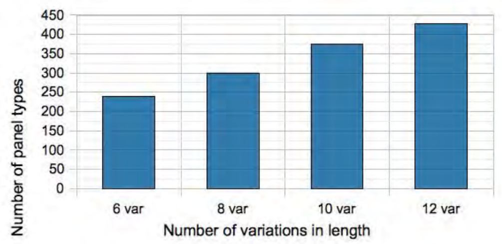
Figure 11. Final rest lengths of spring 1 for 10 variations

5.4 Analysis of Panel Types

The purpose of the Panel Binning solution phase is to group similar panels with certain tolerances. The springs are released with 6, 8, 10 and 12 variations in lengths. Then the panels are casted and the panel binning solution is applied (Figure 12-14).



(tolerance 0.1)



(tolerance 1.0)

Figure 12. (left and right) Reduction in the number of panel types with different variations in lengths

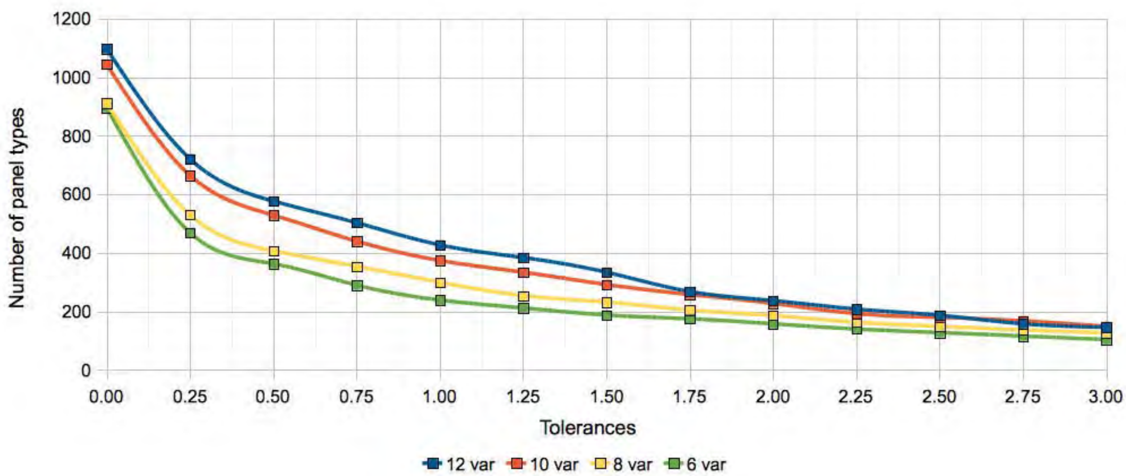
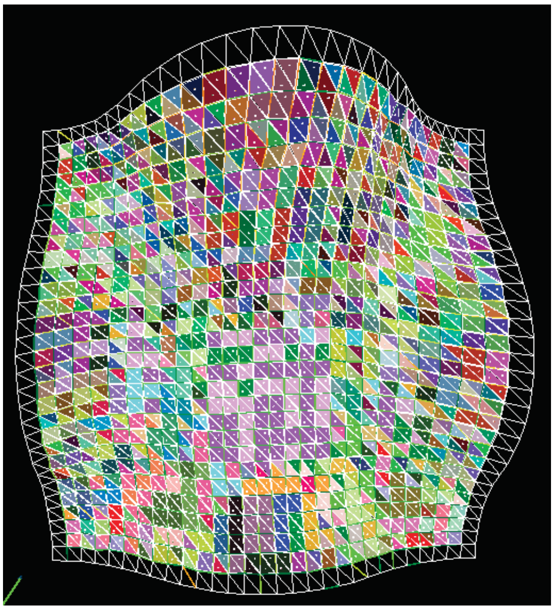
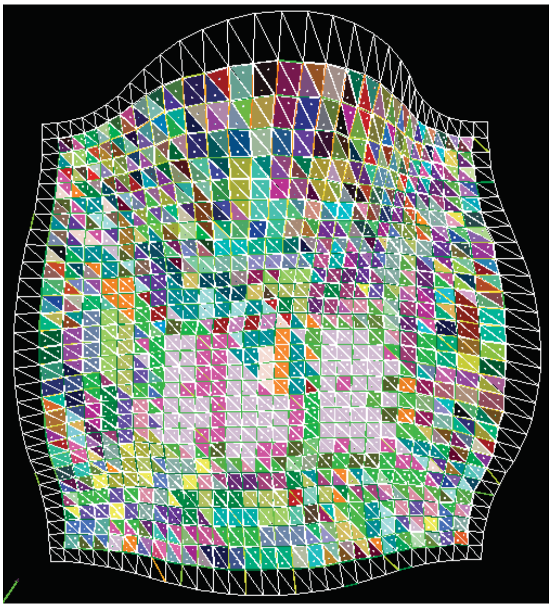


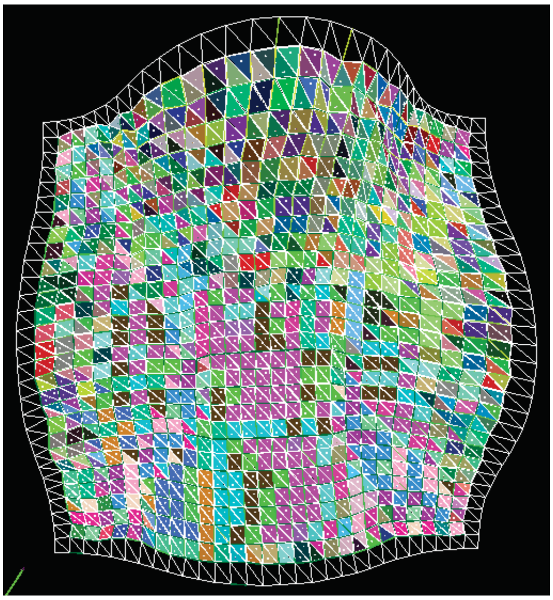
Figure 13. Reduction in the number of panel types with panel tolerances

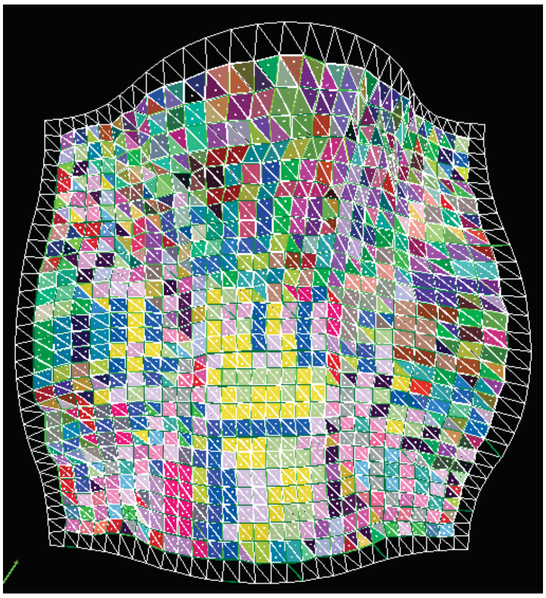
When dealing with tolerance less than 0.1 the 6 and 8 variations produce similar number of panel types. Also there is not much significant difference in reduction in number of panel types between 12 and 10 variations. For tolerance less than 0.25 there is a steady drop in the number of panel types for all the variations. With the increase in tolerance, the rate of decrease in panel types is reduced (Figure 14).





(12 variations – 427 panel types) *(10 variations – 341 panel types)*





(8 variations – 330 panel types) *(6 variations – 239 panel types)*

Figure 14. Reduction in the number of panel types with different variations in lengths (fixed tolerance 1.0)

Use of dynamic relaxation before the release function slightly increases the kink angle in the area of transition of high to low curvature (Figure 15).

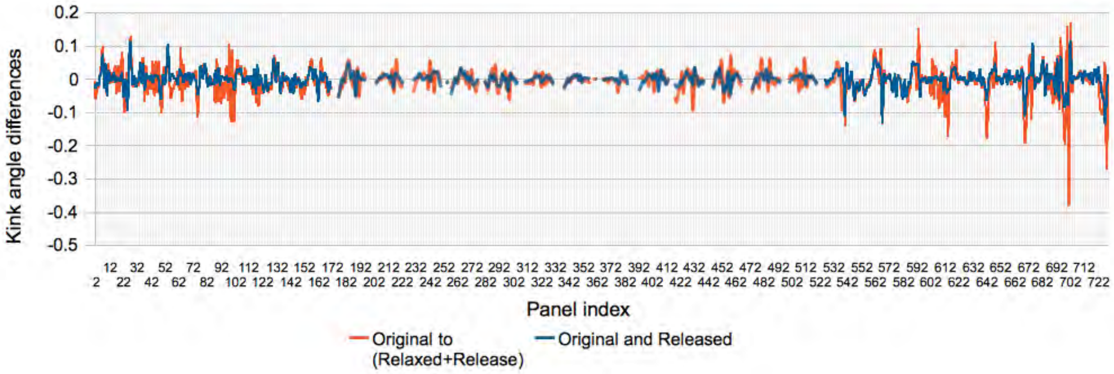


Figure 15. Difference in kink angle after releasing the springs (with and without relaxation in the first stage)

It is interesting to note that, as the number of variations is decreased from 12 to 10 more kink angle variation is seen in the area near the saddle point. With 8 or 6 variations, kink angle gets distributed over the surface. 8 variations give a moderately less kink angle as compared to 6 variations (Figure 16).

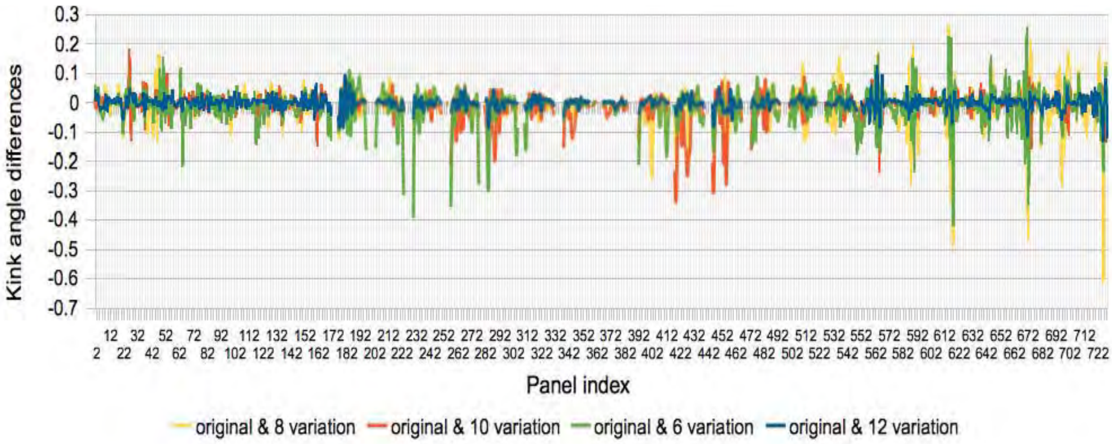


Figure 16. Variations of kink angles with different variations of spring lengths

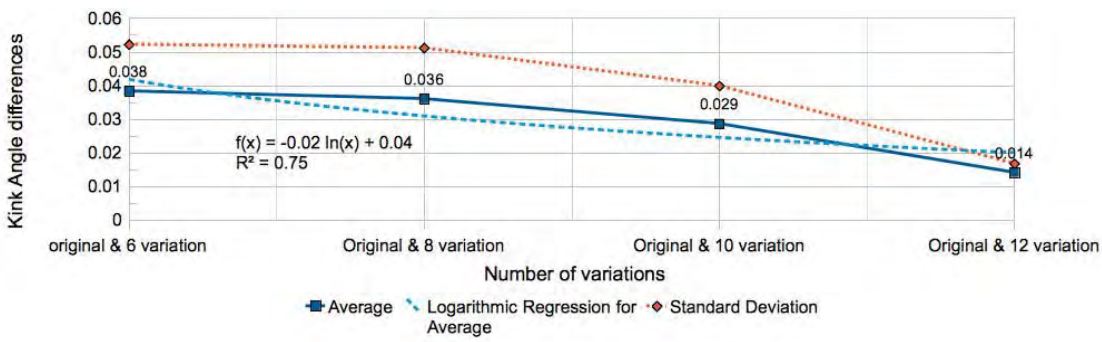


Figure 17. Variations of kink angle differences with variations of spring lengths

Seven ranges of average kink angles ranging from low (blue) to high (red) are mapped on to the panel colour of the surface (Figure 18).

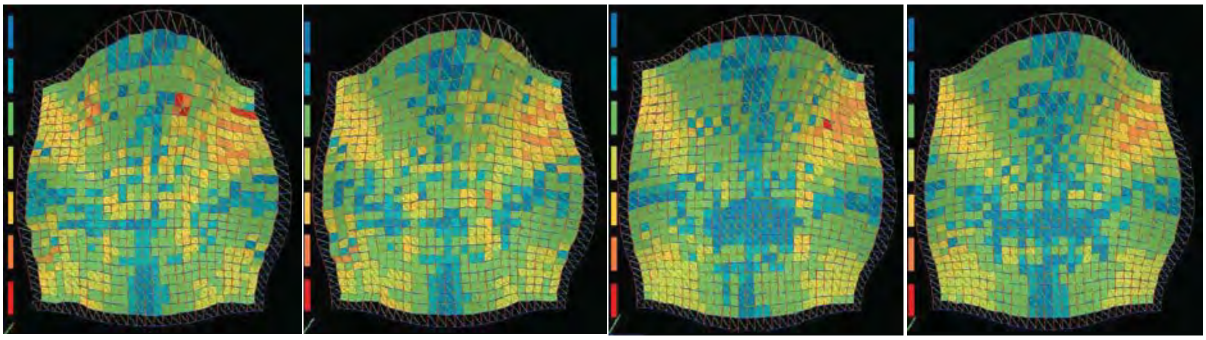


Figure 18. Average kink angle for 6 (left) to 12 (right) variations

In order to understand the deviation from the original surface, the actual XYZ deviations of the node from the original position is studied (Figure 19, 20).

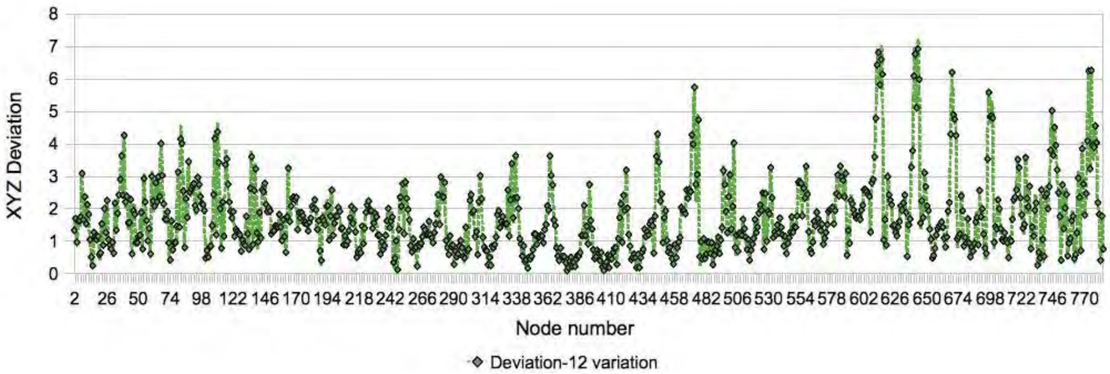


Figure 19. Deviation for 12 variations in spring lengths

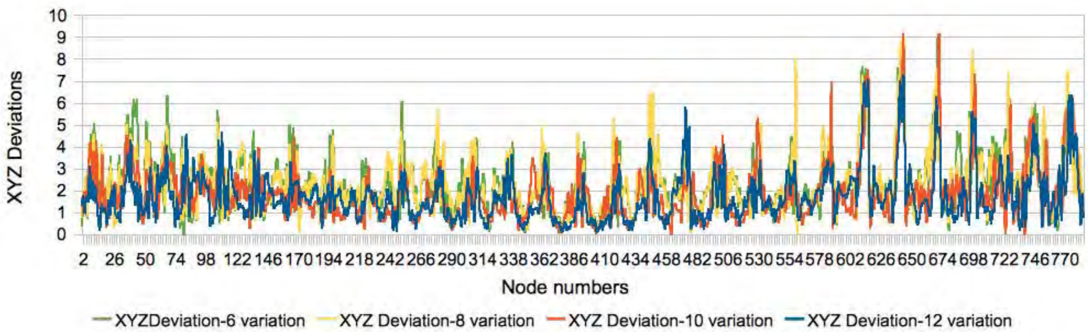


Figure 20. Deviation for all variations in spring lengths

12 variations have a consistent and less deviation throughout the surface. 8 variations have more deviation in the whole spectrum; it is less than 6 variations at the start but is higher in other areas. There is a significant drop in kink angle from 8 to 10 variations (Figure 21).

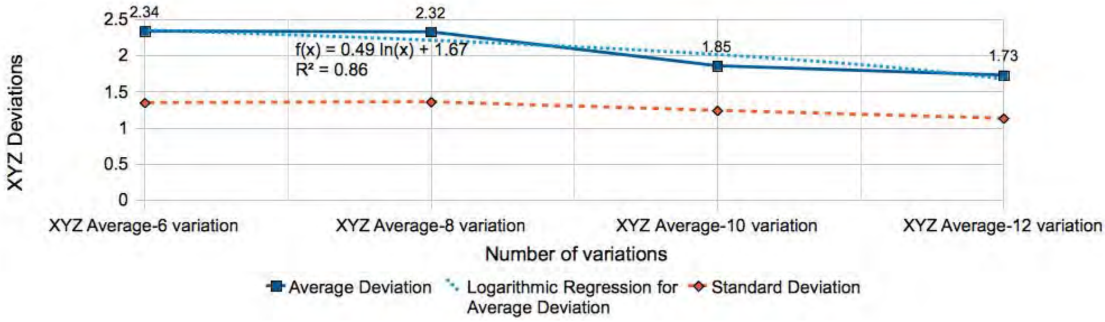


Figure 21. Deviation for all variations in spring lengths

5.5 Structural Analysis

The following experiments aim to find the variation in structural efficiency with the decrease in number of variations in the structure. Structural analysis is performed with pinned edge supports at the edges and fixed connections. Only the self weight of the structure is considered. If the loads and sections are the same, the measure of the structural efficiency of the geometry is done approximately by the stresses. The maximum and minimum stress developed in the members due to axial forces and moment help to get a preliminary understanding of the overall change in the structural forces. It is seen that as the number of length variations decrease in the members there is a tendency of increase in the stress of the members (Figure 22). This is only an indication of how the stresses are developed.

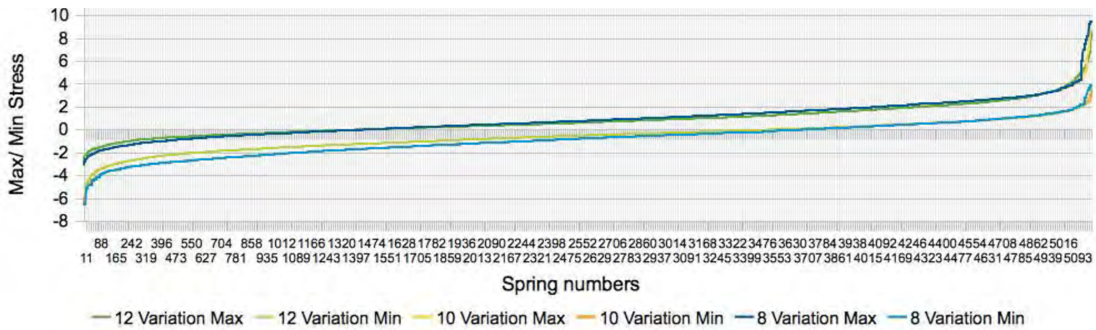


Figure 22. Max and Min stresses for release surface with 12, 10 and 8 variations

5.6 Experiments with *"Example Surface"*

An example surface similar to the Great Court roof of the British Museum is taken to perform a comparative study. With similar setup of experiments like the *"original surface"* all related experiments are performed. These experiments help not only towards the success of the algorithm but also to understand the additional parameters related to the original form of the surface geometry, which affect the paneling solution [15]. The surface is released with the set lengths for the panel edges and panel binning solution is applied (Figure 23-26).

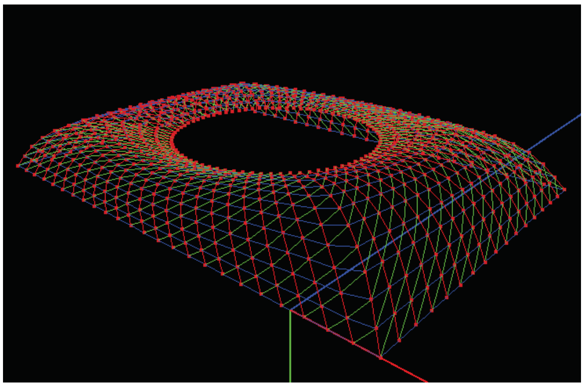


Figure 23-Original surface

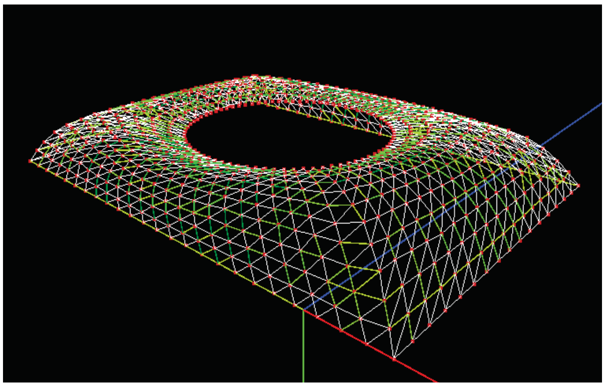


Figure 24- Released with 6 variations

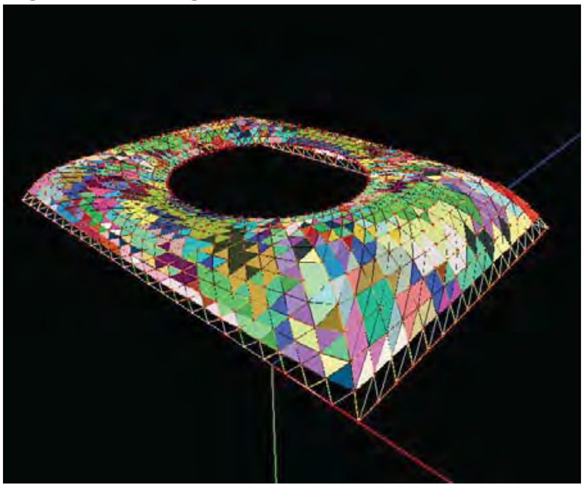


Figure 25 – Original paneling layout

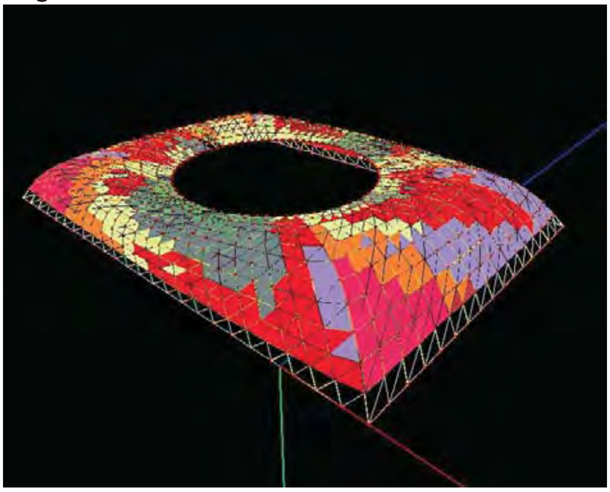


Figure 26 – Optimised paneling solution

6.0 Discussion

With regard to the aim of the paper, the results show that out of the initial 1280 panel types on the original surface the applied algorithm reduces this to 374 panel types, which is a reduction of 70.78% with acceptable average deviation of 1.85 and an average kink angle of 0.029 for a tolerance of 1.0. This can be further reduced with different length variation as per the acceptable deviations, surface kink and tolerances. Analysis of dynamic relaxation results show that the use of relaxation helps to reduce the number of panel types when dealing with less tolerances resulting in a minor increase in kink angle. Dynamic relaxation mostly contributes to the paneling aesthetics by distributing the nodes on the surface and reducing the range and standard deviation of the spring lengths.

Further experiments with the Example Surface reflect that the original surface geometry, its curvature conditions and symmetry influence the optimum panelling solution. The initial curve network and the original organisation of the nodes have a unique influence on the release of the surface. The variations in edge length and the panel geometries influence the effect of the binning solution. Curvature conditions, like the presence of saddle points affects the kink angle change. Interestingly a similar overall rate of decrease in the number of panel types is seen in the example surface as seen with the original surface, with the increase of tolerance.

Feeding in actual design constrains, project specific optimum solution can be achieved. Further details of the panel mapping for the computation of inter-panel distance and the intersection of panel with centreline need to be analysed. The variation of panel types has been reduced but the resultant node and connections between the panel frameworks still remain differentiated and are open for further experimentations. Angle constrains and spring particle geometric solver can also be implemented specially to constrain the kink angles in areas of high visibility. Such a structural design has a lot of complexity and further investigation with loads, predefined member sizes, movable nodes and related structural parameters are required for detail analysis. The study focused on a specific topic of modularity for triangular panels but it can also be extended to different geometric shapes of panels. This can lead to the creation of a tool that could embed the geometric behaviour, manufacturing constraints and paneling logic into a single system.

7.0 Conclusion

This research sets out to analyse some panelization issues concerned with the construction of freeform surface. A method to deal with the number of variations of panel sizes in such surfaces was proposed by using a generative algorithm combining dynamic relaxation and particle spring optimization. The experiments are conducted in three main stages which include the effectiveness of the dynamic relaxation, exploration of panel edge length variations and finally reduction in the number of panel types. The variations in lengths are tested against the node deviations, kink angles, structural efficiency and design tolerances for deriving the optimum panel types for specific projects.

A trade off to reduce the extra panels against the deviation from the design surface can ideally be possible in an actual project scenario. This is a multidimensional issue related to the complex interplay of various objectives related to design, geometric, aesthetics, structural, fabrication and cost constraints that need to be considered in a similar scale with respect to the actual project. The scale on which the two issues of cost and deviation are plotted to find the optimal point of panel complexity would change with specific project and a unique project optimum would be achieved for that project. This tool can be used to trade off the cost of extra panels against the deviation from the design surface. It allows the designer to achieve a paneling solution not only as an intuitive design rationalization tool but also as a method of post rationalization of an optimised geometry for achieving an optimum paneling solution.

8.0 Acknowledgements

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Alec Groysman	**Use of Art Media in Engineering and Scientific Education**
 ***Topic: Art, Science and Technology*** ***Author:*** ***Alec Groysman*** *ORT Braude College of Engineering, Karmiel, Israel* *http://www.wcjs.org/cv/groys/groys.html* ***References:*** [1] Alec Groysman, "*Corrosion for Everybody*", Springer, Dordrecht, 2010, 368 p. [2] Alec Groysman, "*Corrosion and Music*", *Proceedings International Festival-Congress Symmetry Art & Science, Gmund, Austria, 23-38 August 2010, pp. 68-71.*	***Abstract:*** ***Background:*** *How many engineers and scientists like art? How many engineers are interested in science and its achievements? Why there is no progress in art, but there is progress in engineering and science? What is the relationship between art and engineering, art and science? How can engineers and scientists use art in their inspiration and creativity? Thus we should explain what art media, engineering and scientific education are. In spite of differences in terms "technology, engineering and industry" we will use one of them "technology" or "engineering". Engineering is the "third culture" in addition to the "two cultures" art and science. There is mutual influence between these "three cultures". What is the general meeting point in them? We speak about interdisciplinary, humanistic and artistic thinking of engineers and scientists.* ***Aim:*** *To show how art media can help in engineering and scientific education. The philosophy of our work is establishing of interrelationships between the "three cultures", studying new inspirations and creativity in engineering, searching and determining common aspects and differences in the "three cultures" in order to show the young generation of engineers, scientists and educators how learning, education and our very existence may be interesting, fascinating, creative, productive, exciting, attractive, rich, and as a result **<u>beautiful</u>**.* ***Methodology:*** *The examples of use of different arts (music, painting, literature, poetry, sculpture) in curricula of materials science, thermodynamics, and corrosion of metals are shown. Analogies, interrelations, metaphors, common aspects and differences between art and engineering disciplines are used in engineering and scientific education for the third and fourth year students.* ***Results:*** *Students and young engineers and scientists who received explanations of engineering and scientific disciplines in comparison with humanistic aspects showed more creativity and satisfaction in their job and life. They have another approach to apprehending of engineering and scientific disciplines and very existence which is now seems **beautiful**.* ***Conclusions:*** *Humanistic aspects should be more and more included in engineering and scientific education, namely we can talk about "beautifying" engineering and scientific learning and education of students and educators using art media results in attractiveness of engineering and scientific disciplines, their "beauty", inspirations and creativity of young generation of engineers and scientists.*
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Use of Art Media in Engineering and Scientific Education

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Abstract

Background: How many engineers and scientists like art? How many engineers are interested in science and its achievements? Why there is no progress in art, but there is progress in engineering and science? What is the relationship between art and engineering, art and science? How can engineers and scientists use art in their inspiration and creativity? Thus we should explain what art media, engineering and scientific education are. In spite of differences in terms "technology, engineering and industry" we will use one of them "technology" or "engineering". Engineering is the "third culture" in addition to the "two cultures" art and science. There is mutual influence between these "three cultures". What is the general meeting point in them? We speak about interdisciplinary, humanistic and artistic thinking of engineers and scientists.

Aim: To show how art media can help in engineering and scientific education. The philosophy of our work is establishing of interrelationships between the "three cultures", studying new inspirations and creativity in engineering, searching and determining common aspects and differences in the "three cultures" in order to show the young generation of engineers, scientists and educators how learning, education and our very existence may be interesting, fascinating, creative, productive, efficient, exciting, attractive, rich, and as a result beautiful.

Methodology: The examples of use of different arts (music, painting, literature, poetry, sculpture) in curricula of materials science, thermodynamics, and corrosion of metals are shown. Analogies, interrelations, metaphors, common aspects and differences between art and engineering disciplines are used in engineering and scientific education for students, young engineers and scientists.

Results: Students and young engineers and scientists who received explanations of engineering and scientific disciplines in comparison with humanistic aspects showed more creativity and satisfaction in their job and life. They have another approach to apprehending of engineering and scientific disciplines and very existence which is now seems beautiful.

Conclusions: Humanistic aspects should be more and more included in engineering and scientific education, namely we can talk about "beautifying" engineering and scientific learning and education of students and educators using art media results in attractiveness of engineering and scientific disciplines, their "beauty", inspirations and creativity of young generation of engineers and scientists. Our experience is summarized in the book "*Corrosion for Everybody*" published by Springer.

Keywords: *Art, Science, Technology, Engineering Education, Scientific Education*

1. Overture, or Prologue

"*History is a race between education and catastrophe*"
Herbert George Wells (1866-1944), the English writer, "The Father of Science Fiction"

What do we live for? Here may be different answers. We suggest universal reply on this question – *searching of beauty* in every step of our existence, beings, that is also in *teaching*, *learning*, and *education*. What is the place of *art*, *science*, and *technology* in modern society, in modern culture, in our beings? What are the aims and main functions of *art*, *science* and *technology*? There is no discussion that future of our world depends on *education* of all groups of people, especially young generation of students, engineers, and scientists. Scientific – technological revolution was favourite term of the second part of the 20th century. Progress in science in the Ancient Greece in 6-4 BC resulted in differentiation between *art* and *science* [1]. The same situation took place with *science* and *technology* in the 18-20th centuries. They were separated because of progress in both fields. There was no progress in art [2], and it moved away else from science and technology. We can mention that in the Middle Ages students learned the seven *liberal arts*: the Latin and Greek *grammar*, *rhetoric*, *logic*, *arithmetic*, *geometry*, *astronomy*, and *music*. Even in that time, a person who showed that they knew the arts well enough became a Master of Arts, M.A. Students could choose to study either law, medicine, philosophy, or theology. Those who taught this type of education were known as *doctor of philosophy (Ph. D)*. Today some universities still offer the same degrees as the ones in the Middle Ages.
The British physicist and philosopher Charles Snow differentiated "*two cultures*", *art* and *science*, and we mark out *technology* (*engineering)* as the "*third culture*". It was suggested to use "*split culture*" instead of "two cultures" [3]. This is correct, but real situation shows that the specialization in the last two centuries lead to the splitting of one general culture into many different disciplines, while most problems are complex and require interdisciplinary approaches. What carries out the mission of such bridges for "splitting culture"? First, *computer revolution*. Second, *globalization*. Third, *stresses and loneliness of a person in the world*. Fourth, *education* on different levels. Art can help to overcome many of our problems, and in the first turn improve scientific and engineering education. The use of art-science-engineering connections appear at various levels [3]:

a. Strengthening interdisciplinary thinking in general.
b. "Beautifying" science/engineering and "technologizing/scientifyzing" art education.

All achievements of science and technology have two-Janus faces. Development of computers in the 1990s, the internet, new technologies and new materials changed drastically our world, our beings, and as a result interaction, communication, mutual relations and influences between *"three cultures*" *(art, science and technology)*, and of course, *education* consisting from *teaching* and *learning*. Today *art* is a very complicated phenomenon (field) of our beings included various combinations of traditional *art* (painting, sculpture, music, poetry, literature, theatre, cinema, and ballet), *sciences* and *technologies*. *Digital art* and *multimedia* appeared. *Computer* is the common feature, platform, where our "*cultures*" have cross-sections. Our generation is eye-witness of many scientific and technological achievements describing before only in science fiction.
There is nearly no artist, musician, sculptor, physicist, chemist, biologist, doctor,

engineer in classic term and understanding which were generally accepted even 30-40 years ago. We enter deeper and deeper into small parts. There are specialists in every small thing. On one side we deepened and know more about each thing. On other side, we lose general picture. Today there is no topic in *science* and *technology* where people of only one speciality deal with. Chemists work together with biologists, physicists and mathematicians. Each cannot work without other. With development of computers, we lose something sensual, spiritual, soul, noetic feelings, cultural, and artistic. People speak each other less and less; go to performances, museums and exhibitions less and less. People do not talk each other, but prefer correspondence. The modern world is divided into "lyrics" and "physicists"; "humanitarians" and "naturalists"; *artists, scientists and engineers*. What is the difference between artist, scientist and engineer? The difference is in objects, freedom of their work, creativity, and methods. The task of art and science is similar: "*Science and art have common roots; and they solve general problems of cognition of the universe"* (D.I. Mendeleyev). The aim of engineering is different: engineering is the process of designing and making tools and systems to exploit natural phenomena for practical human means.
There are many examples how *art* helps in understanding and comprehension of our world, work and beings of *scientists* and *engineers*, and what is important, in *scientific and engineering education*. Opposite is also correct: knowledge of science and technology helps in creativity of artists. The world is united (one). We do not speak about the role of art in life and creativity of scientists and engineers. We will discuss how art media is used in achieving purposes of better understanding of scientific and engineering disciplines, such as thermodynamics, materials science and technology, corrosion science and technology.

Thus the aim of this work is to show how art media can help in engineering and scientific education. The philosophy of our work is establishing of interrelationships between the "three cultures", studying new inspirations and creativity in scientific and engineering education, searching and determining common aspects and differences in the "three cultures" in order to show the young generation of engineers, scientists, educators and students how learning, teaching, education and our very existence may be interesting, fascinating, creative, productive, exciting, attractive, rich, noetic and as a result <u>beautiful</u>.
Our experience is summarized in the book "*Corrosion for Everybody*" published by Springer [4].

2. Science, technology, engineering, and art

"Scientists study the world as it is;
engineers create the world that has never been."
Theodore von Kármán (1881-1963), the Jewish- Hungarian-American aerospace engineer and physicist

History of human society shows that *art* was at the dawn of its existence and development. Primitive man had to show to his relatives and friends by means of pictures, motions of his body and sounds what happened during the hunt or other events. Thus the first representations in the form of pictures in caves, sounds and motion imitations of animals and his friends appeared. Pristine people were the first *artists*. *Education* in the form of *teaching* and *learning* appeared in that period. Then *technology* appeared as a requirement to survive and improve life of people. Only then people began to think how one thing worked with other, what were the causes of phenomena around him. People began research, endeavour, compare, analyze, synthesize and thus “primitive” *science* appeared. Thus we should differentiate between *technology*, *science* and *engineering*.

The Great Pyramid of Cheops predates the Parthenon by two thousand years, and the Egyptians were certainly far in advance of the Greeks in terms of their development of weighing scales, cosmetics, inks, wooden looks, candles, and many other inventions. These, however, are examples of *technology*, not *science* [5]. The same concerns *technological and engineering activity* in Rome Empire. *Technological* inventions promoted different *arts* in the ancient world and today they play probably leading role. *Technology is a practical activity*, as demonstrated by the Egyptians and Rome examples already given, which helped to facilitate life: trading, beautification, conquests and protection, writing, death rituals, etc. In short, *technology is all about making life more comfortable, while science is simply an effort to understand the world* [5]. *Scientists are driven by curiosity, rather than comfort or utility*. *Science is investigation or study of phenomena.*

Egyptians could be successful technologists without having any grasp of science. When they brewed beer, they were interested in the technological methods and results, but not why and how one material was being transformed into another [5]. Probably, the Greeks were the first real scientists, and the French mathematician, engineer and philosopher Jules Henri Poincaré (1854-1912) described this difference two thousand years later: “The scientist does not study nature because it is useful; he studies it because he delights in it, and he delights in it because it is *beautiful*. If nature were not *beautiful*, it would not be worth knowing, and if nature were not worse knowing, life would not be worth living. Of course, I do not here speak of that *beauty* that strikes the senses, the *beauty* of qualities and appearances; not that I undervalue such *beauty*, far from it, but it has nothing to do with science; I mean that profounder *beauty* which comes from the harmonious order of the parts, and which a purr intelligence can grasp”. The Greek scientists began to build scientific logics – the main scientific principle. *The scientist was like a creative artist, working not with paint or marble but with the unorganized sensations from a chaotic world* [6].

Engineering is the discipline, art and profession of acquiring and applying scientific, mathematical, economic, social, and practical knowledge to design and build structures, machines, devices, systems, materials and processes that safely realize solutions to the needs of society. The *concept of engineering* has existed since ancient times as humans devised fundamental inventions such as the pulley, lever, and wheel. Historically, the first was military engineering and then civil engineering.

The differences in scientific and engineering education exist in titles of modern disciplines: materials science and engineering, corrosion science and engineering.

We also should take into consideration different meanings and definitions of word *art*. *The Encyclopaedia Britannica* defines art as “*the use of skill and imagination in the creation of aesthetic objects, environments, or experiences that can be shared with others*” [7]. *Art* is something that stimulates the individual’s thoughts, emotions, beliefs, or ideas through senses. Generally*, art* is made with the intention of stimulating thoughts and emotions. Similar situation occurs in *engineering* and *science*.

Usually people think that *science* predates *technology* and *engineering*. Let me give two examples where technology and engineering appeared long before scientific understanding of these phenomena. The first example concerns the invention of

steam engine. Steam engine was invented in 1698 by an English military engineer Thomas Savery (1650-1715), improved by an English blacksmith Thomas Newcomen (1663-1729) in 1712 and by a Scottish mechanical engineer James Watt (1736-1819) in 1769 and worked long before the explanation by a French engineer Nicolas Léonard Sadi Carnot (1796-1832) in 1824 why and how it worked. With remarkable insight, Carnot made an abstract model of the essential features of the heat engine, and analyzed its operation with cool and faultless logic [6]. This was the work of a scientist-engineer-artist which resulted in formulation of the 2nd law of thermodynamics (the most important and probably leading law in nature!) by a German scientist Rudolf Julius Emanuel Clausius (1822-1888) and a Scottish scientist and engineer William Thomson (Kelvin) (1824-1907) in 1850s. Let me mention the phrase of an American scientist Lawrence Joseph Henderson (1878-1942) that "*Science owes more to the steam engine than the steam engine owes to Science*" (1917). Another example is the invention of the *daguerreotype process of photography* in 1839 by a French artist and physicist Louis-Jacques-Mandé-Daguerre (1787-1851) long before scientific explanation how it works. Both inventions resulted in drastic changes in our life, in science, in technology, in engineering, in industry and, of course, in art. First, many works of art about the 2nd law of thermodynamics were appeared. Second, photography became an important part of modern art and our very existence.
Some people think that many engineering and scientific disciplines are dull, especially when they are provided with mathematics. We would like to show that these disciplines are attractive if we use art media in their learning.

3. Use of art media in scientific and engineering education

"Education is an admirable thing, but it is well to remember from time to time that nothing that is worth knowing can be taught."
Oscar Wilde (1854-1900), an Irish writer and poet

Art can help in understanding and remembering of different processes and phenomena studying by scientific and engineering disciplines. There were given examples of comparing of corrosion phenomena with pictures and statues of famous artists and sculptors such as Alberto Giacometti ("Tall Figure" was compared with general corrosion), Philip Guston ("Pit" was compared with pitting corrosion), Hieronymus Bosch ("The Garden of Early Delights" was compared with three periods of car's life: new car, beginning of corrosion, and destruction), and Umberto Boccioni ("Unique Forms of Continuity Space" was compared with erosion) [4]. Examples of descriptions of behavior of materials were given in literature by writers Lyman Frank Baum, Alexander Volkov, Brothers Grimm, and Hans Christian Andersen [4].
There is mutual influence of art, science and technology. Advances in science and technology (especially in computers) always influenced art. For instance, existence of computer music, computer poetry, computer painting, computer graphics, etc. *Industrial design* and *architecture* cannot exist without achievements of technology. Probably, architecture is art plus science multiplied technology and engineering. We don't mean this side of interaction.
Our aim is to show how art can be used in scientific and engineering education, show <u>*beauty*</u> *of engineering and scientific disciplines, arouse (excite) creativity in engineers and scientists to discover, invent and compose new technologies, new decisions, new vision and explanations of the world around us.*

3.1. *Beauty* as a general denominator of use of arts in scientific and engineering education

"*Everything has its beauty, but not everyone sees it*"
Confucius (551-479 BC), a Chinese thinker and philosopher

What is the general denominator in our approach? *BEAUTY*. *Beauty* belongs to philosophical aesthetic category and many its definitions exist. Many philosophers, people of art and scientists discussed what *beauty* is. There are many researches regarding *beauty* in art and science and its place in life of people. But … we did not find researches about *beauty* in engineering and industry, *beauty* of soul or character of a person. We will try to discuss what beauty in engineering is. People perceive and feel *beaut*y through their organs of sense, including intuition. *Beauty* is a quality which is impossible to measure and give a quantitative estimation. The variety of the objects of beauty has been used as an argument for beauty's subjectivity [8]. Elaine Scarry wrote manifesto for revival of *beauty* in our intellectual work, as well as our classrooms [9]. Which neuro-pshycological processes occur in the brain of people, when they say "beautiful tree, beautiful picture, beautiful sculpture or beautiful music"? We are far from deciphering of biochemical processes occurring in our organisms during *perception of beauty*.

Beauty and *symmetry* play important role in our lives. Symmetry is an important element and phenomenon in assessing *beauty*. Symmetry is considered as main bridge between art and science. Based on general concept of symmetry, beauty and harmony, it was shown that theoretical physics can be borderland between science and art [10]. This is correct for any discipline. For instance, mathematics was the basis of searching *symmetry, harmony and beauty* [11]. Then the same principles of symmetry, harmony and beauty were found in physics, chemistry, physical chemistry, and biology. Then similar things were found in corrosion science [4]. We consider *beauty* as main bridge between art, science and technology, especially in education.

Physicists and mathematicians are often motivated in their theorizing by a desire for *beauty*. There is the consensus that the laws of physics and mathematics should be elegant, simple and harmonious, and these factors often act as excellent guides for pointing physicists and mathematics towards laws that might be valid and away from those that are false [5]. *Beauty* in any context is hard to define, but we all know it when we see or hear it. The mathematicians in the Ancient Greek were probably the first who connect different principles in mathematics with aesthetic philosophical principle of *beauty*. Then physicists contributed in understanding of *beauty* of physical laws, and now chemists with elegant, harmonious and *beautiful* chemical reactions, chemical forms and structures including different smells.

We can illustrate how historical evolution of science and technology influence philosophy and art, and as a result *conception of beauty* as a philosophical category. The ancient Greece (~ 4th century BC) was famous by science of mathematics which was in the centre of its philosophical scheme [12, 13]. Art and all life in the ancient Greece was a reflection of this "mathematical philosophy". This approach is seen in any work of art (sculptures, architecture, music, theatre): proportions and harmony (symmetry, golden section, Fibonacci numbers). Accordingly, *beauty* was based on the same conceptions, namely, physical beauty of body was considered as harmony and correct (*beautiful*!) mathematical proportions. Sport in the ancient Greece was

organized on service for reaching such *beauty*. We can even say that art was on the service of such “philosophy of mathematics”.
The term *beauty* was specific in every civilization. Jews did not create works of art because it was forbidden depicting people and animals. The only achievement of *beauty* in Jewish architecture was the Temple built/enlarged by Herod the Great in Jerusalem in the 1st BC: “One who has not seen Herod’s Temple, has never seen a *beautiful* building” [14]. The concept of *beauty* among Jews was concentrated on morality, thinking, soul, philosophy, on spiritual state of a person.
The Middle Ages in Europe (12th-16th centuries) were marked by development of theology, and this relationships between God and human being was reflected in art and philosophy. Most work of art (painting, music, sculpture, architecture) in this period were created on Biblical motives or were devoted to God. Accordingly concept of *beauty* was shifted in the direction of God and Bible motives.
In the 16th-19th centuries natural sciences began flourishing in Europe, presentations and ideas about the world and the place of a man began changing. Accordingly philosophical thinking, art and *concept of beauty* were changed. We can see beginning of strong mutual influence and reciprocal penetration of science, art, and technology in this period.
The 20th century was marked by intensive development of science and technology, and at the end of the 20th - beginning of the 21st century our civilization came to *computerized society*. This *computer revolution* immediately influenced *art* and philosophy. In spite of these drastic changes in our beings, we did not find objective definition of *beauty* till now. Therefore our findings of use of *conception of beauty* in art, science and engineering are subjective. We searched also how *beauty* relates to *engineering* (*technology*). We revealed new realm named *art engineering* where principles of *art* penetrated into *engineering*. Here are some examples: coating of industrial structures from aesthetic point of view, use of music for productive work of employers, spreading of good smell in toilets and offices, flowers and sculptures outside and inside offices and factories. We are eyewitnesses how *beauty* enters and catches important place in engineering (technology). Elegant decision of engineering task may be beautiful, simple and harmonious, similar to mathematical and physical laws, rules and equations.
We will show how poetry is used in scientific and engineering education.

3.2. Poetry in scientific and engineering education

Poetry is probably one of the most philosophical branches of art, and *poets are obliged to supply proof as scientists*. We will give two examples of use of poetry in scientific and engineering education. When you teach *entropy* you can talk about Anglo-American poet Wystan Hugh Auden (1907-1973) who has been admired by physical laws and wrote brilliant poem “*Entropy*” which is well studied by students and perceived with great pleasure. Here is a part of this poem.

I’m not being negligent
Nor plain, messy no!
But somebody intelligent
Once made up a law:

This is not a simple verse,

It's a scholar rhyme –
Entropy in the universe
Increases all the time.

From Big Bang to Bigger Boom
One thing just we may assume:
Universe-roulette-wheel spins –
Order loses! Chaos wins!

The Canadian engineer Tom Watson created brilliant poem "*Rust's a Must*":

Mighty ships upon the oceans
Suffer from sever corrosion;
Even those that stay at dockside
Are rapidly becoming oxide.
Alas, that piling in the sea
Is mostly Fe_2O_3
And when the ocean meets the shore,
You'll find there's Fe_3O_4.
Cause when the wind is salt and gusty
Things are getting awful rusty.
We can measure it, we can test it;
We can halt it or arrest it;
We can gather it and weigh it;
We can coat it, we can spray it;
We examine and dissect it;
We cathodically protect it.
We can pick it up and drop it,
But heaven knows, we'll never stop it.
So here's to rust: Not doubt about it,
Most of us would starve without it.

Historical aspects may be beautiful and enjoyable in learning scientific and engineering discoveries.

3.3. Chemist Johann Döbereiner, poet Johann Goethe, discovery of catalysis and Russia

The German chemist Johann Wolfgang Döbereiner (1780-1849) is known through his theory of triads (as a pioneer of the periodic system for classifying elements in 1817, that is 52 years before Dmitri Mendeleyev), great teacher on chemistry, and discoverer of catalysis [15]. He was a chemical assistant, friend and protégé of famous poet Johann Wolfgang von Goethe (1749-1832) who was also a Minister of State Saxe-Weimar at the Grand Duke Karl August in Germany in that period. Döbereiner showed in 1823 that if platinum sponge is spread out on a watch-glass and a stream of hydrogen is directed on to it in such a way that it mixes with air before touching it, the gas bursts into flame at once. This discovery was developed into the Döbereiner lamp in which a jet of hydrogen, generated from zinc and sulfuric acid, is ignited by a small amount of finely divided platinum. This lamp replaced the tinder box as a means of lighting domestic lamps and candles and functioned until it was replaced by the phosphorous match. The Swedish chemist Jöns Jacob Berzelius (1779-1848), the master of chemical nomenclature, gave the name "catalysis" in 1835 to the process of acceleration of oxidation of hydrogen on the surface of platinum discovered by Döbereiner. This story is related to Russia, because Döbereiner got platinum from the Grand Duchess Maria Pavlovna from Russia. She was a daughter of the Czar Paul I and was married Karl August's son; two of her brothers became the Czars Alexander I and Nicholas I. Deposits of platinum were discovered in Ural in 1820s. Platinum was already in demand in Western Europe for both decorative and scientific purposes. The Minister of Finance in the government of Nicholas I the Count Egor Kankrin decided to use the platinum for coinage. Neither Kankrin nor the Russian chemist Sobolevsky were satisfied with the chemical methods of manufacture of platinum in Russia. Maria Pavlovna was interested in chemistry and, through her brother Czar Nicholas I, she was well acquainted with work and problem with platinum. Similarly at Weimar, through her father-in-law Karl August, she was aware that Döbereiner had some experience in this field. Maria Pavlovna obtained some amount of platinum from Russia to help his work. Döbereiner helped in refining of Russian platinum, discovered catalysis and reported about his work to Goethe. We can only suspect that both (chemist Döbereiner and poet Goethe) discussed this, that Döbereiner read the tragedy "Faust" and the novella "Elective Affinities" written by his elder friend Goethe. The latter work of art gave impulse to new scientific field named *human chemistry*.

3.4. Human Chemistry

In *exact sciences* there are quantitative measures of estimation of each value: mass, length, force, energy. In *humanistic disciplines* (history, philosophy, psychology) as well as in *art* there are no quantitative criteria. This is similar to question *how to measure beauty, love, friendship, democracy*? If there is no quantitative estimation of some category or phenomenon, any definition becomes undefined, ambiguous and abstract. We know that in chemistry there is the function named *Gibbs energy* which defines the "*love*" between substances. Why there is no such function for estimation of love between people? Thus people tried to estimate this and *human chemistry* appeared [16, 17]. *Human chemistry* is the study of bond-forming and bond-breaking reactions between people and the structures they form. Historically, *human chemistry* appeared in 1809 with the publication of the novella "*Elective Affinities*" by Goethe, a chemical treatise on the origin of love [18]. In this stage today *human chemistry* is similar to alchemy in the middle ages, it borders with art, but further investigation on the molecular level in human brains will help to discover what happens in our organisms, and intimacy will end. Probably, such discovery will cause us to be unhappy, because mystery and wonder of love and relationships between people will be finished.

3.5. Music in scientific and engineering education

"*Life without music would be a mistake*"
Friedrich Nietzsche (1844-1900), a German philosopher

Music has always been among the leading arts, and therefore has been used for different studies. Plato (428-348 BC), the founder of Western philosophy, declared in the "*Republic*": "*Education through music is extraordinary important because rhythm and harmony penetrate to the depths of the soul, seize and ennoble it*" [19, 20].

Children learn the alphabet "*ABC*" to the tune of "*Twinkle, Twinkle, Little Star*", and the states of the USA in the alphabetical order from a song "*Fifty Nifty United States*"; students learn some chemical reactions to the tune of "*Oh, my darling Clementine*", or the tune of "*America the Beautiful*". Thus, music can be useful in learning and remembering the basics of language, social disciplines and science.
In order to understand the role of music in scientific and engineering education, we should mention that music is the most abstract form of art, but word is a real and concrete form of expression of our thoughts. We use mostly visual and hearing perception in education. Thus, we can connect music, word and picture or writing and use them in education. Such education by means of humanistic topics turns any dull discipline in aesthetic form of scientific and engineering education. Here are some examples.

a. When you explain what happens with crude oil in distillation column during rectification, how different organic substances containing in crude oil move and boil, are separated according to their boiling temperature, and gasoline, kerosene, gasoil, fuel oil are obtained you can imagine and compare with the music composition "*Rhapsody in Blue*" (1924) by a Jewish-American composer George Gershwin (1898-1937). In other words, distillation of crude oil and moving of fuels in heat exchangers can be associated with music of George Gershwin.
b. Thermodynamic reversible processes (a quasi-static process that happens infinitely slowly) can be associated with the eternal motion, namely, with the "*Flight of the Bumblebee*" (1899-1900) by a Russian composer Nikolai Rimsky-Korsakov (1844-1908), or the "Perpetual Motion" by an American composer Edward MacDowell (1861-1908). When we are listening to these music compositions we feel that this music is eternal as well as there is no end both for it and for any thermodynamic reversible process.
c. The 2nd law of thermodynamics (the entropy of the universe tends to a maximum) is associated with the "*Bolero*" by a French composer Moris Ravel (1875-1937) or "*In the Hall of the Mountain King*" (suite "Peer Gynt") by a Norwegian composer Edvard Grieg (1843-1907) or "*Polovetzkian dances*" (opera "Prince Igor") by a Russian composer Alexander Borodin (1833-1887). The analogy is in the "expansion" of music during its development. The same occurs with the universe.

3.5.1. "Music" in Corrosion Phenomena [21]

Many corrosion phenomena are accompanied by "musical sounds and shouts" which are used in acoustic emission and electrochemical noise measurements for determining localized corrosion. Pitting corrosion is a local anodic dissolution of metallic atoms, when they, in the form of cations exit the lattice. The number of cations leaving the lattice area in a unit of time is the electric corrosion current which occurs with a definite frequency. What is a sound in music? A sound in music is a physical phenomenon and this is the spread of waves with a definite frequency. We can transform the electric corrosion current into the "language" of music waves in this way and "listen" to any destruction of passive film and pit formation. This "music" is stochastic and the waves probably are not analysed for harmony, so we can name it by "corrosion dissonance", or "corrosion dodecaphony". We can listen to such "stochastic" sounds in music compositions of the Jewish-Austrian composer Arnold Schönberg (1874–1951) and the Russian composer Alfred Schnittke (1934–1998).

When cavitation occurs in the centrifugal pumps, we listen to the specific "music of cavitation" like the flow and blows of stones. Tin is a malleable, ductile, highly crystalline silvery-white metal. When a bar of tin is bent, a strange crackling sound known as the "*tin cry*" can be heard due to the breaking of the crystals. Any cracks in metals can be "heard". Interesting analogy, comparison and association between stress corrosion cracking (SCC) and music by Alfred Schnittke can be done, and even each stage in SCC can be "described" or accompanied by some of his music compositions, for example, "*Quasi Una Sonata*".
Certainly such music examples can connect *beauty* of scientific and engineering disciplines with the harmony – disharmony of our world, namely, better understanding and remembering of scientific and engineering disciplines.

4. Humor in Scientific and Engineering Education

"The more you know humor;
The more you become demanding in fineness."
Georg Christoph Lichtenberg (1742-1799), a German scientist and satirist

Humor, smile, laughing occupy not the last place in our life and help to overcome many difficulties and misunderstandings. *Humor* is the tendency of particular cognitive experiences to provoke laughter and provide amusement. In other words, *humor* is the ability to perceive, enjoy, or express what is amusing, comical, incongruous, or absurd. The term *humor* derives from the *humoral medicine* of the ancient Greeks, which taught that the balance of fluids in human body, known as *humors* (in the Latin, *humor is body fluid*), control human health and emotion. *Humor* is very fine and clever *art* in the area of *human creativity* (art, science and engineering being the varieties). *Humor* occurs when the brain recognizes the pattern that surprises it. *Humor* in education can help take away the tension, tiredness, "sleepness", even misunderstanding, and relax. Anecdotes, jokes, jests, and quotes of famous scientists, engineers and artists may also help in understanding and accepting of the complexity and *beauty* of scientific and engineering disciplines. Here are several examples [22].

a. What is the difference between thermodynamics and stick? Stick has two ends and no one beginning. Thermodynamics has two "beginnings" (the 1st and 2nd laws) and no one end.
b. When we use several times the name of some scientist, for example, Gibbs phase rule, Gibbs function or Gibbs energy, Gibbs-Helmholtz equation, chemical potential suggested by Gibbs, we may tell about the movie "The Angel's Ash". A pupil of twelve years old in small town in Ireland was asked to write a composition about Jesus. That was in 1930s. The weather was rainy all time (Ireland's weather!), there was no job for parents, no good flat, no enough food, and many little children died in Ireland. A little pupil of 12 wrote in the composition: "Jesus lived in the South in warm country (Israel) with much sun, there were no rains, and he had not to wear shoes. If he wanted to eat he went to fig or pomegranate trees and ate much fruit. If Jesus was born and lived in Ireland, he was ill and has died in the little age, and I had not to write this composition". This is the place to joke that "because of Gibbs we should learn more and more thermodynamics".
c. The German physico-chemist Walther Hermann Nernst (1864-1941), who received the Noble Prize in 1920 "in recognition of his work in thermochemistry"

and was a founder of the 3rd law of thermodynamics, commented in 1937, that it had taken three scientists (Mayer, Joule, and Helmholtz) to formulate the 1st law of thermodynamics, two scientists (Clausius and Thomson-Kelvin) to formulate the 2nd law, but that he (Nernst) had been obliged to do the 3rd law all by himself. He added that it followed by extrapolation that there could never be the 4th law of thermodynamics [23]. This is fine joke, as in the same 1930s scientists understood the importance of the law of thermal equilibrium, and they called it the "*Zero Law*". Not the fourth one!

d. The British cosmologist Stephen Hawking said that we get pleasure from sex and science (and engineering), but from the latter much more time … You may mention to your students that cognitive process in science and engineering is the permanent discovers, and we can enjoy every new ascertain in knowledge.

5. Conclusion

"The aim of life is self-development.
To realize one's nature perfectly—that is what each of us is here for."
Oscar Wilde (1854-1900), an Irish Writer and poet

We use five organs of sense (*sight, hearing, smell, taste, and touch*) plus *intuition* in *art, science and engineering*. People use their organs of sense not in similar manner in life, especially in education. Only *sight* and *hearing* are mostly used in education. We know also that all people are different in use of these organs of sense. Is there any quantitative measure for them? No, we can use only qualitative estimation. Such situation causes trouble in use of art media in scientific and engineering education (comprising teaching and learning). Educators should show that meaning of life is *searching beauty* and enjoy by every step of education. But how to enjoy? To learn seeing *beauty* in every day life: in engineering, in science, in their teaching and learning. This depends on point of view. Use of art media in scientific and engineering education helps in this searching. Thus we can make the *scientific* and *engineering* education productive, attractive, fascinating and then to make the job of a scientist and an engineer also creative and interesting. The students which acquire *engineering education* will remember some things, but many of them will not use and forget what they were taught. But … if to teach students the same things combining with art, they will remember probably forever. This is main philosophical approach to *engineering/scientific teaching* and *engineering/scientific learning*.

6. Epilogue, or Instead the End

"I am not young enough to know everything."
Oscar Wilde (1854-1900), an Irish writer and poet

Arts and *science* are similar in that they are expressions of what it is to be human in this world. Both are driven by curiosity, discovery, searching, and the aspiration for knowledge of the world or oneself. The British physicist Brian Cox reveals in the TV series "Wonders of the Universe" on the BBC how the most fundamental scientific principles and laws explain not only the story of the universe, but the story of us all. This is art/science movement, sometimes called "*sciart*" [24]. But *technology/engineering/industry* also takes part in this convergent process of interaction. Therefore I would like to spread this and call "*sciartech*" or "*sciarteng*".

This is another step in uniting of "*three cultures*". We should popularize art which promotes formation aesthetic and high moral (spiritual) principles mobilizing aspiration for self-knowledge and self-realization [25]. We should continue our approach of use of art media in scientific and engineering education, investigate *creativity* and where it comes from, as it is one of the last human frontiers, and one over which we have little control. In order to develop and use *creativity* and our *imagination* in teaching, learning and work we should unite "three cultures".

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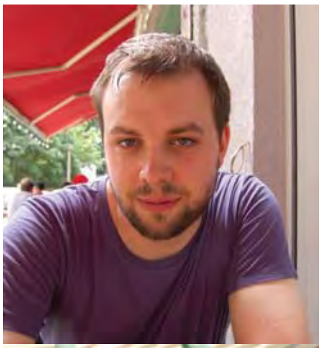
Alison Clifford/ Graeme Truslove

Presentation/ Artwork

TITLE "Palimpsest: Articulating the Interstitial"



Topic: Art

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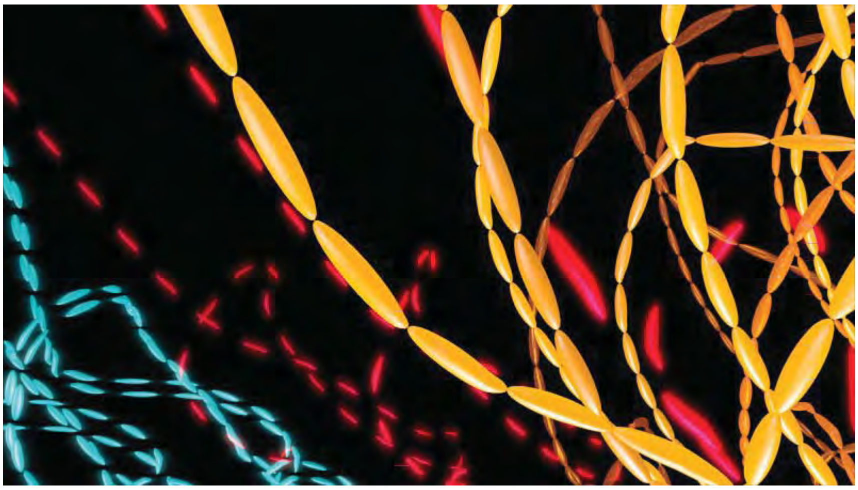
"Palimpsest" is an audiovisual artwork exploring the space between sound and image through collaboration. Two distinct narratives, audio (Truslove) and visual (Clifford), are brought together through algorithmic means to find alternative paths and perspectives around a virtual light sculpture. The piece reinterprets one of a series of photographic light paintings [1] taken during a drive at night. The photographs were experiments: improvisations with long exposures, motion and gesture. As images in themselves however, the artists found them to be engaging both visually and conceptually.

Visually they bring to mind the poetic: the camera has captured ethereal light trails drawn by the motions of passing traffic in mid-air, giving them an almost sculptural quality.They suggest contours, energies, volumes and spaces that are open to further exploration and interpretation. Conceptually, their contradictory nature seems to suggest ideas of the interstitial - the space or place in-between things - or what Duchamp termed the "infrathin or infra-slim"[2]. The light-forms captured in the image, exist in-between the real and the virtual, brought together in a moment by the camera. They occupy the gaps and breaks between events, and find form in the moment between the shutter opening and closing.

It is in the idea of the interstitial that the collaboration is based. How might these forms be reinterpreted and rewritten for another context? And how might a generative algorithm be used to structure our visual experience of them? *"Palimpsest"* responds to these questions, extending and re-imagining the source image, in an attempt to articulate the interstitial.



Still from *"Palimpsest"* (2011)
More info at: http://www.duck-egg.co.uk/palimpsest

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Interstitial Articulations: Reflections on Audiovisual Collaborative Practice

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Abstract
"Interstitial Articulations" is an audiovisual collaboration between visual artist Alison Clifford and composer Graeme Truslove. Artworks created within the series bring together ideas from Clifford's doctoral study that explores notions of the interstitial through new media art practice, with Truslove's acousmatic composition, which focuses on temporarility and intuitive performance in electronic music. The series explores the space between sound and image, questioning whether collaborative practice could also be seen as "interstitial" practice.
The aim of this paper is to explore conceptual motivations and creative processes involved in the production of two works in the series, "*Substratum" (2010)* [1] and *"Palimpsest" (2011)* [2]. It firstly defines the background and conceptual framework informing the collaboration, followed by a discussion of the generative methods used in creating audio and visual content, finally it concludes by critically reflecting on each work.

Background and Conceptual Framework

This section outlines the background and conceptual framework informing the collaboration. It explains shared motivations in the work of each artist's practice that have led to the collaboration.

Visual Conceptual Framework – the interstitial

For the series "*Interstitial Articulations",* photographic light paintings taken during a drive at night (fig. 1 and fig 2.) are reinterpreted and re-imagined in different contexts to create new audiovisual abstract narratives that embody ideas of the "in-between". The conceptual background informing the visual approach is based around Clifford's interpretive readings of the source photographs (the photographic light-paintings) and her subsequent translation of these ideas into new contexts. The photographs are considered as "texts" for interpretation, and the search to find meanings within them has much in common with the practice of close reading found in literary studies. In her readings of the photographs, she argues that these images could be seen as photographic representations of the interstitial or what Duchamp referred to as the *inframince/ infraslim* [3]. The images document how the camera captures or "sees" the motions of headlights of passing traffic, together with recording any motion made by the photographer into a single, still image. The passage of time over which the moving objects are recorded – defined by the moment in-between the shutter opening and closing - and the final resulting photographic representation of it in a still (single frame) is, she suggests an example of an "interstitial moment".

To clarify, these photographic events are recordings of durations of discrete, moving objects, combined and compressed by the camera into a single, and contradictory, fixed moment in time – found in the still image. The still image presents us with moving subjects as actual static phenomena existing as unique occurrences within the timeframe of the photograph. Extended exposures allow the camera to record such motion into a single image (frame) that is otherwise invisible to the human eye. The resulting light-forms captured were, in terms of human perception, never actually there and have been "drawn" by the motion of passing traffic and the gestures of the photographer combined. The moment in-between the shutter opening and closing is the moment that light passes to the lens, and any motion made by the photographer (or subject) affects how light is drawn onto the final photograph. Ultimately then, the camera becomes an instrument that allows the photographer to directly intervene in the representation of the scene depicted. (Perhaps most famously demonstrated in photographer Gjon Mili's (1949) portrait of Picasso in which Picasso uses a flashlight to draw a centaur in the air. [4]) It enables him/her to draw forms with light that aren't and were never actually there – interstitial forms - that are a hybrid between the actual (the motions of passing traffic) and the virtual (the light-forms captured do not actually exist) in a similarly hybrid space. What is recorded is the trace of motion and duration, and it is this trace that embodies the interstitial. The series *"Interstitial Articulations"* is a response to these intriguing light-forms, considering the details within them as a source for imaginative departure leading to new and unexpected ground. As Bachelard states:

> "Thus the miniscule, a narrow gate, opens up an entire world. The details of a thing can be the sign of a new world which, like all worlds, contains the attributes of greatness." [5]

Audio: Background

Graeme Truslove is a composer of acousmatic and live electronic music. His practice is largely concerned with creating, shaping and organising sounds that have as few mimetic references as possible – allowing listeners to find their own meanings in his work. Truslove often synthesises sound from granular principles, forming timbres from extremely brief micro-sonic elements, or grains. A key part of his approach involves the creation of electronic instruments that he performs himself, either during live performance or in the studio, where he incorporates the recordings into acousmatic montages.

What unites Clifford and Truslove's individual practices is a desire to work with non-referential materials, in order to create new worlds from abstract audio-visual forms. Through their respective attention to "the details of a thing" (or the grain) divorced from its original visual or sonic context, they construct and imagine new audiovisual “worlds”.

Generative Methods and Critical Reflections

This section outlines generative methods employed in the creation of both audio and visual content, exploring interrelationships between them. It concludes with a critical reflection on each of the works discussed.

[fig.1]

“Substratum” (2010): Visual Generative Methods

> *...make something which lives in time and makes the 'spectator' experience time...*
> *...make something indeterminate, which always looks different, the shape of which cannot be predicted precisely...*
> (Hans Haacke 1965 statement)

The first artwork resulting from the collaboration *“Substratum”* (2010) is based on and responds to the forms in the above photograph (fig. 1). The dense, organic textures in this image could be considered to suggest breathing, and the trace left behind objects in transit. These observations informed how the light forms would be redefined in a new context, together with ideas expressed in Hans Haacke’s 1965 statement (above), which were used as prompts for practice-based exploration. *“Substratum”* therefore aimed to create a work which *“lives in time”* making the spectator *“experience time”*. The organic quality of the light-forms – seen in the source image as “noisy” or wavy groups of lines – was something Clifford wished to explore and which also reflected Haacke’s statement to *“… make something indeterminate, which always looks different, the shape of which cannot be predicted* *precisely…"*

To create the line-groups, algorithms were designed and programmed in Processing [6] to generate short visual sequences based on specific line groups (texture, colour, etc). These were then edited together using video editing software (Final Cut) to interpret the dense textures of Truslove's audio. The line-group sequences were generated by re-plotting the individual x and y coordinates of each point placed consecutively across the width of the screen that, when joined together with the previous point, created a continuous line. To capture the sensation of breathing, trigonometric functions (sine and cosine) were used to determine each new x and y coordinate for each frame. When the resulting still image outputs from Processing were combined together in animated sequences, a "breathing" line was created (constructed in Final Cut). To convey the organic, imprecise nature of the lines in the photograph, Perlin noise was also added to the position of each x and y coordinate. In addition to this, rather than solely creating lines with Processing's line function (– i.e. line(x1, y1, x2, y2),) various pixels were sampled from the original source image and reprinted across the screen at these points, leading to subtler visual effects as seen in the photograph.

"Substratum": Creation of the Audio Material

Similarly, generative methods were used to create the audio. The audio in *"Substratum"* was created from samples of bowed notes performed on a double bass, multiplied and arranged into rich, deeply layered textures by computer algorithms and digital montage processes. The audio for *"Substratum"* was created using one of Truslove's self-devised computer interfaces – the *grain folder interface*. [12]

The grain folder interface has a simple functionality: to play back the contents of a folder, filled with monophonic (single channel) wave files, in a random order. Each wave file is played once until all files have been played. The files are then re-ordered and played again, a cycle that continues indefinitely. Between the playback of each wavefile is a short period of silence, and the duration of this period is randomised, in an attempt to avoid exact repetitions. On playback, each wavefile is processed by a set of DSP algorithms that randomly locate the monophonic sound within a two-dimensional sound field (i.e. somewhere within a Left-Right/Front-Back matrix).

In "*Substratum"*, multiple instances of this interface are used, increasing the layering and complexity of the source materials. The source materials were a set of long samples of bowed notes performed on a Double Bass. In all samples, the bassist bows the same note (D Natural). Despite the fact that all samples can be described as being the same thing, every sample is unique - for every articulation there is a minute variation in bow pressure and bow position, making each articulation unique, albeit infinitesimally.

Randomising and layering this set of long notes creates a dense, amorphous harmonic texture. The onset of each note is never synchronous with any other, meaning that *the grain folder interface*, keeps propagating new material without repetition. The phase relationships between simultaneous notes are rarely repeated, creating harmonic interest through iteration.

What unites the work of both artists in "*Substratum"* is the individual processes they use, which are concerned with constructing works from the level of the grain, albeit sonic or visual (light-grains). Both rely on the capabilities of the computer (through programming) to participate in the creation of the audio and visual material used to construct the final piece. Clifford incorporates Perlin noise into her algorithms to add a level of unpredictability to the visual form; Truslove incorporates randomness into the playback of audio form to avoid repetition, consequently creating continuous harmonic interest.

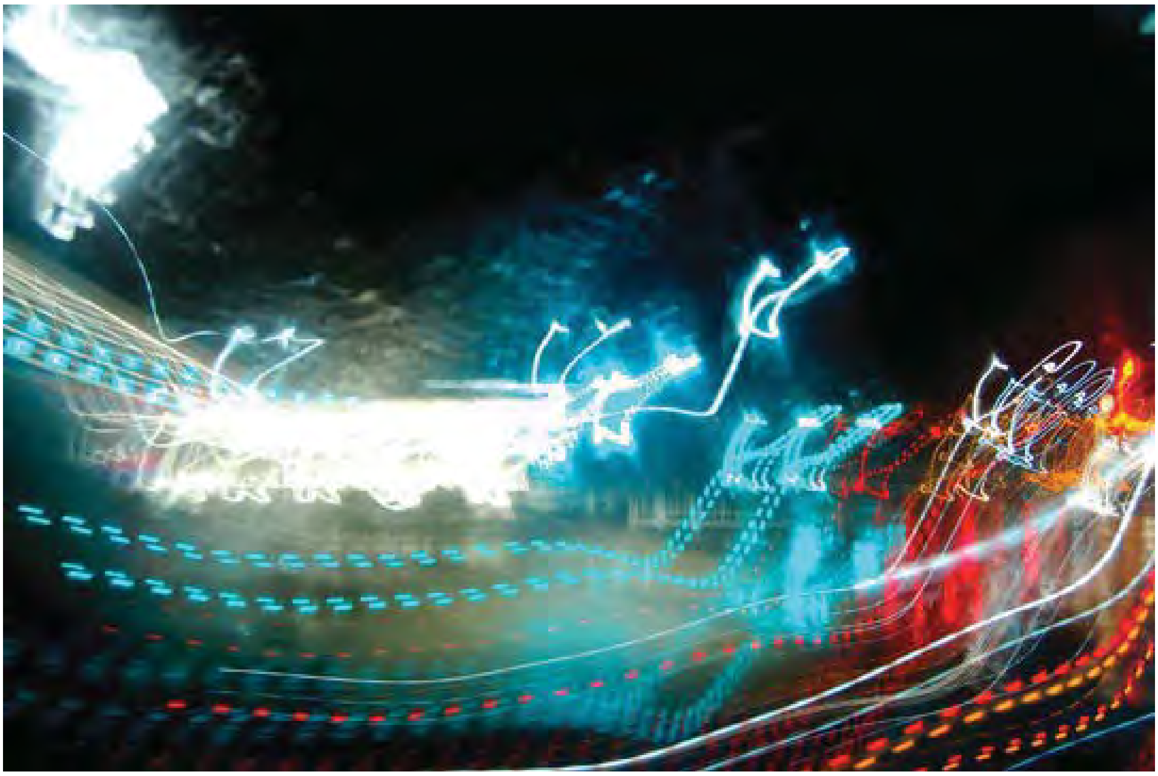
Critical Reflections on the work:

Whilst the work does capture the density and heavy layering of textures in the photograph through both sound and image, the limitations of the processor intensive image generation algorithms meant that there was no opportunity for real-time interaction between sound and image. In terms of the visual aesthetic, the most appropriate means to create the final work was employing montage techniques using an external video editor. This approach also enabled individual manipulation of each visual segment in terms of colour, speed and direction of play (i.e. forward or reverse). Although this ensured that the work satisfied the artists in terms of its visual aesthetic, the final format of the work – fixed medium [video] - somehow removed the possibility of indeterminacy, a trait that both collaborators wished to incorporate.
"*Substratum"* interprets one of the source photographs, which is largely textural, however there are a number of other photos in the series that are gestural in nature (that demonstrate the movements of the photographer combined with the headlights of passing traffic.) The work that followed, "*Palimpsest",* aimed to explore such gesture.

***"Palimpsest"* (2011): Visual Methods**

> *...make something which cannot 'perform' without the assistance of its environment... (Haacke)*

The interpretation of space in *"Substratum"* was very much concerned with the claustrophobic nature of the multi-layered "world" found in the photograph (suggested by the title of the work: Substratum - *"6. the nonliving material or base on which an organism lives or grows."* [7]) In *"Substratum"* the work locks the viewer in the same frontal location, revealing a singular perspective view of the gradually undulating forms, conveying the feeling of being locked inside this closed "sub"-space. However for the next piece, as stated above, the artists wanted to create a work that was more gestural in nature, informing the choice of the next photograph selected for interpretation.



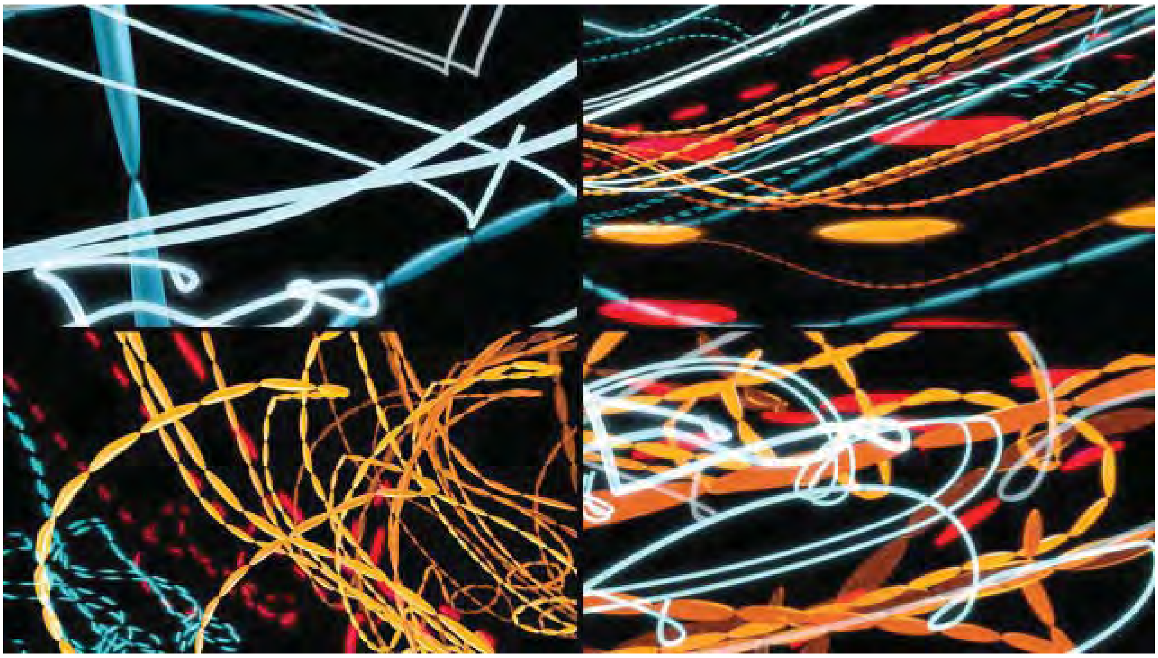
[fig.2]

The forms in photograph (fig.2.) have an almost sculptural quality to them; the momentary improvised gesture of the photographer is recorded in the final image as seemingly physical, synthetic objects – tubes, wires and beads of light – that suggest contours, energies and spaces. These qualities were ones that Clifford wished to translate visually into this next "articulation". Where the light-forms in the first photograph are organic in nature, those in the second (fig.2) are much more synthetic. Matt Pearson (2011), artist and coder, cites English philosopher Alan Watts (1958) who distinguishes between the organic and the mechanical:

> ".. natural forms are not made but grown, and there is a radical difference between the organic and the mechanical.
>
> Things which are made, such as houses, furniture, and machines, are an assemblage of parts put together, or shaped, like sculpture, from the outside inwards.
>
> But things which grow shape themselves from within outwards - they are not assemblages of originally distinct parts; they partition themselves, elaborating their own structure from the whole to the parts, from the simple to the complex."[8]

To investigate their physical and synthetic nature, Clifford felt the most appropriate method would be to model them using 3D software (Blender [9]). In this sense then, the visual interpretation of *"Palimpsest"* is mechanical (contrasting with the visual material in "*Substratum"*, which is constructed using more organic techniques). Individual forms were modelled and placed together as a group to create a virtual light sculpture in 3D space. With reference to the above quote from Watts, the light sculpture is made from “parts put together … shaped like sculpture” with the role of the computer becoming more of a **producer** than a **collaborator** (as was the case for *Substratum*.) [10]

With this translation to a 3D environment, Clifford did not aim to produce a “realistic” simulation; rather the aim was to produce an artistic simulation influenced by her interpretation of the light-forms, as a “foundation for something beyond.” [11] In this work, what was of interest visually, was a more comprehensive treatment of the light-forms. To this end, a series of short clips of journeys around the sculpture were created, documenting multiple perspectives of it as an object in space - i.e. travelling underneath it looking upwards, travelling through it, along it, around it, etc. (see image below). These perspectives were then edited together to create a 6-minute video loop providing the visual material for the collaboration.


[Different views of 3D light-sculpture]

Returning to Haacke’s 1965 statement, the prompt for further exploration of this virtual light sculpture, together with the desire to create a work from more gestural materials, came from the instruction “…*make something which cannot 'perform' without the assistance of its environment.*” In “*Substratum”*, the work resulted from interpretation and manipulation of the visual material in terms of the audio, it was a deliberate, conscious process that resulted in a fixed, non-changing work. With “*Palimpsest”* however, in order to make *“… the light sculpture perform without the assistance of its environment*”, the artists began to consider how sound might structure the visual experience of the journeys around the light sculpture.

***“Palimpsest”*: Audio Methods**

Truslove’s role in creating “*Palimpsest”*, was to compose a fixed-medium audio piece, and design a software interface linking the audio to the set of visual materials (mentioned above), created independently by Clifford. The challenge was to somehow unite the audio and visual elements into one coherent audio-visual experience, by forging causal relationships between sound and image.

The audio component of the work consisted of a fixed-medium montage of improvised performances (performed by Truslove) on a self-devised interactive software instrument, using a technique he calls *Live Micromontage.* [12] The software interface (created with Max/MSP [13]) was designed to remix the visual materials (the series of journeys around the light sculpture) created by Clifford, to synchronise them to significant events within the audio (what was 'significant' was defined by the composer). It functions by matching cues from the audio with different sections in the video, so that events in the audio will appear to 'cause' visual changes of scene.

Clifford and Truslove worked closely together to define which parts of Clifford's visual materials 'matched' certain sections of Truslove's audio. In many cases, Clifford had a number of visual responses to Truslove's audio, not one single interpretation. With this in mind, the interface was programmed to randomly *choose* which visual materials accompanied the audio track, from a predefined set of 'suitable' visual materials. "*Palimpsest"* is therefore an open-formed audio-visual piece, which is never identical from one playback to another.

The version presented here [2] is a recording of two successive playbacks of the audio file, with two different visual interpretations. It alludes to the process of rewriting, referred to in the title of the work, Palimpsest, as defined by American poet H.D: *"Palimpsest, i.e. a parchment from which one writing has been erased to make room for another."*

Critical Reflections on the work

The aim of "*Palimpsest"* was to investigate the gestural nature of the source photograph; a further aim was to make the sculpture *"perform without the assistance of its environment"* (Haacke). Both of these aims have been achieved through the Max/MSP patch that enables the viewer to experience different "remixes" of the visual material at different speeds depending on the gestural activity in the audio. However, whilst the collaborators are interested in the possibilities of this open form, Clifford was not fully satisfied with the visual response. For her, the level of interest in the forms themselves was somewhat limited as opposed to the forms in "*Substratum";* in "*Substratum"* different forms move independently creating moving micro-textures and micro-worlds, each form appearing to have a life of its own. With "*Palimpsest"* however the forms move as one solid, frozen mass; we [the viewer] move around the sculpture, the sculpture does not move in itself. It doesn't live or breathe.

In addition to this, although satisfied with the synthetic quality that 3D modelling lends to the work, she felt that many of the "interstitial" qualities of the photograph remain unexpressed. Namely, the subtle cloud-like mist of shadows and echoes surrounding the light-forms that exist in between the bright light forms and the black of night. The next articulation in the series addresses this directly, attempting to bring together these two different visual approaches – the organic ("*Substratum*") with the synthetic ("*Palimpsest*").

Conclusion: Reflections on the Collaboration

In conclusion, the collaborative series "*Interstitial Articulations*" brings together the individual artistic practice of two artists – a visual artist and a composer – to create, new audiovisual narratives exploring the space between sound and image. The first articulation in the series "*Substratum*", focused on sculpting and interpreting the deep, textures of the audio to structure the final work; the visual component of the work was therefore created in response to the audio. The second articulation "*Palimpsest*", relied on programming an indeterminate visual playback system to synchronise with significant events in the audio: the visual experience was therefore determined by events in the audio. Essentially then, the interdependence of audio and visual, and the conversation between them was what provided the creative force behind these works. Both "speak" from the interstitial space between two "separate" disciplines (visual art and music), questioning how one can shape our experience of the other. It is in this sense that this particular collaborative practice could indeed be described as interstitial practice.

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Anastasios Maragiannis

Paper

How to be Creative: Collaboration in Web 2.0 community with or without text

Topic: Design Approach – Creative communities

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Abstract:

Rob Pope (Pope 2005) states „being creative is, at least potentially, the natural and normal state of anyone healthy in a sane and stimulating community ... realising that potential is as much a matter of collaboration and „co-creation" as of splendid or miserable isolation". Just as the music design and other industries and the trajectories for musicians and designers have been evolving in response to technological change, e-readers and print-on-demand publishing have all had an impact on the landscape of authorship. If here has been a growth of collaborative and participatory cultural practices in society can the question be asked as to how creative content, distribution and engagement from collective input are produced?
Dr. Maria Chatzichristodoulou questioning in her research the role of Web 2.0 beyond the hype? O"Reilly Media and MediaLive describe Web 2.0 as "an attitude rather than a technology".1 O"Reilly and Batelle suggest that the term refers to "cumulative changes in the ways software developers and end-users use the Web"2, rather than a technical upgrade of the system.
How can processes such as „interactive", „animated" or „sound" within the field of typography be applied through a global creative design communication process?
Richard Lanham in The Electronic Word (1994) suggests that the interaction of typography and image goes back to the Greek poet Simias in the 4th century BC, when the interaction of type and objects was very common for the expansion of communication of an artistic piece or environment.
This paper will present an analysis of how the amalgamation of virtual typography and visual sound influences the process of design communication, within creative media practices, and the focus will be on representation and "hybridity" in art and design. It will examine relevant theories and practices on typography (e.g. Lapton, Bringhurst, Mencia, Hillner) and image and sound (e.g. Landy, Wishart, United Visual Artists) which have influenced the development of Typographical Experimental Research in Audiovisual Spaces [T.E.R.A.S.] within the contemporary digital era. Furthermore, it will provide an account of particular issues that artists and designers face in global communication by employing computational technologies, and it will develop a usable body of knowledge to aid the creative communication process.

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[2] Web 2.0 In: *Wikipedia*. Available from: http://en.wikipedia.org/wiki/Web_2.0 *16/11/2009, 17:39* [accessed 16/11/2009][3]

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Keywords:
Design, Creative industries, Collaborations, Virtual Text, Typography

How to be Creative: Collaboration in Web 2.0 communities, with or without text.

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Introduction

This paper will present an analysis of how the amalgamation of virtual typography and Web 2.0 computational technologies influences the process of design communication, within creative media practices through a series of experimental workshops, and the focus will be on representation and "hybridity" in art and design. It also examines relevant theories and practices on typography (e.g. Lapton, Bringhurst, Mencia, Hillner) and image that have influenced the development of Typographical Experimental Research in Audiovisual Spaces [T.E.R.A.S.lab] within the contemporary digital era. Furthermore, it will provide an account of particular issues that artists and designers face in global communication by employing Web 2.0 computational technologies, and develops a usable body of knowledge to aid the creative communication process through the use of text or not.

Creativity can be proposed as an activity of exchange that enables (creates) people and communities (Leach 2003). Creativity can be viewed as an emergent property of communities. Marika Luders (2009) observes that creativity 'is now commonly understood as part of what constitutes human beings. Moreover, creativity is not necessarily an isolated phenomenon'. [1]

1. How to be Creative

Rob Pope (Pope 2005) states 'being creative is, at least potentially, the natural and normal state of anyone healthy in a sane and stimulating community ... realising that potential is as much a matter of collaboration and 'co-creation' as of splendid or miserable isolation' [2]. Professor Janis Jefferies declare "just as the music and fashion industries and the trajectories for musicians and fashion designers have been evolving in response to technological change, e-readers and print-on-demand publishing have all had an impact on the landscape of authorship" [3].

For example, the concept of "vernacular videos" as proposed by Henry Jenkins is increasing daily as more people make and share video across the Internet. Such changes in video production and distribution are mapped by Tony Dowmunt in ‘Video Nation and digital storytelling: BBC/public partnerships in content creation.’ [4]

Is that the new and old forms of authorship co-exist in a digital context that produces both change and continuity across communities and communications. Or is the web 2.0 technology that influences the individual’s creativity.

Community web 2.0

In order to explore the use, understandings and meanings of the terms creativity, community and collective in international or global cultural projects, we will have to approach the Web 2.0 applications and attitudes to redefine, consciously or not, both terms and, most importantly, to explore the collective and collaborative artistic practices within the web 2.0 technology.

O’Reilly in Media and MediaLive describe Web 2.0 as “an attitude rather than a technology”[5]. O’Reilly and Batelle suggest that the term refers to “cumulative changes” in the ways programmers, and developers and end-users use the Web, rather than just a technical upgrade of the system. [6]

The distinctive feature of this movement and one of the key lessons of Web 2.0 is that “users add value” [7] in mainly three different ways: 1) users are hired to put in value to an existing Web 2.0 application, 2) users willingly contribute and add value to an application (open source communities) or, 3) users add value as part of their regular use of the application.

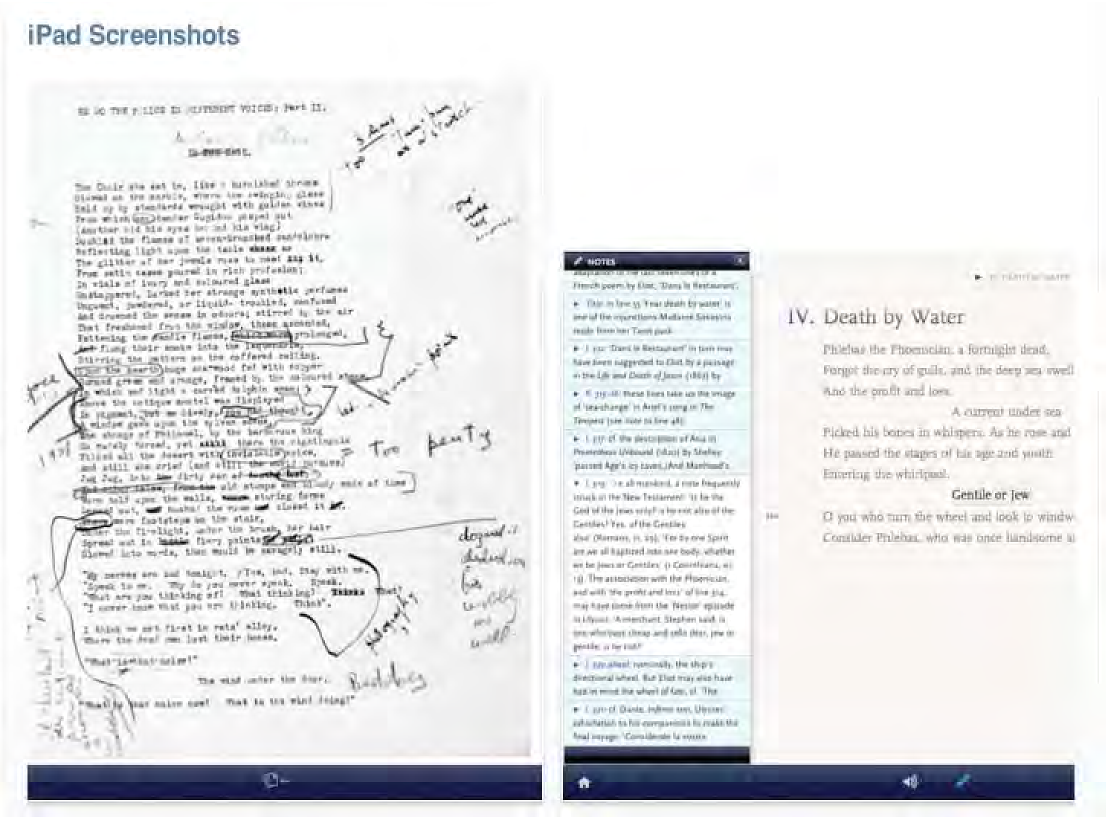
Electronic Text

How does this Digital web 2.0 Technology could influence the creativity within the digital communities with the use of hypertext?

According to Richard Lanham in The electronic Word (1994), the interaction of the typography and image goes back at the Greek poet Simias from the 4th century BC when the interaction of type and objects was very common for the expansion of an artistic piece or environment.

Further to Simias artistic based approach, Brereton declares that “The page is no longer a flat surface but a virtual field unfolding in time. Words, sounds, images and graphics are now all part of the poetics of the web. Web typography now allows a kinetic plasticity of form not possible with the conventional printed page… informing the creative communities” [8]

Digital media and computational technologies has become an integral part of contemporary screen base creativity and design, and it is now impossible to ignore typography and hypertext in this field. It has a breadth and a depth that encompasses multiple media and multiple industries. Well craftiness of the experience of the user on the screen. For example, with the introduction of the iPad the question of how the qualities of a book, reading and authorship can be adapted to the manipulation of text and image on screen in order to enhance the online or onscreen creativity. A case in point is how Touch Press has partnered with Faber and Faber digital for The Waste Land.



Apple, iPad Screenshots

“The Waste Land for iPad brings alive the most revolutionary poem…this digital edition carefully respects the typography and integrity of the original yet offers spectacular new ways to explore the significance and influence of the poem.” [9]

The above example showcasing on of the ways that creative collaborative work can be used within Web 2.0 applications. In this particular example Electronic typography and hypertext enhances media cultural and communication experiences [10]. Further to the Development of digital technologies, Digital Arts is not only improves the creative practice but also changing both the communication research that can be done and the way researchers work and communicate.

Creativity can be proposed as an activity of exchange that enables (creates) people and communities [11]. Creativity also can be viewed as an emergent property of communities. Advances in the most of disciplines now depend on the generation or manipulation of digital data, sometimes in unimaginably large quantities. Dicky Maidment-Otletand and Judy Redfearn in their date article "A Research Revolution: The impact of Digital Technologies" describe this new JISC activity to highlight how digital technologies are changing creative or non-creative communities [12].

Current practice creative text as an image

So if creativity, in itself, ‘creates’ communities (Leach 2003), are all communities – local to global or global to local - potentially creative?

The V&A “Decoce” website showcasing the creativity, collaborative expansion and communicate messages across interdisciplinary communities. V&A has commissioned Karsten Schmidt to design a digital identity for the Decode exhibition using open source code. The V&A website was giving the opportunity to recode Karsten's work and users to create their own original artwork as an extension to th existing practice. The images below are some of the recorded works submitted demonstrating the outcome of this online creative community. [13]

JULIUS POPP ,Decode exhibition V&A

Talking about screen based communication and creative communities we definitely need to explore and discuss further the interface design and its relation between creativity, Web 2.0 technologies and hyper-action. Is that the new and old forms of authorship co-exist in a digital context that produces both change and continuity across communities and communications or is the web 2.0 technology that influences the individual’s creativity?

The screen-based environment influenced by the computational technologies is currently very different and ambitious than it used to be. Designers and Artists are now used to another “reality” (Slagger, 2000), for example, they use typography as a form and as the vehicle (Meggs, 1992) to create visuals instead of words of communication.

The creation of the online virtual community “TERASlab”, [Typographical Experimental Research in Audiovisual Spaces] investigates the above-mentioned Web 2.0 applications where typography presented as a creative form of visual screen-based representation, influenced by processes of ‘interaction’, ‘animation’, in a global creative design communication system.

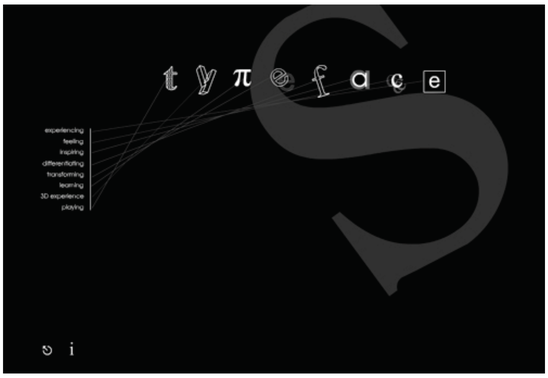
T.E.R.A.S lab - Workshops

In order to explore the significance and present role of the text in a virtual screen based environment a series of workshops contacted. In this first pilot case study, called “2D/3D Typo.graphic workshops” participants had to explore the “Project phase 1: Typeface” and Typeface Project phase 2, and define the basic rules and principles of screen based text exploited on the screen according to their own experiences and understanding.

This workshop was conducted of the repetition of a number of workshops using different tools, investigating how the use of Web 2.0 applications, mentioned above, and design approaches can affect the online communication and creative process and form participant’s professional identity, as well as exploring the association between the user as designer, user and technology.

During the workshops participants in each focus group have to evaluate the experiments and to critically analyse the current typographical experimentations, and been able to operate the existing ethics of each “application” as basis for their exploration and “dialogue”.
“Series-based typographic applications force the designer/user to consider variables beyond the basics of composition. Including the number of items in the system, differing format sizes or media, informational similarities…” [14].
Therefore, the participants could “envision” typography as a form of creative communication as well as create better understanding with the principles of the screen. (Morrison, 1936)

Project phase 1: Typeface



In 2009 I approached the ‘Typeface’ project (http://i4type.com/typeface) tentatively. It attempts to showcase different potentials of the letterforms within a screen environment. The term ‘tentative method’ refers to the ways in which the typeforms can be used in order to discuss and analyse a series of different approaches. It must also be specified that, as a method, this first approach of the practice-based research used these ‘experimentations’ to outline an additional usable form of screen base text when employing computational technologies.

The ‘Typeface’ practice-based research project includes eight different experiments with a common objective. All of them attempt to showcase the different potential of letters and words in a first journey from the traditional typographic principles to screen based design, taking the participants into a journey of typographic exploration, as a communicative function. Davies and Parrinders (2009, p.270) examine, “In contrast of Acconci’s settings on text in print, on screen it becomes a temporal – moving – space”, unfolding characteristic and meanings that were hidden or unreached in the past.

The following practice based projects arranged into three categories that address particular issues that today’s designers facing: Type in Space, Hypothesizing, Informing.
The results of this practice-based work attempt to identify the significant role of kinetic text in the art and digital design, and in particular the impact of computational technologies to the creative online collaborations. It was also being attempted to move forward existing visual communication structures, enhancing the experience between the participants and the applied typographic practice. [15].

Typeface Project phase 2

Further to the previous research project the following examples, considered in this project, deliver information about the service and use of motion/kinetic text. The medium creates a message, which is supported by sound.

Networked narrative

Approaching a new decade and observing carefully the stories that appear on the networked environments prove that Narratives and in particular text, have lost a great deal in the communication of stories in networked collaborative environments. The text may have been preserved, however the framework in which that text was premeditated to exist has disappeared. According to Carter (2001) and Bellantoni (2002), this discrediting and reduction of the framework is set to continue in the

future. In this “Networked narrative” project, the multidimensional interactive text and the notes on non-linear context exist in a non-real space. The digital environment of that practice based work uses an invisible interface structure in order to be navigated.
This work emphasises more on a diverse approach of typographic features. There is a mixed use and overlapping methods of typographic elements and the approaches show an extensive discrepancy.

Hypothesizing

This project includes experimentations of hypertext in relation of sound. This example uses a particular code design and some mathematics and algorithms not only to express and generate how text appears on the screen but also how sounds can influence use and appearance.

The primary goal here is the manipulations of binary code to realise new ideas, functions and methods in order to communicate the information to users within the hypertext and lettering environment. This work addresses issues such as the creation of type in relation with the computer pixilation and approaches how these hypertext elements (type-images, letters), can be composed by using various materials for the purpose of information.

Further development of this research will investigate a number of effective ways to practice screen-based text and collaborative communications. Moreover it will go one step further and explore the use of diverse visual sound as a typographic element. To conclude, both the theory and this experiment will be an original contribution to debates around hybridisation and representation in visual art with the use of computational technologies as well as to the knowledge of synchronisation and association with Web 2.0 applications, real world sound and text as image.

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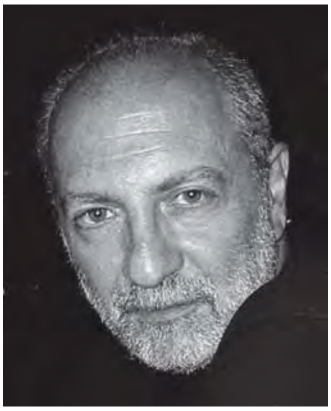
Professor Anthony Viscardi

TITLE: PLAY-TECH-TONICS



Topic: Architecture

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Abstract:
The desire 'to know,' or 'wonder,' is the human need for knowledge. It exists in all of us and stimulates one toward inquiry and dwells in our acts of 'serious play.' In play we allow ourselves to enter into the limits of another world; a world apart from reality, yet so vital to understanding the meaning and significance of that reality. We allow ourselves the opportunity to play to a different song (a new set of rules) and unlock the doors of our imagination to the construction of meaning.

What I would like to suggest in this paper is that in learning, and especially in the initial years of an architectural education, a more playful point of view must be encouraged to provide an arena of inquiry that produces architecture and a culture that is more wonderfully humanistic. The pretending quality of play should not be misunderstood as preventing it from proceeding with intense seriousness. This is easy to understand when observing the intensity young children exhibit in their daily adventures in the play of life. As Dr. Benjamin Spock explains in one of his many writings about child rearing: "Play is serious business. When we see children building blocks, pretending to be airplanes, learning to skip rope, we're apt to think, in our mixed up adult way, that these are just amusements, quite different from serious occupations such as doing lessons and holding a job. We are Mixed-up because most of us were taught in our childhood that play was fun but that schoolwork was a duty and a job was a grind...Children love their play, not because it is easy, but because it is hard!"

Play is the means by which children discover and process the meaning of things around them. As a child uses these (things) to re-affirm his perception of the play, the play becomes the thing to bring him through the transformation of perceptions. It becomes the means allowing for the acquisition of knowledge through personified experiences of wonder rather than through the supplement of information which can short-circuit discovery. Alvar Alto once spoke of the importance of experimentation and play in his design process when speaking about his 'Experimental House at Muuratsalo:

[I have] a firm convection and instinctive feeling that in the midst of our labouring, calculating, utilitarian age, we must continue to believe in the crucial significance of play when building a society for human beings, those grown-up children. The same idea, in one form or the other, surely lies at the back of every responsible architect's mind. A one-sided concentration on play, however, would lead us to play with forms, structures and, eventually, the body and soul of other people; that would mean treating play as a jest…we must combine serious laboratory work with the mentality of play, or vice versa. Only when the constructive parts of a building, the forms derived from them logically, and our empirical knowledge is coloured with what we might seriously call the art of play, only then are we on the right path. Technology and economies must always be combined with a life-enhancing charm.

In the practice and education of architecture, the element of risk should always be present in the persona of the architect. If one only dwells in the *workmanship of certainty* rather than the *workmanship of risk*, only established and tested methods and solutions are throughout their work. With the element of risk, the architect tends to experiment with novel structures, forms and materials. In this haptic state of emersion, the hand explores, searches and touches all that the imagination presents as if it was fresh and new. This is a very important notion especially when engaging the new computer generated design studies. I mention this because of my suspicion concerning the false precision and apparent finiteness of the computer image when compared to the natural ambiguity and innate hesitancy of the hand. It is in this ambiguity that one can dwell in the play mentality and allow assurance and precision to arrive at a satisfactory resolution after many trial and error iterations. This is not to say that a skilled computer artist cannot find this counterpoint in its medium but I do not believe it encourages this type exploration. As Juhani Pallasmaa states in his book; THE THINKING HAND, with concern:

Precision of thought and performance, as well as emotion, is crucial, but only in a counterpoint and dialogue with embracing and vague, all-encompassing and oceanic creative imagery. The seminal role of vagueness is totally ignored in today's pedagogical philosophies and methods… Does the computerized hand allow ' the happy moment when all conscious control can be forgotten? Does it permit a multi-sensory imagery and an embodied identification?

This paper is not an attempt to favor the hand drawing over the computer drawing (although I do have my preferences) but an admonition in terms of the importance of a playful mindset in how these two skills are employed as a creative design process in generative art and architecture. I will try to demonstrate this pedagogical notion by positioning 'play' in several different design situations as conducted in my architectural design studios. I will address play as analogy, as portal of entry and as a tectonic then finish the paper with a design proposal I am currently pursuing to bring play into the collaborative act in the building of community.

References:

[1] Juhani Pallasmaa THE THINKING HAND,

[2] Alvar Alto, The Experimental House at Muuratsato

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Keywords:
The Importance of PLAY in the Creative Design Process

PLAY-TECH-TONICS

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The desire ‘to know,’ or ‘wonder,’ is the human need for knowledge. It exists in all of us and stimulates one toward inquiry and dwells in our acts of ‘serious play.’ In play we allow ourselves to enter into the limits of another world; a world apart from reality, yet so vital to understanding the meaning and significance of that reality. We allow ourselves the opportunity to play to a different song (a new set of rules) and unlock the doors of our imagination to the construction of meaning.

What I would like to suggest in this paper is that in learning, and especially in the initial years of an architectural education, a more playful point of view must be encouraged to provide an arena of inquiry that produces architecture and a culture that is more wonderfully humanistic. The pretending quality of play should not be misunderstood as preventing it from proceeding with intense seriousness. This is easy to understand when observing the intensity young children exhibit in their daily adventures in the play of life. As Dr. Benjamin Spock explains in one of his many writings about child rearing: “Play is serious business. When we see children building blocks, pretending to be airplanes, learning to skip rope, we’re apt to think, in our mixed up adult way, that these are just amusements, quite different from serious occupations such as doing lessons and holding a job. We are Mixed-up because most of us were taught in our childhood that play was fun but that schoolwork was a duty and a job was a grind...Children love their play, not because it is easy, but because it is hard!”

In the practice and education of architecture, the element of risk should always be present in the persona of the architect. If one only dwells in the *workmanship of certainty* rather than the *workmanship of risk*, only established and tested methods and solutions are throughout their work. With the element of risk, the architect tends to experiment with novel structures, forms and materials. In this haptic state of emersion, the hand explores, searches and touches all that the imagination presents as if it was fresh and new. This is a very important notion especially when engaging the new computer generated design studies. I mention this because of my suspicion concerning the false precision and apparent finiteness of the computer image when compared to the natural ambiguity and innate hesitancy of the hand. It is in this ambiguity that one can dwell in the play mentality and allow assurance and precision to arrive at a satisfactory resolution after many trial and error iterations. This is not to say that a skilled computer artist cannot find this counterpoint in its medium but I do not believe it encourages this type exploration.

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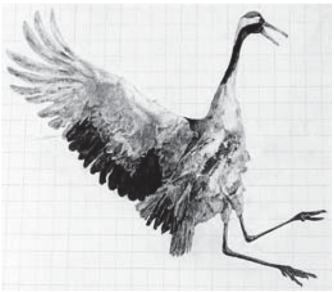
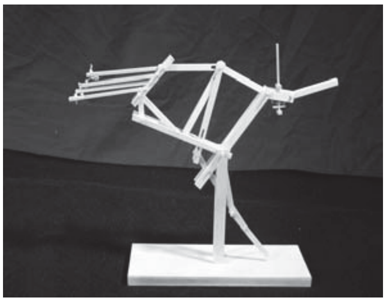
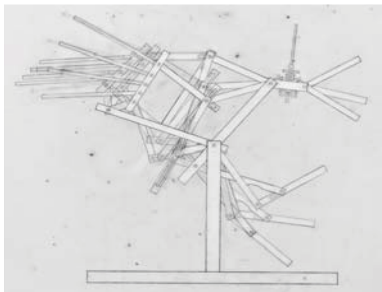
PLAY-TECH-TONICS

A process of constructing one's imagination

" Imagination is the faculty of transforming the experience of what is into the projection of what could be, the faculty that frees thought to form ideas and norms"
(Iris Young)

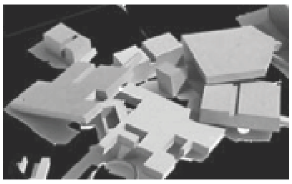
PLAY as interLUDE

As many scholars have suggested from Plato to Huizinga, play forms are the separate worlds apart which help us to be informed about the worlds within. It is through myth, fantasy and the many forms of analogy, metaphor and personification that great wonders of the imagination are given meaning and realization. Although play is but an interlude, "...it adorns life, amplifies it and to that extent a necessity both for the individual - as a life function, and for society by reason of the meaning it contains, its significance, its social associations, in short, as a cultural function."[3]

In order to establish the studio as a setting for wonder, research, and invention, **analogy** can also be used as an effective device to develop a constructive imagination, since parallel readings are implicit at many levels, from surface meaning to operative functioning. Analogical exploration also allows beginning design students to assimilate complex forms and processes from realms outside of the architectural discipline. The students are thus enabled to discover architectural form and use in a manner unencumbered by preconception and conventional program.

An analogical studio process at times might appear to be paradoxically restrictive and formulaic, if each step is prescribed for the student. On the other hand, it is possible that the student is instead liberated from the burden of process, and thus enabled to dwell in the wonder of focused enquiry. Each step of the process re-contextualizes the student's own work, in effect expanding the meaning of the work. Similarly, the use of analogy opens up, rather than closes down, a set of architectural possibilities. This form of design exploration is ultimately open to change and evolution. Meaning, therefore, is derived from an implicit search for understanding formative principals rather than definitive conclusions. "Arms, Wings and Mechanical Things" is the title of a previous paper presentation at the GA 2002 conference that gives more detail about this analogical studio.



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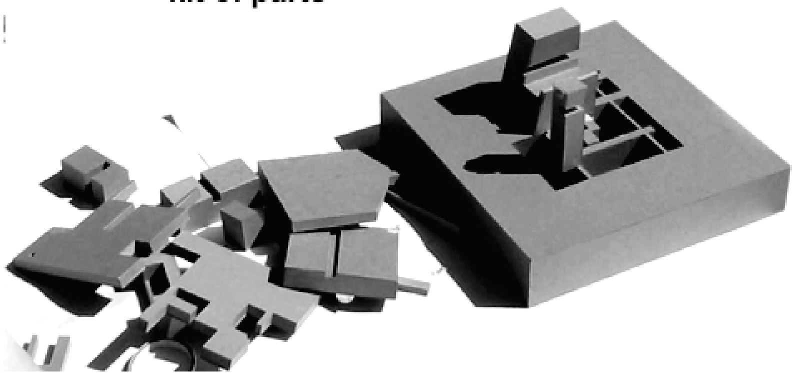
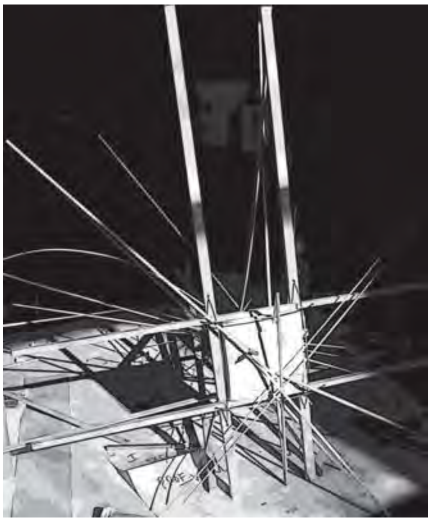


PLAY as TECH

Most students entering beginning design have already experienced at least 18 years within the designed world. The knowledge gained from that experience and the skills developed become valuable assets to the design student. Viewing education as a process of discovery, design education orients toward a "search process" and allows one to use personal history as both a knowledge base and a procedure for designing. In the act of making, an immediate dialog is established with the project at hand. The hand directs eye and existing knowledge is used free of the limitations of an architectural form "image." Making is a process that reveals thinking, embodying in the work and in the doing, the self.

Form making can begin with the derivation of basic elements of architectural form and space—architectonics. These elements can provide a 'search field' within which interrelationships are discovered, promoting structuring strategies or concepts that demonstrate 'how' they are to be manipulated in the act of making. Although architectonics supports the overwhelming desire to make a building (the noun), it could dangerously result in a design inquiry that parallels stereotypical production and preconception. When building, as a *verb*, is pursued, tectonic making results in forms of investigations, discoveries and formal dialogs where innovation occurs as a result of design negotiation. The design process is freed from preconceived outcomes or deterministic methodologies; it reveals itself through choice. The process is one of design research where the choices are made on the basis of a search for meaningful relationships, their premises and consequences. It is then a series of approximations born out of possibilities. Architectural knowledge, here, is 'tacit knowledge', acquired by *doing* rather than by being instructed in the rules of doing. Experimentation and transformation provide irresistible stimulus to the formation of new ideas. The process of transformation, the concept that all forms or ideas can be rearranged, synthesized, and put back together to make a new whole, increases the likelihood of making 'intuitive leaps of invention'. In this architecture of Play, learning becomes fluid and open ended and innovation starts with the question: What if? Knowledge is drawn from wonder — giving form to answers, redirecting stereotyped thinking towards a search process where hidden intentions and accidental discoveries lead to new alternatives and solutions. Through many forms of deduction, abstract relationships are tested and defined as they materialize into and demonstration—of intent.

As an initiation into this design realm of thinking/doing, I have employed an exercise I had as a student of Tom Regan at VPI, called, "The High Variety Model"(3). On the first day of their first architectural design studio the are directed to the hobby shop to buy a 1/25th scale model kit, some felt tips, a roll of yellow trash and return to class in an hour. When they return they are told to build something architectural from all of the parts (box and instructions included) in their kit. There is one stipulation, the parts cannot be used in such a way to resemble the intended image depicted on the original model kit as bought. In other words, an immediate and random sets of variables are injected into the creative play. Use of the model forces one *to select* representative parts, *to organize* them, *to evaluate* and re-evaluate their suitability in relation to the new project at hand, and then *to modify* inconsistencies, thus differentiating between what is understood and what requires further search. As the detail of the element is modified, so is the totality of the organization in reference to one's new knowledge and decisions. The construction is continually in the process of re- creating itself in the process of its own creation. In the end the significance of using the High Variety Model is that it necessitates decision making as a design activity, forcing the introduction of random information to be used or discarded, and it directs a focus on organizational concepts as opposed to architectural form images.



PLAY as a TONIC

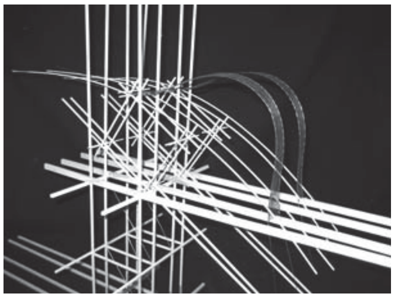
'Opening an Artifice'

A students' introduction into their first design studio is of immense consequence upon the initial impressions one receives about the creative design process. In order to short circuit the beginning design students propensity to rely on preconceived ideas and images, "an enabling theory" can be immediately introduced in the design process that can allow form to beget form. I have referred to this process of design initiation as 'The Opening an Artifice' [from the Latin *artificium*, a trade or profession, ars, art, and *facere,* to make]. As Kristopher Takas, one of my former students, put it in his recapitulation of his previous design experience called; "ARTIFICE INSEMINATION," as published in our student design magazine, *eyelevel*:

> *"A theory of making must be invented: it will either elucidate how to construe or how to construct…this is called the process of opening of an 'artifice.' The concept of artifice, of course, must be understood in several manners. Usually it denotes skill or ingenuity. But it also connotes something more: trickery and craft. Since a productive enabling theory commences with an artificial separation between form, content, and function, this [threshold] to design can be seen as a clever expedient from ideation to creation. To separate content and function from the syntax of form, for example, means to deal initially with a formalist, repertory of tangible vocabulary. Hence, the artifice is device. In the artifice-al (and ergo,artificial) scenario, meaning is theoretically subtracted from materiality so that the designer may manipulate the tangible constituents of formalism—-i.e., materials, space, form, shape, color,et al— without getting wrapped up in the infinite chain of signification's inherent to any system of making. For some architects, this is natural and unquestioned act; for others, however, the conception of an artifice is a conscious art through which formal components of form are exploited and then abandoned to collude as they might. Yet, this design purism isn't architecture yet. The artifice*

relies on deception: its purpose serves to suspend belief, and to postpone reality, so that the designer may first enter through the imaginative portal. Architecture begins on the other side.”

‘Design’ is the form of architectural thinking that traditionally is considered paramount in the education of an architect. The design studio is typically the place where students bring together the practices, concepts and knowledge that are introduced in other areas of the curriculum. Consequently, it is necessarily a synthetic process. Form, function, and content (meaning) have long been critical constituents of the process of design. In the past, architectural design academies dictated a specified order to the critical constituents of form, function, and meaning (content) resulting in a deterministic means of design inquiry. In the current heterogeneous state of the architectural design studios in academia, the hierarchical prescriptions, or sequence, of the three notions of form, function and content (meaning) have been freed from the strict boundaries of former theoretical paradigms. Although the separation of these three notions is admittedly artificial, it allows beginning design students to immerse themselves into the task at hand without relying on self-conscious preconceptions.



If we begin to view these components as metaphorical portals that the student opts to pass through, their order becomes particular to the personal design route for the project at hand. Thus, one can choose form from meaning, form from function, or form from form itself. This becomes a point of departure that frames a particular perspective with which the student can proceed in his or her design process. Alberto Perez-Gomez calls this theorizing the inventing of an ‘enabling theory’; it enables the designer ‘to make’, serving as a rationale for ideation and fabrication. As the project develops, a design scaffolding it is able to support the other architectural constituents of design theory. It becomes a vehicle for the student to initiate creative associations and evaluations to direct decision-making. (see Paper presentation GA conference 2003, “Imagined Architecture via Material Imagination)

PLAY vs. GAME

Play In The Public Sector As Community Building:

“Shadow Casting”

> ‘Play’ means different things to different people, however. When Huizinga (1960) wrote that ‘civilization is, in its earliest phases, played’, he was linking the evolution of rituals and ceremonies, of the rules of diplomacy and those of warfare, to the contests and competitions that characterize games. Competitive play, however, is not the same as the more fluid and self-determined play that I am advocating here. My view is closer to that of the artist Alan Kaprow, who contrasts play with games: This critical difference between gaming and playing cannot be ignored. Both involve free fantasy and apparent spontaneity, both may have clear structures, both may (but needn’t) require special skills that enhance the playing. Play, however, offers satisfaction, not in some stated practical outcome, some immediate accomplishment, but rather in continuous participation as its own end. Taking sides, victory, and defeat, all irrelevant in play, are the chief requisites of game. In play one is carefree; in a game one is anxious about winning.
> (Kaprow, 2003, p. 122)

Up to this point in this paper I have referred to design studios that exist in the confines of the classroom. I am developing strategies to bring the act of making into the public realm where working together toward a common goal can build more than the architectural project at hand. I am planning a project that will require people from the community to rely on one another in an act of constructing; shadow casting. In this situation ‘game’ takes on a different character in that it does provide a set series of rules but the outcome is non-deterministic because the form in the forming. This releases the notion of victory or defeat traditionally associated with game, for all players are working to construe a common construction.

The collaborative event should take place in a public plaza, green on our campus or a city’s public park. There will be teams of two to begin the shadow casting process. One will be designated the shadow caster (with long bamboo poles) the other will be the shadow chronicler (using field marking chalk or spray paint) to mark the cast shadow on the ground surface. This process will be conducted at three different times of the day (morning, afternoon and sunset). Once these lines are drawn on the ground we will begin to transform them into cuts into the ground (foundations and darkness) and overhead constructions (cutting the sky). These moves will occur as a result of translating the maps into full scale, habitable, architectural constructions. They may be permanent or temporary depending on the site locations. The event can be conducted with as few as 10 people and as many as 50, it also depends on the time and place of the event.

During my current sabbatical, my intention, is to create a new set of drawings or “Shadow Maps” as well as to re-engage my previous maps. These maps will be translated into 3-dimensional constructions using a variety of materials and sizes to concretize my theoretical inquiry, “If a object can cast a shadow, can a shadow cast an object?” I will be preparing the maps/drawings, models, and strategies that will facilitate a full-scale collaborative shadow mapping construction in the public sector. I recently met with Michelangelo Pistoletto to propose the possibility of work-shopping this theoretical inquiry in a full-scale collaborative project with resident artists at Cittadellarte-Fondazione, Biella, Italy during my sabbatical year or soon after. After an artist in residency at Domus Argenia in Sardinia to prepare strategies for this creative collaboration, I have been invited to conduct a shadow-mapping event in Rome, Italy with artists from the Generative Arts Conference later next year. I plan to incorporate these ideas of creative collaboration in the other countries I will be conducting design workshops at such as Sao Paolo, Brazil and Nanjing and Shanghai China. After my sabbatical in August 2012, when I return to teaching my design studios, I plan on conducting a similar shadow-casting event with my architecture majors as well as other students and faculty from the College of Arts and Sciences.

> *“Play by the rules, in order to begin*
> *Through the ambiguities of the play comes the dialogue; through the dialogue comes invention. To design is to ask the questions; How? Why? What if? In the question lies the answer, yet the answer must always seeks the new question- new theories.*
> *Beauty - in form dwells, in the knowledge of the rules of play.*
> *In order to play a new order, to design is to re-interpret the rules of the play to transgress through the rule until a new order is uncovered,*
> *to rediscover the familiar as something new. To bring light to the invisible,*
> *to create a consciousness manifest in the making of things that represent the world, to bring the sacred to light, to reveal the place of man.” (Viscardi)*

Dr. Ben Baruch Blich

Design and Architecture as a philosophical question

Design and Architecture as a Philosophical Question

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We live in a world of constant and rapid change. Values, ideologies, beliefs, regimes, institutions, etc., etc., have transformed their identity beyond recognition. Among them are objects of design and architecture. The problem I want to discuss in my paper has to do with this rapid and unprecedented changes: how do we identify and classify design and architectural artifacts vis-a-vis their new and frequently unrecognizable appearances.
In fact the problem I point at goes back to Aristotle who was the first to note that in a world of constant growth and change, one has to ask whether there are necessary and sufficient conditions for a thing to be considered as such; is there an idea, a definition, a thing should comply with in order to be properly identified.
Aristotle's epistemological question is still relevant today, especially in the context of design and architecture, which are constantly changing and growing, but also in linguistics as the father of generative grammar (syntax) developed by Noam Chomsky. According to Chomsky it is necessary to assume the existence of a deep structure to languages if we want to give a rational meaning to the proliferation of languages, which he labeled as surface structure. Adopting this idea to Design as well as to Architecture one has to look at a common object of design – a chair, and compare its lexical definition to its numerous real appearances in the course of its history. Or refer to the lexical definition of a building, and put it next to buildings around you. Having performed this gedankenexperiment, i .e.: comparing the lexical definition of the relevant category to its diverse appearances in reality, is in fact an epistemic dilemma as well as a methodological query. On the one hand we have an idea of an object, i.e.: of a chair or of a building, and on the other hand chairs and buildings hardly fit nowadays to their lexical established definitions. Moreover, due to the growth and rapid developments of design and architecture, their objects and products simply do not resemble each other any more. Look at chairs designed by Eero Aarnio, Alessandro Mendini, Ron Arad, Marcel Breuer, Nana Ditzel, and the chair prototypes sketched in the Bauhaus by Erich Dieckermann – the differences among them are unbridgeable, eliciting the question why and how do we cluster them all under the same family of objects and treat them all as chair. The same goes with Architecture. Buildings designed by Ludwig Mies Van der Rohe, Philip Johnson, Le Corbusier, Richard Rogers, Renzo Piano, Bernard Tschumi, Frank Gherry, Daniel Libeskind, and many others, who have contributed to the proliferation of the language of Architecture, and have enriched our experience of structure and design, have challenged by the same token the merits of architecture and its foundations, expanding the notion of buildings beyond recognition. Guggenheim's museum by Frank Gherry has 'violated' traditional concepts of architecture, the same goes with Daniel Libeskind's Jewish Museum in Berlin, Renzo Piano's Nemo in Amsterdam, and the Pompidou Center designed by Rogers and Piano. And still, they all belong to the same family of architecture in spite of the fact that each one of them hardly relates to the other, as well as to buildings in architecture at large.
In light of my examples, it is vital to discuss the question originally raised by Aristotle: how do we classify objects of design and architecture, and furthermore - which of the many instances of design and architecture are the most paradigmatic; the one we would prefer as the most representative, fully exemplifying values of design and architecture.
A partial answer to our dilemma is given by two philosophical approaches: the first is Quine'stheory of natural kinds, which rigidly bases similarity (of objects, phenomena etc.) on induction. The second philosophical approach is Wittgenstein'family resemblance, which treats similarity in the context of games, interpreting classification as an open texture endeavor. With these two theories in mind we can explain and eliminate some of the problems put by modern and post-modern design and architecture, and make sense of their diversity.

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Keywords: ***Design, Architecture, generative syntax, natural kinds***

Design and Architecture as a Philosophical question

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1

- **We live in a world of constant and rapid change. Values, ideologies, beliefs, regimes, institutions, etc., etc., have transformed their identity beyond recognition. Among them are objects of design and architecture. The problem I want to discuss in my paper has to do with this rapid and unprecedented changes: how do we identify and classify design and architectural artifacts vis-a-vis their new and frequently unrecognizable appearances.**
- **In fact the problem I point at goes back to Aristotle who was the first to note that in a world of constant growth and change, one has to ask whether there are necessary and sufficient conditions for a *thing* to be considered as such; is there an idea, a definition, a *thing* should comply with in order to be properly identified.**

Aristotle and Plato in Raphael's painting "The School of Athens" 1509

- **In his 'Categories' which is an excellent prelude to our problem, Aristotle discussed ten categories in the light of which he defined the essence of things based on his observations for the purpose of establishing a theory of order. According to his theory, an animal can not be called a 'horse' without manifesting its 'horsiness' and in order to do so, it must fulfill definite criteria.**

In other words, Aristotle basically determined that all things, animals, plants and objects, exist only by fulfilling certain qualities. One can not even think of an unclassified or uncategorized object; it simply would not exist for us, it would have no essence or shape.

- **To illustrate Aristole's point, allow me in few words address Terri Schivo's case.**
- **Terri was a woman who suffered brain damage fifteen years prior to her death in 1995, leaving her paralyzed, totally disconnected from her surroundings and dependent on constant help and support. Her husband appealed to the US courts to end Terri's life, which had indeed ruled that Terri was in a permanent vegetative condition, claiming that her life had no purpose as she could no longer fulfill basic human functions.**

Terri was no longer in the same category as other human beings, and yet in spite of the courts' ruling, she was not a plant either, but a human being living in special conditions which were denied from her.

Could she not have continued to be fed and sustained as someone who represented another aspect of human existence? Does the human category denies a place for anyone different? And the most important question of all – what is the boundary between the human and those who are found not fit into this definition?

The lesson to be learned form this case and other boundary cases, is that objects that go beyond accepted categories undermining accepted views, are cases which compel us to re-examine our categories and classifications. Applying this lesson to Architecture and Design, we should ask ourselves whether Aristotle's rigid principle of classification is relevant and helpful.

- **Since we are all surrounded by designed objects as well as spaces planned by architects, which have gone dramatic changes in the last century, both in terms of content, appearance, material and mostly in terms of the growing public awareness, it is only natural if we question their identity and essence.**

Centre Georges Pompidou, Piano and Rogers, 1971

- When Renzo Piano and Richard Rogers built the Pompidou Centre in 1971 it seemed to resemble a brewery or an oil drill site far more than a center for the arts. The question was - how should we look at this odd and unfamiliar building in view of our past experience with museums and public buildings in general? Must this contemporary building bear true resemblance to similar institutions erected in the past, namely museums? Must our acceptance of new appearances depend on having seen similar things already? And furthermore, did Renzo Piano and Richard Rogers only change the paradigm of museums or can this amended paradigm be applied to other public buildings such as legislative offices, hospitals, and airports. How is the compatibility between the style of a building and its public function determined?

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The same goes with other buildings designed by Ludwig Mies Van der Rohe, Philip Johnson, Le Corbusier, Richard Rogers, Renzo Piano, Bernard Tschumi, Frank Gherry, Daniel Libeskind, and many others, who have contributed to the proliferation of the language of Architecture, and have enriched our experience of structure and design, have challenged by the same token the merits of architecture and its foundations, expanding the notion of buildings beyond recognition. Guggenheim's museum by Frank Gherry has 'violated' traditional concepts of architecture, the same goes with Daniel Libeskind's Jewish Museum in Berlin, and Renzo Piano's Nemo in Amsterdam. And still, they all belong to the same family of architecture in spite of the fact that each one of them hardly relates to the other, as well as to buildings in architecture at large.

Guggenheim, 1959

Nemo, Amsterdam 2000

Berlin Jewish Museum, 2001,

Similar questions could be asked in reference to design. The chair, the table and many other objects have all been altered dramatically over the years and one wonders at observing their development and transformations should they all belong to the same family tree? Indeed, a look at the history of chairs shows how far designers exceeded the usual prototype predicted by Erich Dieckmann. Dieckmann taught at the Bauhaus school and sketch out a linear, gradual development of chairs with each new addition fulfilling the potential rendered by the chair preceded it. According to Dieckmann's model, which reminds Mendeleev's periodic table of elements in chemistry, one can predict any evolution of form in the new model of chairs.

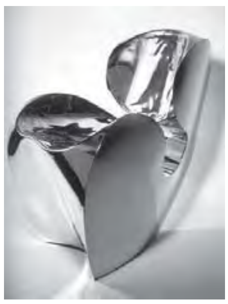
Erich Dieckmann 1896-1944

Going from left to right the location of each model presents the options of the chair design: it begins with the most basic and simple model on the left and then moves on to the bold and complex on the right. In other words, Dieckmann's chart drew several categories of design, in this case of chairs, to present the range of possible chairs as well as its limits. Any deviation from this model is ipso facto a realization of the potential inherent already in one of the options portrayed by him.

Rafael Rossi, 1936

Gerrit Rietvelt, 1924

One could say that each of these examples, and many others, 'pulls you' towards a unique design direction, yet they all maintain the familial model advocated by Dieckmann.



Ron Arad, 1989

The question is how do we explain the dissimilarities in design and architecture, and further more, how do we explain our recognition of this dissimilarity?

The answer I intend to forward is based on two theories of similarity: the first was elicited by the American philosopher – Quine, and the other was suggested by the Austrian philosopher – Wittgenstein. Both of them are analytic philosophers whose main interests were in language and logic. I will skip, with your permission, their methodological insights on language and logic, and concentrate mainly on their approach to the question of clustering.

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Quine based his understanding of similarity between objects on what he labeled as *natural kinds* , i.e.: if a, b, and c, are of the same manifested feature (let us say black ravens), they are all ipso facto a group. In order to identify objects as belonging to a group one should point at a certain generative feature with the help of which he can inductively put a, b, and c under the same group. Clustering objects into one group is a non-open game, and it practically means that objects of architecture as well as objects of design should comply to certain inherent rules. To identify a raven as belonging to the group of black ravens means that it should comply to their black generative feature in such a way that the new raven in question does not break the chain of induction. According to this theory a collection of chairs would be considered a group if their manifested features such as size, colour, function, shape, etc. can be identified.

William van Orman Quine 1908-2000

- For example, chairs whose function is to sit on near a table, would not 'tolerate' a medical chair, the one used by dentists, as an equal member in their group. The same goes with decorative or experimental chairs, chairs placed in an airplanes, chairs whose function is to teach student of design how to build chairs, etc, etc.
- In other words, objects of design as well as buildings in architecture, are identified, according to Quine’s theory of natural kind, by their categorical manifested features.

The Eames chair, 1941

A leather dining room chair

Chairs to sit on and an experimental chair intended to represent a new and uncoventional model.

A commercial Italian chair

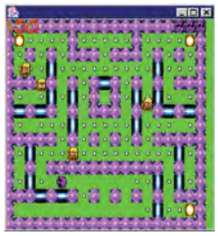
Chris M. Todd, Tripartite, 2006

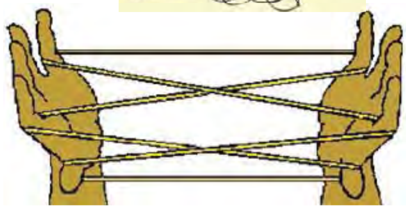
- The second philosophical approach to the problem of clustering was advocated by Wittgenstein. Wittgenstein's theory is much more democratic, tolerant and less rigid. He has denounced induction as a scientific method, introducing instead his concept of *Family resemblance.* According to Wittgenstein members of a family should not consider themselves members of the same family only on one inherent basis, such as similarity, size, height, etc. Belonging to a family is based, according to Wittgenstein, on the member's wish and desire to become a family. An adopted child would be considered an equal member of a family if he complies with the fate and interests of his fostered family, even though he does not resemble them whatsoever.

Ludwig Wittgenstein 1889-1951

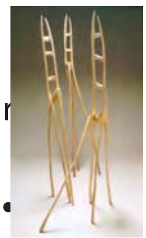
A family with adopted children

The same goes with games: ball games, doll games, computer games, string games, etc. are all considered a family in spite of the fact that they do not resemble each other. English, Italian, Hebrew, Chinese etc. have no external common features, and yet they all belong to one family due to their function in communication, expression, etc.





- Design objects of various kinds, buildings of various styles, are, no doubt, of different kinds (have different appearances, different functions, different histories etc.), and yet according to Wittgenstein's family resemblance theory they all belong to the same cluster. Considering them as belonging to a family means that categorization is based on human interests and decisions and not on their inherent hidden traits.
- The bottom line is that Wittgenstein puts emphasis on deliberation, brainstorming, decision making, and not so much on the principle of induction, as Quine did.



- Design and Architecture, as other artistic disciplines, provoke within us philosophical questions. One main question concerns the problem how do we classify objects in the fields discussed, and what are the criteria for categorizing an object in the bounds of Design and Architecture. I have pointed at two ways of categorization, and now we should make our minds which of them suits us well.

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Benjamin Busch

Paper: **Adaptive Structure: A Modular System for Generative Architecture**

Topic: Architecture

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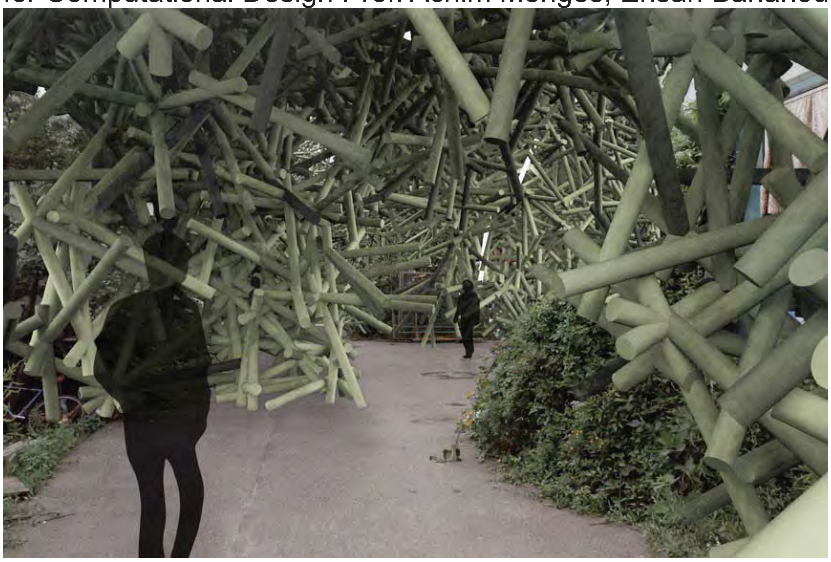
Abstract:
Continuously changing human requirements necessitate adaptive solutions in architectural design. Physical space should evolve efficiently in response to programmatic requirements, taking into account existing structures by mutating rather than replacing them. The aim of this research is to create a model for an adaptive structure that responds to user input relating to its use.
Diffusion Limited Aggregation (DLA), a computational model for natural aggregation, is capable of generating biomorphic aggregate structures. Because DLA is an additive and comprehensive system, it has the possibility of infinite growth. The growth process of DLA begins with a starting aggregate, and from its starting point the structure grows in an unexpected way with a certain degree of parametric control. Each aggregate in a digital model can be considered an architectural element that is added to or removed from a physical structure. Because we can stop and restart the simulated aggregation process, the architectural structure can evolve by responding to the specific needs of the user. Like a living organism with cells that die and arise based on immediate necessity, an adaptive, complex structural system can morph over time with great resource efficiency.
As a case study, we developed a generative system based on the principles of DLA, including growth parameters (e.g. gravity, stickiness) and top-down spatial influencers (positive and negative attractors) based on user input. With further development, the following case study examines more closely the material implications the system, in particular its ability to adapt to changing spatial demands of the user.
This work was completed for the seminar Advanced Algorithmic Architecture, University of Stuttgart, Summer Semester 2011, Institute for Computational Design Prof. Achim Menges, Ehsan Baharlou



Impression of void space inside generative DLA structure (first study)

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Keywords:
Diffusion Limited Aggregation, generative architecture, emergence, adaptation

Adaptive Structure:
A Modular System for Generative Architecture

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Abstract

Complex spatial phenomena necessitate adaptive architectural design solutions. Consequently, physical space should evolve in response to shifting programmatic requirements and environmental stimuli through a process of structural adaptation, rather than being an immutable permanent entity. The aim of the research presented is to utilise an algorithmic, self-organising system in order to generate emergent, adaptive structures composed of mass-producible modular building components.

Diffusion-limited Aggregation (DLA) is a model for natural morphogenesis which is capable of generating biomorphic aggregate structures. It is an emergent, self-organising process in which randomly moving particles attach to a continuously growing cluster of aggregates. Because the cluster has potential for infinite growth, its process can be started and stopped. Additionally, the cluster can be made subject to environmental complexity through manipulation of aggregation probability. The model of DLA thus presents one possible mode of thinking and production for an adaptive structural system.

This paper introduces a case study in which a modular material system was developed based on the morphogenetic principles of DLA. Initially, the terms self-organisation and emergence will be introduced as an overarching research paradigm, thereafter DLA is explained in detail. The case study shows possible architectural implications as well as the technical detailing of the aggregate parts. The results of the case study will be discussed and further developments outlined.

Keywords: Diffusion-limited Aggregation, DLA, emergence, self-organisation

1. Introduction

Complexity theory provides a mathematical understanding of the systematic process from which complexity emerges. As opposed to reductionism (i.e. closed systems and linear relationships), complexity theory focuses on the collective behaviour that emerges from the milieu of interactions within a multitude of singular components. These interactions take place at all imaginable scales, from molecules and cells to ecosystems and climates. The complex is heterogeneous, composed of many varied and interdependent parts, which all behave uniquely based on encoded processes and specific environmental conditions [1]. Consideration for the natural complexity of ecological systems begins to provide a comprehensive understanding of the natural environment and its inherent intelligence.

Emergence and self-organisation, two generative processes found in nature, often occur in complex systems, usually in combination. De Wolf and Holvoet propose a working definition for emergence: "A system exhibits emergence when there are coherent elements at the macro-level that dynamically arise from the interactions between the parts at the micro-level. Such emergents are novel with regards to the individual parts of the system". They also propose a working definition for self-organisation: "Self-organisation is a dynamical and adaptive process where systems acquire and maintain structure themselves, without external control" [2]. Both emergence and self-organisation are dynamic processes that arise over time, and both are robust, meaning that they are capable of surviving occasional failures of single elements. The only possibility to obtain a coherent behaviour at the macro-level is to let that behaviour arise and organise autonomously. Thus, combining both phenomena is a promising approach to engineer a coherent behaviour for complex systems.

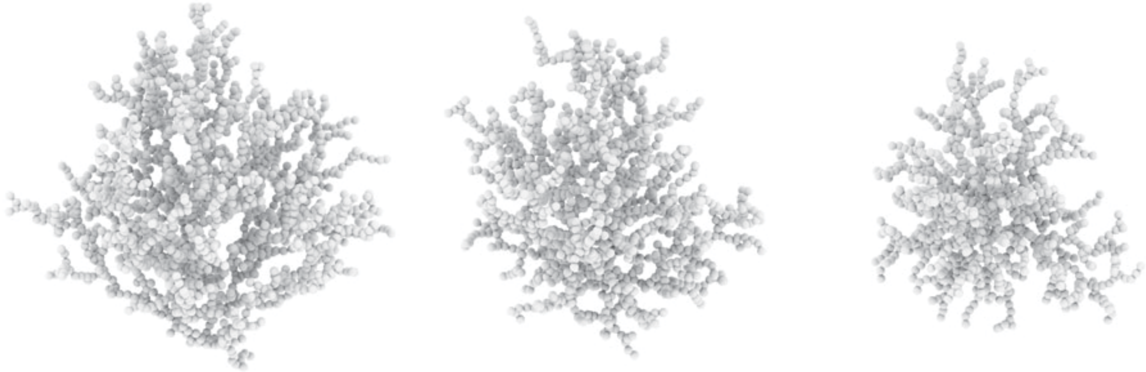
Furthermore, emergence should be adaptive in order to foster a system that is capable of self-organisation in a state of environmental flux, where the system responds to changing stimuli. Each element arises in relation to local conditions as well as factors that influence the entire system [3]. Adaptation can be viewed as a consequence of parallelism and iteration in a competitive environment with finite resources [4]. Behaviour is in this case subject to fitness, which determines a reaction for or against particular actions based on feedback mechanisms at all levels. It is particularly useful to consider adaptation in complex systems, because it allows the complex to evolve based on rules that can relate to practical applications.

Digital morphogenesis, or the generation of digital form, is capable of utilizing emergence and self-organisation as generative principles. However, in architecture, it is important not to regard the process of morphogenesis explicitly in terms of form generation: the geometric rigour and simulation capability of computational modelling can be deployed to integrate manufacturing constraints, assembly logics and material characteristics in the definition of material and construction systems [5]. In terms of adaptation, criteria for selection of the fittest can be developed that correspond to architectural requirements of performance [6]. Adaptive structures adapt to spontaneously changing environmental conditions while reacting to necessities resulting from the structure itself [7]. Therefore, computational morphogenesis is possible when complex systems incorporate the physical constraints of architecture and adapt to changing environmental conditions.

Complex spatial phenomena necessitate adaptive architectural design solutions. Physical space should evolve in response to shifting programmatic requirements and environmental stimuli through a process of structural adaptation. The aim of this research is to utilise an algorithmic, self-organising system in order to generate emergent, adaptive structures composed of mass-producible modular building components.

2. Diffusion-limited Aggregation

Diffusion-limited Aggregation (DLA) is a process of accretion over time which is observed in many natural systems, including electrodeposition, mineral deposits, snowflakes, dielectric breakdown (lightening paths), and even in living organisms (e.g. the growth pattern of some coral) [8]. Witten and Sander proposed a mathematical simulation of DLA: beginning with a single seed, a particle “walks” randomly from a distance until it reaches a position adjacent to the original seed, where it attaches to form a cluster. Subsequent particles appear at random distant points and walk randomly until they reach the developing cluster of aggregates [9]. The resulting cluster is a combination of many parts in defined relation to one another; therefore DLA is a self-organising system. Additionally, the coherent cluster at the macro-level dynamically arises from interactions between parts at the micro-level; therefore DLA is emergent. It also has the potential for infinite growth.



(Fig. 1) Left to right: gravity = -1.0; gravity = -0.5; gravity = 0

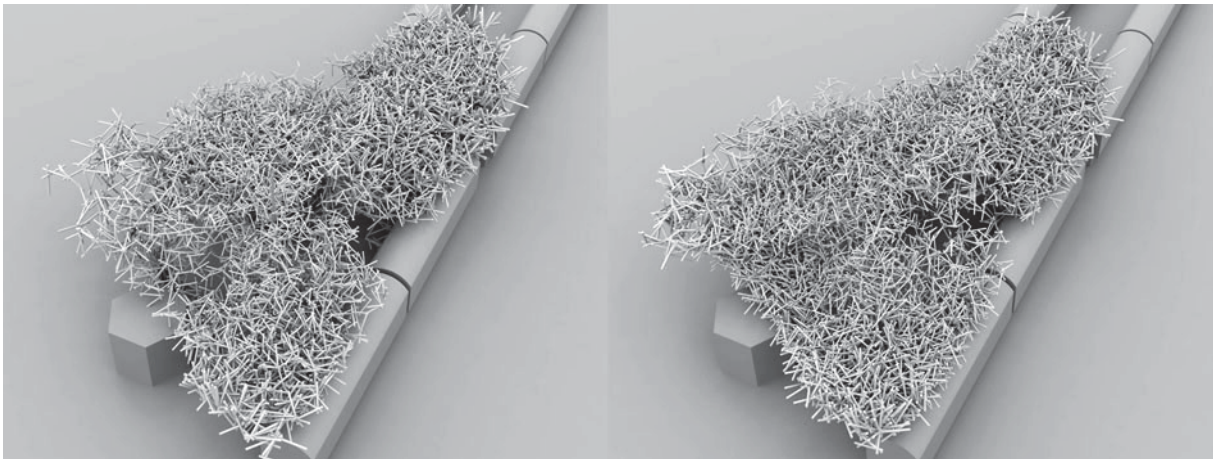
(Fig. 2) Left to right: stickiness = 1.0; stickiness = 0.5; stickiness = 0.1

The same probabilistic logic of Witten and Sander can be used to generate three-dimensional DLA through the implementation of a diffused particle system contained in toroidal space. Rather than walk, particles fly around at random velocities from random starting points at the boundary of the space, then attach to the cluster after breaching a specified threshold distance. Within this simulated environment, additional system parameters can be implemented to influence self-organisation. Gravity (Fig. 1) affects directional growth, creating clusters that appear to grow upward. Stickiness (Fig. 2) reduces the probability of a particle attaching to the cluster, which results in denser clusters.

3. Case Study

3.1 Digital Morphogenesis

First attempts toward architectural design based on DLA resulted in abstract instances of digital morphogenesis. Though not generated using material based computational methods, the resulting structures provide an initial glimpse into the power of DLA as a form generator and illuminate the problems that need to be addressed to implement an adaptive material system.



(Fig. 3) Emergent structures with identical boundaries and unique parametric settings

Several emergent structures were programmed to grow within predefined spatial boundaries (Fig. 3); all structures eluded prediction and culminated in a final “fit” iteration that best satisfies environmental and spatial requirements. System boundaries were manually modelled as a combination of physical-contextual boundaries (e.g. ground, walls, and doors requiring access) and desired spatial cavities for inhabitation (in this case, we performed “subtractive” architecture from a yet-to-be-generated structure that theoretically could have consumed the entire site). The aggregation distance threshold varies within the self-organising structure in a manner which supports perceived local structural requirements. This placement resulted in aggregates inheriting a specific size based on their proximity to chosen areas of the structure requiring more massive components (e.g. the base). The lack of a material system results in structures composed of proto-architectural components, all of which are unique in size and connection detail.

The algorithmic process allows for space-oriented mediation of the growth process as a means to impose top-down order onto an otherwise unpredictable self-organised system, yet there is also the option to influence growth via the parametric settings of the complex particle system and structure's encoded growth rules. Five settings were discovered to have the greatest impact on the outcome of each emergent structure: amount of flying particles, number of time steps, gravity, stickiness and threshold range of components. For clarification: time steps refer to the iterative, incremental movement of individual particles in the particle system (it is not practical to simulate a particle system in real time). Particle abundance and time step quantity mostly have to do with the efficiency of the algorithm: more particles means faster growth at the front end of the process, but slower growth as the structure matures; more time steps infer less particles and vice versa. Gravity value refers to the susceptibility of individual particles in the particle system to Earth's gravity. Reduced stickiness did not prove to be useful for architectural applications, as problems with density and intersection occur when a particle enters an already developed part of the structure and then attaches. The threshold distance for component aggregation is determined on the low end by a user-defined variable and on the high end by direct proximity to localities with greater normal stress. Because each manual setting can have a drastic effect on the fitness of an emergent structure, it was necessary to run many trials to find the right combination.

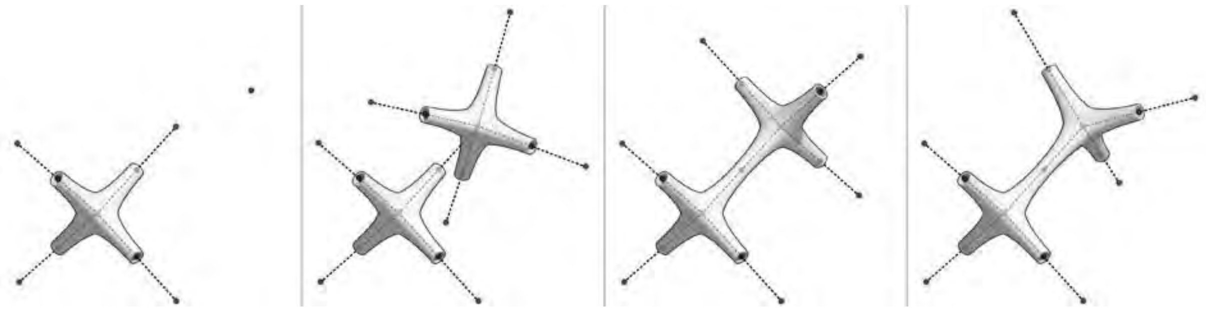
(Fig. 4) Interior perspective of generated structure with primitive geometry

Throughout the initial trials, primitive geometry was used to materialise the geometrical data culled from the algorithmic DLA simulation, more specifically aggregate coordinates and the connections between them (Fig. 4). Rather than constructing an architectural component directly at the point of each aggregate, an algorithmic function essentially converts generated information between aggregates into extended three-dimensional solid geometry (extension of the solid geometry was an early attempt to create tectonic relationships between the architectural components). Yet, this digital morphology fails to relate to real-world constructability due to the tendency toward unmediated topological intersection.

The initial algorithm, which bears a close resemblance to DLA, is capable of responding to environmental input in the process of generating emergent structures. However, its lack of a material system makes it impossible to generate a process for producing architecture in physical reality. The algorithm also does not take into account further expansion of the structure or reconfiguring building components for overall structural modification. Therefore, a modular material system (specifically composed of the same mass-produced module) must be generated parallel to localised geometry in order to produce adaptive algorithmic architecture.

3.2 Modular Material System

When a modular material system is generated alongside the emergent geometry of DLA, the algorithm implements computational morphogenesis. A series of localised modules oriented to the three-dimensional coordinates of each aggregate form a material system that can crystallise the structure in physical space. Taking advantage of industry standard CAD/CAM processes allows for precise and efficient prototyping of singular yet morphogenetically related components (as well their multitudinous connections). While CAM allows for mass-customisation and offers the potential for completely unique modular components, the goal in the development of this material system is to design a structure that can physically adapt to changing user demands and environmental conditions while undergoing only strictly controlled local transformations that facilitate the use of one mass-produced module.



(Fig. 5) Left to right: particle approaches existing module; new module appears at aggregate coordinates; new module is aligned to existing module; new module is rotated randomly to diversify local connections

The original model of DLA was inspired by the aggregation of metal particles observed through an electron microscope, and although the phenomenon occurs elsewhere in nature, it does not occur at the architectural scale. Challenges arise as the structure is magnified and used for the production of architecture, especially in the case of this modular system, because only one mass-produced module is eligible for aggregation. As opposed to the self-organisation of three-dimensional geometry in DLA, the computational logic of this material system introduces new rules for growth based on constructional constraints. Each identical module in the material system consists of four connection points and attaches to an existing module in the structure. Afterwards, the three free branches of each module become connection points for potential aggregation (Fig. 5). In this way, structural growth is strongly influenced by the morphology of the user-defined module.

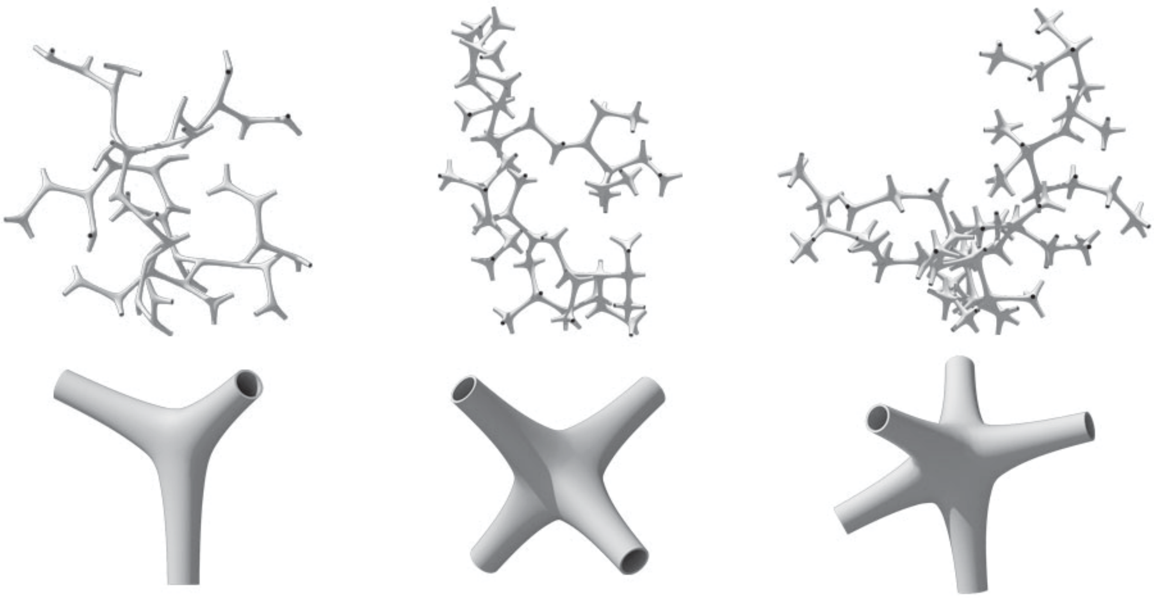
Material properties, manufacturing techniques and assembly logic of the material system must be considered in tandem with the overall generation of crystalline growth. A physical prototype has yet to be manufactured; therefore it is premature to decisively select a construction material and its most suitable manufacturing process. However, it is clear that the material must be light, formable, durable, and resistant to stress. Subsequent production techniques could potentially include thermoforming or injection moulding with a robotically-manufactured mould. Assembly can be carried out through a set of written or digital instructions or even by employing the precision of a robot.

Material system assembly logic, which was a priority in this research, is central to the performance of the generative algorithm based on a modular aggregate. The standardised nature of each module lends the material system to rapid adaptation. Each branch of the module is capable of attaching to all other uncoupled branches with six specific degrees of rotation. This allows a module to be removed from one portion of the structure and immediately reused in another. Modular components are able to correspond to a variety of connections at the micro-level in order to accommodate adaptation at the macro-level.

3.3 Design Solution

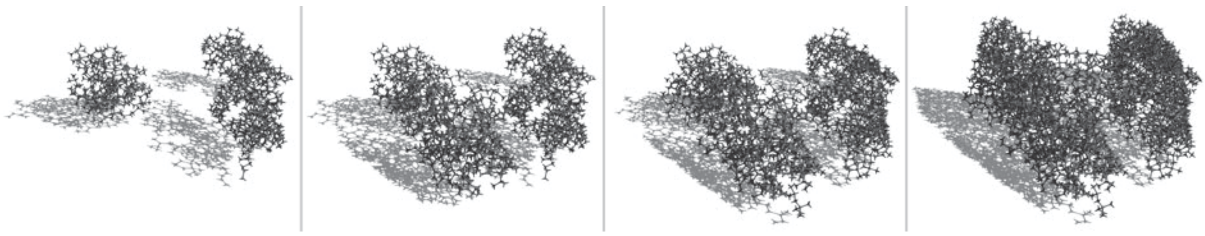
After critically defining the probability of growth based on information within the DLA system, architectural constraints can be incorporated to augment morphogenesis. Hensel and Menges posit: “Today the development of performative material systems, and in particular the technological advances of simulating their behavioural patterns of modulating and being modulated by the environment from the very early design phases on, enables us to further develop such modes of spatial organisation based on gradient conditions in interaction with physical thresholds” [10]. Adaptive material systems for architectural space begin to emerge when each aggregate in a generated DLA cluster is regarded as an architectural component. Through addition and subtraction of architectural “aggregates”, the DLA based tectonic structure is able to grow as well as degenerate over time. It shapes aspired forms and architectural configurations. The structure can adapt to specific needs of the user (e.g. use) and shifting environmental conditions (e.g. daylighting) through a continuation of the DLA growth algorithm and subsequent rearrangement of components in physical space.

Converting the DLA algorithm from digital form generation into a computational design tool that automatically constructs a modular material system was an essential step toward making a meaningful design proposal. The design tool is similar to the original algorithm in that aggregates are bound and influenced by user-input geometry and parametric variables. Its self-organising growth process is no longer a direct representation of DLA due to modified aggregation logic; despite its diminished “authenticity,” the algorithm has been effectively translated into a design tool for architectural morphogenesis. Additionally, the tool is adaptive: it is capable of restarting growth on existing constructions as well as intelligently subtracting modules based on changing performance criteria over time.



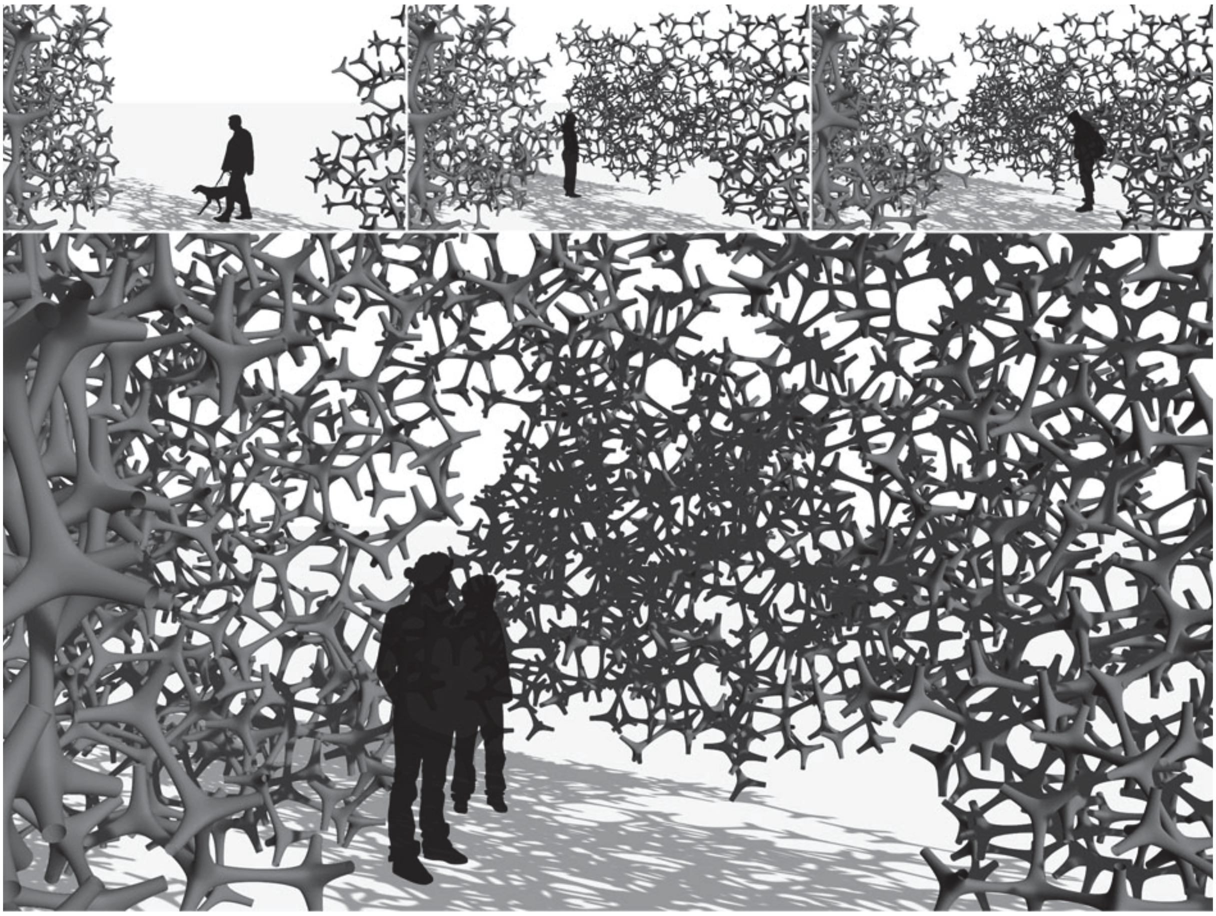
(Fig. 6): Module variations with three, four, and five connection points

First of all, the design tool is capable of computing an emergent structure that relates directly to a physical construction based on a modular material system. The construction is generated in a bottom-up process based on a user-input module with specific connection joint details for subsequent aggregation. The tool begins by identifying user-defined seeds for the emergent structure and places the first modules at their coordinates. Further local interactions occur when uncoupled branch termini lie within the defined spatial boundaries for aggregation. Self-organisation in design tool, the process for which was originally inspired by DLA, maintains its natural capacity for emergence. Local relationships between repeated modules of with varying connection capabilities continue to give rise to unpredictable behaviour in the overall composition (Fig. 6). There is a positive relationship between the amount of connection points in the module and the density of the structure overall.



(Fig. 7): Growth of structure over time based on circulation patterns and shading

As a means for adaptation, the computational model can be reloaded and the design tool initiated yet again. Growth is continued with new parameters responding to environmental conditions, for example thermodynamics, spatial assimilation and daylighting as well as performance criteria, such as structural optimisation and use (Fig. 7). Modules that are determined to be unnecessary or “unfit” by the tool are removed, while new modules are added and catalogued for implementation in the physical construction. Because the morphology of the module is consistent throughout the process, it is versatile. Formerly unfit modules can be again added to the structure as a way to reduce the ecological and economic impact of producing new modules. Architectural space can be reconfigured over time with significant ease following construction rules generated by the digital model.



(Fig. 8): Interior perspectives exhibiting structural adaptation and spatial nuance

The resulting construction, while in its current theoretical state not yet realised as a physical prototype, is capable of providing a series of environmental modulations based on desired affects (many of which can be simulated). Because the design tool was not envisioned based on traditional design methodologies, the construction itself is capable of producing architectural spaces with emergent experiential qualities. Unforeseen characteristics of the generated construction contribute to a gradient space between what is typically understood as outside and inside (Fig. 8); the modular material system allows structures to grow in a generative way with unexpected outcomes that carry the potential for unimagined uses.

Conclusion

The complex DLA based structure presented in this paper exploits design tools readily available in computational design, namely self-organisation and emergence as means to produce realisable constructions. Through this design process, the structure is able to adapt over time to a range of stimuli, and with the implementation of a modular material system, the design tool produces not only digital geometry but also offers the potential for production and assembly at the architectural scale. Perhaps most importantly, the module (which corresponds to the aggregate in the mathematical model of DLA) is repeated throughout the structure and can be mass produced as well as reused in subsequent constructions.

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Brian Evans

Paper: **A Substrate for Creativity**

Topic: creativity, cognition, computation

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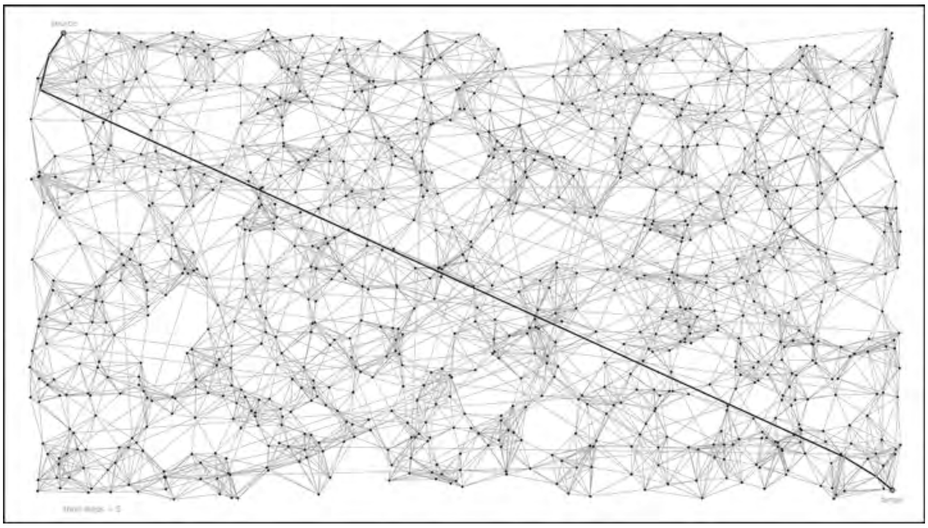
Abstract:
Hofstadter tells us that, "in regards to cognition analogy is everything." [1] It follows then that creativity, a subset of cognitive processes, is also an exercise of analogic thinking, a process of pattern matching, building conceptual metaphors, "mapping across conceptual domains." This process is fundamental to creativity, novelty and knowledge building. [2]

Systems science tells us "structure determines behavior." Creativity, a basic behavior arising from our neural structure, is "the act of noticing patterns…making them visible in some kind of model, or theory, or poem, or sculpture." [3] Patterns are noticed across some conceptual divide and manifested/mapped into physical form. The maps, the objects we make, are also conceptual metaphors, analogs of the real.

There are computational models that afford us the opportunity to see this structure, a substrate for the mechanisms of creativity. We can model and explore that substrate at many stages or levels, stretching from the complexities of human culture to the simple material movement of electrons. Behavior begins as the movement of ions, electro-chemical activity—signals moving though the complex networks of our brains. Eventually those signals manifest as social structures, human networks of action in the world. Interestingly both our created culture and our neural signaling have at their base this same process—pattern matching—built on small-world networks. [4, 5]

By modeling and visualizing this network structure, within some new topographies, we can investigate the process of finding the novel within the known, and see how a new idea is nothing more than effective way-finding through a dense network of connections—with each link simply an association, a pattern match.



A model of a small-world network with 1000 nodes, 10 links per node. With 99% linking to nearest neighbors and 1% random links, it is both structured and connected, taking only four steps from source to target. That "short-cut" is a model for the "aha" moment when we make the familiar strange, and see something in a new way.

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Keywords:
creativity, metaphor, network, computational models

The Substrate of Creative Thought

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Abstract

The structures and processes of creative thought mirror the structures and processes of our neural networks. In creating and learning, the fundamental process is conceptual metaphor, where ideas, like neurons, connect based on matching patterns. The connections exist in clustered networks. What allows the subtle connections needed for novelty is a small amount of randomness within the linking—a small-world network structure results. Small-world networks are explained and illustrated. A new model of small-world network topography is also described and visualized. The model offers a substrate upon which creativity, understood as a neural process, can occur.

1. Introduction

There is a mechanism for creativity. We can explore that mechanism at many stages or levels across a wide expanse, stretching from the complexities of human culture to the simple material movement of electrons. Human behavior, working from perception and cognition, manifests as culture. That behavior begins as the movement of ions, electro-chemical activity—signals moving though the complex networks of our brains. Eventually those signals manifest as human action in the world. Interestingly both our created culture and our neural signalling have at their base the same process—pattern matching.

We can define creativity as “the act of noticing patterns…making them visible in some kind of model, or theory, or poem, or sculpture, so that the insights gained don’t just float away.” And “creative people don’t just express themselves in metaphor, in analogy, they see and think in metaphor and analogy…” [1] Patterns are noticed across some conceptual divide and expressed as metaphor.

Hofstadter tells us that, “in regards to cognition analogy is everything.” [2] It follows then that creativity, a subset of cognitive processes, is also as an exercise of analogic thinking and conceptual metaphor, building from the idea that metaphor “the mapping across conceptual domains” is fundamental for creative practice, novelty and knowledge building. [3]

2. The Loop of Learning and Innovation

A metaphor is a pattern match found between conceptually unlike things. It exists for us as a loop of desire that is the essence of being cognitively alive. The loop parallels our more basic desires for food, sleep, etc. Our survival instincts (materially existing as genetic neural structures) have us scanning our environment in search of difference. If something changes it might be a threat to survival (fear) or enhance survival (pleasure). We compare and contrast signals coming in through our senses to signals stored in our memory, looking for a pattern match. If there is no match then the incoming signal is new and strange. We need to know and so search more deeply for a match. Some dimension of the new must match something in memory or we cannot know the new. Desire to know the new is strong. Our survival might depend on it. Life is the constant processing of our surroundings in support of this desire. The search for knowledge is ongoing.

"The relation between what we see and what we know is never settled." [4] This is a relation of the strange and the familiar—the loop of learning and creativity (manifested as innovation). See Figure 1.

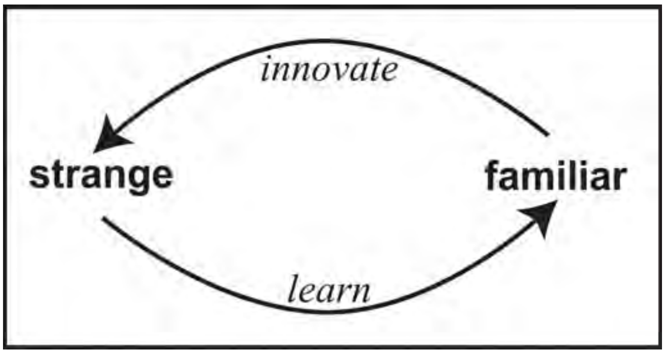

Figure 1: The metaphoric loop of learning (new knowledge from new information) and creating (new knowledge from known information). [5]

2.1 Learning

The tension inherent in desire is a motivation for learning. The fundamental mechanism for learning is analogic thinking through metaphor. All knowledge builds on prior knowledge though the pattern match of conceptual metaphor. New information enters the system and is understood in relation to the already known. The strange is connected, compared and contrasted with the familiar.

The signals come from outside of us, entering through our senses. Signals are converted to data, stored in our short-term memory where the brain seeks to link the new patterns to patterns stored in memory. Pattern matches of new ideas, concepts and experiences become new network links, new synaptic structures in our plastic brains, allowing new paths for electro-chemical spikes to move from neuron to neuron. [6]

2.2 Creativity

Poet Stephen Spender reminds us, “All that you can imagine you already know.” Creativity is also a process in the metaphoric loop, but now the new connections are made within what we know. What is required is seeing the known in new ways—making the familiar strange. In developing “the creative habit…Metaphor is the lifeblood of all art, if it is not art itself.” [7]

A new idea is a new connection from old knowledge. Einstein saw light as a vehicle for space travel. Shakespeare compared his love to a rose. At the material level in the neuronal lattices within our cortex new links are made, built on the firing of a metaphor. New synapses create new pathways, connecting clusters of firing neurons—cognitive representations of things, ideas, objects and emotions.

3. Ideas, Neurons and Networks

There are models of signal flow and network structure that can help us understand how human activity demonstrates creativity. In particular is the small-world network structure, modeling well-connected and well-structured networks. Small-world networks use a small percentage of distant (random) connections among a large percentage of close, tightly clustered links. [8]

A clustered network is a model of ideas organized and incestuously linked within segregated conceptual domains. In an academic environment we can think of these clusters as disciplinary silos. To move beyond the closed thinking that can occur within these silos academic departments sometimes look outside, seeking the diversity of interdisciplinary connections—a social construction of a metaphoric link, with individuals as nodes in the network.

These connections to the outside can be modeled as a very small amount of random linking within the clustered structure. This small amount provides for a substantial increase in connectivity of the network, dramatically improving the odds of new connections (new ideas). This is the dual advantage of the small-world network structure—well organized and highly connected. Recent research in neuroscience indicates that this structure is present in our neural networks as well. [9,10] It would be a natural result of a selectionist model of brain morphology. [11] Computational approaches to this structure are also starting to appear, built primarily on the Watts and Strogatz model. [12]

The small world structure is a useful substrate for the creative linking of ideas and is also the structure of our brains. A small-world network of neurons is the material embodiment of idea flow, with the distant links allowing for novelty—“making the familiar strange.” The traces of signals through our neuronal networks are the materials of cognition. Conceptual metaphors are the key connectors at the cognitive level. These connectors exist as the distant links in the small-world substrate. This substrate can be easily modeled computationally.

3.1 Clustered Networks

Figure 2 is an illustration of a clustered graph or network built on a ring lattice. The figure shows a network of one hundred agents or nodes, with each node connected to its four closest neighbors. A cluster shows a high structure of repetition as each node has many nodes in common with each linked neighbor. The clustered nodes could represent a close circle of friends or perhaps a group of wired neurons. What the graph shows is that while clusters are tightly structured, information does not flow through the network very effectively. To move a signal from the source node (#0) to the target node farthest away from the source (#50), will take at minimum twenty-five steps.

3.2 Random Networks

Figure 3 is an illustration of a random network, with properties that are exactly opposite those of a clustered network. Here each node is randomly linked to four other nodes. Linked neighbors will rarely have other nodes in common. Signals will move through this network with little coherence, but will traverse the network quickly as it is highly connected.

3.3 Small World Networks

A small-world network is one that is clustered and so highly structured, but with a small amount of randomness. Figure 4 is an illustration of a small-world network, based on the Watts and Strogatz model, with just 5% randomness in the links. Note that the network is nearly as effective as the random network in regards to moving a signal quickly through the system, while nearly as structured as the original clustered graph. While most linking is clustered there are a very small number of random connections as well.

Hebb's law states that "cells that fire together wire together." [13] Our brain's network is built on associations. Some associations have the appearance of randomness. However a connection is a pattern match. Pattern match means repetition, which means structure. Sometimes what is repeating might be subtle, seemingly random when out of context. When two neurons are firing simultaneously a synaptic connection begins to form—two nodes are linked and some essence of structure is recorded for later recall as metaphor. The brain learns.

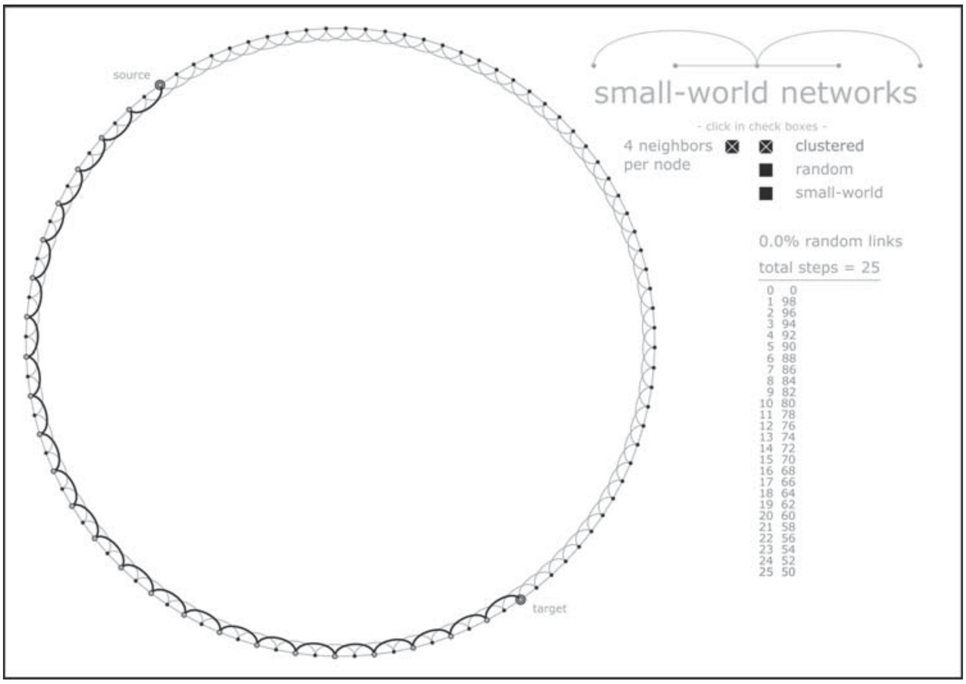

Figure 2: Graph of a 100-node clustered network, each node connected to its four closest neighbors. The bold line shows the 25 steps needed to traverse the network from the source to the target. Clustered networks are highly structured but poorly connected.

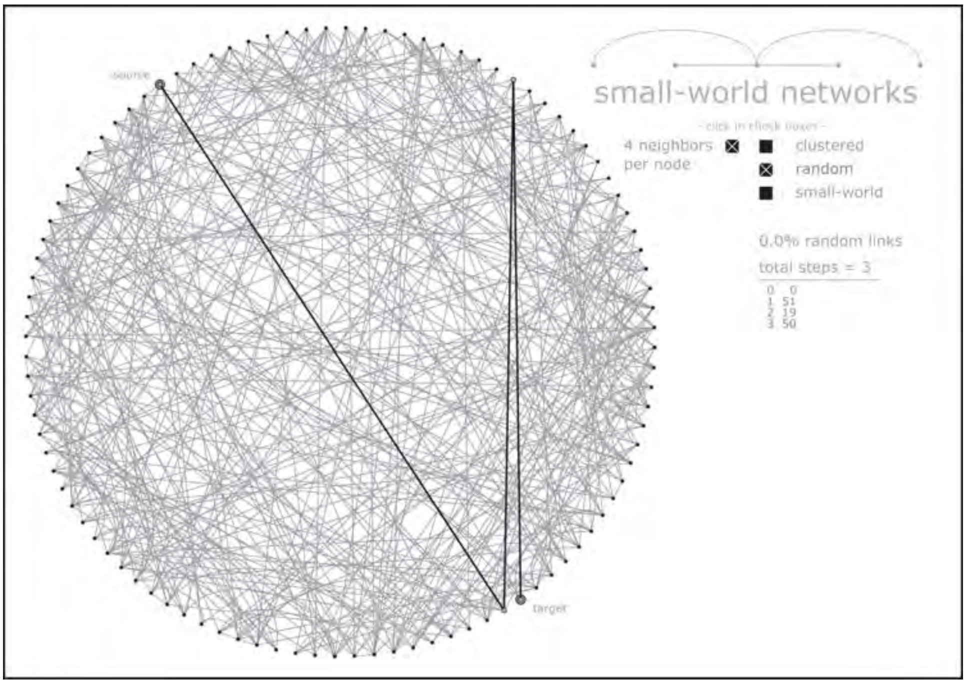

Figure 3: Graph of a 100 node random network with each node randomly linked to four others. This random network is poorly structured but highly connected, in this instance requiring only three steps to get from source to target.

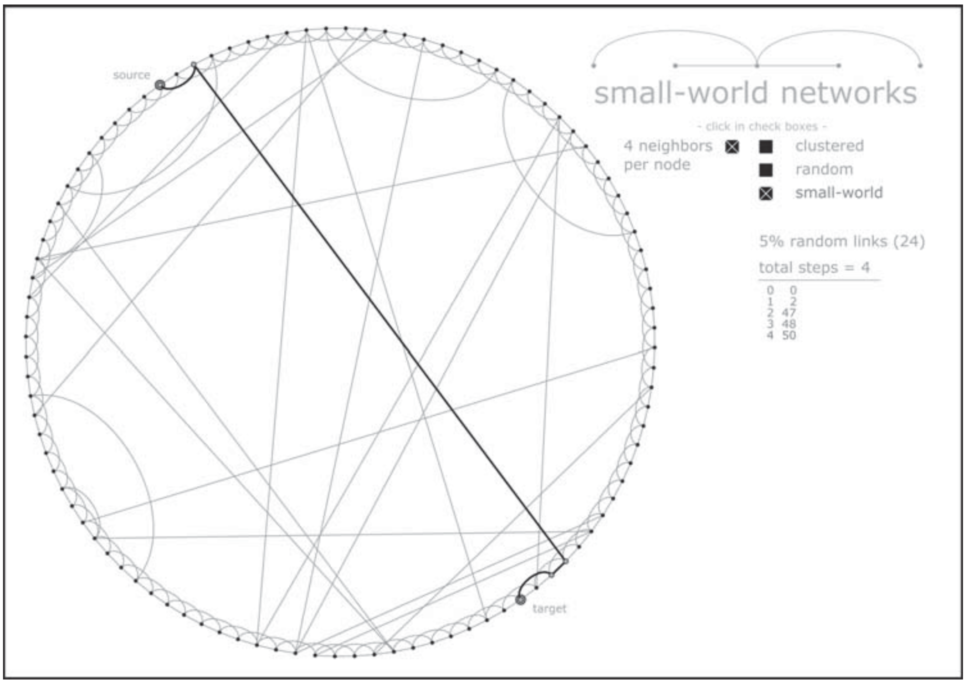

Figure 4: Graph of a 100 node small-world network, developed as a clustered network with approximately 5% random links. This network type provides all the benefits of a clustered (structured) network, with nearly the same connectivity as a random network. This instance requires only one link more that the random network to get from source to target.

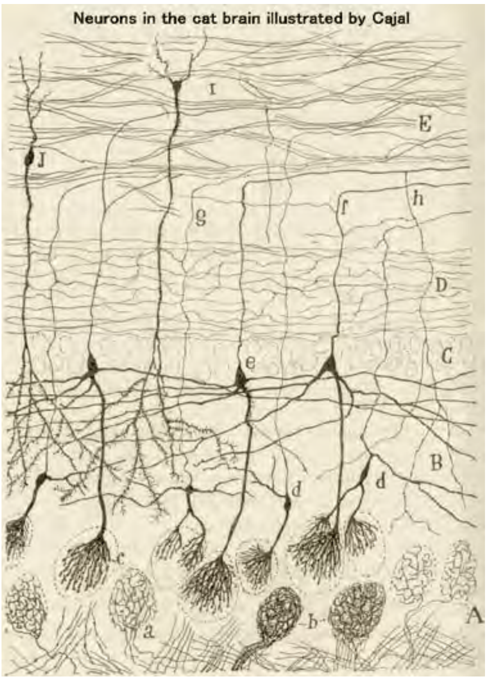

Figure 5: A rendering of a neuronal structure, illustrated by Ramón y Cahal nearly a century ago, that shows similarities to the ring lattice network topography.

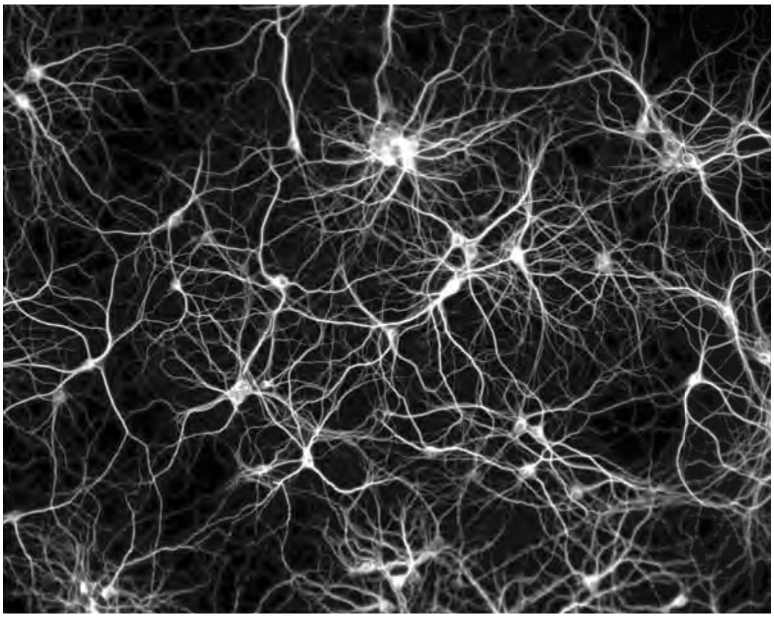

Figure 6: An illustration of neurons, evenly distributed in space. © Paul De Koninck, Laval University, www.greenspine.ca.

4. Creativity Substrates

The ring lattice is the basic topography used for the Watts and Strogatz network model. It is a convenient structure to illustrate the function of small-world networks, and it is possible to find the structure in the wiring of the brain, as illustrated by Ramón y Cahal's drawing of nearly a century ago, seen in Figure 5. [14] However, the simple geometry of the ring lattice is not the only useful structure from which to model and explore networks of conceptual domains or signalling neurons. There are other neuronal distributions within the brain to consider.

Figure 6 is microscopic picture of a neuronal tissue culture. While simple, it shows a more random (and oddly, as a result, more evenly spread) distribution of neurons. To build a clustered network, with nodes distributed in this way, the nodes link to other nodes in closest proximity. In a model of this topography, seen in Figure 7, there are 1000 nodes, placed randomly within the frame. Each node links to its ten nearest neighbors.

It is interesting to note in this model that, due to randomness in the topography of the nodes, the clustered network is more connected than the ring lattice. The clustered network illustrated requires thirty-three steps to get from the source to the target. If we built a ring lattice model with the same number of nodes and links it would require 100 steps to travel the same distance.

Figure 8 shows a rewiring of the network with 1% random links. The path from the source to the target is now only four steps! Again we see the effectiveness of adding a tiny amount of randomness into the network structure

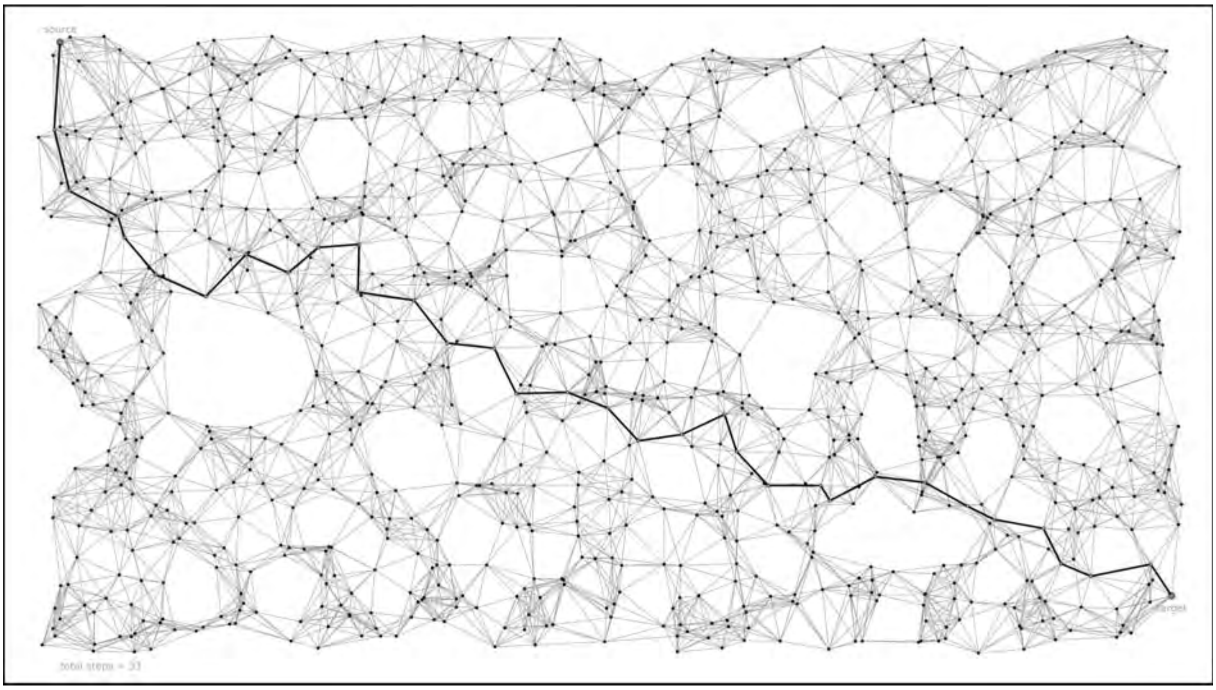

Figure 7: A clustered network of 1000 nodes, distributed randomly. Each node is linked to it 10 nearest neighbors. In the clustered network 33 steps are required to get from source to target—well structured, but not well connected.

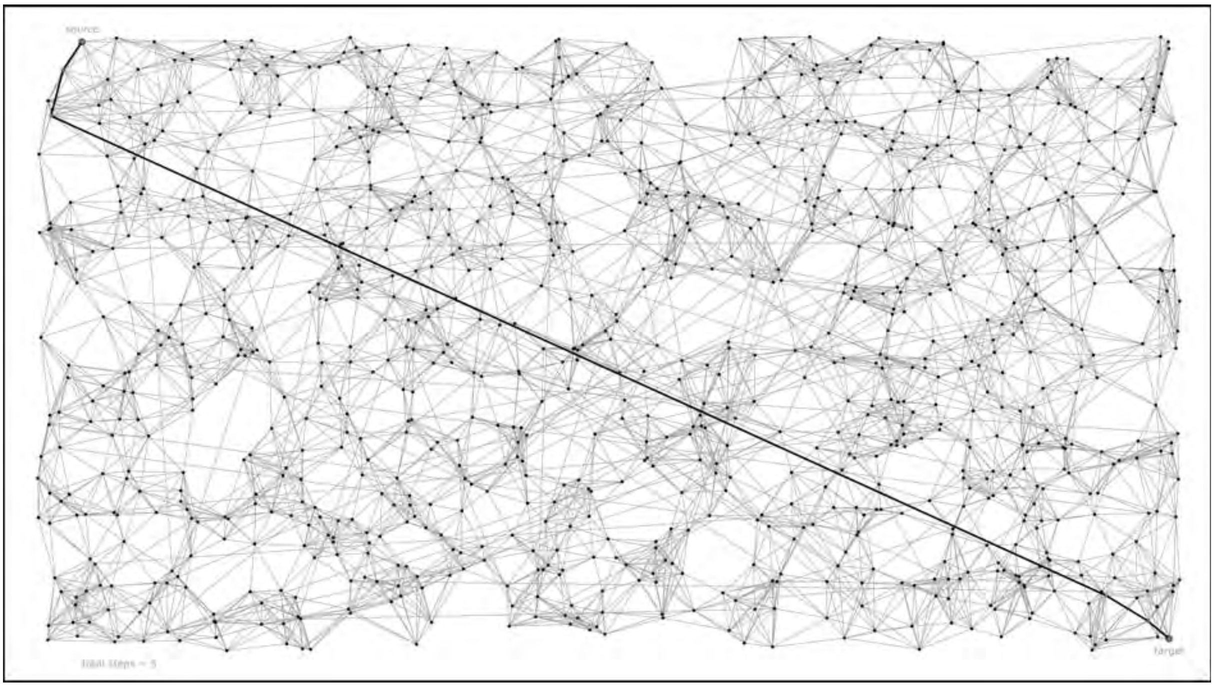

Figure 8: A small-world version of the 1000 node network. Both structured and connected, with 1% random links, it takes only 4 steps from source to target.

5. Way-finding in Small-worlds

These small-world networks illustrate a substrate upon which new metaphors can be found, and new neuronal connections can be made. Understanding this substrate is a first step in constructing models where not only a behavior of creativity can be emulated, but also the actual mechanisms for the behavior.

A big issue for further study is the fact that *having short paths through a network is not the same as knowing where those short paths are.* How might we parse this network structure to take advantage of its connectedness? How can we find our way through the tangles of the small-world? In considering the massive complexity of our brains the task is indeed daunting but necessary for creativity. Creative thought requires a substrate that allows for metaphor and then actually finding the metaphor (the proverbial “aha” moment). [15,16]

Neuroscience is paying new attention to other cells in the brain—the glia. [17,18] There are at least as many glia in the brain as there are neurons. Recent studies are finding that neuronal signals continue outside the synaptic gap and are carried as waves propagating through the brain outside the network of neurons. [19, 20] The external signals appear to be modulating neuronal activity throughout the network. Being able to impact the traversals of signals within a network from outside the network could significantly facilitate way-finding. As our models develop this points to one area of interest for future investigation.

6. Acknowledgements

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Brigid Burke

Paper : **The Process of Integrating Poly-media in *Blooms and Death***

Topic: Music/Visuals

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[2 Russolo, Luigi The Art of Noises (extracts) 1913 Published as a leflet by Direzione del Movimento Futurista, Milan 11 January
[3 Colour and sound by Maura McDonnell mmcd@soundingvisual.comAcknowledhements

Abstract:
This paper will discuss the methods and meaning of the polymedia processes represented in *Blooms and Death* as a live interactive performance composition, giving audio and visual examples throughout.

Blooms and Death incorporates sounds and images based on a series of graphics created following the transformation of a freshly cut bunch of yellow roses through to their grey death of decay. The visuals (video samples and stills) are layers of video footage displaying blowing yellow flowers, grey pencil drawings, layered scrolls of paintings incorporating the combination of computer transparencies of images. All the visual material has been treated extensively in various computer software packages to form this series of electronic artworks and video.

Blooms and Death explores many facets of polymedia in live performance, integrating through the audio, a response to the transformation of the dying roses employing breath sounds, and digitally processed clarinet with percussive processed piano sounds (performed by David McNicol), live processed acoustic environmental sounds, fans and the sampled video projections. The process of the disintegration of the roses and the response to this is explored through manipulation of sound and visuals to another timbral plane of textural ambience, colours and exploration in the context of polymedia. The music of *Blooms and Death* is scored for B ♭ clarinet, fan, live audio mulching (via laptop computer), multiple video projections and piano. The opening movement, Prelude, is for solo clarinet and visual shadows, with the following movement making a clean yet rough audiovisual statement through diffused fan and air sounds with thick clusters of sound from the piano presaging the later movements of the work. This is quickly broken down with many 'peaks' and subtle layers, the piece again emerging into transformed breath sounds moving into complex paths of high overtones and repeated notes as if conversing. The live audio computer interaction in the second and third movement adds to the sonic world of layering throughout the composition, while the Interlude between the second and third movement makes a short statement combining many sounds and visuals.


Images of Blooms and Death

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Keywords: music, composer, multi media artist, clarinet soloist, visual artist, film maker, peformance artist, installation artist, printmaker

The Process of Integrating Polymedia in *Blooms and Death*

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Abstract

This paper will discuss the methods and meaning of the polymedia processes represented in *Blooms and Death* as a live interactive performance composition, giving audio and visual examples throughout.

Blooms and Death incorporates sounds and images based on a series of graphics created following the transformation of a freshly cut bunch of yellow roses through to their grey death of decay**.** The visuals (video samples and stills) are layers of video footage displaying blowing yellow flowers, grey pencil drawings, layered scrolls of paintings incorporating the combination of computer transparencies of images. All the visual material has been treated extensively in various computer software packages to form this series of electronic artworks and video.

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Introduction

This paper will explore the processes of integrating sound and visual counterparts of the composition *Blooms and Death* for clarinet, live interactive audio and visuals.

It will define polymedia and other terms that correspond with evaluating the many media that are associated with creating *Blooms and Death*. In the creation of *Blooms and Death* consideration of the use of elements is discussed in individual movements of the work.

Blooms and Death is made up of a Prelude, Interlude, Movement 1, Movement 2 and Movement 3 for Bb Clarinet, piano, live and pre-recorded electronics, Fan, 2 video projections and live video mixing. The physical human presence of performers, objects, real-time interaction are key elements of exploration.

Blooms and Death will explore elements of real-time performance, microtonal exploration, electronic timbres, acoustic instrumental samples and the relationship between tuning, timbre, melody and visuals. The overall focus is to create a world of space and texture in a sonic composition.

The discussion of *Blooms and Death* will be divided into 2 sections: How was polymedia integrated in the process of the composition? How will polymedia be integrated in the process of performance?

Definition of Polymedia

In the context of *Blooms and Death* polymedia is defined by the layered or different media that is performed at one moment of time in live performance. Other terms that can describe polymedia is multi-media, hybrid art, visual/music, visualized music, multi-arts and VJ-ing.

My definition of polymedia is one performer, composer and visual artist creating a whole identity. As the performer the concept of polymedia is opening new palettes for the audience to interpret in terms of form. The composition integrates acoustic sound, live audio mulching, acousmatic sound (fixed music that exists only in a recorded format (as a fixed medium), and is composed for reception via loudspeakers), live video mixing and fixed video during performance.

Visual/music is a loose term that describes a wide array of creative approaches to working with sound and image. It can also be referred to as visualized music in which the visual aspect follows the sound's amplitude, spectrum, pitch, rhythm, often in the form of light shows or computer animation, while in other instances it may refer to "image sonification" in which the audio is drawn from the image in some form. Both sound and image may be presented live, fixed, or as part of an interactive multimedia installation. [i]

Visual music has much in common with music visualization, and is used to describe electronic music visualisers and media player software. The term describes how the music generates animated imagery based on a piece of music. The imagery is usually generated and rendered in real time and is usually synchronized with the music as it is played. The changes in the music's dynamics and frequency spectrum are among the simple properties used as input to the visualization. Sometimes visual music can be described as a non-hierarchical correlation between sound and image, in which both are generated from the same algorithmic process, while in other instances, they are layered without hierarchy or correlation altogether.[ii]

VJ-ing is another term that can be loosely associated to Visual/Music as it is primarily real-time visual performance which is the creation or manipulation of imagery in real-time and synchronized music. VJ-ing is the manipulation or selection of visuals, the same way DJ-ing is a selection and manipulation of audio. One of the key elements in the practice of VJ-ing is the real-time mix of content from a "library of media", such as DVD disks, video and still image files on computer hard drives, live camera input, or from computer generated visuals. In addition to the selection of media, VJ-ing mostly implies real-time processing of the visual material. The term is also used to describe the performative use of generative software, although the word "becomes dubious (...) since no video is being mixed.[iii]

Blooms and Death
How was polymedia integrated in the process of the composition?

In the creation process of *Blooms and Death* the polymedia creator (in this case myself) makes decisive day to day notes on the theme the rose from a moody personality. My decisions within each movement both musically and visually are random, spasmodic and erratic. The overall creation especially in the sonic world is in the form of an abstract narration. Each of the movements takes you on a journey that inevitably leads to the next idea. The musical composition is written first but without the visual of the dying rose the music would have no context.

The score and acousmatic pre-recoded audio is a combination of extended clarinet and piano techniques. Clarinet techniques include: throat sounds, hums, glissando, tongue clicking, kissing sounds, micro-tonality, key clicks, screams, multiphonics, monophonic, quarter tones, over-blowing, teeth on reed and interrupted tones.[iv] The piano techniques include: transferred clusters, tone clusters, tremolo, repeated notes at changeable speeds, harmonics (keys pressed down without sounding) glissando, extreme registers, erratic rhythmic patterns with indeterminate durations and pedal effects (fluctuating at different speeds with differing pressures and improvisation on graphic notations. Many of these extended devices on the clarinet and piano such as quarter tones, multiphonics, tri-tones, microtones, transformed clusters are reorganised and work cohesively to create sound clusters by just changing how each of the devices are orchestrated. The score incorporates graphic notations especially in the 2nd and 3rd movements that can be either literally or intuitively interpreted according to the ambience and sound world the musicians are creating and visual setup of the space at the time of the performance.

Examples of electronic plug-ins I have used in the processing of the audio samples include: Stereo Delay, Delay, Transposition, Grain Duration, Pan, Granulation, Ring modulators. [v] The process continues with manipulation of files into different layers and multi channels, concentrating on microtonal interaction between the samples.[vi] A similar process is applied to the visual materials including analysis of brightness, colour, contrast, duration, speed and complexity. The images have two categories: graphic based images and film/still images. The sound and image influences the shape and analysis of each of the works. The audio in the compositions uses a real-time environment of acoustic sound and generative structures. All audio samples were pre-recorded and processed in Adobe Audition (multi-channel audio processing program.

Diagram 1 Original photographs

Diagram 2 Pencil Drawings

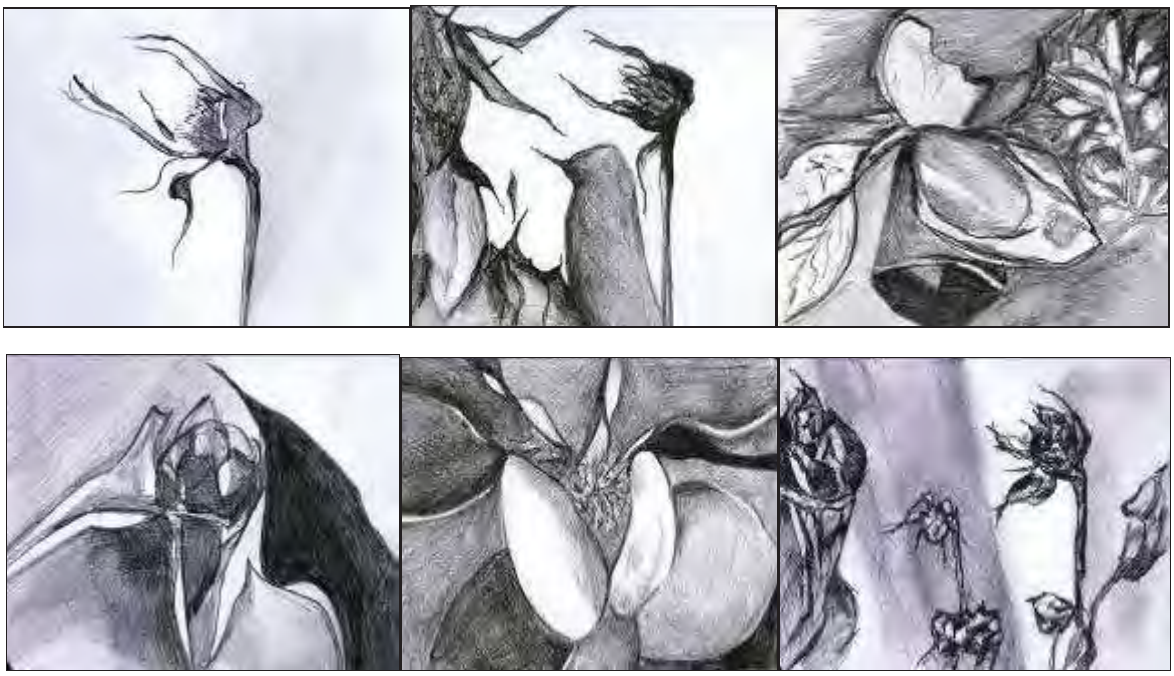


Diagram 3 Computer processed art

The imagery in *Blooms and Death* is a process of timing; every image has a fade, so it's all about the dissolve and the transformation in the image rather than in the fade. Very little manipulation is involved to fade one image to the next only the length of the fade is calculated. The layering of the transparencies with luma, chroma, speed (pulse), and cut-outs dominate many of the visual samples. The aim is to make the still images move through these effects. The use of stained glass plug-in with the treated rose images is animated.

All these structures have given me freedom of process and uniquely affect the outcome of the piece. There is no correlation between the musical and video layers as the music is written at the onset and the animated video samples added afterwards so as the creation of the musical composition has created movement in a cohesive whole.

Technical Requirements for Performance

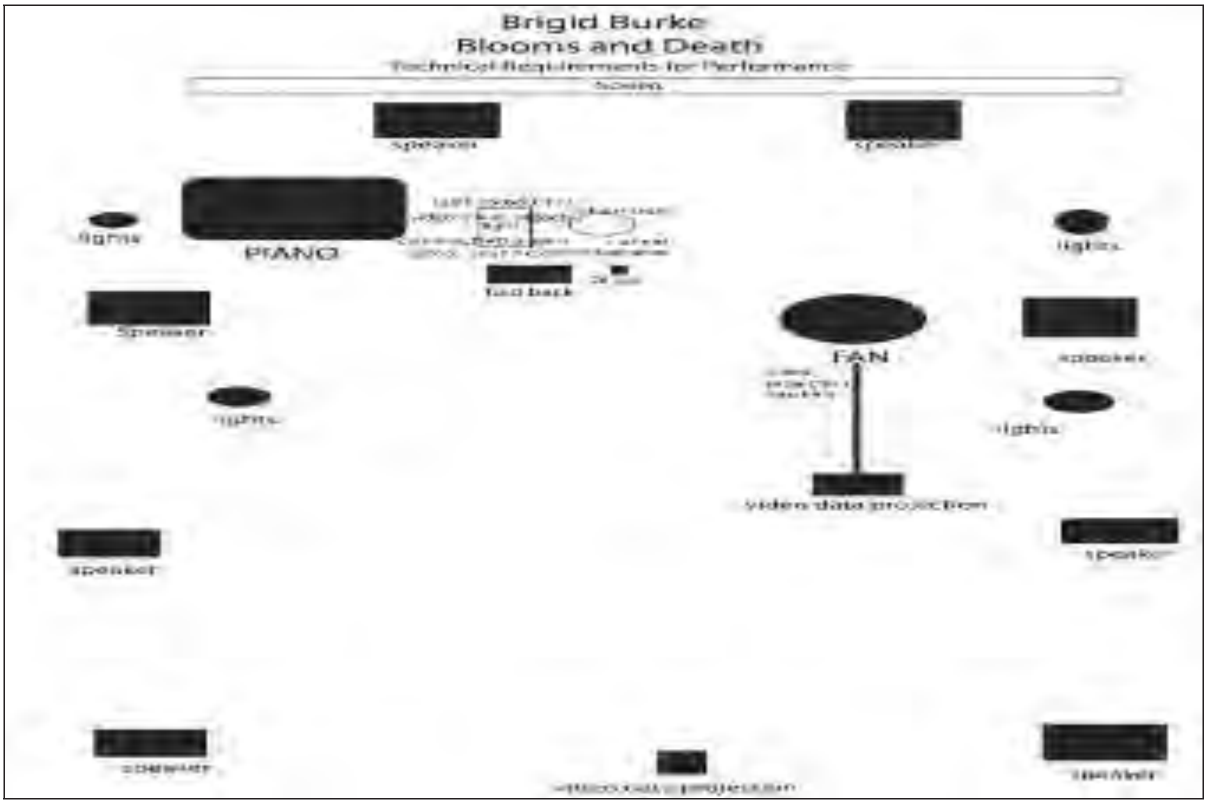
1) Eight speaker surround sound system 100+ watt stereo amplifier, speakers and mixer operated by sound engineer
2) 1 speaker (wedge) for fold back and mixer DI box for stereo sends
3) White backdrop (Screen) for visuals to be projected on to fill space
4) Two (data) Projector/Screen Composite/S video inputs
5) One 150cm x 70 cm high table
6) One chair (stool preferably)
7) One music stand
8) Lighting: two side washes and two spots (one to left and one centre) not directed on back screen
9) Two 6.35 mm plugs line-out from stage mixer into main audio mixer
10) Two Svideo/composite output connection from video mixer on stage to 2 data projectors one on Fan the other on Screen
11) Sound and lighting engineer
12) 3 microphones
13) Grand Piano
14) 30–40 inch Fan on Stand
15) Small 4to 6 channel stage mixer for on stage to be connected to main mixer operated by sound engineer

Technical Equipment performer is providing

1) Bb/Bass Clarinets
2) Lap-top computer

3) Objects
4) 1 microphone
5) Effects units, pedals and sensors
6) 2 cameras, DVD Pal player and video mixer

Diagram 4 System layout of equipment (computer/audio/visual)

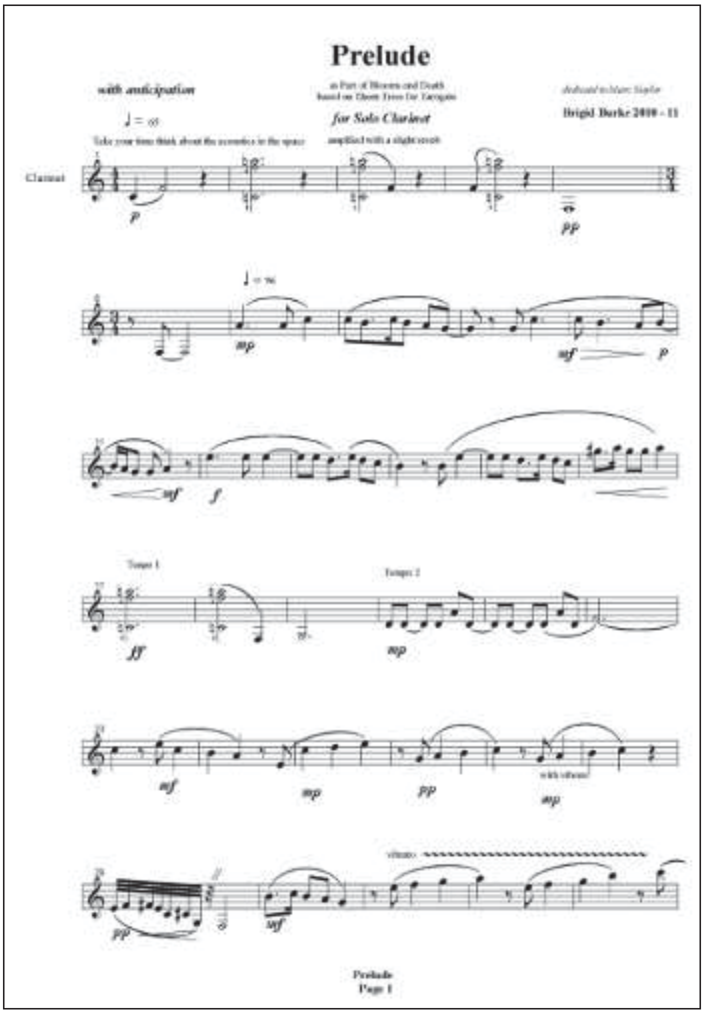


Prelude

This movement for solo clarinet and visual shadows (video) starts the journey of *Blooms and Death* as a Prelude**.** It fuses the original roses as shadows into hinted layered digital images. The vivid rose is only seen in the distance as part of the many layers the movement is made up of.

Prelude is to be played in an intimate, subtle and lyrical manner, taking time over single notes with little interruptions throughout the work. The atmosphere both visually and audibly is driven by the colour of the rose and is unique. Full of rich sonorities just waiting for the ambience of the space transform the clarinet. The aim was to try and convey moments of stillness with simplistic and guttural sound worlds while the rose with all its beauty blows in the wind.

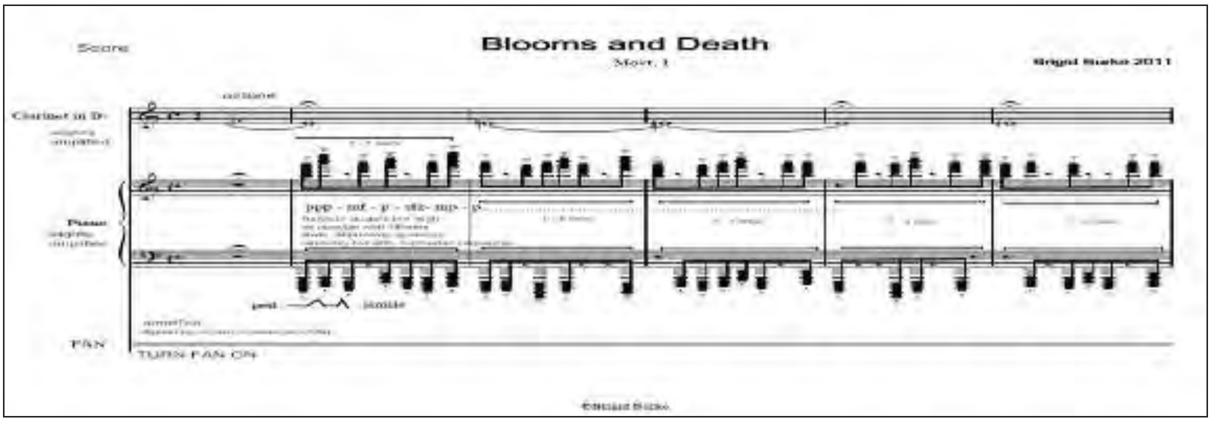
Durational time is used to interpret Prelude. It is counting a unit for rhythmic organisation to destroy any sense of regular beat groupings. The beat or pulse, if present is an abstract concept whose function is to hold all the parts together. In durational music it is common to see ties, freely accented notes, uneven groupings and a wide variety of temporal subdivisions. The purpose of these is to destroy any feeling of the beat. Its absence makes the music non–metrical.[vii]

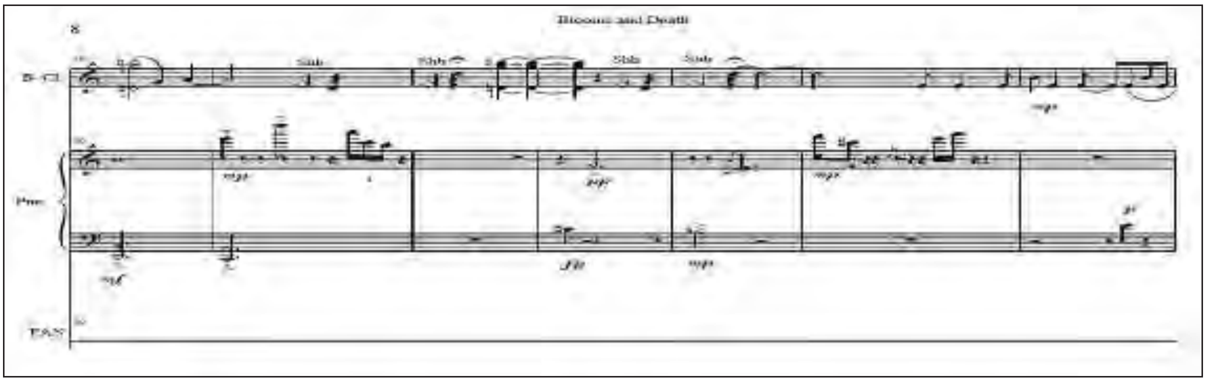
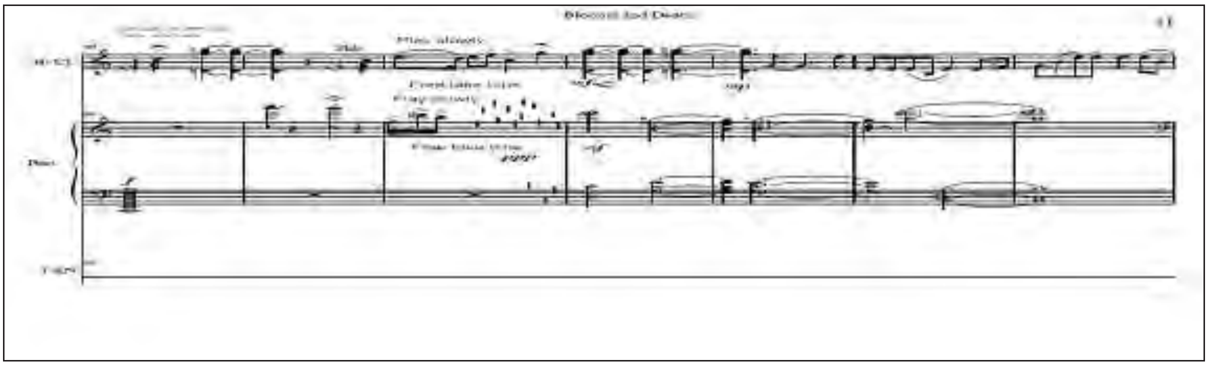
Diagram 5 Prelude score for acoustic Bb clarinet

MOVEMENT 1

This movement is scored for Bb Clarinet, fan, multiple video projections and piano with audiovisual statements made through diffused fan and air sounds with thick clusters of sound of extreme registers and dynamics from the piano. The clarinet adds another layer of suspense with ambient long notes in low register of the clarinet that are coloured with quarter tones and tremolos. There are many interruptions with quotations from the 1st movement which brings us back to the beauty of the rose. This is quickly broken down with many ‘peaks’ and subtle layers, and repeated notes and repeated rhythmic dynamically erratic clusters as if conversing.

The piano motives which were notated were recorded and divided into small samples with the blowing sounds of the fans. With many rehearsals starting out with rough ideas that soon developed into the final score. As each rehearsal was recorded the final score was now audible and the video samples of both the still images and video clips were added. The process of refining the audio samples was similar to the rehearsal refinement of the notated score and this was done in the multi-channel program Adobe Audio.

Diagram 6 MOVEMENT 1 score





MOVEMENT 2

The music of *Blooms and Death* is scored for Bb clarinet, fan, live audio mulching (via laptop computer), multiple video projections and piano with audiovisual statements made through diffused fan and air sounds again with thick clusters of sound from the piano presaging in a processed state later in the work. This is quickly broken down with many ‘peaks’ and subtle layers, the piece again emerging into transformed breath sounds moving into complex paths of high overtones and repeated notes as if conversing.

Diagram 7 MOVEMENT 2 Graphic drawings in score

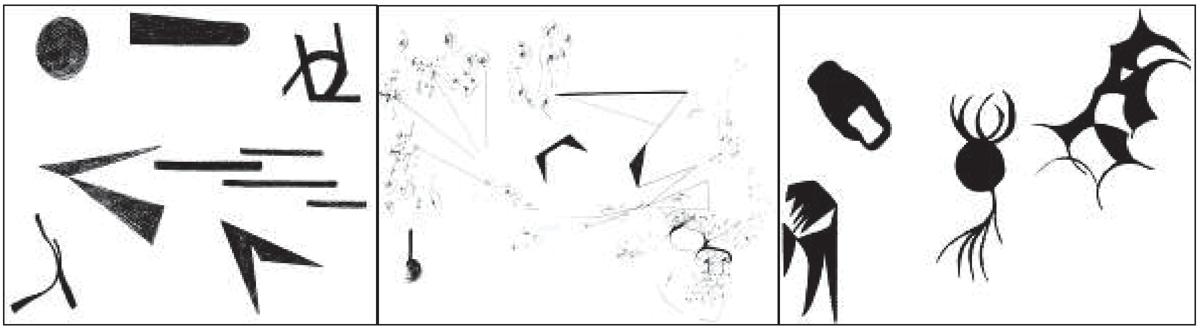
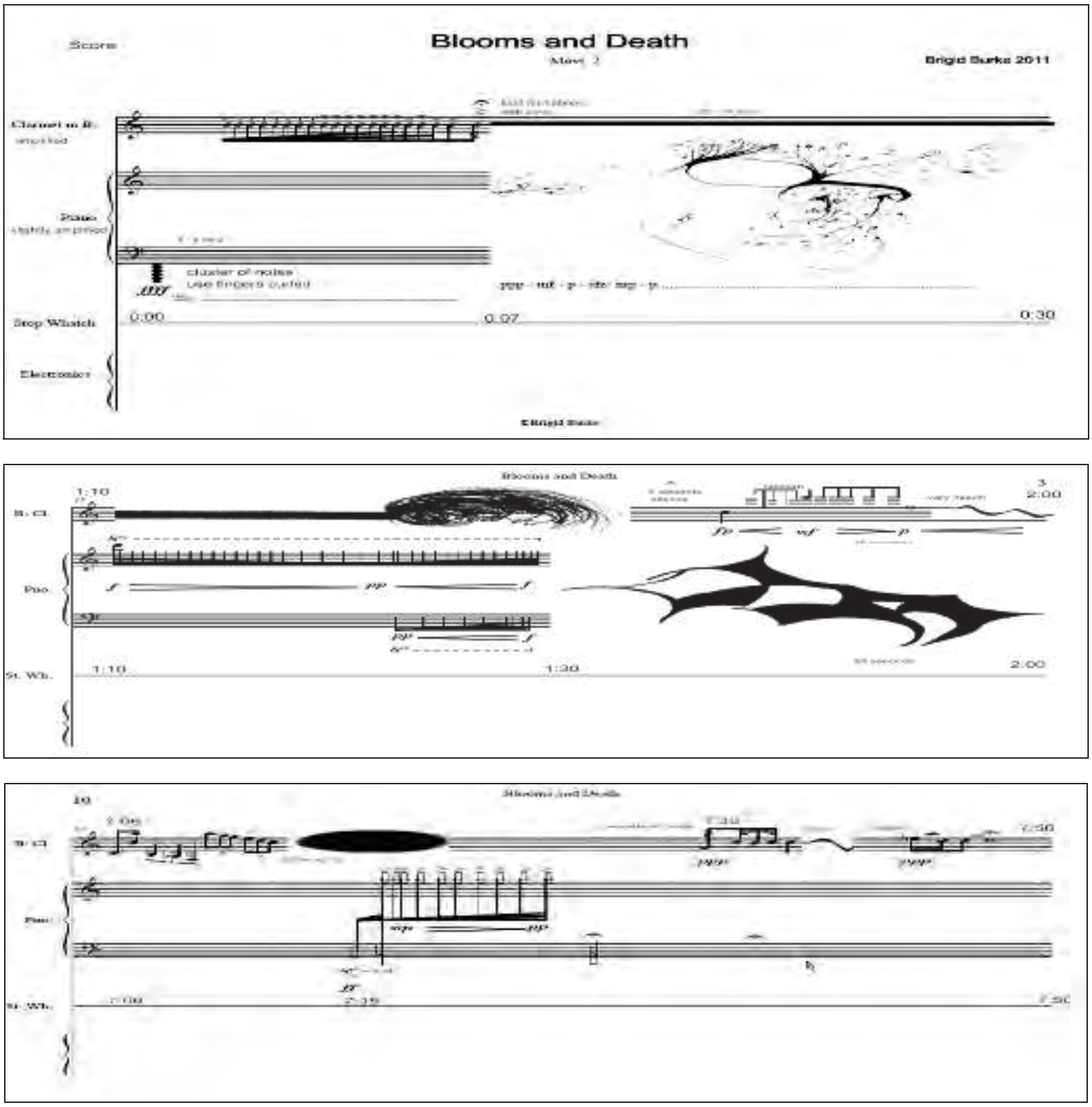


Diagram 8 MOVEMENT 2 score



Interlude

Live Audio Mulching (laptop) and video projections.

This short Interlude brings new life to the red and blowing images in the fan of the image of red stationary rose and is fast and racy visually, accompanied by a beautiful soundscape. The Interlude also features the use of constrained random material gathered from Movt.1 and 2 interlocking with occasional raw utterances from the clarinet motives. This only adds to the freshness and sense of surprise created in the tapestry of the work. The visuals are forever moving, creating their own pulse and energy to the point where the rose fades to become unrecognizable.

Diagram 9 Audio mulch patch for Interlude Movement 3

Movement 3

The concept of the third movement takes the vivid yellow roses, breath, acoustic clarinet and percussive piano sounds to next level of textural ambience, colours and exploration. The sounds and transformations came from images that depict grey colours and slow decay but show new life in their transformation through diffused timings and multiple layers of images and sounds. In the graphics one can see a series of yellow shades and grey pencil drawings layered to delicate tranquillity of refinement.

How will polymedia be integrated in the process of performance?

The polymedia performer in *Blooms and Death* plays Bb clarinet, controls the audio samples through the laptop and visual samples through the interactive responses on the video mixer, which is directly influenced by the sonic output of the system. In addition the first and second movement involve a pianist who is directed through a notated score and cues. During the performance one is continually creating new musical ideas that trigger fresh sonic audio improvisations that then influence different combinations of visual layering that give fluidity to the balance between the visual and audio output. Both are reacting off each at all times. In other words the performance could perhaps be conceived as creating polymedia counterpoints on player-defined fragments, effectively enabling the musician to perform a time-extended improvisation.[viii] The visual output is based on an abstract representation of how the music is progressing. The audio is affected by the live video feed samples taken which is affected by the lighting and the amount the performers interact with the footage in real-time.

The aim is to make sound and image structurally integrated. To achieve this integration in performance the audio is analysed and used directly to control the manipulation of specific aspects guided by the visuals.

Blooms and Death uses microphones and laptop to control the granular synthesis of acoustic audio material sampled during the performance, producing a musical confluence of live clarinet, piano and visual components which can only be described as polymedia.

The use of Organic Time is utilised throughout as the performers interpret the construction of sound durations not as a pulse or counting unit but using other parameters such as physiological determinants responding to the general conditions of the environment around them.

Blooms and Death explores the sonic vocabularies of extended clarinet acoustic micro-tonality techniques, keyboard, tonal and percussive techniques, interactive mapping audio devices and visual components. The interactive audio techniques used are pitch-shifters, frequency changes, room placements and granulation. All these filters and parameter modulations are controlled live using a mapping software device. The visuals go through similar processes as the audio samples but are pre recorded and include video footage of flowers blowing, photos, dead flowers and drawings with live editing through video mixing. These performance strategies open up enormous avenues for improvisation and inventiveness throughout the performance.

All audio processing is created in Audio Mulch a live audio interface for real-time audio performance, manipulated during performance.

The performance outcome aims to develop from the audio samples of the clarinet, the fan and piano audio-visual media. The element of air blowing literally from both sources symbolizes a virtual moving space. This in turn reveals that the visual images are preceded by the audio Bb clarinet, piano and audio mulching with the soft purr of the fan sounds.

The audio and visuals are all triggered manually. This is purely by choice as I treat all the components individually in a polyphonic manner. As an acoustic Bb Clarinet performer the natural state is to have no added attachments to the instrument so reaction to musical moments is spontaneous. However the addition of the laptop is another line of the control that affects/ influences the outcome resulting in a fluid and reactive performance.

Diagram 10 Photograph of set up used in performance on 6th March 2011 at UTAS

Prelude

Throughout Prelude there is always a glimpse of age, death and familiarity as a tangible sound through the clarinet with the rose being familiar and beautiful visually.

At beginning point what happens between the music and listener in the performance depends on the strategy of the composition and how familiar the audience is with the structures of the performance.

MOVEMENT 1

At the first performance of Movement 1 on 6th March 2011 the recital space was quite different from my original plan in the placement of the fan on the stage and the image it created on the big screen. So it was decided to create a double image on the screen one with the fan switched on directly in front of the projector the other with the straight image. The result was quite astonishing and created the austere atmosphere that was envisaged.

The aim in this movement was to test the material of the diffused fan, making the score; acoustic space and pulse of the visuals form a balance with the experimentation of structures and ideas.

MOVEMENT 2

The live audio mulching in this movement is controlled through the computer and adds to the sonic world of layering throughout the composition.

The aim was to take the sonic world to the next level of real-time interaction in which compositional decisions are made continually through the graphic notations in the score during the performance. There is much random computer affected samples which open up the free improvisational shaping leaving much of the decisions to the performers being intuitive with the pre-formulated material. Within these pockets of improvisation there are key meeting points. This result means no two performances are the same.[ix]

Diagram 11 Audio Mulch Patch for performance for Interlude and Movement 3

Interlude and Movement 3 for live Audio Mulching (laptop or acousmatic - fixed audio) and video projections.

These 2 movements in performance are fixed so according to the set in the performance space which should be in the form of a movie theatre with surround sound the out come is totally immersive with the integration of sound and visuals.

Conclusion

The performance work *Blooms and Death* demonstrates a creation of balance that is sensitive to environmental thought and fluidity in polymedia performance. The polymedia attributes as defined earlier in the paper achieve the use of acoustic sound in a sound environment at the present time that is of processed sound. The meaning of creating a polymedia work is each voice enhances the other (the music and visual). The aim is to create video with an emphasis on it been a moving piece with a direction even in the still image. The components of a live feed of the clarinet, piano and fans with the interactive mechanisms of video and audio mulching add a component that will captivate a moment of time. By encouraging interaction with adaptive sound as from the clarinet and visually engaging footage one can enrich the creative possibilities of polymedia processes in art, and in particular music. On a practical level, by bringing these independent processes of interactivity with computer orientated music in a traditional improvisation framework an interactive polymedia performance practice develops that offers a means of ‘humanising’ this age of the computer.

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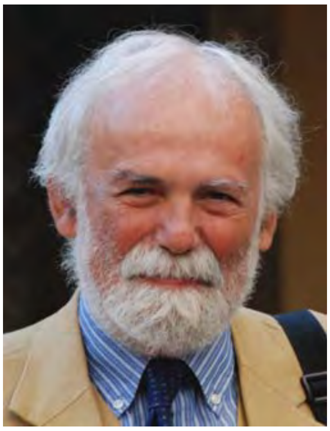
CELESTINO SODDU

Paper: **Generative Baroc Algorithms**



Topic: Architecture

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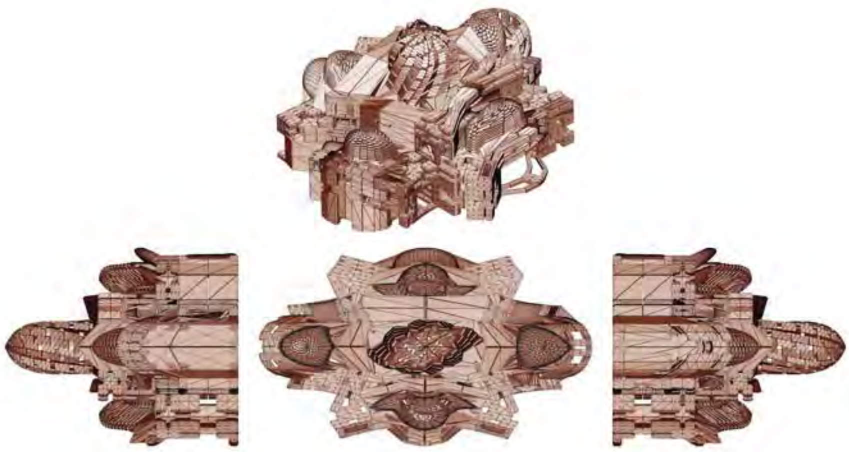
[4] generativeart.com

A constant of my generative operative research was to "abduct" by the Baroc a series of transformation logics that characterize my generative architectures. More specifically identifying and writing as algorithms my geometrical interpretations of the dynamics of the architectures of Francesco Borromini. The approach was to try to discover a possible interpretation from the complexity of Borromini architectures and not to analyze and copy them. Recently I have developed more in detail these potentialities by focusing these logical interpretations from Borromini dynamics that, for the first time, I try to render explicit in this paper telling how I designed "baroque" algorithms, a work that, as I already said, started from 1986.
Conceptually it was not difficult for me, since my interpretation is based on the possibility to read not only the existing forms but how these forms could spring from progressive transformations of pre-existing events. This is organized by the morpho-genetic process when it runs and performs the complexity. Following my approach, the Borromini architectures are like progressive tales of a creative thought able to generate complex and unique events based on progressive increases of three-dimensional geometric and topologic logics. And sometimes the third dimension, operating logical translations from the traditional bidimensional formal orders, unexpectedly finds again unthinkable and amazing fields of development. These are like progressive stories where each person could be able to find again a really unexpected, subjective and suggestive path of discovery and to follow his own increasing ability to appreciate the beauty, and to find out how to generate it. In other words, interpreting the Baroque structures as algorithms is surprisingly immediate. And it is what I have done in the last thirty years; increasing my generative approach starting from my vision of dynamic baroque architecture.
In this paper I use as example some logical-operational interpretations of mine, many times very "out of rules", as, after all, Borromini was; and I identify the logical-geometric structure of these algorithms and the use of them inside the progressive project Argenia, my generative software for artificial events.



Generated architecture designed with generative "baroque" algoritms.

Contact:*celestino.soddu@generativeart.com*

Keywords: Baroc, Borromini, Creative Evolution, Generative Algorithms, Identity, Complexity, Variations

Generative Baroque Algorithms

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Figure 1: Generated baroque architecture inside an engrave of Piranesi. C.Soddu, 2011

Premise. Why Francesco Borromini and Baroc.

We are in Rome and I would like to point out my references to the Baroc of Borromini and the essential contribution that I have found in the work of this Master when I developped my generative approach to the architecture.

I didn't loved the Baroc for its decorative structure, of for the redundance of forms and I have never considered it as synonymous of decadence or synonymous of "female culture", definition that was established by some philosophers to expressly identify a culture of the void, of the nothing, almost a not-project in which to lose themselves following empty metaphors without end. Such interpretation of the Baroc and of its architects is, for me, completely out of my experience. I started to appreciate the Baroc contemporarily to my passion for the geometry and mathematics and for the possibility to use them in the creative innovation. And I am interested, above all, of the architectures of Francesco Borromini, not only for his ability to read and use the classical geometric systems as dynamic structures in transformation, but, particularly, for his ability of invention, of going over the remixing, by tracing architectures that knew how to conjugate the unpredictabilty of the true innovation with the power of being surprisingly harmonic, as the architectures out of the time are.

I learned from this Master how it's possible to operate through logics of geometric transformation, moving from the orthogonality to concave-convex systems, from square to equilateral triangle, as Borromini developped in Sant'Ivo alla Sapienza, not losing the harmonic structure consolidated by the tradition but performing unthinkable creative processes. The progressive transforming rules can perform not only the geometrical basic matrices, but also each single events through progressions of orders that could be, as in Borromini, not only unpredictably harmonic but surprisingly carrying of a pleasure of possible variations.

In this field, the Baroque architectures of Francesco Borromini identify a creative logical thought which fulcrum is the increases of geometrical complexity by finding out fields of possible progressions developed without preclusions, neither the constrains of consolidated classical paradigms. If we reduce this approach only to metaphors, as some philosophers has done, we deny the deep sense of the pleasure of complex systems harmony, able to imitate the Nature through a deeply artificial approach.

The variations are fundamental for the Baroque approach, as they are for the Generative approach. The architectural variations of Borromini, as the variations in the Baroque music, succeed in increasing the appreciation of the subtended logics, of the identity and recognizability of the creative thought, of the pleasure of living the architecture, its creation and its fruition. As, centuries later, it's possible to find in Gaudi, other my great reference for establishing my Generative vision.

It's not easy to read the geometries subtended in these architectures. After all Francesco Borromini has carefully avoided to communicate the geometrical generative structures, particularly when, as in San Carlino, he introduces a complexity not easily readable through simple forms. This approach, typical of great masters in all cultural fields amplifies the need to operate through logical interpretations that must be a subjective interpretation, by rendering explicit, and at the same time stimulating, the vision of each people that look at these architectures. It's not casual that a lot of books and innumerable articles are full of different interpretations of the works of Borromini.

Abstract

A constant of my generative operative research was to "abduct" by the Baroc a series of transformation logics that characterize my generative architectures. More specifically identifying and writing as algorithms my geometrical interpretations of the dynamics of the architectures of Francesco Borromini. The approach was to try to discover a possible interpretation from the complexity of Borromini architectures and

not to analyze and copy them. Recently I have developed more in detail these potentialities by focusing these logical interpretations from Borromini dynamics that, for the first time, I try to render explicit in this paper telling how I designed "baroque" algorithms, a work that, as I already said, started from 1986.

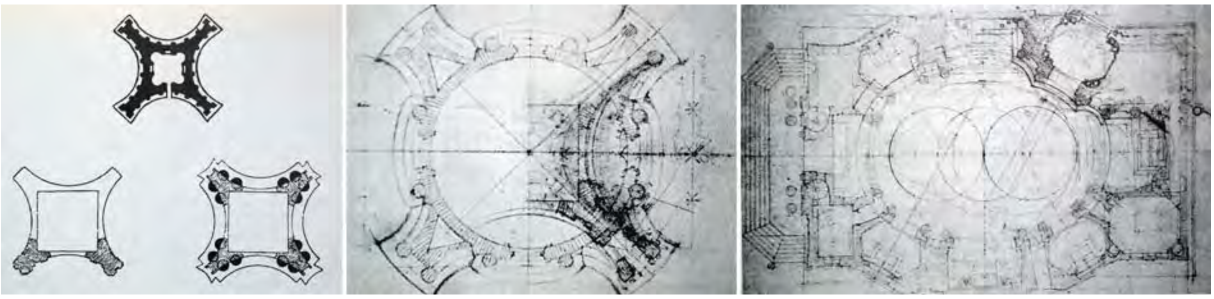


Figure 2: ancient grave, two geometries of F.Borromini, S.Andrea delle fratte and S.Carlino, from H.Sadlmayr, 2-3, original drawings of F.Borromini for S.Andrea delle Fratte and S.Carlino.

Conceptually it was not difficult for me, since my interpretation is based on the possibility to read not only the existing forms but how these forms could spring from progressive transformations of pre-existing events. This is organized by the morpho-genetic process when it runs and performs the complexity. Following my approach, the Borromini architectures are like progressive tales of a creative thought able to generate complex and unique events based on progressive increases of three-dimensional geometric and topologic logics. And sometimes the third dimension, operating logical translations from the traditional bidimensional formal orders, unexpectedly finds again unthinkable and amazing fields of development. These are like progressive stories where each person could be able to find again a really unexpected, subjective and suggestive path of discovery and to follow his own increasing ability to appreciate the beauty, and to find out how to generate it. In other words, interpreting the Baroque structures as algorithms is surprisingly immediate. And it is what I have done in the last thirty years; increasing my generative approach starting from my vision of dynamic baroque architecture.

In this paper I use as example some logical-operational interpretations of mine, many times very “out of rules”, like, after all, Borromini was; and I identify the logical-geometric structure of these algorithms and the use of them inside the progressive project Argenia, my generative software for artificial events.

Basic Structure of architectural events. The paradigm “27” and the paradigm “21”.

The reference to Borromini, in my project Argenia is constant. Both in the paradigmatic basic structure and in the progressive logics of transformation.

Borromini affirmed that the number 27 is at the base of his primary constructive structure of the architecture. This affirmation was not well specified. It mentions it in his only written work, the "opus architectonicum", by the way written by another people over his suggestions.

My approach is using the number 27 as definition of a space (1) surrounded by 26 interfaces that organize the relationships with the other surrounded spaces. If we verify this structure in the schematic constructive order of an architectural simple space like a parallelepiped, around the space we will have: a floor, four bases of columns, four beam-connections among the bases, four columns, four walls, four capitals, four beams, a coverage. In all 26 interface events + the inside space = 27.

I have directly used this systematic structure in my generative softwares of architecture. And I discovered that it is a geometrical extremely open and transformable system. Not only, it is able to guarantee the feasibility of the generated architectures and also their harmonic structure: once the relationships among these 27 elements are progressively defined, they mirrors a geometric logical approach. Results are recognizable as built following our cultural traditions and the specific progressive vision of our poetic. In fact, once that we apply progressive three-dimensional transformations to a so conformed system, by foldings it for fitting topological needs and by applying other geometrical transformation mirroring our architectural vision, our cultural tradition, as the Baroc is, we succeed in generatively easily managing the complexity of the architectural systems and the relationships among its events.

Thia adaptivity and ability to keep alive harmony happens also when we apply transforming rules able to capsize the topological system. A geometry, that we could identify as “not Euclidean” geometry, can be found by using algorithms able to transform the parallel straight lines by bending them in a way to converge them in two points. Other possible logics can be reached designing algorithms able to transform the orthogonality into hexagonal systems, into concave-convex systems, or in three-dimensional hyperbolic geometrical systems, or other. And into all multiple possible systems based on their mutual contaminations and convergences.

As examples: Euclidean – Not-Euclidean geometrical system, from rectangle to ellipse, the “flower” transformation, Orthogonal into Hexagonal System (Sant'Ivo), from orthogonal to convex systems. (S.Andrea delle Fratte, Sant'Ivo), from Rectangle to rounded Cross (Can Carlino), from Rectangle/Triangle to concave-convex sequence (Sant'Ivo).

The difference between working on forms and working on transformations is simply identified: the forms are hardly stratifiable, the transformations are easily usable one after/over the other. The forms are data (A=B), also if "parametrical" data A=function(B), the trasformations are algorithms that transform what was before in what will be A=A+1.

Reflecting on the quality inherent in the geometrical idea of Sant'Ivo, I have tried to move from the orthogonal structure to a triangular-hexagonal one, with the aim to enter into a system able to manage the generative progressive path to which this work of Borromini alludes. I have built therefore a geometrical system non based on 27 but on 21, that is an interior space based on the equilateral triangle surrounded by 20 interface. Running again the constructive schematic example used before, but with a based triangular prism, a floor, three columns, three beam-connections, three walls, three capitals, three beams, a dome. The number of all these interfaces are 20 + the inside space = 21.

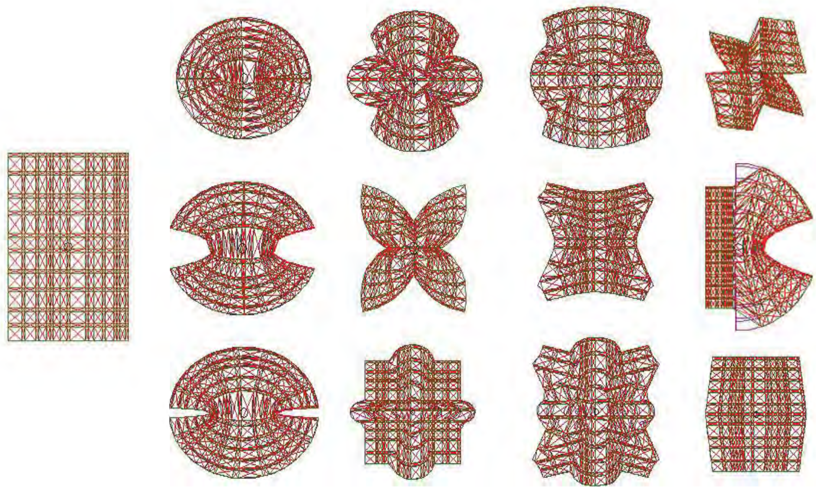


Figure 3: Starting from orthogonal system, possible transforming algorithms to fit Baroque geometrical systems.The used paradigm is "27".

I have realized that this paradigmatic system, also if similar to the one based on 27, don't has the same feasibility in being subsequently transformed since it is hardly able to maintain identity and harmony through transforming paths. May be that this is the reason why Sant'Ivo alla Sapienza is unique: it appears as a perfect architecture but hardly repeatable with variations.

However the based paradigmatic matrix on 21 is able to produce variations if directly used inside its geometric logical specification. In other words the initial order doesn't easily admit to be forgotten, as instead it happens for the based paradigm on 27 that is extremely adaptive and able to forget its own basic apparent order to strongly reach unpredictable and innovative orders.

This resistance to accept logical-geometric transformations is also due to its topological basic structure. While in the system 27 all the events have 26 interfaces, in the system 21 every event has a different number of interfaces. In the basic order the triangular event has 20 interface, the rectangular events, the "walls" surrounding the triangle, has 26 interfaces and the hexagonal "knot" 38 interfaces. This difference creates a hierarchical structure that forces the maintenance of some relationships and their basic structure of formalization and that is not able to accept

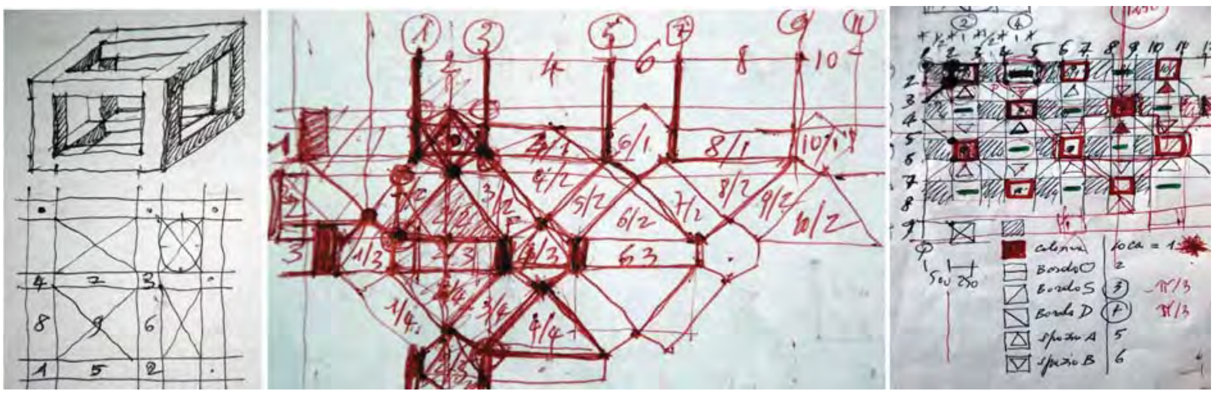


Figure 4: The 27 and 21 Paradigm. In the 3rd image the orthogonal system performed for managing Hexagonal systems.based on equilateral triangles and related interfaces.

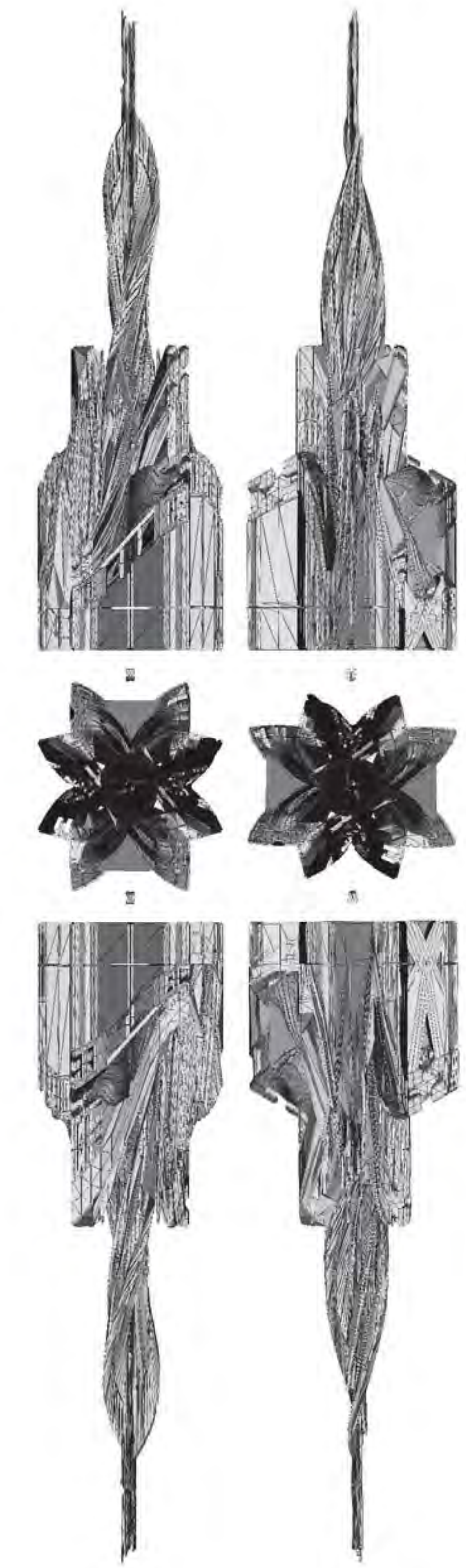


Figure 5: baroque architecture generated using transforming rules from orthogonality to curved spaces. C.Soddu 2011

transformations that modify these basic orders.

In other words, we can apply transforming rules if these logics are based on polar coordinates and not on cartesian coordinates. And the center of these coordinates must be located on the center of the main triangle and cannot be easily moved.

How to contaminate the orthogonal matrix and the hexagonal one in managing the generative processes? A purely geometric contamination was obviously impossible. I tried to follow a different approach. The main idea was to use a geometrical system based on orthogonality, and, when the system needs an exagonal plot, making "empty" 6 events of a the system 27 so that to reduce the operational events to 21, and defining some specifications of transformation and mutual correlation, in other terms defining the preliminary behavior that every event that "remains" must activate before being object of the following transformations.

The result is interesting, also because it is possible to make experiment already based on transformations around three Cartesian coordinates, and therefore based on the orthogonality, on the hexagonal system, not limiting it to the transformations based on the polar coordinates that, instead, directly appear operational on the hexagonal system.

The 3D models generated are amazing and imitates the innovation paths without prejudices that, for me, are proper of the work of the Borromini.

Progressive logics of transformation

The most Baroque of these logics of geometric transformation is, obviously, the algorithm able to turn a rectangle into an ellipse. Instead of progressively bending the sides until everything becomes "continuous" as a circle-ellipse, logic that I have used sometimes and that has, as possible result, the possibility to move from convex system to rectangle, to ellipse and to flower, I have preferred to imitate a possible path of transformation from the Euclidean geometry into Not-Euclidean geometry. In practice, in a rectangle, my algorithm operate in a way that the two opposite parallel sides meet themselves in two points, as it happens in the Not-Euclidean Geometry. The transformation acts progressively moving the vertexes of two parallels sides with the aim to bring them to coincide two to two: while the sides among the two vertexes that are going to coincide fold up itself toward the inside, the other two sides bend toward the outside, in a logic of concave-convex. (*Fig. 3, first column*)

Potentially the two vertexes have the tendency to form one of the fires of an ellipse through the point of progressive folding of the side, and they identify it if the side is completely folded up in two, abandoning its convexity. But it is not necessary to arrive till this final order, also because when it happens, the generated Not-Euclidean system apparently come back to Euclidean. The best "baroque" character appears during this process. Enlarging the transformation rule to the 3rd dimension is completely inside the Baroque character, as the images (*Fig. 8 and others*) can explain,

The interesting aspect of bending in this way the rectangle-pareallelepiped is that the system of the three-dimensional points insides the transforming space maintain their congruity and correlation also if them tend to perform a specific unpredictable complex "baroque" space. Congruity that also remains not only when transforming a single event but also when a connected net of events is globally transformed. Until a "city" system (*Fig. 6*). A concave-convex structure that, in a new curvilinear structure, surprisingly is able to maintains unchanged the initial topological connotations. More,

Figure 6: The bending process from Euclidean to Not-Euclidean system. A generated city with Not-Euclidean system performing the bidimensional plan inserted in a drawing of Leonardo da Vinci for Tuscany environment. In the other image a generated city in Sardinia. (C.Soddu 2009)

these transformations are able to increase the topological relationships by structuring new relationships (the contiguity of two vertexes that were before distant) not as change but as increase of complexity.

All these logics of transformation remain, however, very “axiomatic” if they are not used in series and if they are not contaminated one each other. The more satisfactory results, mainly from the point of view of the possibility to generate "baroque" architectures, is reached through the progressive use of different logics, and the application of these algorithms to the whole structure and to single parts.

The experimentations that I done by contaminating different algorithms of transformation are very complex and diversified. I try to show some meaningful examples always drawn by my interpretations of Borromini.

The algorithms interpreting the Baroque geometric dynamics are transformations applicable to the pre-existing form (even if already transformed) and they are finalizd to an increase of complexity and to a further stratification of identity and recognizability of the idea. They are dynamic tools for performing the vision. As we use tools for drawing, and we choose each tool following our singular vision, in the same way we use algorithms as possible tools for performing our subjective vision.

For instance the concave-convex algorithms, that are my interpretations of Borrominian architecture, are my tools for generating my architectures. In my experimentations this Borrominian character is reached using at least two different tools, two or more different algorithms able to perform, step by step, my baroque idea of architecture. (*Fig. 3, 2nd and 3rd column*)

Transform the sides of a square, or as in Sant'Ivo of an equilateral triangle, setting to the center a bending (a niche) and in the vertexes a convexity is not transferable in algorithms if not through a specific interpretation of the dynamics of these subsequent transformations.

One of my interpretations was based on exploding each internal virtual point from the center, according to a logic curve (the niches of Borromini in Sant'Ivo are not semi-circles). The whole three-dimensional space, not only event belonging to the sides, are pushed to the exterior when they are inside the angle focused on the middle part of each side. This because the aim was not to form a niche in a wall but to operate the spatial transformation of the whole space. In the same moment I performed the algorithm for lifting, with the same logic, the same points by harmonically increasing the Zs in relationship with the transformations on the other dimensions. The result is surprisingly very Baroque (Fig. 8 for the “27” paradigm and Fig. 9 for the “21”

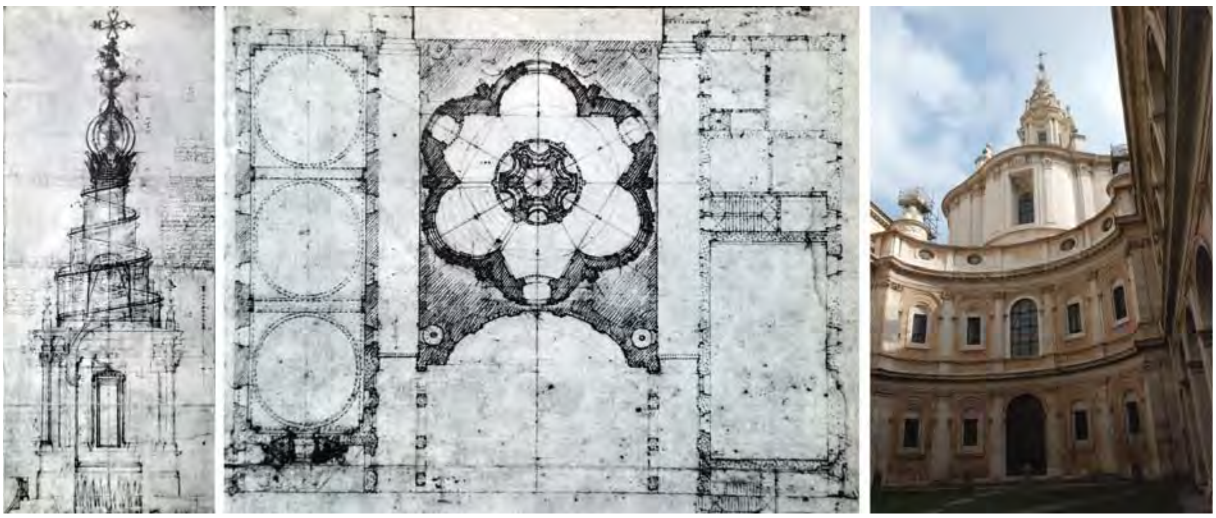


Figure 7: Sant'Ivo alla Sapienza by F. Borromini. Original Drawings and photo.

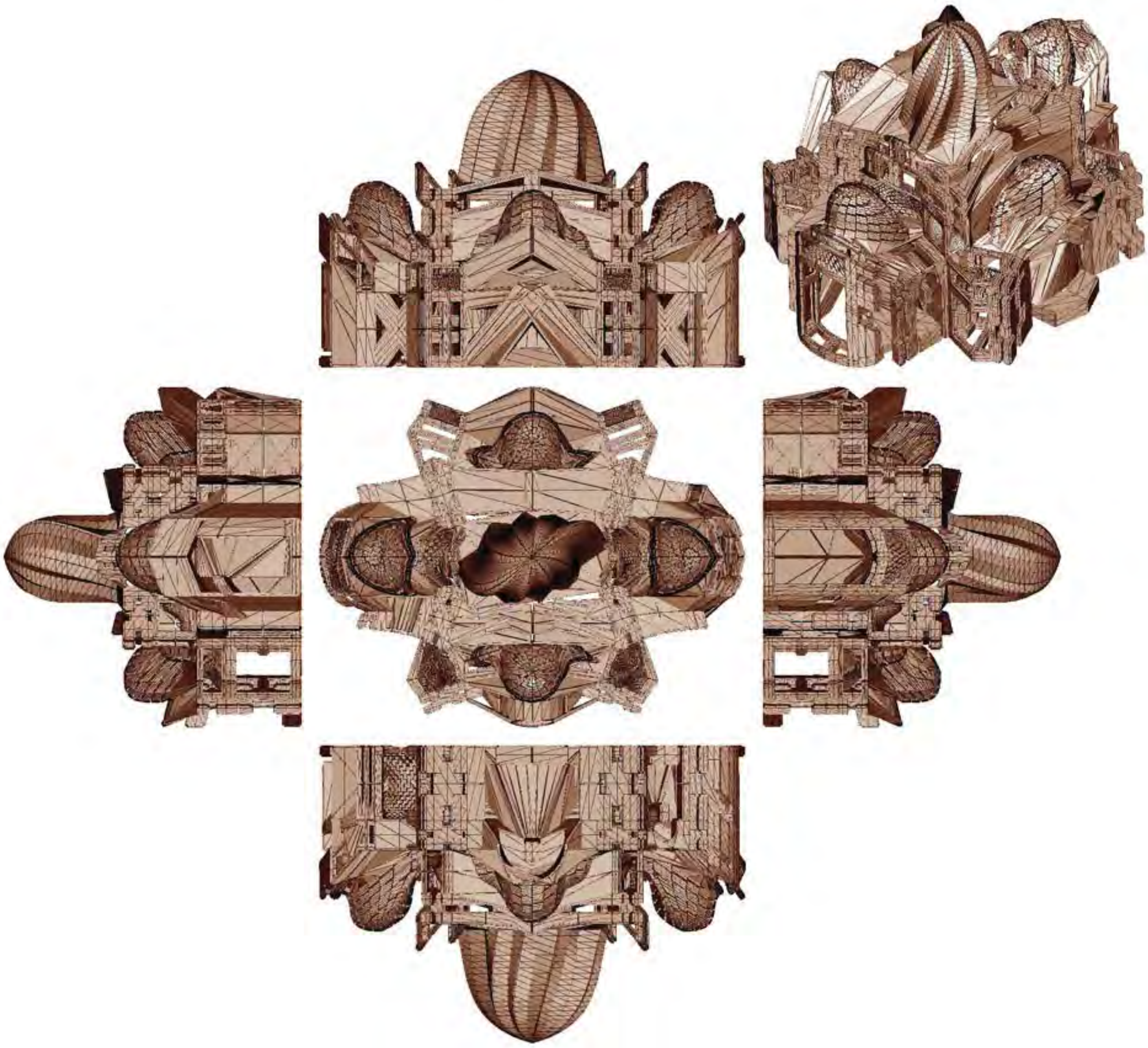


Figure 8: Generated architecture using different "baroque" algorithms with the paradigm 27. The contamination of two geometrical transforming logics: the Baroque niches and the orthogonal- convex system. In the following images, the generation is made using the 21 paradigm with the same transforming logics. (C.Soddu 2011)

paradigm). The harmonic transformation of the heights with a tied up progressive logic to the concave-convex one is inside the Baroque identity and recognizability.

Another algorithm of transformation, appliable and able to contaminate the first one, realizes the convexity of the angles. And the parallel use of these two algorithms produces the concave-convex geometrical system that we are looking for.

Progressive logics of transformation of the local events

First of all it is necessary to clarify that, inside each event, the structure of the relationships with the surrounding events (but not only) are primarily managed, at topological level, by the position of the event in the system 27 or 21.

Every single event has inside the possibility to refer to a series of spatial points,

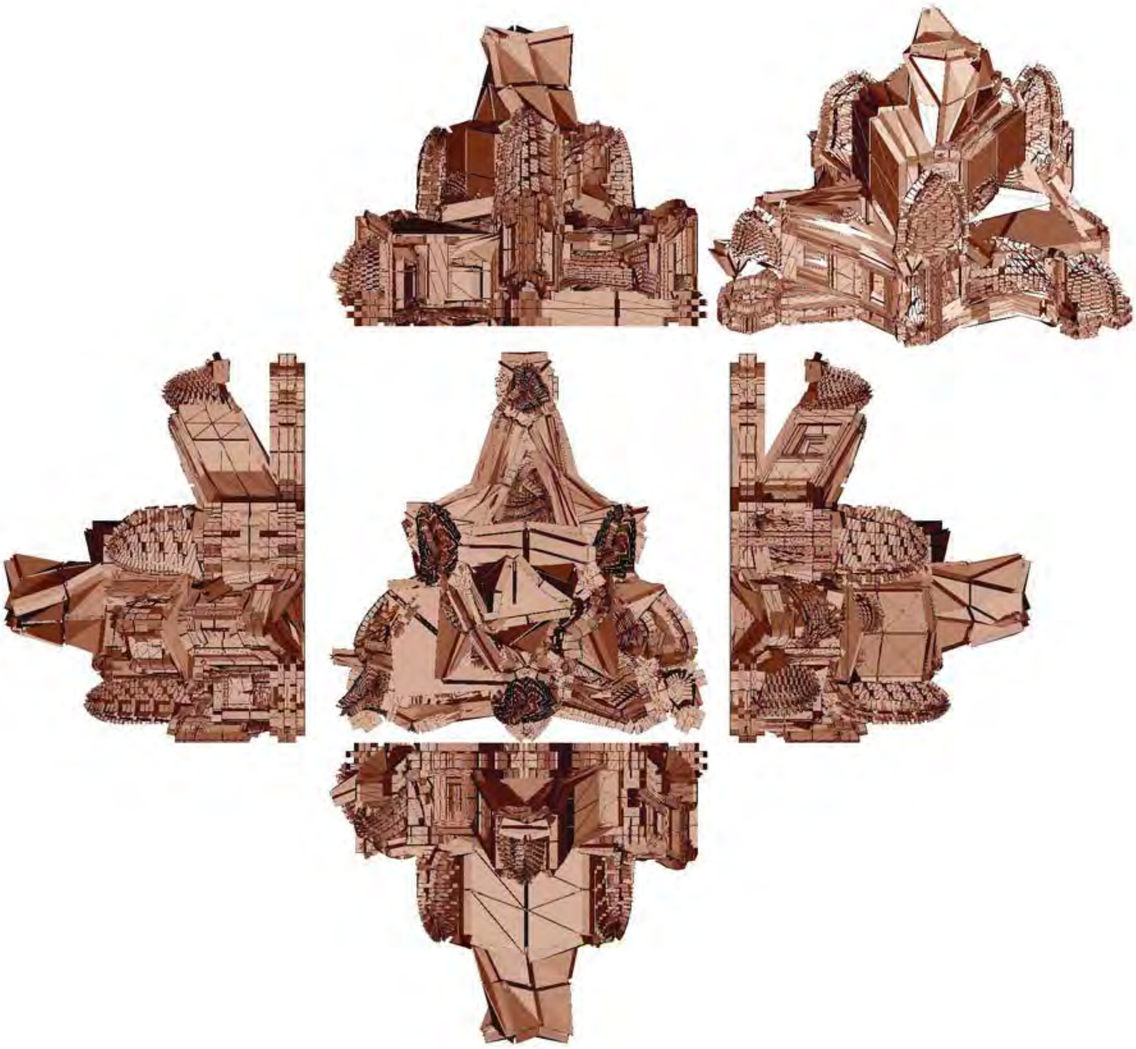
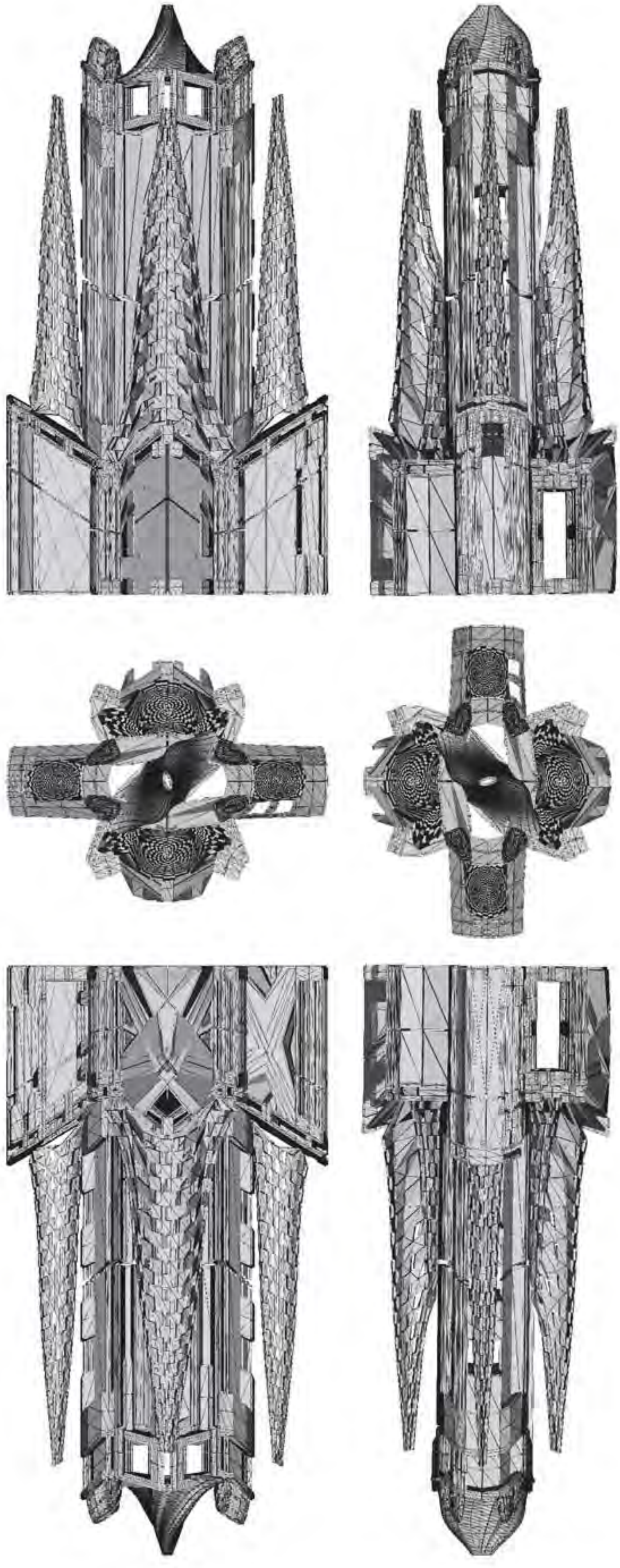


Figure 9: Generated architecture using different "baroque" algorithms with the paradigm 21. The contamination of two geometrical transforming logics: the Baroque niches and the convex system. (C.Soddu 2011)

around 2500 characterized 3D points), divided in A) parametric points, based on harmonic relationships and parametrically connected to the geometrical basic paradigm of the event, B) varying spatial points, based on progressive "topological" sliding of series of points. More, there are C) a series of just-generated points, generated in real time following polar coordinates and following nurbs surfaces in a way to fit the increasing complexity request by the complex system. In other terms the starting event, before subsequent transformations, springs through the contemporary use of parametrical, dynamical and realtime-generated coordinates. Each 3d event springs by varying dramatically its possible starting structure in relationship to the context in the moment of its birth; and such variations will not be casual but tightly in conformity with to the logic and subjective references of my architectural vision and peculiar aim of each projects.

Then each starting-event will vary following the subsequent geometrical transformations and the codes of congruence that define the relationship with surrounding events with which it has to be connected by respecting specific rules identified and defined by the topological structure. If, for instance, the event must be a “capital”, it will owe “to lean” on the column, a “wall” on a “beam”, and so on.



The generations and transformations of local events are managed by “matrixes” able to control the incoming transformations by using subjective interpretations of specific cultural references. In other terms all events, starting from their first generative step, are not static structures but dynamic events able to answer to each incoming algorithms, each interpretative dynamic code belonging to own subjective cultural, historical, constructive, geometrical and material references and preferences. These matrixes are, therefore the result of a further oriented reading of own cultural tradition through algorithms. In my generative work I didn't designed algorithms using only the references proper of my cultural tradition, but also of those with which I came in contact. Starting from late Seventies, in my experience of designing algorithms for the generation of architectures, I have tried to identify the characters of different environments and cultural contexts and I have tried to build progressive logics able to represent their identity and, obviously, my interpretation of their uniqueness.

All the environments where I had the occasion to interact by

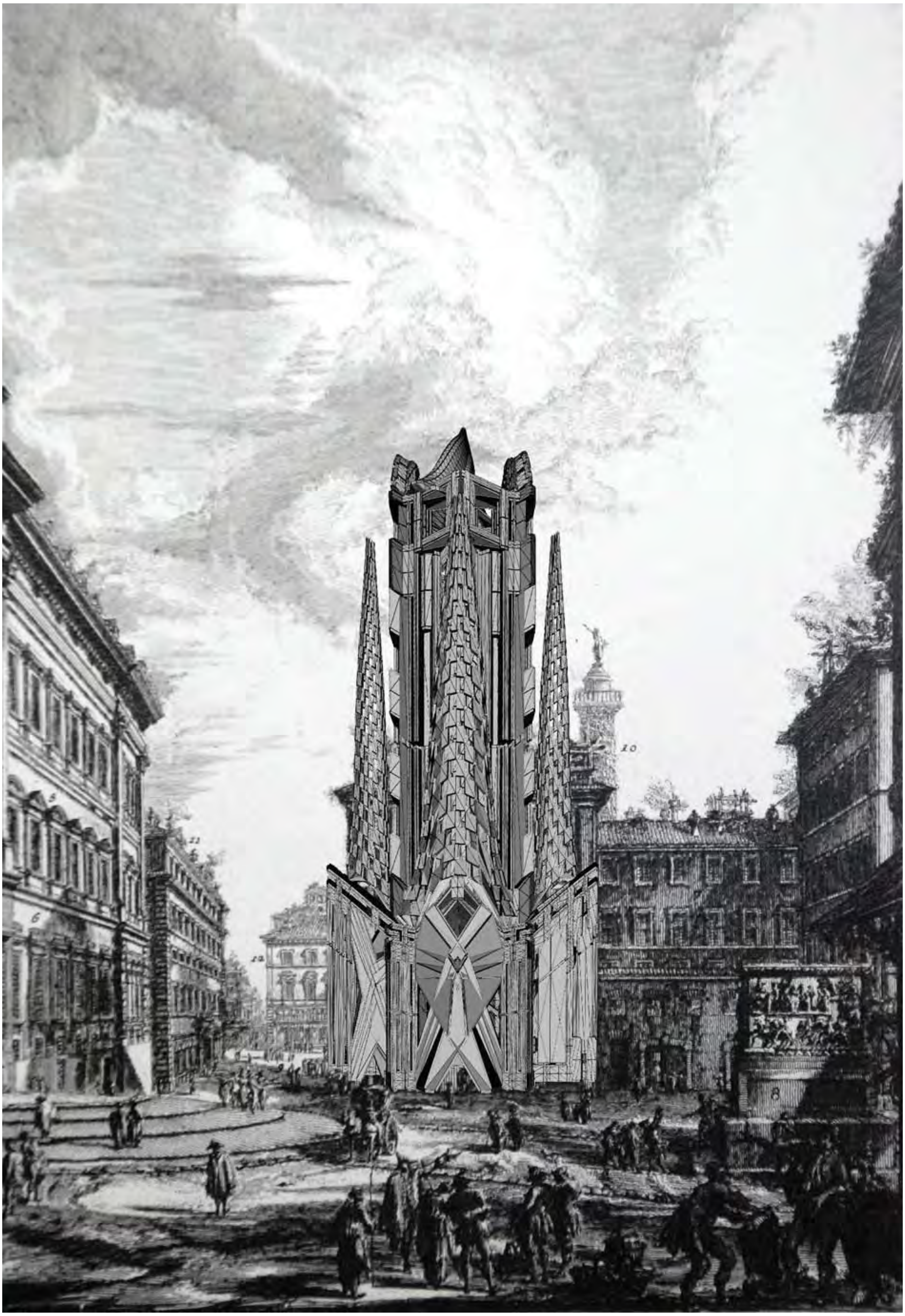


Figure 10: Generated Baroque Architecture inside an engrave of Piranesi representing Rome. In the previous figure plan and elevations. C.Soddu 2011

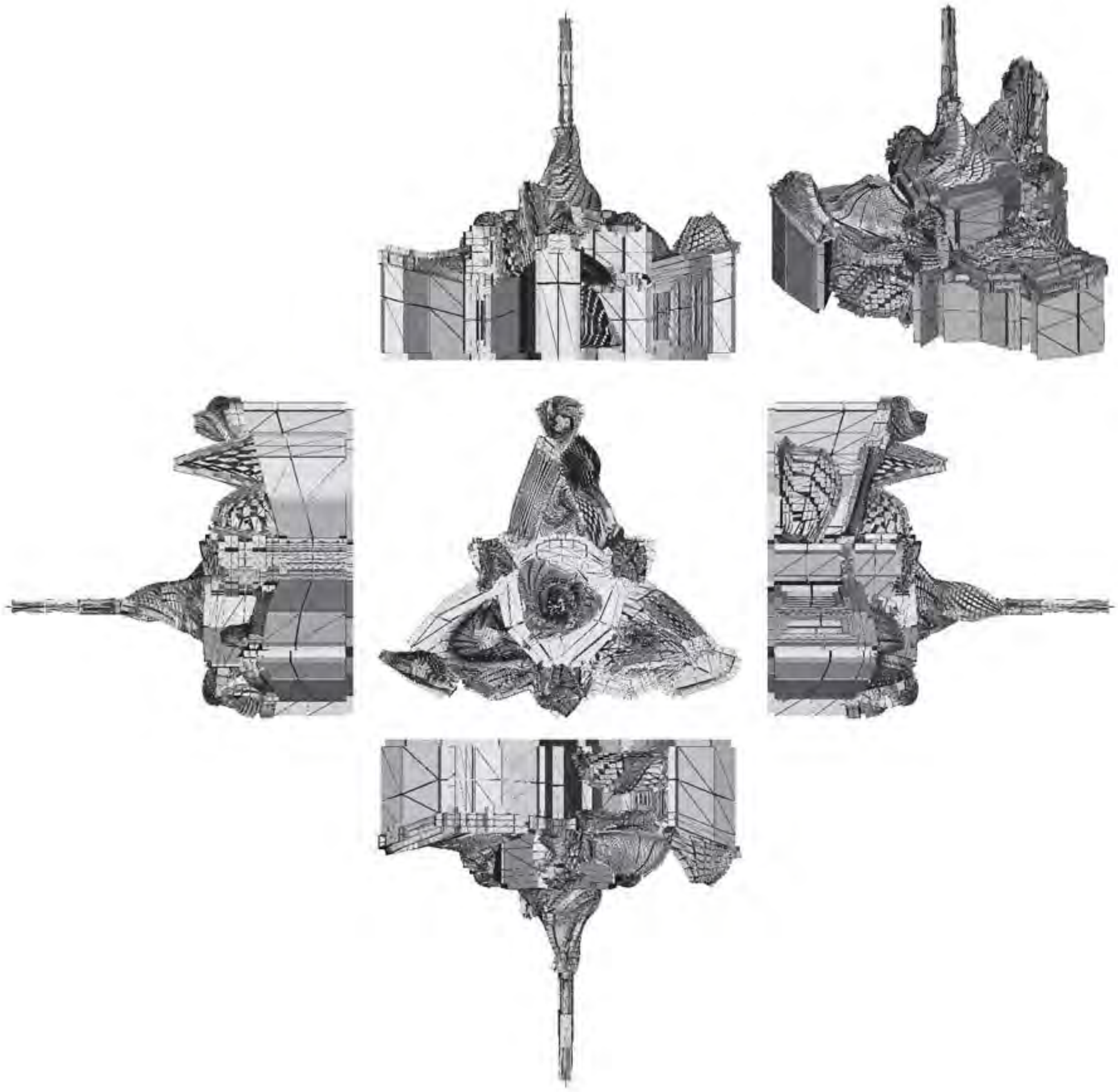


Figure 11: Another variation of generated architecture using the geometrical system based on paradigm 21, together with transforming rules based on polar coordinates and spiral development. C.Soddu 2011.

designing these generative architectures, were interpreted by me by building original algorithms based on each different local cultural identity. Through solo exhibitions and lectures, I tried to verify with the local people if these interpretations of their cultural identity were legible and pertinent to their vision of the genius loci, of their Ideal City. And this was the way to increase the complexity and to fit the possibility to reach each unique environmetal identity.

Nothing can be identified by a form. Designing with generative algorithms, every event belongs to a progressive tale springing from a creative approach to complexity. As, for me, the Baroc is.

Figure 12: Two Roman Piranesi "locations" with generated baroque architectures. C.Soddu 2011

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Paper: **BRAIN ART: ABSTRACT VISUALIZATION OF SLEEPING BRAIN**

Topic: Art

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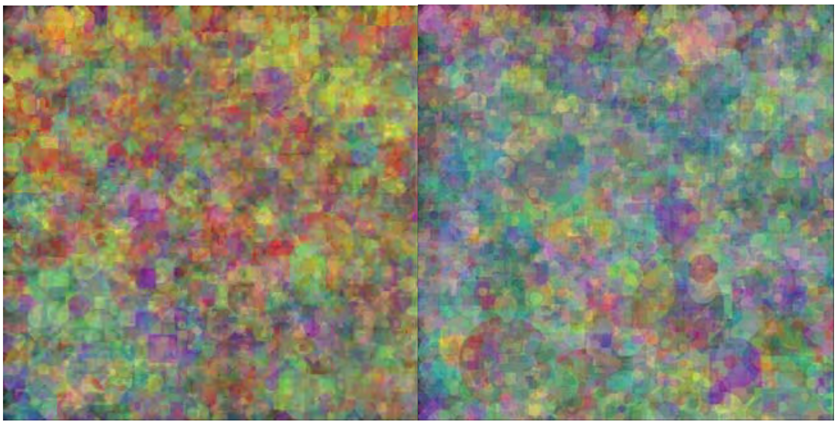
Abstract:
This work introduces a novel artistic approach of looking at the electroencephalogram of the sleeping brain. Known imaging procedures generate two- or three-dimensional representations of the brain, highlighting different chemical, magnetic or electrical distributions, regions and structures. This paper is an attempt to visualize the data extracted from sleep EEG signals in a different way, by presenting them as global abstract images, which are visual representations of the macro- and microstructure of the sleep, generated by combination of different EEG features, events and states.
While global resulting images still contain some information regarding the structure and quality of the sleep, the main goal is to create a result that is aesthetically pleasant.



Left: Image, generated from the EEG signal of the normal sleeping brain
Right: Image, generated from the EEG signal of the baby sleeping brain

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Keywords:
Generative Art, Data Visualization, Visual Abstraction, Computer Art, Biomedical Signal Processing, Electroencephalogram

Brain Art: Abstract Visualization of Sleeping Brain

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Abstract

This work is an attempt to visualize the data extracted from sleep EEG signals in a different way, by representing them as global abstract images, which are visual representations of the macro- and microstructure of the sleep, generated by combination of different EEG features, events and states. All important information about quality of sleep and its structure is hidden behind the colors and shapes of the image; and every image is as unique as the whole night sleep of every subject.

The goal is to study if it is possible to encode whole night sleep EEG events into sequences of shapes and colours in order to obtain a painting which is aesthetically pleasant and allows a global appraisal of the dynamics and cyclicity of sleep and dreaming process.

1. Introduction

There are different techniques used for monitoring brain activity, such as positron emission tomography (PET), single photon emission computed tomography (SPECT), and magnetic resonance imaging (MRI), along with electro-encephalography (EEG). Advances in all these techniques are enabling scientists to produce remarkably detailed computer-screen images of brain structures and to observe neurochemical changes that occur in the brain as it processes information or responds to various stimuli.

Known imaging procedures, such as PET, SPECT and MRI, generate two- or three-dimensional representations of the brain, highlighting different chemical, magnetic or electrical distributions, regions and structures, and provide results in the form of colour or black and white images (Fig 1). Unlike these procedures, output of electroencephalography EEG is represented as a plain signal (Fig 1). Results provided by these techniques are mostly used for scientific purposes only and play no particular important role in the fine arts.

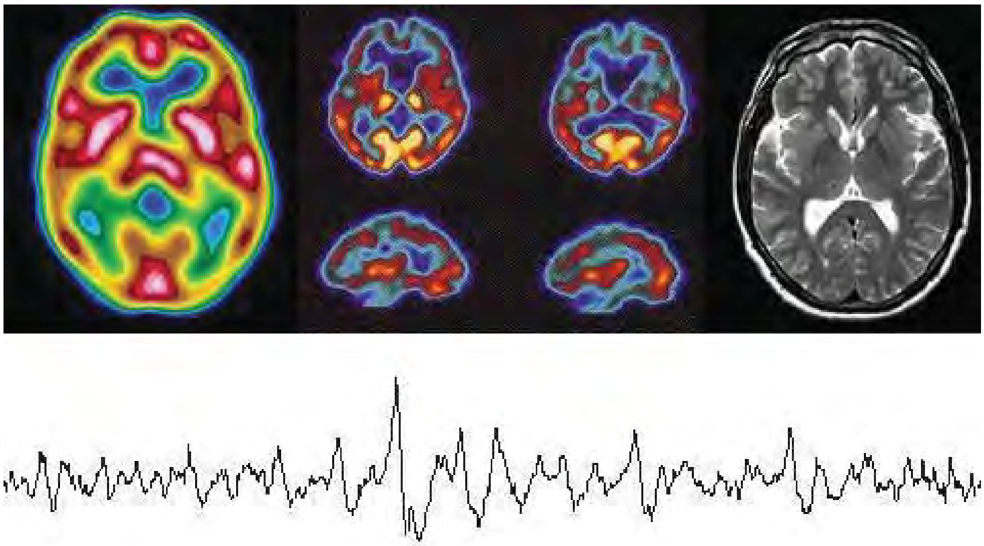

Fig.1 Top (left to right) > Examples of PET, SPECT, and MRI scans Down > Example of EEG signal

There have been, however, several attempts at using brain analysis results to generate artistic output, both by artists and scientists alike. Their work was mostly focused on integrating fragments of the brain signals and images into a final painting, as in [1] or on using real-time EEG analysis of an awakened brain in neurofeedback systems for painting without hands and creating visual images of individual's brain activity, as in [2,3].

This work introduces a novel artistic approach of looking at the EEG of sleeping brain. This study not only allows creating abstract images of the whole night sleep EEG signals, obtain from different subjects but also includes all important information about the quality and macro- and microstructure of their sleep. Sleeping brain images are represented by sets of different shapes and colors corresponding to the real EEG features, extracted from signals and transformed into unique images of single night.

Sleep is a dynamic process with known trend variation along the night, cycling between different states and dreaming episodes, as in [4]. The left-right side of the brains has common and independent activities making it a good candidate for left-right special differentiation. The frontal, central and posterior regions of the brain also differentiate from emotional, global and visual activities. The main problem of using these ideas is to find a way to code the EEG signals in a normalized way and then define a comprehensive mapping between features, colors and shapes in order to result in a pleasant and informative image.

First, we describe features extraction and encoding methods, used for obtaining the data from sleep EEG signals and their transformation into sleeping brain images. Then, two methods for images representation and final results will be discussed.

2. Features Extraction and Encoding Methodology

2.1 Band-Pass Filtering and Segmentation

The EEG waveforms are commonly classified according to their frequency, amplitude, and shape. The most known classification uses EEG waveform frequency – one of the main characteristics of the EEG signal. In accordance with manual analysis the classification of EEG frequencies on major bands (rhythms) was introduced, as in [5].

The following frequency rhythms are the most clinically relevant: Delta: < 4 Hz; Theta: 4 – 8 Hz; Alpha: 8 – 12 Hz; Sigma: 12 – 16 Hz; and Beta: 16 – 20 Hz. Our work deals with these five frequency rhythms in order to extract necessary information from the sleep EEG signal.

At first, five frequency bands 0.1 – 4 Hz (delta), 4.1 – 8 Hz (theta), 8.1 – 12 Hz (alpha), 12.1 – 16 Hz (sigma) and 16.1 – 20 Hz (beta) from the sleep EEG signals of channel C3-M2 by application of a 8^{th} order Butterworth FIR band-pass filter were extracted. The absolute value of each filtered EEG signal was then plotted and, in order to provide a smoother shape for the signals, a linear interpolation method was applied.

Each filtered EEG signal was then segmented using specific segmentation procedure based on the threshold application. As a result, segments of five different types, corresponding to delta, theta, alpha, sigma and beta frequency characteristics, were obtained.

The next step was to combine segments from five filtered and processed signals in order to obtain events consisting of segments from different types. Frequency segments, appearing simultaneously throughout the EEG signal, were combined together by application of specified set of rules based on the information about durations of the segments and spaces between them. This procedure allowed excluding non-relevant data from the analysis and avoiding the use of excessive information. Thus, events carrying frequency information about analysed sleep EEG signals were created. In total, thirty-one possible combinations of segments were obtained. These combinations are referred to as types of events. For convenience, types of events were numbered from 1 to 31.

From each EEG signal, sequence of events of different types was obtained, and this sequence represents microstructure of a sleeping brain for particular night.

2.2 Sleep Stages: Macrostructure of Sleep

Macrostructure of human sleep has been described as a succession of five recurring stages: four non-REM stages and the REM stage. A sixth stage, waking, is often included. Waking, in this context, is actually the phase during which a subject falls asleep. Rapid eye movement (REM) sleep is marked by extensive physiological changes, such as accelerated respiration, increased brain activity, eye movement, and muscle relaxation.

Sleep quality changes with transition from one sleep stage into another. Stages are, in fact, discretely independent of one another, each marked by subtle changes in bodily function and each part of a predictable cycle whose intervals are observable.

In the middle of 1930s Loomis provided the earliest detailed description of various stages of sleep [6], and in the early 1950s Aserinsky and Kleitman identified rapid eye movement (REM) sleep [7]. Sleep generally is divided in two broad types: non-rapid eye movement sleep (NREM) and REM sleep. After a brief proliferation of several sleep classifications a standard emerged. Sleep Stages are scored according to “A Manual of Standardized Terminology, Techniques and Scoring System for Sleep Stages of Human Subject”, which was elaborated in 1968 by a committee co-chaired by A. Rechtschaffen and A. Kales [8].

NREM and REM occur in alternating cycles, each lasting approximately 90-100 minutes, with a total of 4-6 cycles. In general, in the healthy young adult NREM sleep accounts for 75-90% of sleep time (3-5% Stage 1, 50-60% Stage 2, and 10-20% Stages 3 and 4). REM sleep accounts for 10-25% of sleep time. Stages 2 and 3 repeat backwards before REM sleep is attained. So, a normal sleep cycle has this pattern: waking, stage 1, 2, 3, 4, 3, 2, REM. Usually, REM sleep occurs 90 minutes after sleep onset.

Since the purpose of this work is not only to create an aesthetically pleasant result, but also to provide informative images that would allow tracking of the quality of the sleep and its macrostructure, sleep stage information was also extracted from EEG for further image encoding.

2.3 Grouping of Events

It is well known that delta, theta and sigma frequencies are typical for sleep EEG, whereas alpha and beta frequencies more often observed in wakefulness EEG, although they are also present in the sleep.

Typically appearance of the rhythms in human EEG is following:

- Beta rhythm is associated with normal waking consciousness;
- Alpha rhythm predominantly originates from the occipital lobe during wakeful relaxation with closed eyes. Alpha waves are reduced with open eyes and drowsiness and sleep;
- Theta rhythm tends to appear during drowsy, meditative, or sleeping states, but not during the deepest stages of sleep;
- Sigma rhythm is normally observed during sleep;
- Delta rhythm occurs most frequently during stage 3 and 4 of NREM slow-wave sleep.

Based on this knowledge, events were grouped into twelve groups according to a specified set of rules. These groups are represented according to the information about the structure of the event (the combination and order of the segments inside the particular event) and its relation to the sleep-awake concept. For convenience, each group type was numbered from 1 to 12.

2.4 Encoding of EEG Events into Image Objects

Each EEG signal was analysed according to the segmentation and grouping methods, described above. At the end, EEG signals were transformed into sequences of events. Each event contains information about its type (1-31), corresponding group (1-12), duration in seconds and name of the sleep stage it occurs in.

After sequences of events are obtained, they can be used in creation of sleeping brain images. An image is created by converting information about each event in a sequence into a simple object; and inserting these objects into the same picture, taking their chronological order into account when determining their location.

Each object exhibits three different features: colour, shape and size.

1. The first feature takes into account information about the type of event and defines the colour of the object, choosing from a set of thirty one colours, corresponding to the particular type of current event. The following colours and their association with each event were chosen randomly (Fig. 2).

Fig. 2 Thirty-one colour, chosen for the encoding sleep EEG events into objects of the image. Each colour corresponds to a specific type of events.

2. The second feature has twelve possible values, corresponding to the group information of the current event, and is used to select shape of the object. There are six basic shapes (circle, square, rectangle, line, octagon, diamond), and each can be made opaque or transparent, depending on the corresponding group (Fig. 3).

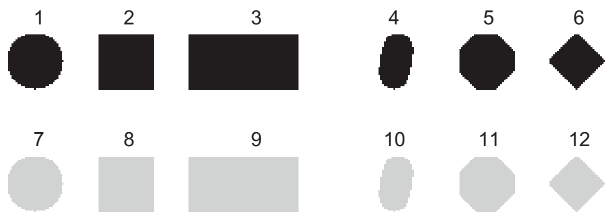

Fig. 3 Six basic shapes used in encoding sleep EEG events into objects of the image. Events from groups 1-6 are represented by opaque shapes, whereas events from 7-12 groups are represented by transparent shapes.

3. The third feature is based on the information about the duration of the current event and is used in determining the size of the object. Longer events result in larger objects.

3. Final Images Representation and Results

There are two different methods for representing sequences of events as images of the sleeping brain. Both of them include information about sleep stages, in which events occur during the whole night sleep.

Twelve whole night polysomnogram recordings (≈ 8 hours each) from normal healthy volunteers and from snorer patients are used in this study. The data were randomly selected from our database. From each polysomnogram recording, single EEG channel (C3-M2) is used in this study.

3.1 Representation Method 1

This representation method groups the events according to their sleep stage information. Five different images are generated, one for each stage, and then combined to generate the final result. For each stage, their individual events are analysed and placed on the respective image. To determine their location the average length for an event of that stage is calculated and then normalized so as to make each resulting stage image the same size. This value is then used as the mean size for the objects of that stage, and is also used as the distance between adjacent events. The events are placed on the image according to their chronological order, with the first event of a given stage being placed on the top left corner and then following a left to right, top to bottom order.

The final sleeping brain image is then created by taking all five stages' images (Stage 1, Stage 2, Stage 3, Stage 4 of NREM sleep and REM sleep), making them transparent and overlapping them over each other.

Resulting sleeping brain images for twelve subjects from healthy normal and snorer populations are represented in Fig. 4, 5.

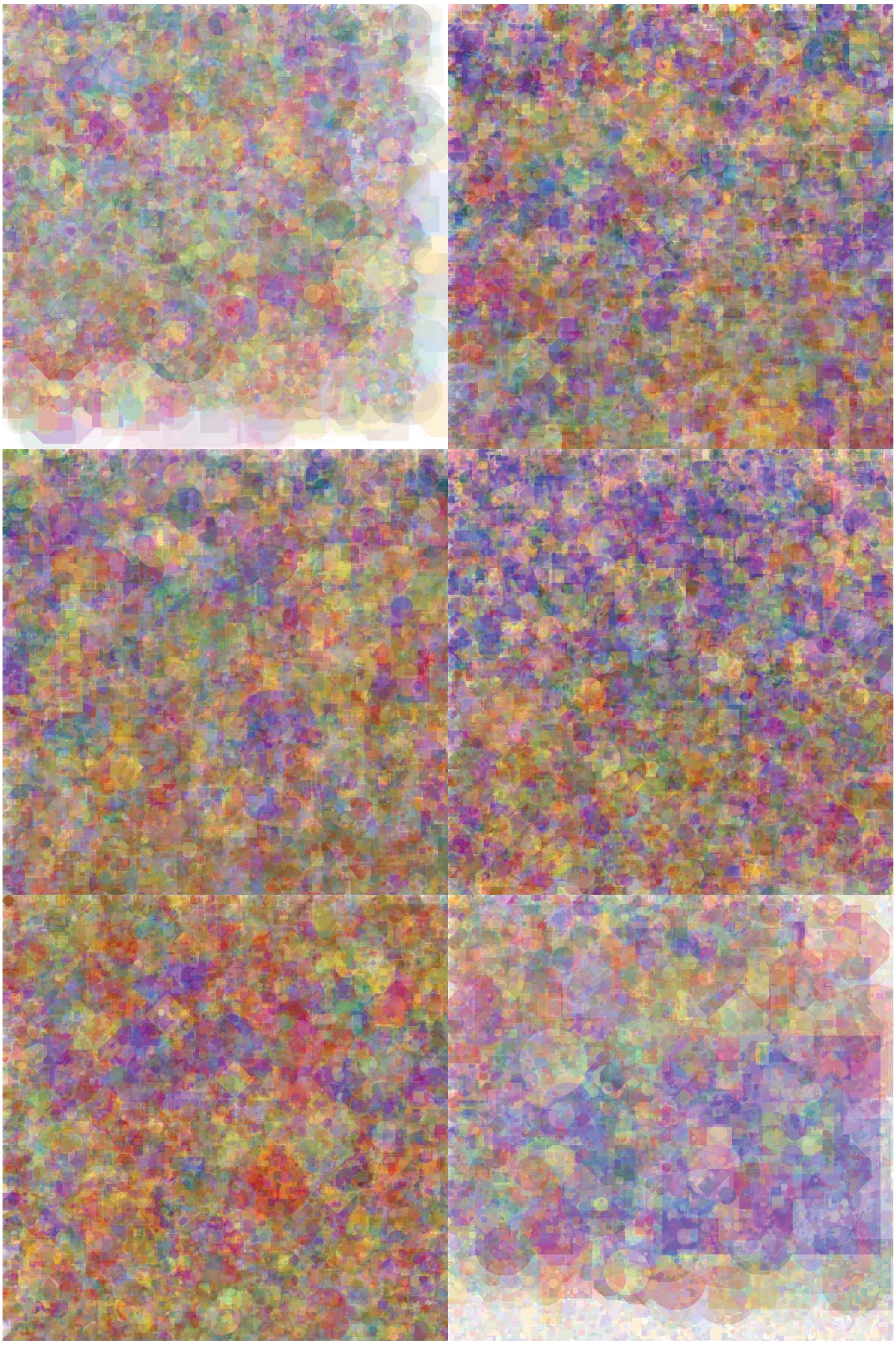

Fig. 4 Sleeping Brain Abstract Images for six snorer patients, created with representation method 1

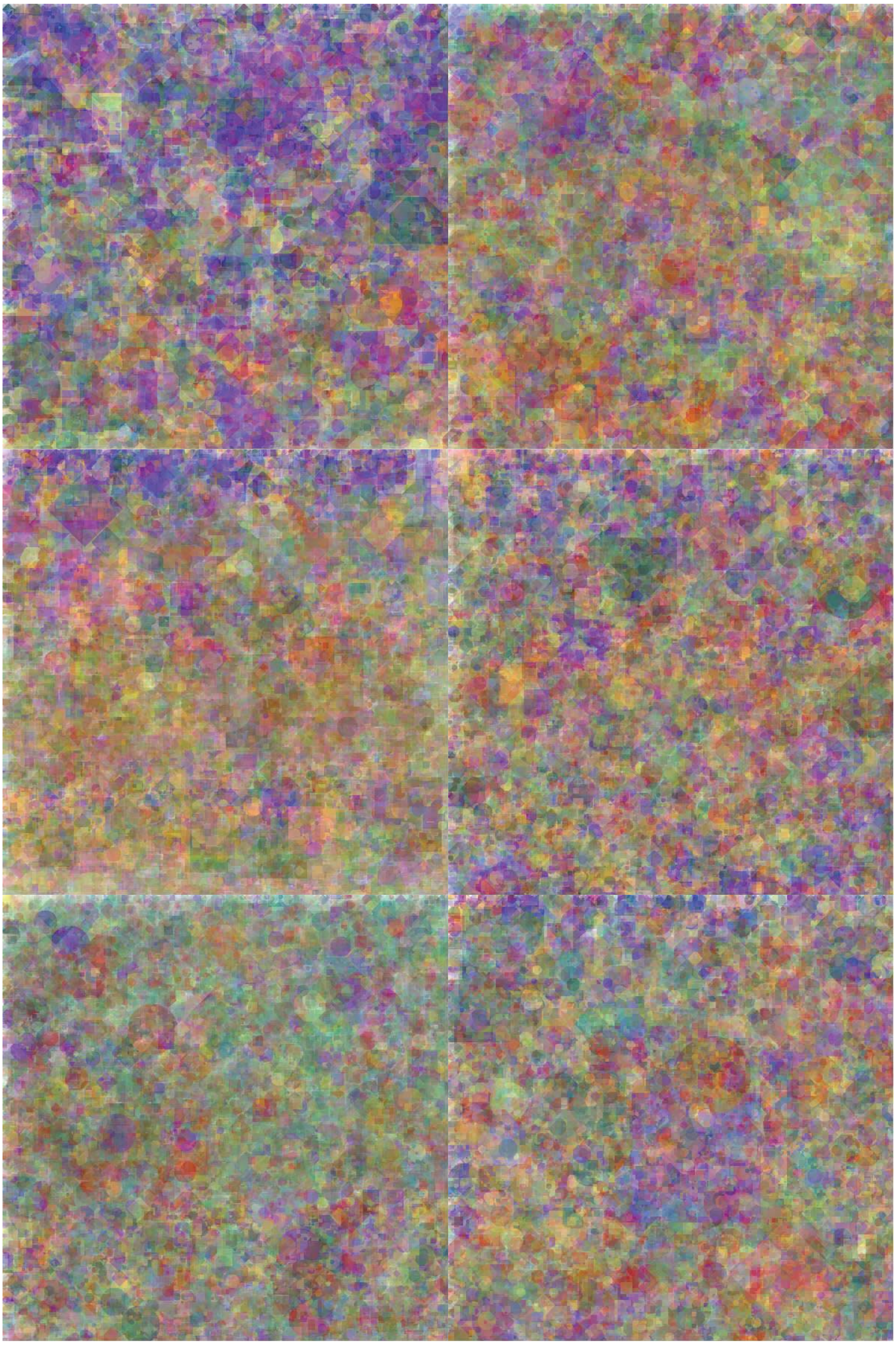

Fig. 5 Sleeping Brain Abstract Images for six healthy normal adults, created with representation method 1

3.2 Representation Method 2

This representation method changes the way the location for an object is determined, as well as the way of using stage information. The objects are now placed in a spiral pattern, starting on the centre of the image with the first event in the sequence and spiralling outwards in a clockwise direction, following events' chronological order.

Objects are spaced at specific distance from each other based on the calculated mean duration between all events (no distinct value for each stage was used as in first representation method).

In this method, stage information is used to determine the background colour for each object, providing information about durations of sleep stages and their cyclicity throughout the whole night.

The chosen background colour associated with each sleep stage is shown in Fig. 6.

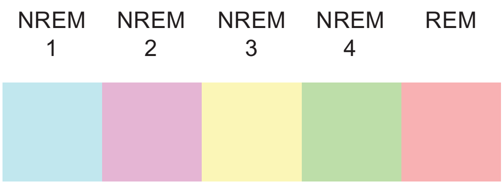

Fig. 6 Background colours corresponding to sleep stages

Resulting sleeping brain images for twelve subjects from healthy normal and snorer populations are represented in Fig. 7, 8.

4. Discussion

The main idea of this work was to represent sleep EEG signals in a different way, as abstract images of sleeping brain. The goal was to create images that are both aesthetically pleasant and informative. Two different representation methods were applied to the sequences of sleep EEG events for their transformation into images.

First representation method allowed creating very interesting and aesthetically pleasant abstract images of sleeping brain, but from the obtained results it is clear that informative side is missing. Although, one can say that images show some specific differences in whole night sleep among different subjects and populations, it is hard to provide a clear interpretation of those results. Since the distance between events is normalized so as to provide images of equal size for each stage, the information about event duration is distorted (stages with less events generate larger objects, even if the event's duration is shorter than events on more populated stages). Information about the sequence of sleep stages during the night is also lost. These issues make it difficult to analyse the resulting image from a sleep quality point of view.

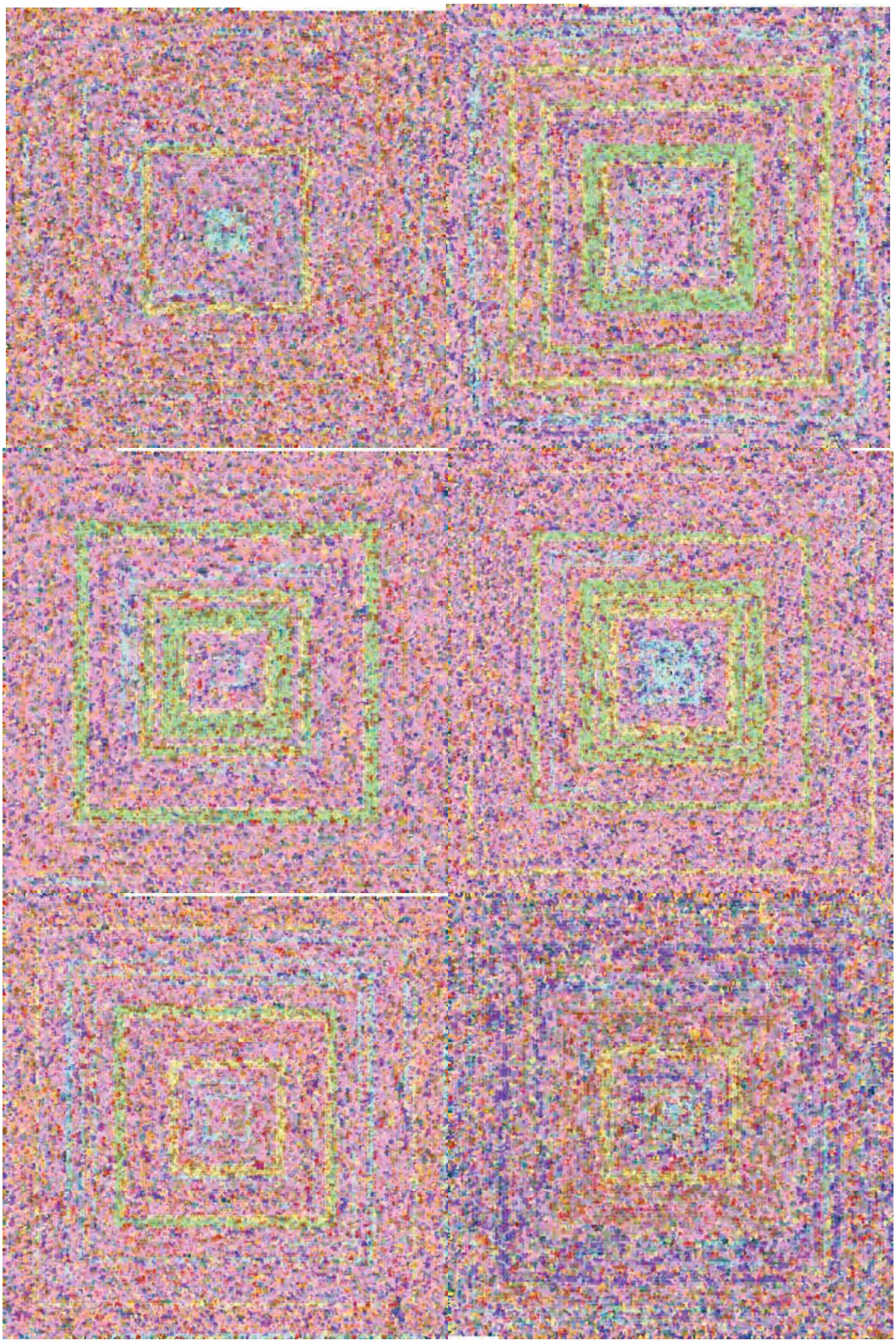

Fig. 7 Sleeping Brain Abstract Images for six snorer patients, created with representation method 2

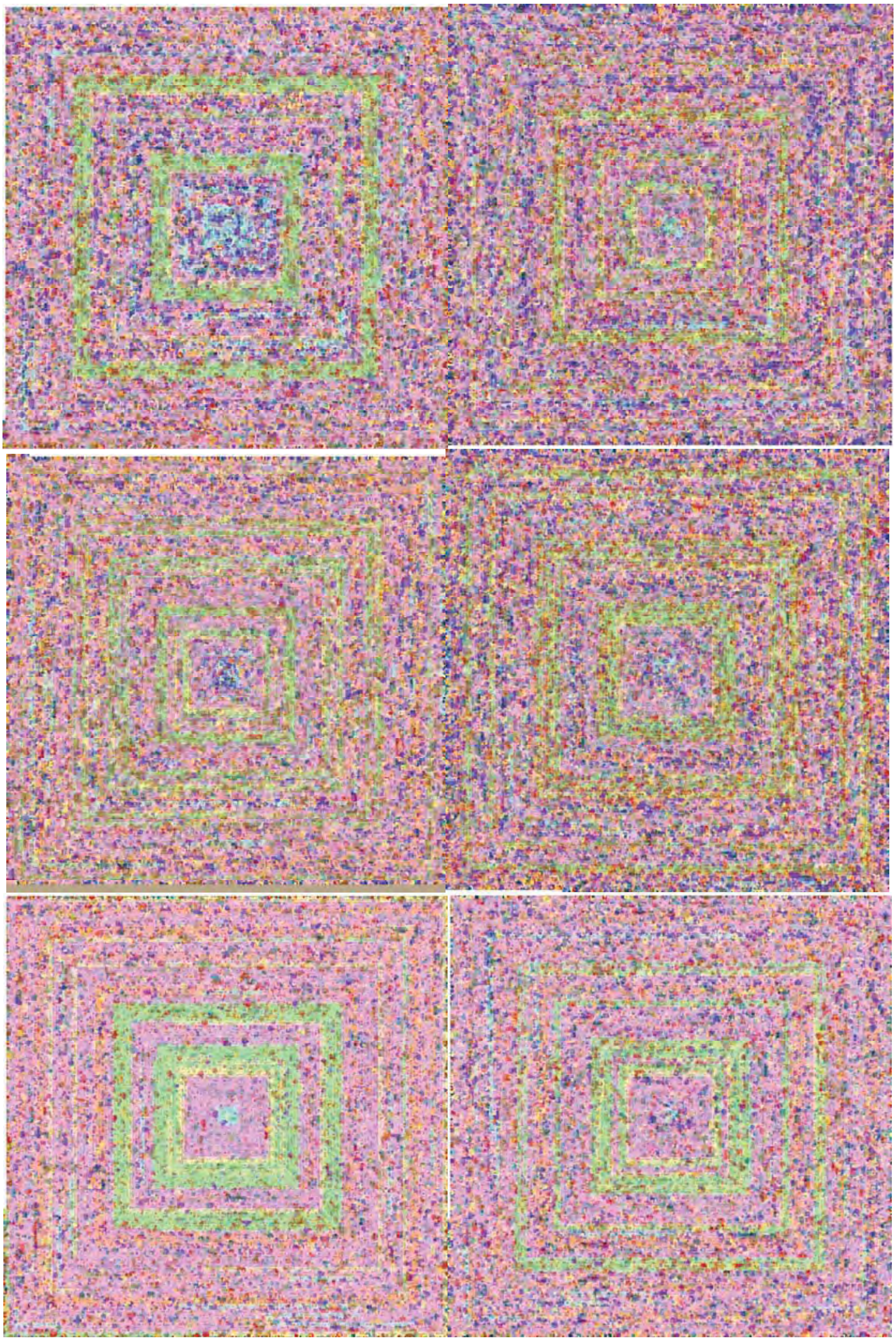

Fig. 8 Sleeping Brain Abstract Images for six healthy normal adults, created with representation method 2

Second representation method allowed creating abstract images of sleeping brain together with providing some information about quality of sleep of the subject and its cyclicity. Created images show how sleep stages replace one another and dynamics of events' changes during the night.

Whereas, first representation provides more interesting results, but makes it harder to interpret from a sleep analysis point of view, second representation method gives more detailed account of the subject's sleep, but might not be as interesting.

In the future work we will use more additional features and different effects for the objects (blurring, transparency), new shapes, and review the colours associated with events' types to have some resemblance between them.

6. Acknowledgments

This work was supported by project the FCT (ISR/IST plurianual funding) through the PIDDAC Program funds.

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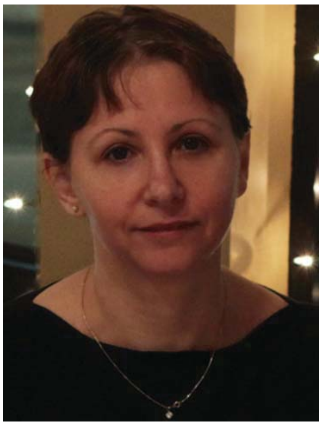
D. Sirbu	*Paper:* **A Framework for Artificial Creativity in Visual Arts**



Topic: Artificial Creativity

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Abstract:

The present paper looks at points of intersection between theories of artificial creativity in visual arts and control theory. The emphasis is placed on approaches based on evolutionary computation in the study of artificial creativity. Analogies and differences are analysed between closed loop models that adapt system behaviour in control engineering and evolutionary models that adapt system behaviour in relation to an estimation function. Computational models of individual and social creativity are analysed in relation to the reference model architecture proposed by Albus and Meystel for the development of computational intelligent systems with autonomous behaviour. The purpose of this analysis is to define a possible framework for the development of autonomous creative systems in a hybrid evolutionary computation and control theory approach.

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Keywords:
artificial creativity, evolutionary computing, control theory, visual arts

Towards a Framework for Artificial Creativity in Visual Arts

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Abstract

The present paper looks at points of intersection between theories of artificial creativity in visual arts and control theory. The emphasis is placed on approaches based on evolutionary computation in the study of artificial creativity. Analogies and differences are analysed between closed loop models that adapt system behaviour in control engineering and evolutionary models that adapt system behaviour in relation to an estimation function. Computational models of individual and social creativity are analysed in relation to the reference model architecture proposed by Albus and Meystel for the development of computational intelligent systems with autonomous behaviour. The purpose of this analysis is to define a possible framework for the development of autonomous creative systems in a hybrid evolutionary computation and control theory approach.

1. Introduction

There is agreement in the research community that creativity is defined through the production of novel and appropriate ideas, behaviours, or artefacts [6], [10], [11], [15], [16]. This defines creativity as being inherently part of the adaptation and evolution processes, which are based on the production of new behaviours and continually evolving existing organisms into new ones with better capabilities to adapt in a given environment. Building on this idea, the goal of the present paper is to provide conceptual grounds towards a framework for the artificial development of adaptive systems capable to produce original visual compositions with artistic value. The process of artificial production of new artworks and designs is based on the principles of evolutionary algorithms [4], [7] and of the visual language shared by artists [3] and designers [19].

2. Evolutionary Concepts and Artificial Creativity

We look at creativity as the aggregation of processes by which artificial adaptive systems can produce new behaviours and modify themselves into improved systems or into systems which are different enough to be considered entirely new and with a better chance to survive successfully in the given environmental niche. Constraints in a given environmental niche are expressed as principles, rules, and concepts related to visual organization of art and design compositions.

We consider a multilayered system based on artificial ontogenetic developmental processes at lower levels, where agent interactions lead to pattern formation, and based on artificial phylogenetic developmental processes at the upper level, where expressed organisms form populations evolving in the given environment.

The agents, the ontogenetic and phylogenetic processes, as well as the environmental constraints at various levels are based on the visual language that provides the basis for art and design creation. Below are described the main ideas and principles at the basis of ontogenetic growth and phylogenetic evolution in the digital production of generative artwork.

3. Artificial Ontogeny of Generative Artworks

If we define a visual composition as an artificial organism, we can interpret the process by which the visual composition is generated as artificial morphogenesis or artificial ontogeny.

In the natural world, morphogenesis is a process of structure formation controlled by complex growth programs leading to the creation of new organisms. We look at artificial ontogeny as a process of pattern formation based on activities and dynamics of kinetic agents that populate the visual field. The growth programs that control this kind of pattern formation are based on sets of rules underlying principles of structuring and organization of visual designs and artworks.

In addition to the growth programs, the artificial morphogenesis is influenced by agents' interactions with the environment and environmental constraints, which could be expressed as sets of rules that dictate the placement and relationships established between components of a visual design or artwork, their relationships established with the boundaries within which the visual composition exists, and the visual field established within such given boundaries.

Agents are forms defined by visual elements such as shape, size, colour, and texture. Artificial ontogeny is the process by which kinetic agents acting in accordance with a number of pre-established rules develop themselves or interact with the environment or with each other leading to the creation of new more complex forms. The structure of these forms, and their placement and relationships with each other or with individual agents determine the structure of the visual field. At the intersection between evolutionary and visual languages, the structured visual fields determine the morphogenetic characteristics of the visual composition.

4. A Simple Example of Artificial Ontogeny

An example of artificial ontogeny creating a spiral structure developing depth, volume and apparent cast shadows is implemented by using simple agents based on primitive geometrical forms like the circle and the line. The small circle agents follow a placement rule based on the iterative increase of the circle radius with a very small amount at each cycle. These small increases offset the agent placement trajectory from a simple circle into a spiral path. The formula used to generate discrete points (x, y) along a spiral is based on the elements of the circle as follows:

$$x = cx + r\cos\theta$$
$$y = cy + r\sin\theta$$

where:

$r =$ circle radius

$(cx, cy) =$ centre of the circle

$\theta =$ angle between radius with end point (x, y) on the circle and the diameter.

Various uses of this method of discrete spiral construction are suggested by Reas and Fry [14] and Pearson [12].

The second agent type provides a population of lines of random length varying within a given reduced range. This agent type, being a line, implicitly has direction. The direction is randomized, but the starting point of the line agent is always placed in the centre of the current circle agent on the spiral. This way, each circle agent becomes the point from where a number of line agents diverge. Over a number of cycles, the randomized directions and lengths of the line agents produce a delicate texture counteracting the directional effect of the line agents. However, the convergence of line agents into circle agents generates a volumetric effect, which is strengthened with every cycle. The simple agents and the attached rules of placement and randomization create clusters distributed along a spiral path. The emerging new form has the appearance of soft bevelling effect on a textured paper surface (see Figure 1).

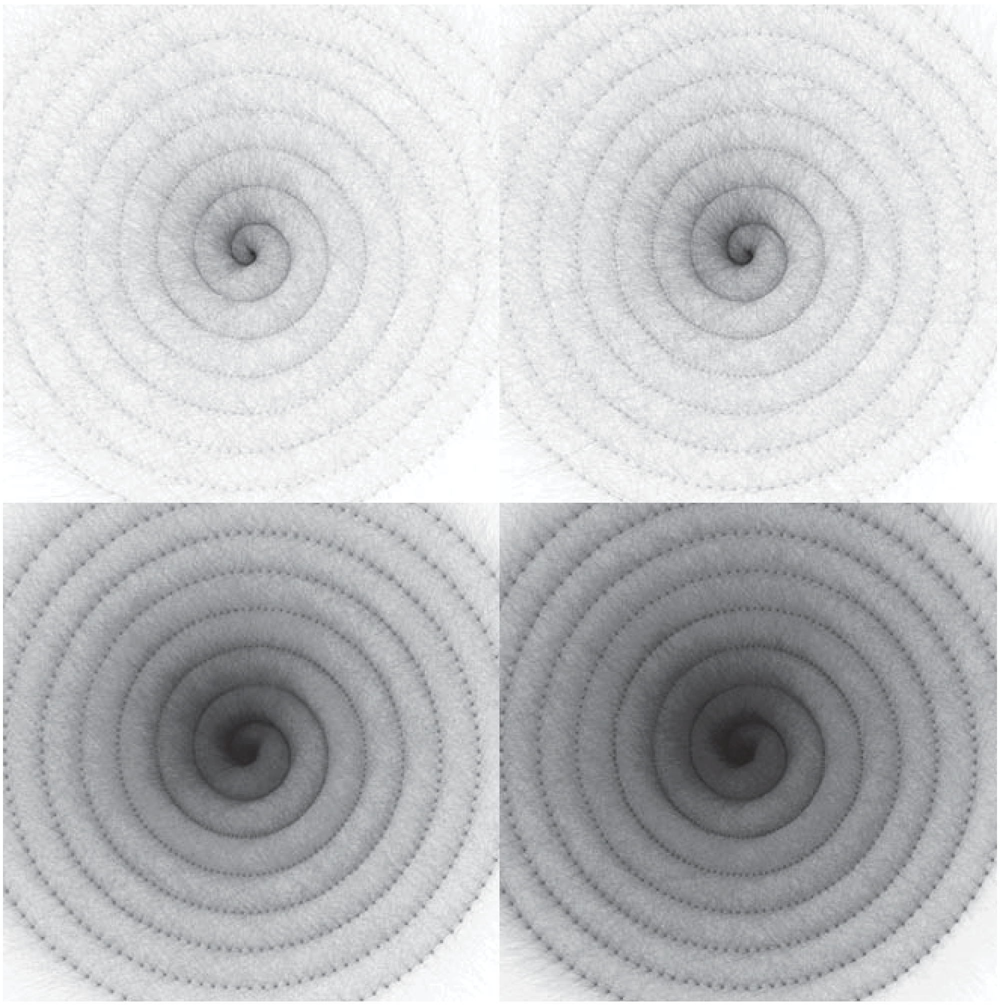

Figure 1. Example of simple artificial ontogeny producing the appearance of soft paper texture with gentle pillow-bevelling effect. Captured intermediary states illustrating various phases of development.

Using the same basic principles, but varying some of the interaction rules between agents may result in quite different results. By restricting the change in direction so that line agents diverge within a limited range on one side only of the circle agent will convey depth rather than the pillow-bevel effect (see figure 2). By varying the range of line length randomization, the depth of the resulting spiral structure can also be manipulated.

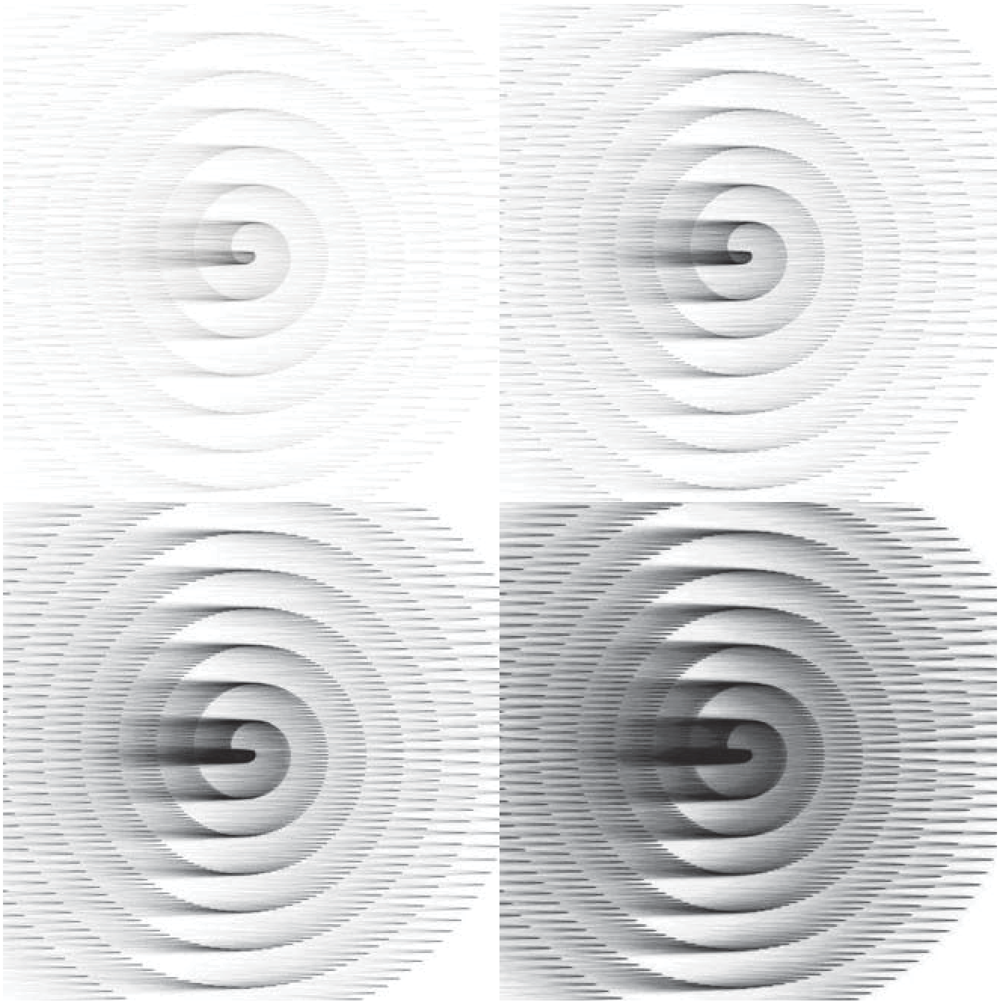

Figure 2. Example of simple artificial ontogeny producing the appearance of depth in the spiral structured form. Captured intermediary states illustrating various phases of development.

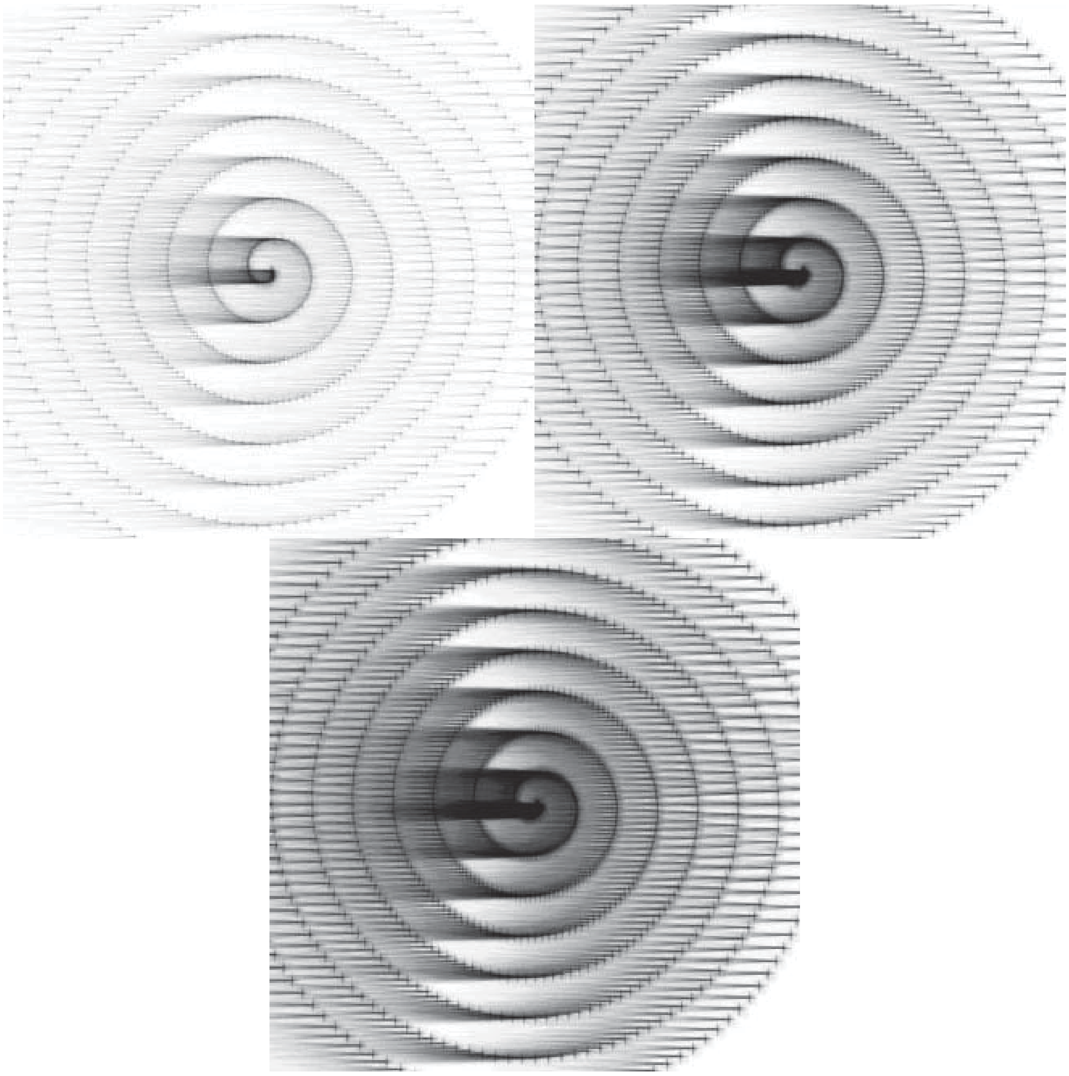

Figure 3. Parametric manipulation producing depth variation in the simple artificial ontogeny presented above. Captured intermediary states illustrating various phases of development.

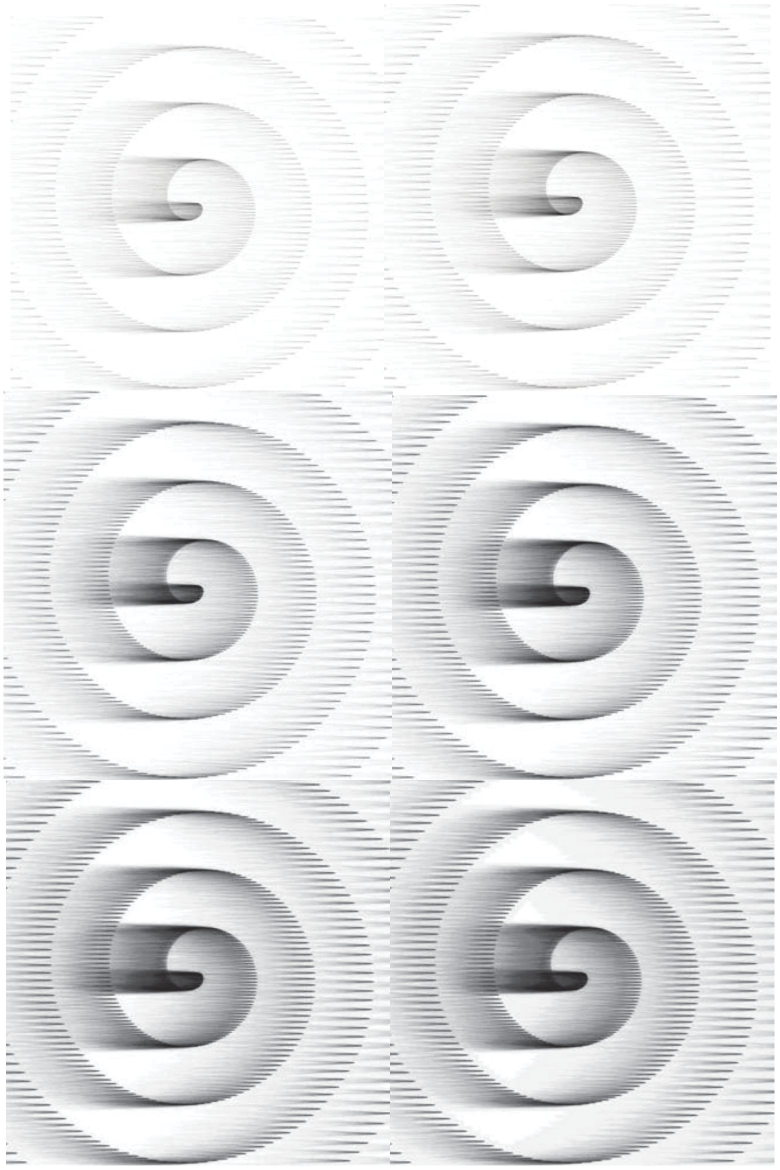

Figure 4. Parametric manipulation producing depth variation in the simple artificial ontogeny presented above. Captured intermediary states illustrating various phases of development.

5. A Generative Landscape – Work in Progress

In the previous examples, the texturing effect and the feeling of volume or depth is built from one cycle to another in a rather linear manner. We try to give a representational touch to the emerging visual composition by creating the backbone structure of a generative night landscape suggesting non-geometrical natural forms and movement. This night landscape is made of generative components, however, some relational elements like for example a sense of separation between the ground, atmosphere, and the sky are predesigned (see Figure 5).

We use, as we did in the previous examples, similar basic agents based on line and circle shape as well as the spiral principle to generate semi-random agent placements along a spiral path. We randomize and vary the randomization range for various parameters to obtain quite different generative forms with slight modifications applied to the same algorithm to convey living natural forms.

By distorting the spiral with Perlin Noise techniques [13], closing the spiral shape, and animating the centre from where the spiral emerges, we can obtain balls of grass-like texture spread over the entire visual field. In order to structure the randomized development of this grass-like texture, we restricted the movement of the distorted spiral centre to a line along the bottom side of the picture plane. This creates the appearance of a field of tall active grass regenerating itself from new positions to shine briefly in the night landscape.

We also convey a sky with shining and fading out moving stars using the same circle and radiating line agent clusters occurring all over the visual field at various distances from one small cluster to another. Also moving clusters of simple circle agents following a given semi-randomized path suggest tree crowns briefly shinning the moonlight. The moon itself is a generative element based on the same algorithm as the grass component, but the spiral remains close and the line agents have a larger variation range. The variation of the line agents' length is the element that makes this an active shining component in the night landscape.

6. Phylogenetic Evolution of Generative Artworks

The previous examples of artificial ontogeny model only to limited degree the kind of growth programs and interactions with environmental constraints that underlie the process by which natural organisms evolve from seed to complex organisms. The morphogenetic capabilities of a species are essential for the species' ability to evolve as a population.

In our model, the structured visual composition resulting from artificial ontogeny represents our artificial organism. This is seen as individual carrying morphogenetic capabilities characterizing a given population of designs or artworks.

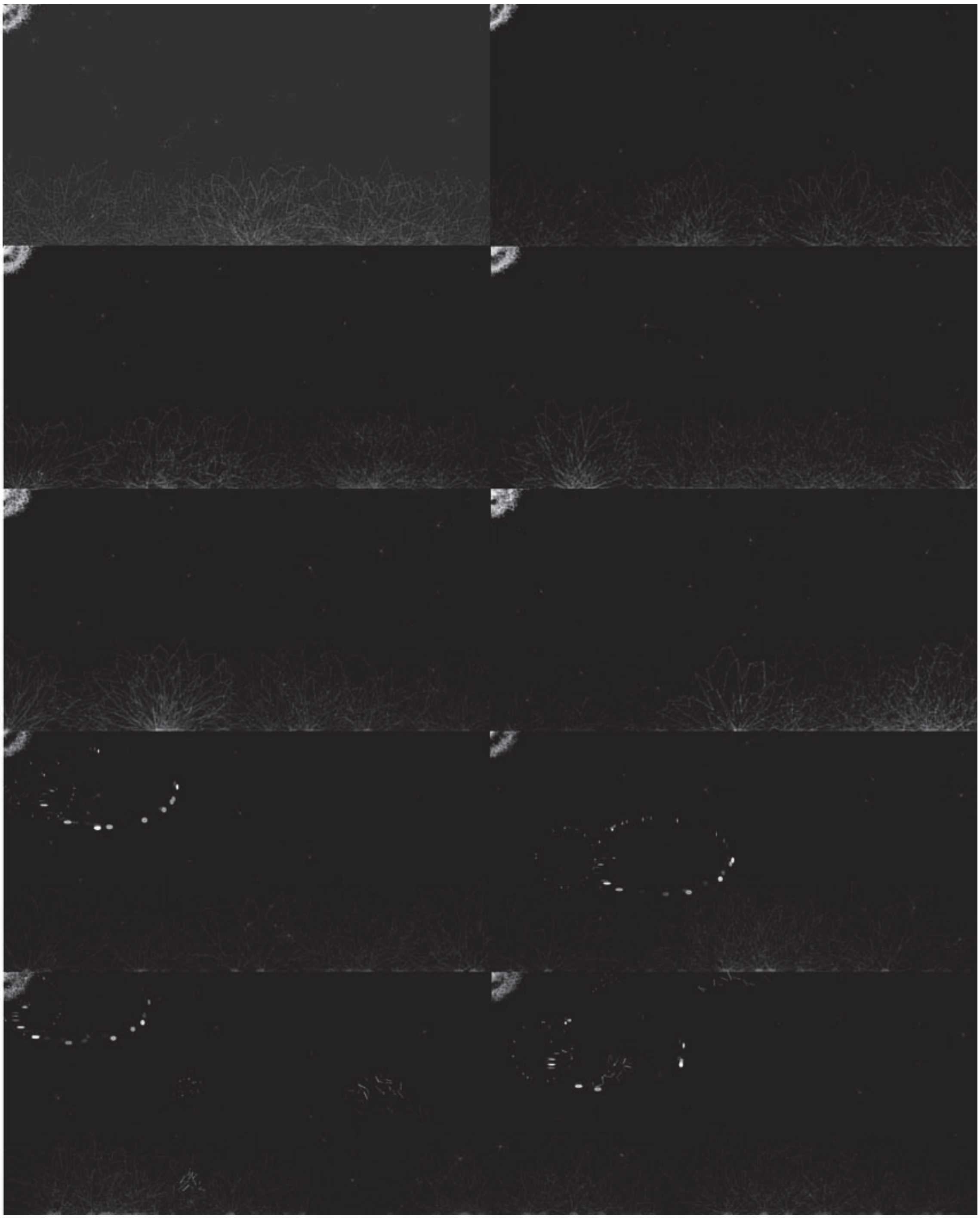

Figure 5. Generative night landscape. Captured intermediary states illustrating various phases of development.

So far, these visual compositions are based on generating a simple emerging form or if multiple generative components are used, like in the night landscape, these are linked through predefined relational components. Further developments of the model require achieving emerging rather than predefined relational elements. These could provide devices to link meaningfully generative components in the structure of the visual composition. It is an important goal to generate visual compositions based on a modular structure organized along directional forces and centres of attraction in the visual field as described by Rudolf Arnhem in his explanation of the structural skeleton of the square or of the spatial organization using such devices as isometric perspective [3]. Modular compositions may also provide a basis for exchanging components and thus create variation in future generations.

Structured modular compositions create a population of flexible adaptive systems capable to evolve in relation to environmental constrains. These constrains could be encoded as rules that express principles of two-dimensional design like repetition, similarity, gradation, radiation, anomaly, contrast and so on. An environmental niche is defined by a partial set of such rules. Visual compositions with modular structures allow reconfiguring the modules along the structural skeleton of the given format in response to changed environmental niches.

7. Artificial Creativity at the Intersection between Evolutionary Computation and Control Theory

Various authors agree [18] that intelligence and creativity overlap to a certain degree, but remain overall different processes. The principal aspect distinguishing creativity from intelligence is what Kris [8] and other authors [9] define as regression into a state of semi-consciousness in order to freely associate and combine ideas in the process of generating new ones. However, testing and validating new ideas, concepts and so on, require long periods of conscious thinking based on previously accumulated knowledge. Intelligence, on the other hand, is always intentional and characterized by conscious thought.

We know that evolutionary processes are blind and that complex organisms and behaviours emerge in a bottom top manner during very long periods of evolution. In order to develop a model of artificial creativity based even lightly on the human model of creativity, it is necessary to combine the two aspects of free association and combination of ideas during regression, which can be largely based on evolutionary computation, with conscious rational thinking during testing and validation stages of creativity.

We think that these two aspects can be linked based on the conceptual framework provided by such a model as the 4D/RCS (Real Time Control System) cognitive architecture for intelligent systems presented [1], [2]. This reference model architecture is based on a theoretical model of the cerebellum, meaning that it is an artificial model of a part of the brain that controls conscious motions and fine motor coordination. The 4D/RCS is a multi-agent system based on hierarchical organization on multiple layers of the computational agents. This system is based on sensory reactive components at the lower levels of the hierarchy while plans of action are generated in a top down manner. We think that such a system may combine generative approaches both at high level for plan generation and low level for emergent behaviour.

8. Conclusion

The present paper maps fundamental concepts in evolution theory, evolutionary computation, creativity, and visual arts and design with the purpose to advance towards a framework for artificial development of visual design and artwork. The next step is to formalize these mapping concepts as a step towards laying down the backbone for developing artificial adaptive systems capable to evolve artificial art and designs.

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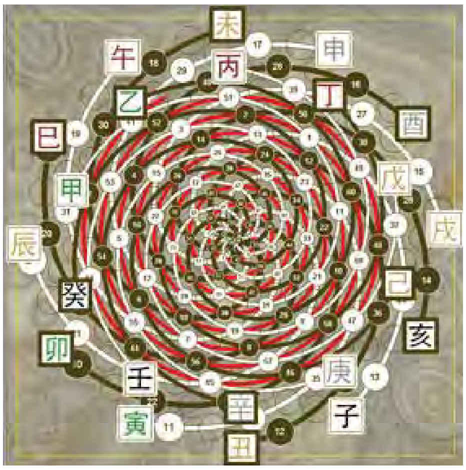
DmitryWeise

Paper: **PHYLLOTACTIC REPRESENTATION OF CALENDARS**

Abstract:
Everywhere we observe the periodic phenomena, for example, change of day to night, seasons of year, etc. Usually for the image of these time phenomena use rectangular or circular tables (calendars, dial of hours). In the general words, rectangular tables are habitual for perception, they transfer originality of varying years, but graphically cycle form, i.e. a circle symbolizing repetition, is lost.
Circular tables are closed, and all periods appear similar one on another.
The spiral form, in a sense, is intermediate. It unites advantages and levels lacks of both mentioned above forms. However, the spiral table is not habitual and is not so easy for perception.

Often used structure for the description of an arrangement of leaves on plants (phyllotaxis) is the integer lattice in polar or cylindrical system of coordinates. From arithmetic positions in these lattices obvious spiral rows of the points numbered by the age represent residue classes modulo m. As a rule, modules on plants are Fibonacci numbers. Modular arithmetic is the reliable tool for work with calendars. The generality of the methodical approach to periodicity in plants and in time phenomena has prompted new graphic images of the well known phenomena.
In the work some of possible constructions of periodic time processes in phyllotactic style are presented:

Chinese *calendar* 60-year cycle,
Maya calendar 260-year cycle,
Daaríisky Krugolét Chislobóga 144-year cycle,
Metonic 19-year lunar cycle,
Scandinavian lunar calendar,
Eternal calendar with possibility of definition of Easter day.



Chinese calendar *60-year cycle*

Maya calendar 260-year cycle

Topic: Design Approach

International Society for the Interdisciplinary Study of Symmetry (ISIS)
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References:

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Keywords:
Phyllotaxis, calendar, integer lattice, modular arithmetic, periodicity.

Phyllotactic representation of calendars

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Premise

In botany the arrangement of repeated units such as leaves around a plant stem does satisfy the prevailing mathematical regularity properties. The generality of the methodical approach to periodicity in plants and in calendars has prompted new graphic images of the well known time phenomena.

1. Phyllotaxis

Phyllotaxis or phyllotaxy (Gr. *Phyllo* - leaf + *Taxis* - arrangement) is the study of the arrangement of repeated units such as leaves around a stem, scales on a pine cone or on a pineapple, florets in the head of a daisy, and seeds in a sunflower.

Most arrangements of leaves fall into 3 or 4 main categories: spiral, distichous, whorled, and multijugate. Mathematically, all these patterns are types of lattices.

Spiral arrangements are most frequent and they are classified by the number of spirals (parastichies) they exhibit.

In a spiral lattice, the eye tends to connect nearest points into spirals. These spirals are called parastichies.

The number of parastichies in spiral arrangements are most often Fibonacci numbers (1, 1, 2, 3, 5, 8, 13, 21 ...) and the angle between successive leaves is close to the Golden Angle - about 137.5 degrees. This frequent type of pattern is called Fibonacci phyllotaxis. [1]

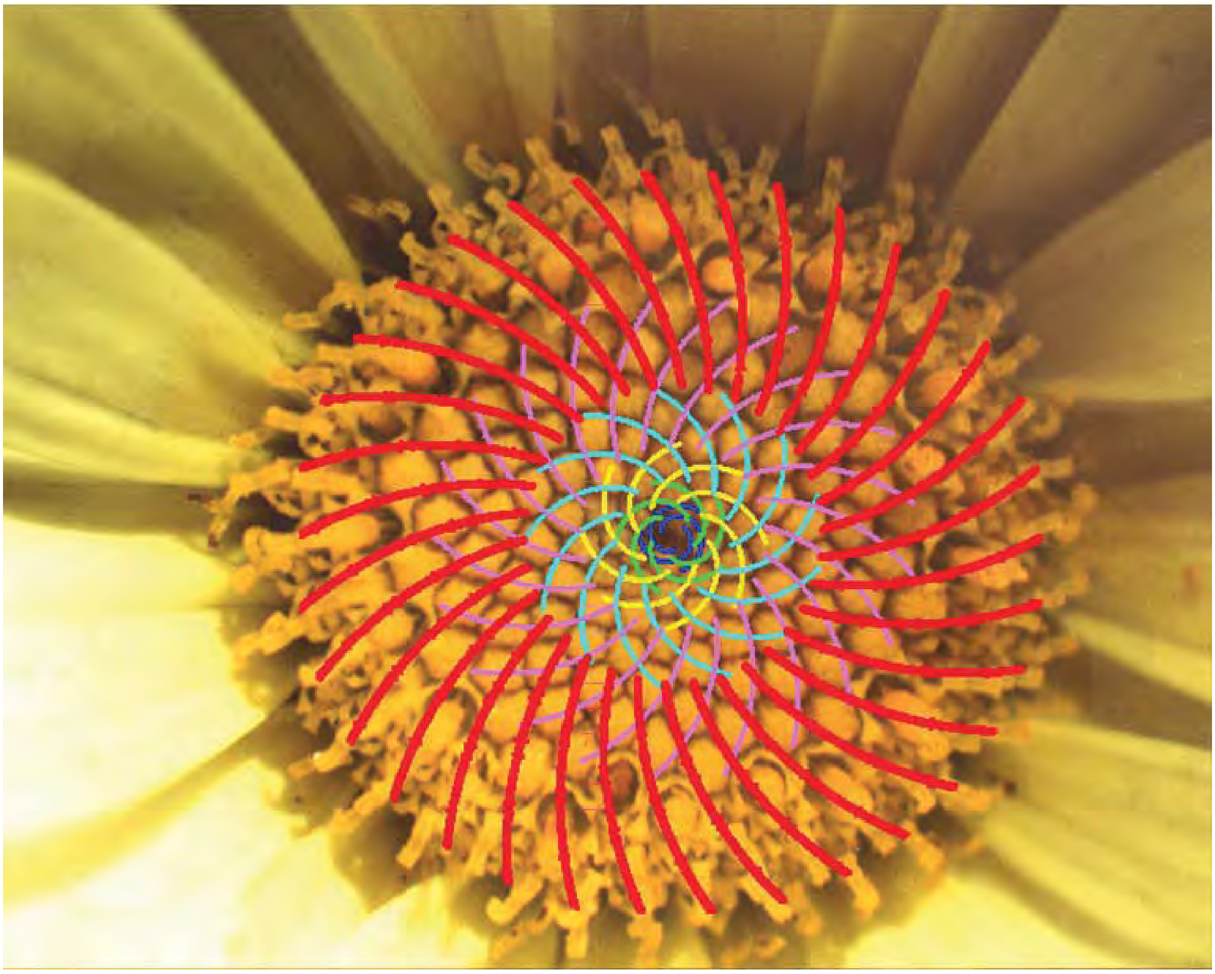

Fig. 1 Phyllotactic pattern on a Daisy

These spirals normally come in two *families*, yielding a pair of numbers, called parastichy numbers.

In 1837 brothers Bravais (Auguste and Louis) have opened, that numbers of the next leaves on a spiral correspond to quantity of spirals in family of spirals.

In terms of Modular Arithmetic the statement of brothers Bravais is equivalent to statement.

There are precisely m residue classes modulo m.

So numbers of leaves on a spiral represent *the residue class or the congruence class of a modulo*.

Each spiral is a residue class.

2. Calendars

Everywhere we observe the periodic phenomena, for example, change of day to night, seasons of year, etc. Usually for the image of these time phenomena we use rectangular or circular tables (calendars, dial of hours).

In the general words, rectangular tables are habitual for perception, they transfer originality of varying years, but graphically cycle form, i.e. a circle symbolizing repetition, is lost.

The circular tables are closed, and all periods appear similar to one another.

The spiral form, in a sense, is intermediate. It unites advantages and levels lacks of both forms mentioned above. However, the spiral table is not habitual and is not so easy for perception.

Modular arithmetic is the reliable tool for work with calendars.

2.1 Chinese calendar 60-year cycle

The system by which years are marked historically in China was by the stem-branch or sexagenary cycle. This system is based on two forms of counting: a cycle of 10 *Heavenly Stems* and a cycle of 12 *Earthly Branches*. Each year is named by a pair of one stem and one branch called a Stem-Branch (*gānzhī*). The Heavenly Stems are associated with *Yin Yang* and the *Five Elements*. Recent 10-year periods began in 1984, 1994, and 2004. The Earthly Branches are associated with the 12 signs of the zodiac. Each Earthly Branch is also associated with an animal, collectively known as the *Twelve Animals*. Recent 12-year periods began in 1984, 1996 and 2008.

Within the Heavenly Stems system the year is advanced up by one per year, cycling back to year one after the last (year ten). Similarly the Earthly Branches also advances by one per year, cyclically. Since the numbers 10 (Heavenly Stems) and 12 (Earthly Branches) have a common factor of 2, only 1/2 of the 120 possible stem-branch combinations actually occur. The resulting 60-year (or sexagesimal) cycle takes the name *jiǎzǐ* after the first year in the cycle, being the Heavenly Stem of *jiǎ* and Earthly Branch of *zǐ*. The term "jiǎzǐ" is used figuratively to mean "a full lifespan"—one who has lived more than a *jiǎzǐ* is obviously blessed. [2]

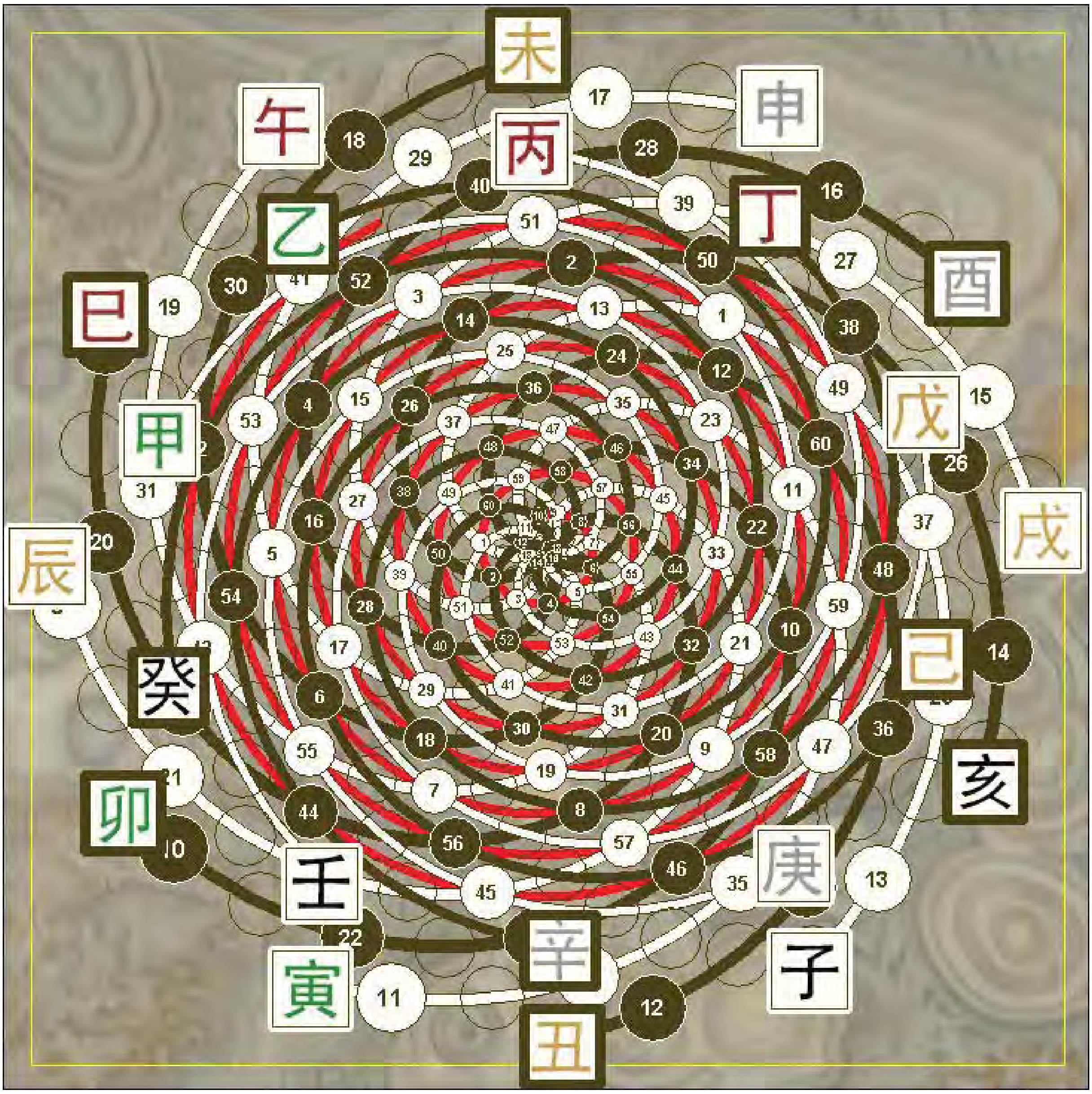

Fig. 2 Phyllotactic representation of Chinese **calendar** *60-year cycle*

2.2 Maya calendar 260-year cycle

Tzolkin is the name bestowed by Mayanist scholars upon the version of the 260-day Mesoamerican calendar which was used by the Maya civilization of pre-Columbian Mesoamerica.

The word, meaning "count of days", was coined based on Yukatek Maya.

The Maya used several cycles of days, of which the two most important were the Tzolkin, or Sacred Round of 260 days and the approximate solar year of 365 days or Haab.

In the 260-day cycle 20 day names pairs with 13 day numbers, totalling a cycle of 260 days. This cycle was used for divination purposes, it foretold lucky and unlucky days. The date of birth was also used to give names to both humans and gods in many Mesoamerican cultures, some cultures used only the calendar name whereas others combined it with a given name. Each day sign was presided over by a god and many had associations with specific natural phenomena. [3]

Fig. 3 The Aztec (also known as Mexica or Nahua) calendar is derived from the Maya

The cycle of twenty day names should really be thought of as an unending circle, or one eternal round. That is how it is depicted on the famous Aztec Calendar stone. The twenty glyphs are shown in the outer circle, beginning at the top and proceeding counterclockwise. One reason that the circular form is important is that it is often important which figures are opposite each other because the often form opposing pairs. For example, the serpent is opposite from the eagle.

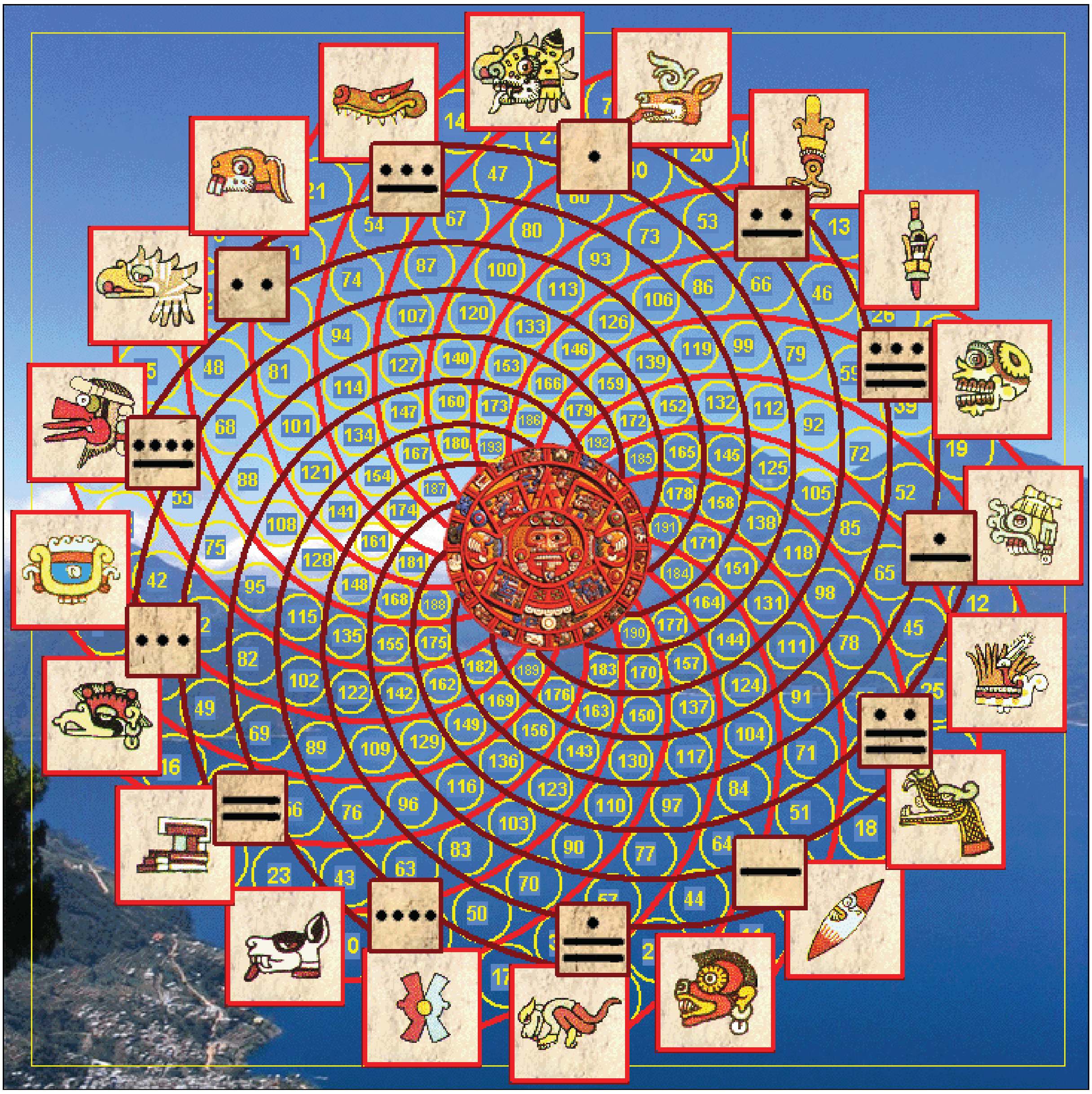

Fig. 4 Phyllotactic representation of Tzolkin. The relative positioning of gliphs in a circle of the new calendar dial is broken, but the opposition in pairs is kept.

2.3 Daaríisky Krugolét Chislobóga 144-year cycle

Krug = a circle; lét = years. Krug-o-lét = circle of years

Chislo = a number; Bog = God

An ancient Slavic calendar has been cancelled by tsar Peter the Great at 1700. Someone consider that there were the calendar "Daaríisky Krugolét Chislobóga" which was based on modules 9 and 16. So, the cycle of years consisted of 9x16=144 parts. [4]

Fig. 5 Phyllotactic representation of Daaríisky Krugolét Chislobóga. Phyllotactic pattern 9x16=144

2.4 Metonic 19-year lunar cycle

In astronomy and calendar studies, the *Metonic cycle* or *Enneadecaeteris* (from Greek words for nineteen years) is a period of very close to 19 years which is remarkable for being very nearly a common multiple of the solar year and the synodic (lunar) month. The Greek astronomer Meton of Athens observed that a period of 19 years is almost exactly equal to 235 synodic months, and rounded to full days counts 6940 days. The difference between the two periods (of 19 years and 235 synodic months) is only a few hours, depending on the definition of the year.

To keep a 12-month lunar year in pace with the solar year, an intercalary 13th month would have to be added on seven occasions during the nineteen-year period. Meton introduced the cycle in circa 432 BC but it was actually known earlier by Babylonian astronomers. [5]

2.5 Scandinavian lunar calendar

The *Runic calendar* is a perpetual calendar based on the 19 year long Metonic cycle of the Moon.
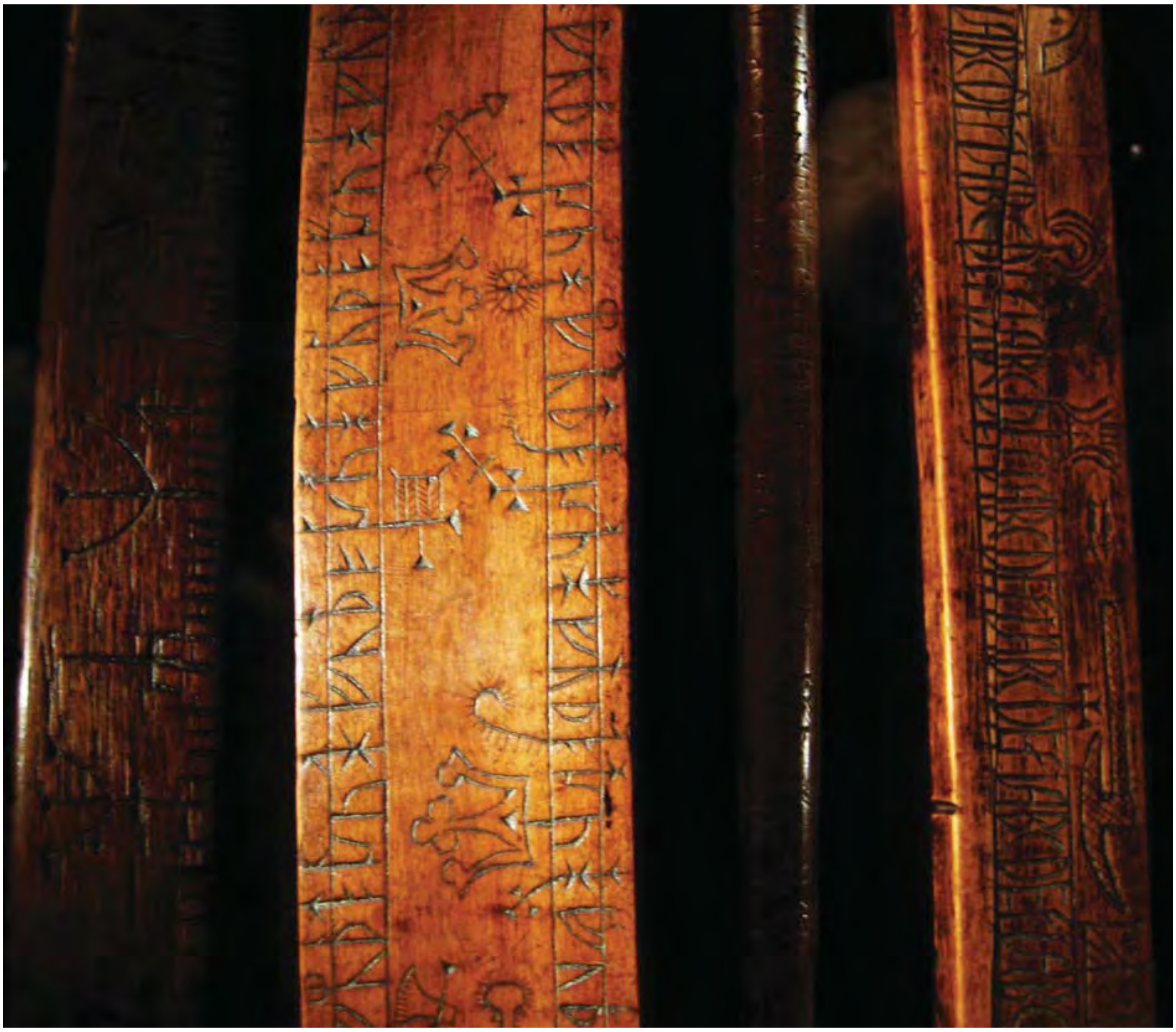
Fig. 6 Rune staffs at the Museum of History in Lund, Sweden.

Also known as a *Rune staff* or *Runic Almanac*, it appears to have been a medieval Swedish invention. Runic calendars were written on parchment or carved onto staves of wood, bone, or horn. The oldest one known, and the only one from the Middle Ages, is the Nyköping staff, believed to date from the 13th century. Most of the several thousand which survive are wooden calendars dating from the 16th and the 17th centuries. [6]

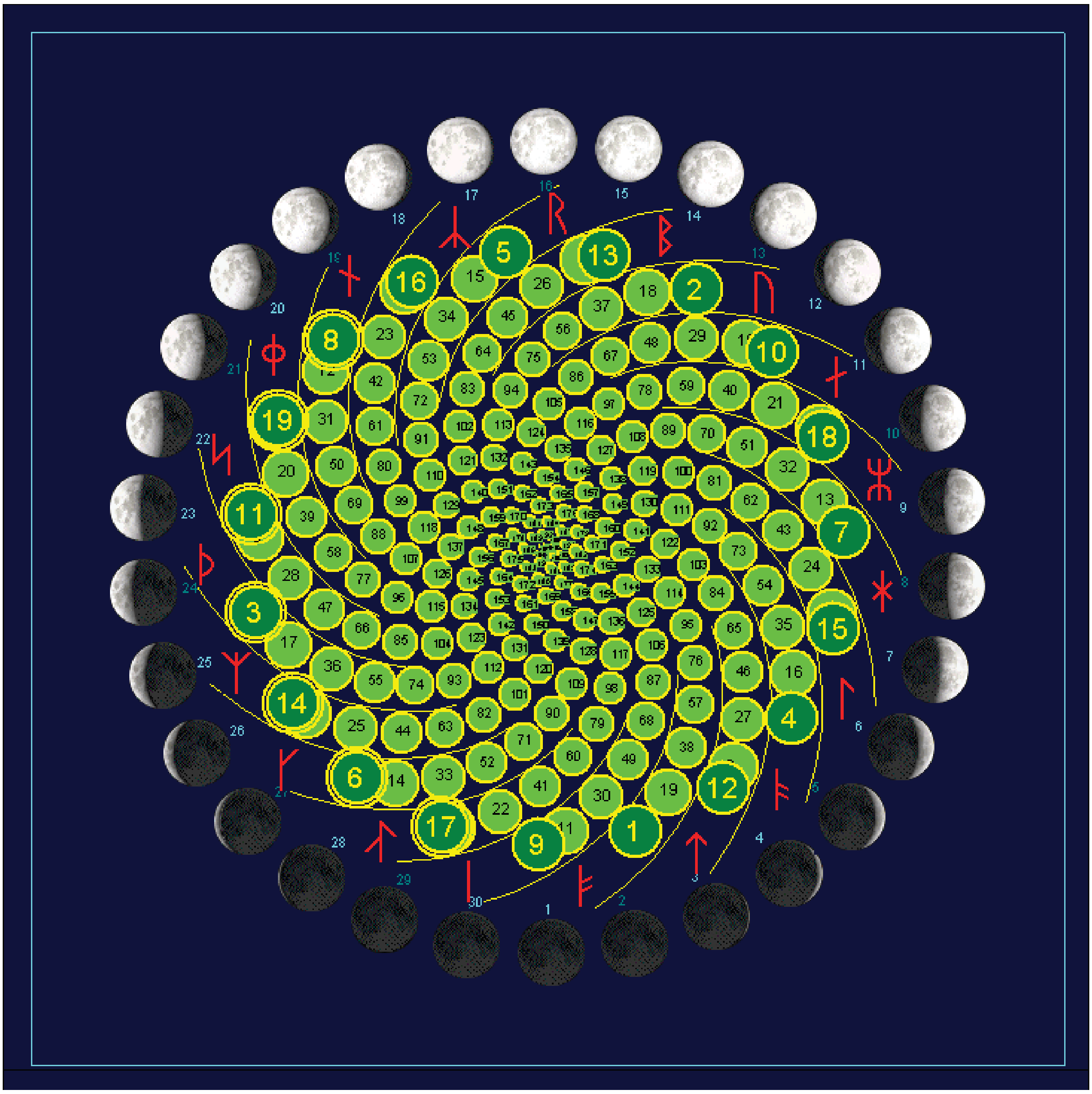

Fig. 7 Phyllotactic pattern of Metonic cycle and Scandinavian lunar calendar. The epacts are located under the order. The years with the embolismic or intercalary month are located in one sector (marked by the numbers 8, 19, 11, 3, 14, 6, 17 in dark-green circles on the periphery). Runes of Scandinavian lunar calendar are designated by red.

2.6 Perpetual calendar with possibility of definition of Easter day

Easter is a moveable feast, meaning it is not fixed in relation to the civil calendar. Eastern Christianity bases its calculations on the Julian Calendar whose March 21 corresponds, during the 21st century, to the 3rd of April in the Gregorian Calendar, in which calendar their celebration of Easter therefore varies between April 4 and May 8.

The date for Easter is determined on a lunisolar calendar. The First Council of Nicaea (325) established the date of Easter as the first Sunday after the full moon (the Paschal Full Moon) following the northern hemisphere's vernal equinox. [7]

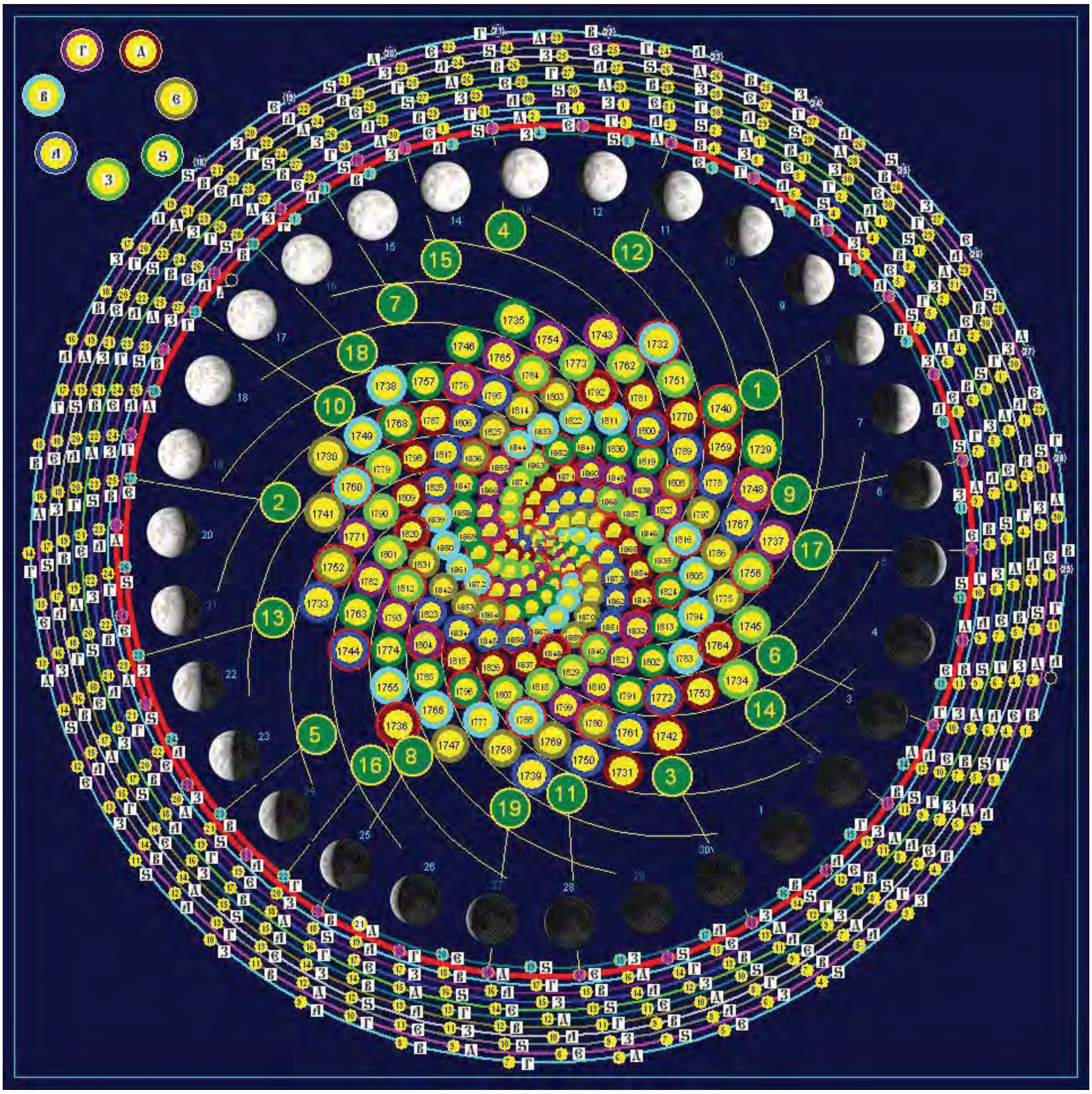

Fig. 8 Phyllotactic pattern of Perpetual calendar with possibility of definition of Easter day.

The calendar makes it possible to identify the day of the week and an Easter day of any year. Accounts and designations are made according to the Julian calendar.

The years are placed in the centre of the picture according to Metonic Cycle. The days of one year are located on the external spiral. The months of the year are noted by different colours of this external spiral.

The period when Easter is possible (March 22 – April 25) is marked by a red thick line.

We should know the *vrutseleto letter* to identify the day of the week. The correspondence of a year to a vrutseleto letter is marked by some colour in the upper left corner of the picture. The vrutseleto letters are depicted on the white background.

In order to determine the Easter day celebration we should move from the centre to periphery on the following rout: a chosen year (we find out and remember the vrutseleto letter) – the spiral of inner inflorescence – Golden number (1-19) in the green circle – a line space in radial direction to a date situated on the external spiral – along this external spiral clockwise to the nearest vrutseleto letter, which we remembered. A number near letter will show the date of Easter celebration according to Julian calendar.

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Paper: **Generative Art Philosophy – Ars Artium**

Topic: Art Philosophy-Meta-poetry

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www.generativeart.com

Abstract: *Sometimes on the mountains in a fragment of a peak appears*
An imaginary city, similar to Celestial Jerusalem….

Ars Artium, the Art of Arts, is Logic, the science of sciences. One of the most expressive logic science is Music, connected on similar structures to Eloquence. Gregorio Magno defined Eloquence the art of talking with heart. The GA philosophy walks on Logic, performed on the ability of transforming the reality into its possible *recognizable creative* evolution. It is a Subjective Logic, that refers to attributes, algorithms and operational sequences. This process organizes reasonable sequences able to structure a *poetic order*. This order, following the ***"Lucidus ordo and callida iunctura"*** **by Orazio in *"Ars Poetica",*** is *similar* to the natural configuration of a genetic code, *varium et idem.* There are a double process of *argomentativo* (thematic nucleuses):

1 - ***resolutio***: analysis. decomposition, *quantity*.
2 - ***compositio***: synthesis, *quality*.

The first is able to discover *substance*; the second discovers *form*. GA methodology (performed with C. Soddu also for teaching at Politecnico di Milano from 1988) is defined by a *poetic generative* language for designing *visionary* scenarios:

Aims: Truth and verisimilitude: ***Mirabilia***.
Ordo as a genetic code able to generate endless variations.

Tools: * 3 attributes, also in opposite significance, for defining the non linear character to reach
* *Impetus* as catalyze for *morphogenesis*. Fragment: ***Petrarca, "La lettera del Ventoso"***
* *The structural point of view – Anamorphosis*
* *Abduction* - "*The living metaphor*" by using words and algorithms in a creative time as a musical time.
* *Paradigm of organization: The time of change in the mirroring space of Art* .

Fragments: ***Ovidio, "Le Metamorfosi "***
"ADAGIA", Erasmo da Rotterdam, 11 adagia from Ars
* *Scenarios as results in variations . An actual question d'aprè Hugo*

Exempla: 1 – Anamorphosis, micro/ macroscale *ad unicum* :
S. Francesco di Paola fresco 2 - *Splendor*: ***S. Ivo alla Sapienza***
Chorus without words: the eternal sound of wisdom

Keywords:
Logic, Abduction, the living metaphor, creative evolution, ordo, impetus

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Generative Art Philosophy – Ars Artium

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Sometimes on the mountains in a fragment of a peak appears
An imaginary city, similar to Celestial Jerusalem.
You can discover it at sunrise, suddenly after the last darkness of the night.
A wonderful splendor resounds in the harmony of the details.
It is just for a moment. If you try to remind to the image in your mind,
You discover that the details are changed following the different time.
Only the vision of the beauty echoes the same character.
The remembering evokes a performing sound:
A natural harmonic order that sings in your heart.

1 .0.1 Ars Artium

The Art of Arts, is Logic, the science of sciences.
One of the most expressive logic science is Music. A music symbol is Saint Cecilia. She is European patron of music and she was a musician. She has inspired many artists; Raffaello, Rubens, Domenichino, Artemisia Gentileschi. The statue of Saint Cecilia made by Stefano Maderno was graven in 1599, when it was made the recognition of her corpse. She xgdfwas found in the position reproduced by the sculptor. Maderno has also wanted to put in prominence the cut of the sword on her neck and the position of their fingers: three open in the right hand and one open finger in the left. According to the tradition, the Saint wanted to point out her faith in the Unity and in the Trinitas of God. In this generative process of discovery, another element important is the left ear, *unveiled* for the listening.

Saint Cecilia statue by Maderno, Chiesa di S.Cecilia in Trastevere, Rome

A piece of music resembles in mind a piece of eloquence. Eloquence was defined by S. Gregorio Magno as the art of talking with heart: *“'The orator has to dip his pen* *in the blood of his heart; in this way he could also reach the ear of the people"*t *Musical expression may be compared with the delivery of an orator. The orator and the musician have, at bottom the same aim in regard to both the preparation and the final execution of their productions, namely to make themselves masters of the hearts of their listeners, to arouse or still their passions, and to transport them now to this sentiment, now to that. Thus it is advantageous to both, if each has some knowledge of the duties of the other.'* [1]

S. Gregorio Magno by Antonello da Messina, Palazzo Abatellis, Palermo

1 .0. 2 Generative Art Philosophy - *Logic and ordo*

The GA philosophy walks on Logic, performed on the ability of transforming the reality into its possible *recognizable creative* evolution.[2] It is a *Subjective* Logic, that refers to attributes, algorithms and operational sequences. This process organizes reasonable sequences able to structure a *poetic order*. This order, following the *"**Lucidus ordo and callida iunctura" by*** **Orazio in *"Ars Poetica"*** [3] is *similar* to the natural configuration of a genetic code.

1 .0. 2a *Paper interpretative key*: *MIRABILIA*

This process follows the interpretative tradition applied by the Middle Ages to the Metamorphoses that is that naturalistic scientific consequential from *Seneca* [4] and *Plinio* [5]and wide to the Mirabilia, that it makes to pass for ***natural*** the metamorphic legends.

1 .0. 3 Logic Process

There are a double process of *argomentativo* (thematic nucleuses):
1 - ***resolutio***: analysis. decomposition, *quantity*.
2 - ***compositio***: synthesis, *quality*.
The first is able to discover *substance*; the second discovers *form*. [6]
GA philosophy rediscover in a very clear way the big different between these 2 ways of reasoning. The ***resolution*** approach is used, still now from more than one century, for teaching creative design for architectural students. The quantity

approach is able to decompose the singular elements and after to add them, destroying the secular organic ability in building abstract proportions. The ***compositio*** approach is able to work for creativity by performing abstract logics in similitude with organic process. These logics can be connected by transforming rules as algorithms, more they can follows also not only numbers, but words too.

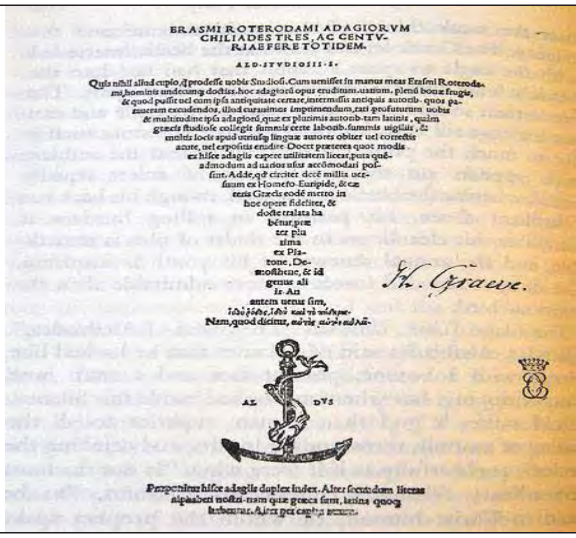
1 .0. 3a Exemplum of *resolutio:*

***Jacobson* [7], *from combinatorics to significans.* Linear logic**

*In the 1958 spring, in an interdisciplinary conference on "Style in Language" near the university of Indiana, the linguist Roman Jakobson introduced an intervention on the relationship among poetic and linguistic. In every linguistic process we can point out, according to Jakobson, the following constitutive factors: **the sender** that sends **a message** to **the receiver** inside **a context** (a referent that allows the receiver to understand the message), through **a code** (shared from sender and receiver) and through **a contact** (a channel physical able of to maintain the communication). Following to these six factors we can establish six functions linguistics different according to if one were privileged of the factors in matter. On the base of this reasoning, Jakobson concludes that, when in a linguistic process the message is privileged in itself, the poetic function of the language can be individualized. According to which linguistic criterion is it empirically recognized the poetic function and which is it the element whose presence is essential in every poetic work? Jakobson invokes to this point two trials that allow the formulation of a message: **the selection and the combination**. The two words that we associate are select and are combined in the spoken chain and the selection of the terms it happens in base to the similarity and the dissimilarity, to the synonymy and the antinomy; while the combination or rather the construction, of this sequence founds it on the contiguity. For Jakobson "the poetic function projects the principle of the equivalence from the axle of the selection to the axle of the combination" From this interpretation a formal reading of the poetic text careful to the autonomy of the significans was born, where for "significans" we intend the linguistic sign which connects him the "significance", or rather the sense, the content expressed by a word. We can affirm that in a reading of this type assumes greater importance the significans (or rather **the form**) in comparison to the significance (**the content** that the form evokes), really in virtue of that combination, that has said being purpose of the poetic language. Such principles explain how come the modern conception of the poetic language **denies the translation** possibility of the poetry: to translate, in fact, means to modify the object in its substance, since it comes to be suitable with a new oral weaving, also it rich of valid suggestions semantics, but surely different from the preceding one.*

1 .0. 3b Exemplum of *compositio:*

ADAGIA [8]*, Erasmo da Rotterdam, 11 adagia from *Ars Poetica
***Callida iunctura.* Translation as interpretative logical exercise. Not linear logic.**


ERASMI ROTERODAMI ADAGIORVM
CHILIADES TRES, AC CENTV-
RIAE FERE TOTIDEM.

ALD·STVDIOSIS·S·

Quis nihil aliud cupio, q̃ prodesse uobis Studiosi. Cum uenisset in manus meas Erasmi Roterodami, hominis undecunq; doctiss. hoc adagiorũ opus eruditum, uarium, plenũ bonæ frugis, & quod possit uel cum ipsa antiquitate certare, intermissis antiquis autorib. quos paraueram excudendos, illud curauimus imprimendum, rati profuturum uobis & multitudine ipsa adagiorũ, quæ ex plurimis autorib. tam latinis, quàm græcis studiose collegit summis certe laborib. summis uigiliis, & multis locis apud utriusq; linguæ autores obiter uel correctis acute, uel expositis erudite. Docet præterea quot modis ex hisce adagiis capere utilitatem liceat, puta quẽadmodum ad uarios usus accõmodari possint. Adde, qd' circiter decẽ millia uersuum ex Homero, Euripide, & cæteris Græcis eodẽ metro in hoc opere fideliter, & docte tralata habẽtur, præter plurima ex Platone, Demosthene, & id genus aliis. An antem uerus sim,
Nam, quod dicitur,

H. Graeve.

AL DVS

Propositus hisce adagiis duplex index. Alter secundum literas alphabeti nostri, eam quæ græca sunt, latina quoq; habentur. Alter per capita rerum.

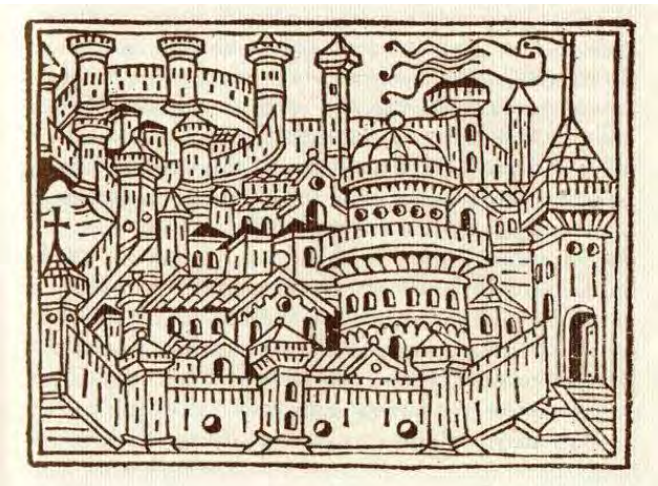
In 1500 the Parisian publisher Jean Philippe published Adagiorums collectanea by Erasmus, a harvest of 818 Latin proverbs and ways of say philologically commented. The collecttion will become larger with the following editions: that of 1505 contains 838 of them, the Venetian edition of Aldo Manuzio, of 1508 - beginning from which Erasmus starts to insert numerous Greek quotations - it contains 3.260 of them and hands the title Adagiorum chiliades that will be also that definitive in the 1536 last edition, published with the types of the publisher of Basilea Johan Froben and container 4.151 proverbs.
The proverbs don't concern, in fact, popular culture, they don't express the native its presumed wisdom: ***they are forms of the knowledge of the Ancient people***, assembled with high rhetorical competence. And in fact the figures typical of the proverb they are rhetorically all describable and in an index (metaphor, adunaton, necessarium, absurdum, contrarium,simile, poliptoto, enantiosi, ossimoro, enigma, comparatio, similitude, epithet).
The work of Erasmus is an extraordinary archaeology of the ancient time: every proverb is brought ***in the source language*** (Greek or Latin: and to the Greek follows the Latin translation), ***the various senses and interpretations*** are discussed of them, the authors are quoted that have used them. Some cards leaven in the various editions until to assume the aspect of real instructed short essays, that go over the simple illustration of the motto and they faces problems of actuality.
Adagia are a monumental work of erudition in which ancient wisdom and modern humanism are found places on a line of substantial continuity , at the light of a solid but clear and communicative philology and of ***a illuminated liberty of thought***, and in a spirit of mediation among the cultures, that curtains to exalt in general ***the similar and universal elements*** of the intellectual and human experience.
Erasmus for first indiscriminately matures the idea of a great popularization of the classical culture in practical and functional forms for the benefit of every lettered person, also extraneous to the cenacles of the erudite protagonists of its rebirth.
Erasmus holds the classical fundamental for the learning of the language, after that the rules of the grammar are assimilated (cf. the De ratione studii,in ASD I/2 114ss.) considering ***the Latin not a dead language but an effective communicative tool***. Under this aspect it is possible to understand the base on which the language and the style of Erasmus are formed. His lexicon, his syntax, his prosody postpone to this

appropriation of the language of the classic opera and of a reading of the ancient authors that it not only transmits his passive competence of the Latin, but also that active, in a continuous process of reusing of the stylemes.
Ordo secundus. *In the 11 Adagia from Oratio we can notice as, from a formal point of view, the Adagia for Erasmus is more often brief figurative expressions, to the infinite, that not periods of sense scita novitas finished as ethic character. Besides, Erasmus had to take on him the responsibility to affirm their proverbial value; i.e.for the motto* ***"In vino veritas"*** *by Oratio, Erasmus in Adagia, I, 7, 17, comments that «not always truth is contrasted to the lie, but it is sometimes contrasted to the simulation». This opens the significance to another reasonable vision of truth.*

2 .0. 1 GA methodology (performed with C. Soddu also for teaching at Politecnico di Milano from 1988) is defined by a *poetic generative* language for designing *visionary* scenarios.

2.0.3 Methodological structure: ***Agrapha dogmata***, not written doctrines.
In the Physics (expressly), in the Metaphysics and in the fragments of the lost *On the Human Good*, Aristotle refers to doctrines not written [agrapha dogmata] in which Plato would have sustained different things from those exposed in the dialogues. In practice he would have developed in the oral teaching a systematic theory of the principles of the reality that is absent or only mentioned in the published works. The existence of contents of technical teaching without direct comparison in the dialogues appears conforming to the indications on the relationship between **dialectical practice and writing** - also dialogue - emerged by the pages of the platonic texts. Written texts can never replace the educational activity, that, for Plato - we can think as Socrates's student - ***exclusive appanage of the orality*** remains substantially.

2.0.3 Aims:



Bonvesin da la Riva, *De magnalibus Mediolani*

a- ***Truth and verisimilitude***

b- ***Ordo*** as a genetic code able to generate endless variations.

a- Truth and verisimilitude

In **Timeo**, one of the last dialogues, to which are tied up some of the greatest platonic myths, Plato structurally connects the myth to the dimension of the *historian natural* becoming, on which more precise discourse of that only *verisimilar* would not be *proposable*.

The intention of Plato didn't probably stop it at the simple ***propedeutica*** to the thought logical-mathematical-philosophical, but, in sight of a cultural action and vast politics, he aimed to compose stories and legends that could be able, for generations, with an own autonomy (the following history has agreed with him), to circular and to mould the minds according to precise demands ***protretticheʼ*** (of starting to the philosophical life).

The myths, really because recalled-expressly or less-, also for their understanding, inside the horizon of the tradition, had the tendency to borrow its credibility of historical narrations: we would owe therefore to prefer at the end at the word truth the weakest verisimilitude , for marking the discard between the reality without time of the objects of the scientific knowledge, and the most indefinite contours of the subject of the myth.

b- Condition sine qua non of the order is the *verisimilarity*, as connection among different plurality but performed by a permanent logic, a meta-code, able of aggregation; in the equality the order dies or changes.

The poetic language is the main expression of a transparent and clear order.

The poet lists his talent among those essential to a writer, and he explains in what this order consists: to know what parts in the treatment go before, what later; what it is to omit and whether to treat for a longer time and the genuine use of the words.

Lucidus ORDO

Ars Poetica is a letter written by Oratio to a Roman family, that of Pisoni, belonging to the gens Cornelia, perhaps addressed to Lucio Calpurnio Pisone, (consul in 15 before Christ: and around this date it seems to go up again his composition) and to his 2 young children; a letter in hexameter verse.

Orazio condenses with great poetic effectiveness the lesson of Aristotle: without any possibility of comparison with other works. It is the text of literary theory, and together of aesthetical theory, firmly more present and rooted in the European culture, from the Middle Ages to the eight hundred.

In alone 476 verses Orazio exposes a finished and functional Poetic Ars. The strategy poetic *argomentativa* of the Ars is planned *asystematic*: it is not a philosophical essay, in fact, but a letter in verses directed to not experts (the Pisonis), and therefore it assumes the communicative functions proper of a text of *institutio* (the gradualness and the agreeability, through the images). But also always you a tripartite scheme easily recognizes in it.

The first part treats of the *poíesis*. "Poetry": but in Greek the verb poiéin properly means "to build", and therefore the poetry is a "construction", that is its subject, its *inventio* - in rhetorical sense - and its employment. It proposes two fundamental rules: the subject has to be simple and unitary (***simplex et unum***), and it has to be convenient with the resources and the abilities of whom writes. The application of this law of the *hendiadys* unum simplex is difficult, Orazio refers particularly to the rhetorical technique of the *variatio* ("variation"),

"..if a painter wanted to unite a neck of horse to a head of man, .., if he wanted to make to finish the body of a beautiful woman in a dirt fish... ". all would be painted to be laughed, because they would contradict the constitutive and primary categories of the beauty: the unity and 'proportion', the convenience and the harmony." These images put in scene the interchange between painting and poetry (the "arts sisters") that it is one of the main point of the whole Ars poetic, and it confirms the direct pertinence of it to a general aesthetical theory, at the same time of poetry and art.
About the ordo (order), Orazio is very concise and rapid: he remembers that the value (virtus) and the beauty (venus) of the poetry consist of immediately saying what it has immediately to be said (that is what is necessary). As it regards the choice of the single words, the poet has to proceed with caution *(cautus)* and delicacy *(tenuis),* working on the position of the words, so that with adroitness *("callida [...] iunctura":* "aware connection") can make to return new the extinguished words; if it is really necessary to do it, he can also use neologisms *("indiciis [...] recentibus"*: "with signs (words) recent":, but only if they pertain to unknown things: a license to be employed with great moderation, and trying to form these neologisms for the tread from the Greek language.

The connection of the words corresponds, in poetry, to the *metrics*. Metric competence is a prerequisite to the poet, but it is not enough alone: it has to accompany him to ***the use of the color*** and ***the style***. They are these the elements of an ars that it is able and must be learnt , always for reasons for convenience and decorum, that the fundamental categories that regulate the elocutio stay in how much "***verborum colores***" ("colors of the words").
The conclusive precept exhorts the poet to the patient reflection (mora), to a long job of cutting ("labor limae"), to numerous cancellations and corrections ("multa litura"), for removing from his verses all of this that is superfluous, up to submit it to the test of the fingernail (that of the sculptors to verify the smoothness of their own work). In short, the perfection of the poetry is the result of a long, patient, tenacious job: above all *to remove and to correct.*
Orazio still proposes a strong image and polemic as it regards the formation of the competence to the poetry: from the moment that Democrito has believed that the most important attribute of the poet is the *ingenium* and not the art (in how much mastery of a technique, laboriously acquired, et cetera), and therefore he excludes from ***the Elicona*** (the mythical place of the poets) all the health of mind (that is those people who are not possessed by *the poetic "furor".*

To designate the classical style of the odes by Orazio, La Penna [9] has told of " clear architectures", allowing to intend that the poetic construction of the Carminas makes to think to a construction on the Renaissance type, as ***the dome of S. Ivo***, that is contemporarily characterized by an extraordinary harmony connected to an exceptional dynamism. The miraculous equilibrium of such so well done and perfect constructions is really the result produced by the syntactic procedure of the lucidus ordo.

3 -0-1Tools:

Si les règles sont fondées sur la nature, elles doivent être souples comme la nature est complexe. Aussi les diversités qu'on remarque dans le style de Cicéron sont-elles infinies; pour s'y orienter, il faut quelques principes généraux; pour en saisir les nuances, il faut se souvenir que ces principes ne sont pas absolus. (Laurand, 331)[10]

a- 3 attributes, also in opposite significance, for defining the non linear character to reach, i. e. ***silent, thunder, shining,*** used by me for this paper.

b- *Impetus* as catalyze for *morphogenesis*.

3 -0-2 ***Fragment:*** **Petraca** ***" Ascesa al Monte ventoso"*** **[11]**

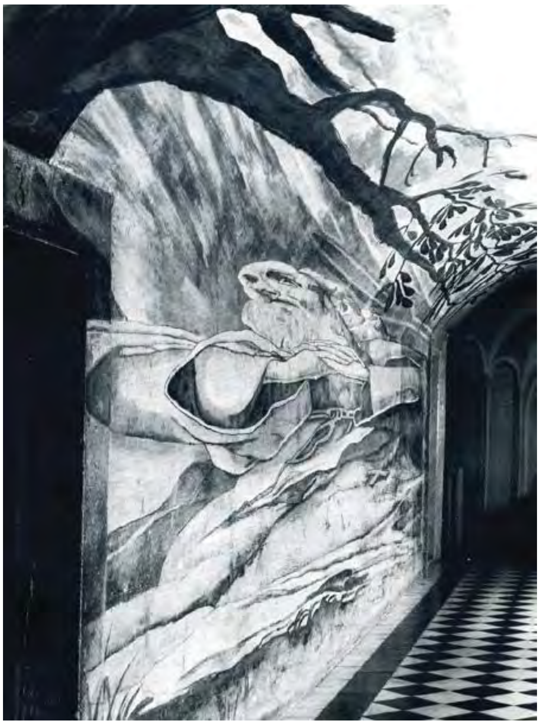
The history of the "forms" as "history of the word" doesn't exhaust, then also when the history of the poets was finished…The poet is a man that is joined to the other men in the field of the culture, and he mportant for his "content" (here is the serious word), over that for his voice, the lilt of voice..Poetry is the man…The researcher of a new language this time it coincides with the impetuous search of the man. in substance, the man's reconstruction deceived by the war."
S. Quasimodo in "*Discorso sulla poesia" [12]*

On *26 April of 1336 F. Petrarca, together with his brother and other two companions, climbed Monte Ventoso (mountain of Provence of 1.909 meters), he also has the unrestrained passion for the reading of the classical Greek and Latin, at search untiringly in ancient libraries and ancient middle ages convents. Joint on the top of the mountain, he opens at random the confessions of S.Agostino and he starts reading these words: "And the men go to contemplate the peaks of the mountains, the vast billows of the sea, the ample currents of the rivers, the immensity of the ocean, the course of the stars and they don't think about themselves." He felt a big emotion that later so he described in his Secretum: "Nothing is worthy of admiration except the soul. ".*
The ascent of the mountain as symbol of ascending (according to the truthful suggestion of the paronomasia) this is the key on which rotates the figurative pattern of the epistle. Petrarca expresses the relation with ***the scientific curiositas*** and strongly introduces **the dimension of time** into the grand general scheme.
"Cepit ***impetus*** *tandem aliquando facere quod quotidie faciebam…" " the desire took me to complete in a good time what every day I imagined to do.."*
"Labor omnia vicit improbus" "Obstinate work wins everything." This is the main significance of the epistle. The mountain Ventoso changes endless the street of lecture, in a continuous double meaning visible/invisible, arriving to rest only as earth's fragments in front of the highness of the human mind. The ***impetus*** is in rediscovering the power of the deep childhood feeling of knowledge.
**** c- The structural point of view – Anamorphosis***
The term *anamorphosis* is relatively recent. It was invented by the most inventive scholar of Baroque illusionism and imaginary worlds, Athanasius Kirchner, in his book **Ars magna lucis et umbrae** (1645), to describe the transformation of an image *(anamorphosis sive transformatio figurae).*

Exemplum: 1 – Anamorphosis, micro/ macroscale *ad unicum* :

S. Francesco di Paola fresco

The „S. Francis from Paola ' is a long fresco around six meters, painted at Trinità dei Monti in Rome by Emmanuel Maignan in 1642.
Frontally seen, the image is a whole of lines, with horizontal course, that doesn't apparently represent anything (fig.1; 2)…… if it were not for of the small details(fig3), boats ,little towns, etc., inserted really to force the reading and to induce who looks at to discover inside a landscape…
but the miracle happens if we move there along the corridor, estranging us from the fresco for about ten meters…more we get far more the lines, seen of foreshortening, are recomposed in an image, this time legible, of the knelt St. Francis from Paola (fig.4), and the small countries with their boats disappear to the sight, overpowered by the great figure.



" Like perspectives which, rightly gaz'd upon,
Show nothing but confusion, —ey'd awry,
Distinguish form!"
Shakespeare, Richard II

d-* *Abduction* - "*The living metaphor*" by using words and algorithms in a creative time as a musical time.

4 -0- 1 Abduction is the ability to discover connections

"Poetry
it is the world, the humanity,
the own life
bloomed by the word,
the clear wonder
of a delirious ferment,
when I find
in this silence of mine
a word
dug in my life / as an abyss."
G. Ungaretti "*Commiato*" (2 ottobre 1916)

4 -0- 2 **Metaphor**

"Noons of dryness see you fed
by the involuntary powers"
W. H. Auden, Another Time[13]

The metaphor is one of the fundamental devices through which a determined linguistic code it is able to generate itself again.
Goffredo of Vinosalvo (Poetria nova, Faral, v.1705) will say that
there are three ways of form himself, ***the art of which the rules are followed***,
the use to which it folds up and **the imitation of the models**.
Giovanni of Salisbury (Metalogicon I, 24) tells us as Bernard of Chartres
conducted his lessons: he pointed out what simple and conforming was
to the rule, he showed the grammatical figures and the rhetorical colors, the fineness of reasoning and, **to educate to the splendor orationis**, showed
the wonder of ***the translatio*** (or metaphor) ubi sermo ex causa probabili ad alienam traducitur significationem.

**** Paradigm of organization:*** *The time of change in the mirroring space of Art*

5 -0-1 De Benedetti, *the homo fictus*

Debenedetti has identified then in Joyce, Proust, Pirandello, Kafka the four riders of this subversion of state. Contemporarily the connections of works and theories of the existentialists are heightened with themes by Freud: themes that are still brought back loss to the " loss of father " equivalent of models ", since father is note the depositary of the models. But the abandoned child has drawn really from his viatico

of pain the last courage of the revenge, almost of a desperate retaliation: in geometric terms: ..it is that he, arrived on the edges from where it opens that other space, that space not more euclidean, has looked without accusing the vertigo, and he has not asked references anymore to the forms, figures and solids of the good useless geometry that measured the Earth.
The call to the double equation of Barthes, according to which:
If I call prose a discourse reduced to the minimum of the signs, the most economic vehicle of the thought, and if I indicate with a, b, c certain particular attributes of the language, useless but decorative, as the meter, the rhyme or the ritual (that however I would prefer to call the ceremonial) of the images, the whole surface of the words will establish itself under this double equation:
Poetry=Prose+a+b+c
Prose = Poetry - a - b – c
“I remember rather – said Giacomo Debenedetti - *that Gobetti (and later also Thovez) contested me the abstractness to want to reduce everything to schemes, operations of math order, to want to do of some criticism an algorithm, to resolve the discourses through a series of transformations, of formulas up to the quod erat demonstrandum ".[14]*

**** Scenarios as results in variations***

Fragments: *Ovidio, Metamorfosi [15]*

Here myths are histories of written bodies and subscribed in the text of the nature. Bodies, that appear on the surface, are looked for, they mix one in the others, and they finally transform themselves: who in flower, who in bird; who in mineral, who in a new divinity.

“I believe there is a singular narrator throughout, who is Ovidio himself”, Solodow 1988.
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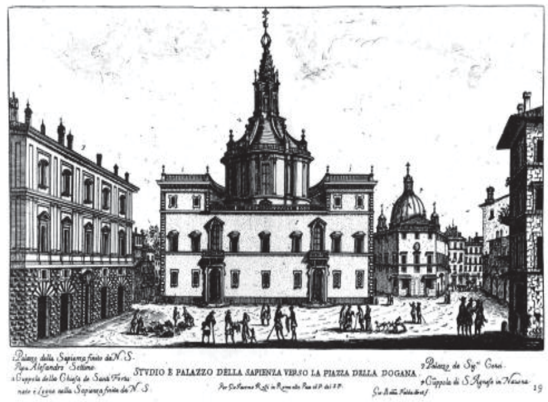
Exemplum 2*:Splendor:* **S. Ivo alla Sapienza***. Chorus without words: the eternal sound of wisdom*

"Do not forsake wisdom, and she will protect you; love her, and she will watch over you. Wisdom is supreme; therefore get wisdom. Though it cost all you have, get understanding."
Proverbs 4:6-7,

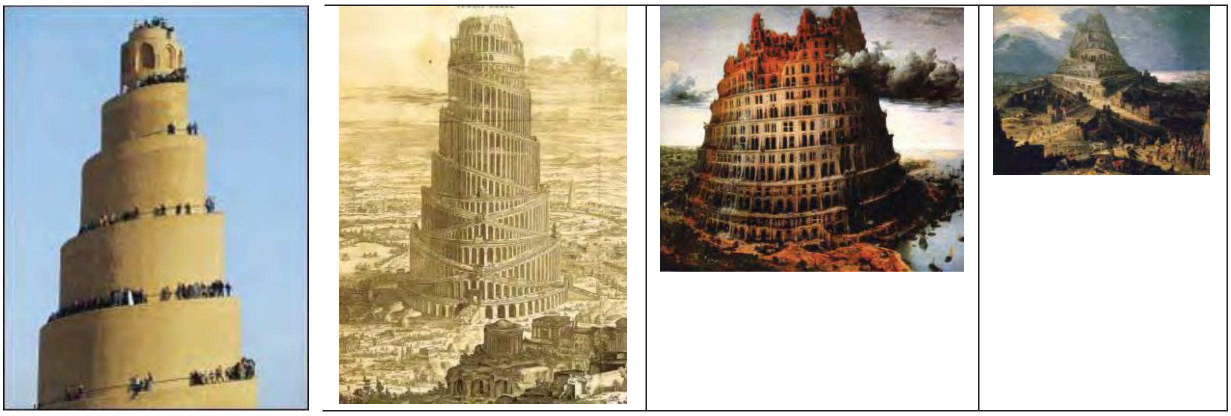
The impetus of Borromini for building S. Ivo was implemented by a strong competition with Bernini. To better understand that time we have to know that Bernini made a great restoring of Pantheon putting on the façade on the boards of dome 2 campaniles, that in very fast time people of Rome surname *Ears of donkey* (see 1). Pantheon is very closed to S. Ivo and in that time the square behind the church was open to the visual (see 2**)**



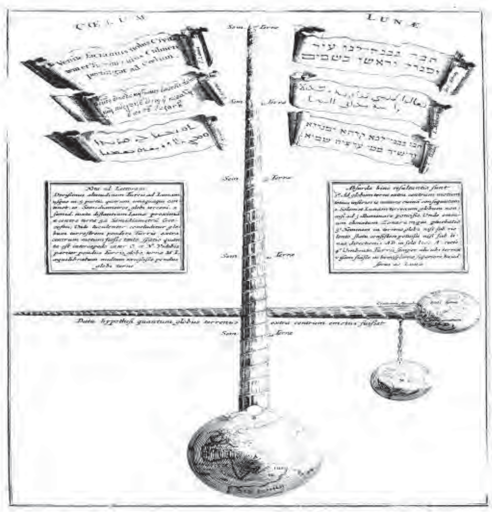
My interpretative key of the morphogenetic process for S Ivo is that Borromini had in his mind to perform the perfection by the geometrical forms, circle and triangle connecting them to a visionary scenario responding completely to *splendor*.
The sentence by Plinio the senior*:" Aliud est lumen, aliud est splendor"* is the clear representation of Pantheon for lumen, in fact the dome through its central hole represents inside on the interior dome with an elliptic form the changing of the sun light during the different hours of the day. For S. Ivo how to gain splendor?
The main question was for Borromini In his competition with Bernini: how to adorn for ***persuading*** in front of a wandering?
In the classical rhetoric the "adorned style" of discourse is defined in relationship to the principal purpose of the oratio that is that to persuade. Cicero in the De Oratore [16] speaking of the "way of adorning" the discourse, says that it has «how effect to make at the most pleasant the oratio at maximum degree, able to make breach in the feelings of the audience...» Constant are in the author the recall to an appropriate use of the ornamentation: «... because the oratio is disseminated of flowers of the words and of the thoughts, we don't have to scatter in way of it uniform in the whole discourse; we will have to distribute them as friezes and lights in a decoration instead.... it is necessary to choose a style that ***not only dear, but dear without satiating***» (op. cit. III, 96)

Few further in the De Oratore there is the call to ***the utility*** that accompanies the beauty making almost it necessary: «... the columns sustain temples and porticos but their majesty (**dignitas**) is equal to their utility... the same thing is **verified** in every part of the discourse: a certain grace and agreeability are consequence of the utility and almost of the necessity »(op. cit., III, 180-181)

So he defined the dome as a helical lantern at micro scale, as a fragment onside the dome. This for reverting the tradition of Babel tower as the site of the confused different fragments of language into the site of mirabilia, as a silent splendor of wisdom. Borromini had a very deep relationship with Kirchner. He knew very well his drawings and his scripts about helical forms and Babel tower. Following his introverted character Borromini spent many time alone in studying ancient books, more than one thousand that he left at his death. This was really a big number for that times.
So he knew in deep all precedents about Babel tower.



1Spiral Minaret in Samarra, Iraq - 2- A. Kirchner – 3 P. Bruegel senior1563 - 4Unknown Flemish artist 1587



Turris Babel: with typical eclecticism, Kircher illustrates the impossibility of the Tower of Babel having reached the moon, 1679.

There is a detail that from many years attracted my attention making a photo: the all equal sculptures of angels on the coronamento of the dome. Borromini started in working at Rome as scarpellino, a big tradition of his birth site Bissone. He worked with Maderno, connected to his mother for relationship. His ability was excellent since his first experience. So he sculptured these angels as equal as a representation of a very focused intent. A hypothesis could be that if we image the anamorphic ellipse generating from moving outside the church on the external square as a passage between a eternal moment able to repeat itself endless. The dimension of real space time is **translate in eternal** by the simple representation of **the same sculpture in elliptic sequence**. If you want numbering, you can start in a point and go to left or to right, coming back into the same point but in a different time, endless. But this remind to me the middle age of *rosone* in the façade of the church, evocative of moon lighting for the Chorus songs inside the church. So the hypothesis might be that he projected the rosone from the façade into the base of dome, seeing it as a section of sphere that moving from 3 dimension to 4 generates the helical lantern: This is the representation of the chorus that without words sing the eternal beauty of wisdom, as in the chorus of *Daphnis et Chloè by Ravel*.

S. Ivo, a fragment of Angels 

Wisdom brightens a man's face and changes its hard appearance
Ecclesiastes 8:1

6.0- 1 Into the fire

Before his attempt to kill being thrown himself on his sword, that gained after one day of atrocious sufferings, Borromini threw in the fire all of his notes and drawings. We have only his official drawings for the realized constructions, that he had delivered to the Congregations, that had commissioned his work.
This follows to the tradition of the Free masons, for preserving the single trial of discovery of each own ability in art.
This was as Goethe made however only for *Elected affinities*.
About Borromini we know only the results, incredible wonderful results. But as for every real work of art in the results is possible to discover infinite possible interpretations.

6 -0- 2 An actual question

Victor Hugo responded in a positive way with faith and optimism to the rhetorical question that he was inquired in Notre dames de Paris *if the book, after the revolution Gutemberg, would have killed the building,*
And now in the genetic revolution will the architecture survive?
To answer is not simple; but may be it will survive if we preserve our ability in *visionarity*, that rises also from our attention *to young people slang*.

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Florian J. Gruber

Paper: **CONCEPTUAL FRAMEWORK FOR GENERATIVE DESIGN**

Topic: Applied Art,

Design Theory

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Abstract:

Designing programmers or programming designers are a rarity. It is usually assumed that one thinks either rational or intuitive. A combination is the exception. The technological hurdle of 'programming for artists' is already overcome by a number of freely available, well documented development environments. Also a number of articles and books have been published, dealing with issues of craftsmanship and the technical aspects of generative design and processual computer art. What is missing, is a conceptual analysis of work practices and the development of specific design methodologies for artists and designers, who understand code as tool and material for their artistic creations.

This paper outlines a conceptual framework by identifying essential aspects of generative design processes, derived from literature and the author s practical experience as media artist. These aspects are presented as process models and a deck of method cards, which help you plan and assess complex projects, by quickly sketching out different scenarios and applications for generative works.

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Keywords:
generative design, conceptual framework, method cards

Introducing a Conceptual Framework for Generative Design Processes

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Abstract

Designing programmers or programming designers are a rarity. It is usually assumed that one thinks either rational or intuitive. A combination is the exception. The technological hurdle of 'programming for artists' is already overcome by a number of freely available, well documented development environments. Also a number of articles and books have been published, dealing with issues of craftsmanship and the technical aspects of generative design and processual computer art. What is missing, is a conceptual analysis of work practices and the development of specific design methodologies for artists and designers, who understand code as tool and material for their artistic creations.

This paper outlines a conceptual framework by identifying essential aspects of generative design processes, derived from literature and the author´s practical experience as media artist. These aspects are presented as process models and a deck of method cards, which help you plan and assess complex projects, by quickly sketching out different scenarios and applications for generative works.

1. Introduction

All computer-based generative design techniques can be simplified to a theoretically straightforward action – the selection and organization of elements from a chosen repertoire, according to a set of rules programmed by the author. The repertoire consists of digitally representable media objects, whose properties can be modulated, varied, automated and transcoded [1]. The generative software runs in real-time with a certain degree of autonomy and self-organization. Generative designers use the principles of circular systems to produce artworks by constantly repeating and modulating a set of computer operations. The designs are ‘classes of artworks’ [2], which are self-similar and vary like natural or organic systems within certain minima and maxima. There are uncertainties, but the sense of cause and effect remains [3]. Designing with algorithms is contiguous to the principle of an aesthetic theory [4], which inextricably link the formulation of procedures and the production of aesthetic objects.

2. Method

Based on several media art projects [5] created with the ambientartlab collective [6] and the author´s PhD thesis research, common aspects of generative design processes were identified. A synthesis of computer art history, design theory and personal experiences in collaborative, interdisciplinary teams led to the development of a Generative Design Model (GDM) and Generative Design Method cards (GDM cards).

The findings are based on an arts-based research method, in which artistic practices are reflected intersubjectively [7] and are transferred to a standardized system to investigate essential elements of the creation process [8]. The results are intended to advance the art discourse and help designers, artists and technicians to plan, discuss and evaluate generative procedures not only from a technical or aesthetic point of view, but aspect by aspect within a conceptual framework.

3. Aspects

3.1. Combinatorics (Repertoire, Selection, Organization)

Compared to traditional design projects in generative design we have to develop processes which continuously vary and transform along a time axis. Possible and particularly interesting makes this one ‘constant’: coincidence. Every person has an individual idea of coincidence and can term the probability or likeliness of certain events to come true. One important aspect of generative design is to articulate those individual perceptions of chance as mathematical probabilities and computable conditions. Pure chance does not exist. There has to be always a certain intention or necessity to make chance happen. Generative art refers to this ‘objective’ or ‘deterministic’ coincidence. While producing random and unpredictable events, the combinatorial process is always deliberately designed and executed with certain intent in mind.

Schulze [9] identified three basic elements of so called 'aleatoric games' in his analysis of nonintentional artforms of the 20th century, which can be easily transferred to generative design processes. The **repertoire** of an aleatoric game consists of single elements or groups (like words, sound samples, acoustic envelopes, geometric shapes, color palettes, photo or video material), which are selected or activated by a certain set of rules (**selection filters**). The selected elements are temporally and spatially distributed by organizational rules. The **organization** can occur serially or according to a prearranged pattern or again determined by chance.

3.2. Programmability (Function, System)

Programming in an artistic context means a very tight intertwining of form and function. In contrast to commercial software engineering, artistic software is not developed in large teams and to serve a mass of users. Sometimes there is only one user – the author him/herself. Programming as an art form is not about solving a defined problem, but to approach problems and to continuously line up questions [10]. A generative designer has a dual role as a programmer and as an aesthete. Aesthetically we formulate the artistic criteria and in practice we develop algorithms that transmit the aesthetic qualities from the creative into the binary language [11]. This transfer is not a single task, but a continuous approximation and revision of the original ideas.

Generative designers often develop self-referential, cybernetic systems or so called nontrivial machines [12]. By changing its internal rule set a nontrivial machine continuously produces a different output when the same input is applied. These machines are analytically undeterminable and unpredictable. They are synthetically determined but in a functional analysis trans-computational. One challenging aspect of generative designers is to describe non static, dynamic forms with computational code and defining the **function** and the aesthetic **system** of the machine.

3.3. Processuality (Openness, Intention)

Generative artists develop systems. Systems are nested processes between the two poles of order and randomness. The most inspiring and complex results are obtained by systems that implement a mix of surprise and redundancy. In our human perception something completely arbitrary and something highly organized holds very few meaningful content. Both poles have a very low effective complexity level, as Galanter [13] showed.

The situation is similar with the artistic concepts of work and process. A work of art in the emphatic sense is untouchable, though open for different interpretations, it will never be altered or questioned [14]. On the opposite side, a process is vague, its form is loose and **open**. A process cannot be objectified, it seems every time different, every time new. Both poles – the pure work and the pure process – are idealized and do not exist as such. More likely in daily practice is a convergence, a hybrid of processual and structural elements to achieve a compelling work of art.

There are two ways of designing with **intent**. In classic form a certain idea is fixed to a semantic relation (coherence) and the subsequent process of enriching, detailing and puzzling is always related to the initial idea [15]. With the technique of ‘heuristic fiction’ [16] an intention, a meaning or an interpretation evolve retrospectively while developing and working with the generative program.

3.4. Interactivity (Communication, Interaction, Dramaturgy)

Delinear processes, self-referentiality, bidirectional communication and networked systems have become paradigms of our time. Instead of objects with static properties, we research, study and analyze dynamic relations in sciences and arts.

Today it is less about the exploration of the essence of things, to question is how the processes evolve, how they connect and how they interact. Generative designers not only rely on these paradigms, they work with it.

Interactivity and participation are not a must-have of a generative design piece, but especially with computer-based art the ability to participate and interact with an ongoing process, is an important aspect. Compared to the batch programs of the early computer artists nowadays playing and improvising with a generative program in real-time is possible in many different ways. Through interaction computer art becomes more tangible and loses part of its per se inherent virtuality and detachment. By creating experimental interfaces or control units a generative program becomes a creative tool.

Developing a **communication model** and anticipating possible or desirable **user interactions** connects a generative artifact to its environment. By creating an interactive **dramaturgy** a generative piece of work can be set up as an instrument or installation.

4. Generative Design Model (GDM)

Generative design is procedural. Not the development of a completed and closed work of art is the focus of the design process, but the creation and formalization of an aesthetic system. Combinatorics and improvisation are two possible approaches to create an aleatoric game. In computer-based arts, both ways are possible through real-time interaction during the combinatorial calculation process. A generative design process can be either combinatorial or interactive or can combine both techniques.

The GD model introduced in the following, shows 1) the procedural scheme of generative design processes, (2) the structural composition and (3) the progression over time. At the intersection of the combinatorial and improvisational part is at any time the current state of the generative system (state S).

The GD model is divided into two halves – combinatorial processes and interaction processes. Analogous to Laurels 'flying wedge model' of interactive narratives [17] at the beginning of a generative sequence the potential of its development is completely open (**Possible**), but with the programs progressive course a specific state becomes more likely (**Probable**) and is ultimately required by the previously made decisions (**Necessary**).

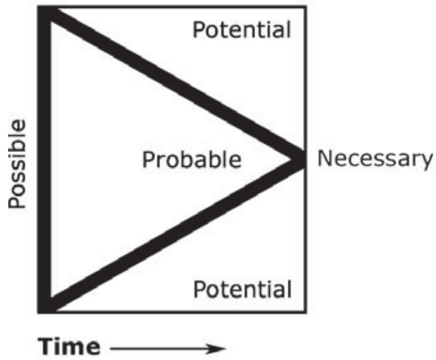

Fig.1 - Laurel´s Flying Wedge Model (sketch by the author)

4.1. GDM Infinity

The development potential at the beginning of an iterative sequence can be compared to the sample space or universe Ω of an experiment in probability theory and is the set of all possible outcomes. The universe of a generative project is the formal and aesthetic framework created by the designer. Every outcome within the scope of the generative program is possible.

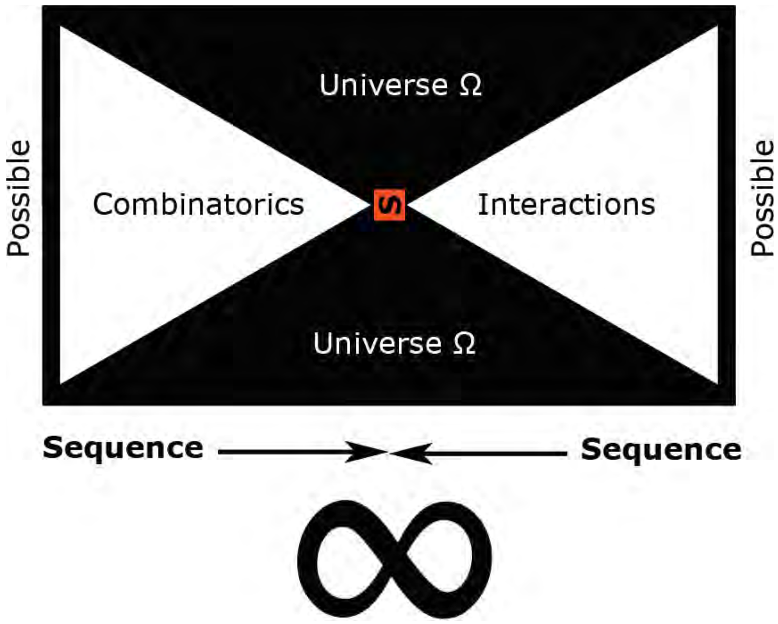

Fig.2 - GDM Infinity

With each loop, if-construct and case differentiation a certain state (**S**) becomes more likely through the interplay of combinatorics and interactions. At the end of a sequence the process restarts. Theoretically for infinity, in practice until a certain termination criteria is met (GDM Hourglass).

4.2. GDM Hourglass

The task of the generative designer is to unify technical issues and aesthetic ideas. Both as generative sequence of combinatorics and interactions frame by frame, as well as a procedural genesis and narrative structure over time until the program finally terminates.

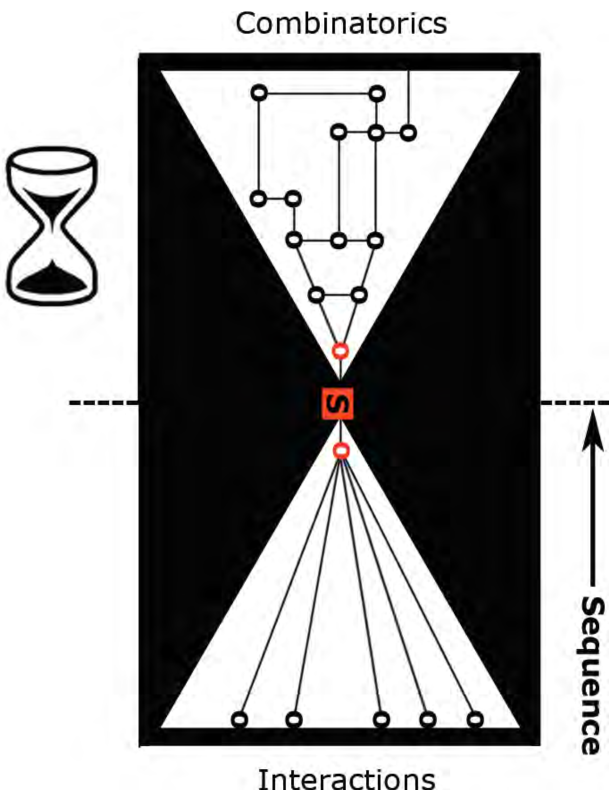

Fig. 3 - GDM Hourglass

The GDM Hourglass reads as a structural model of generative programs. Each node at the combinatorial part represents a different internal state of the machine that modifies the interaction sequence. In return the interactions influences the current internal state (node) of the combinatorics.

Placed on a time axis the GDM Hourglass depicts the principle of a nontrivial machine. It will continuously change its state, respond differently to the same inputs and become analytically unpredictable.

4.3. GDM Time-based

A continuous change over time is a characteristic feature of generative design processes. Depending on the work concept, these changes can be past-dependent or past-independent. Past-dependent processes take into account the current state of the system (**S**) for the next transformation sequence, past-independent processes do not include the current state and restart anew with each iteration. Both concepts can be visualized with the GD Time-based model.

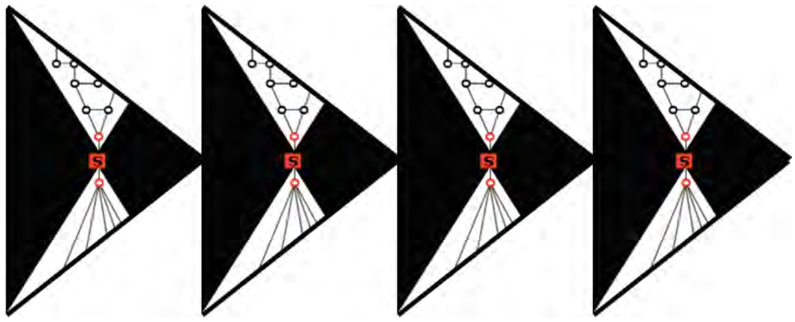

Fig.4 - GDM Time-based (past-independent)

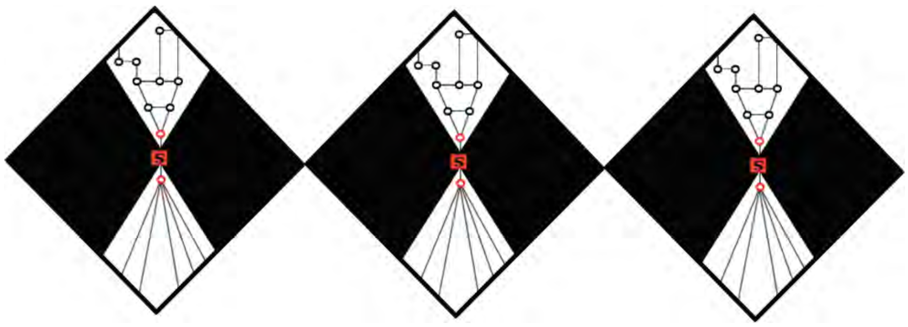

Fig.5 - GDM Time-based (past-dependent)

5. Generative Design Method Cards (GDM cards)

Working with tangible objects in the conception and planning phase of a project can have advantages over purely digital documents. With physical artifacts different scenarios can be sketched out and discussed on the fly by connecting, arranging and combining artifacts on a table or wall. Photographs, post-its and stickers can be used in design and project management teams to collaboratively comprehend complex issues and develop a common understanding [18]. In software engineering, agile development methods with ‘story cards’ and ‘estimation cards’ [19] representing use-cases and complex functions, have become more popular in recent years with developers and clients alike. Using metaphors and defining user stories help to establish a basis of discussion and evaluation, and promote object oriented and module based software design and development.

Programming as an art practice is inherently agile. There is rarely an exact specification or completely worked out plan. Generative designers are continuously refining, testing and exploring their algorithms. ‘Working software’ as it states in the agile software development manifesto [20], is a prerequisite. Generative design is ‘responding to change’ per se, as is the development process by constantly validating, retaining or discarding different options to achieve specific aesthetic goals. The project itself is often in constant transformation and never completely finished. It remains open and contains an invitation for further development and change.

The GDM cards are a set of cards to foster and encourage conceptual thinking in generative design projects and to establish a discursive basis in collaborative environments. Any number of cards from the deck can be used in a project. The point is, to single out specific aspects and elements of the overall process and give an impetus for discussion and reflection. The more cards are used, the better a possible scenario can be analyzed. The GDM cards can be used in any stage of the work. For example at kick-off meetings to work out and evaluate ideas, in the middle of a development process to help designers make decisions, and at the end for reflection and analysis.

The structure of the cards is similar to the IDEO method cards [21], which report a very positive feedback from different areas of applications and from groups that are not necessarily engaged in design initiatives. Each of the ten GDM cards contains a brief description and theory reference of the identified aspect (**know**), a set of questions to **ask** and instructions **how** to continue and what to do.

Fig. 6 - Sample GDM card

The GDM cards are basically designed to be used en suite from 1 to 10 and thereby specifying the generative process from its basic repertoire elements to its dramaturgical concept.

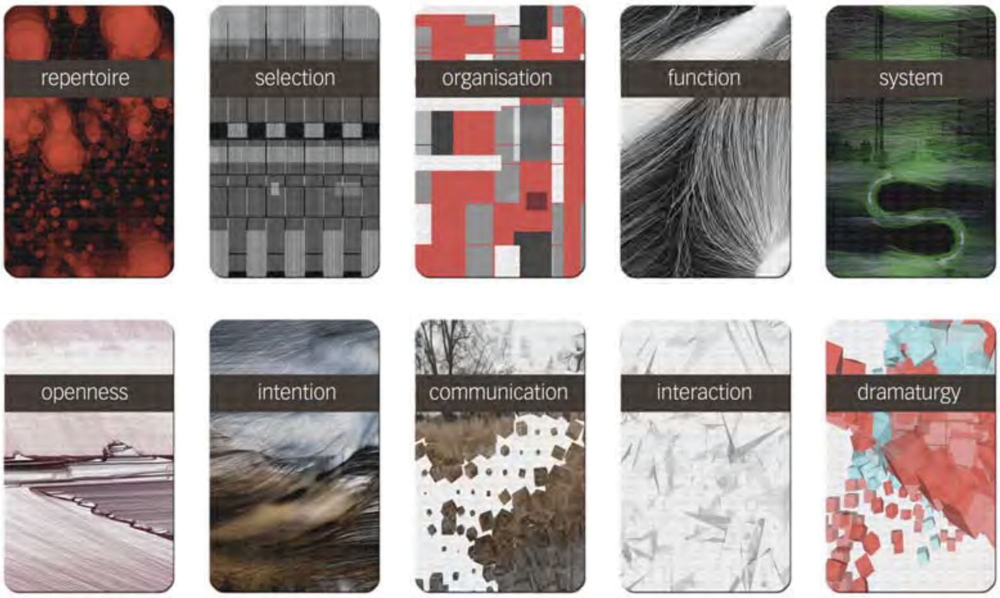

Fig. 7 - GDM cards (front view)

Not every project must go or can go through every aspect. The GDM cards can also be used individually to more accurately define one aspect or specifically work out a connection of two or three aspects in a project. The GDM toolkit is intented to explore different approaches, to solve a problem, to gain perspectives and to adapt and develop own methods.

6. Conclusion

The paper has outlined a conceptual framework for generative design processes based on a review of computer art, design theory and the author´s experiences as media artist in collaborative, interdisciplinary design teams.

All identified aspects refer to computer-based generative design processes. The GD models are visual schemes that depict the cyclical development process, the recursive program structure and the transformative characteristics of generative design programs. The GDM cards are an introduction to a conceptual toolkit for generative design to assist a common understanding and holistic project development. The cards prime intent is to inspire the design process, act as decision-solver and lead to new approaches and agile development processes.

It is my belief that a semantic naming of aspects, a meaningful visual representation and practically usable objects can benefit and enrich a design process for all participants. A study of the usage and effect of the framework in projects with different sizes and complexity would give further insight on how to improve its utilization and design. A fully translated and edited version of the GDM cards will be available soon with the publication of the author´s PhD thesis (spring 2012). Meanwhile I welcome artists, engineers and designers in generative projects to use, peer-review and contribute to the proposed framework.

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Gaganjit Singh & Mario Verdicchio

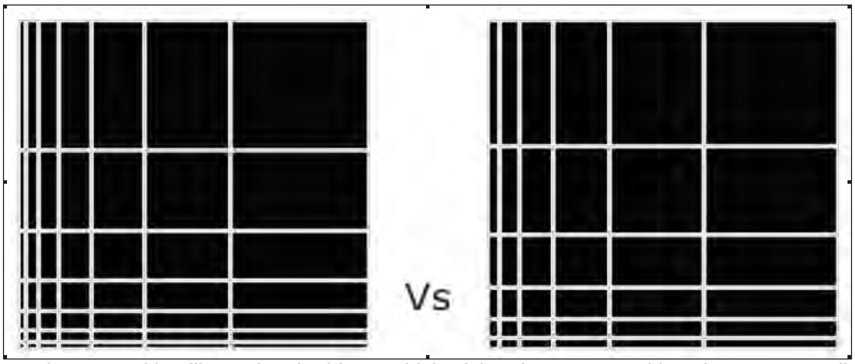
Paper, Artworks: **A Web-based Survey to Evaluate the Aesthetic Impact of the Golden Ratio**

Abstract:

The Golden Ratio is often regarded as the carrier of a strong aesthetic value in the Art World. The aim of this project is to put this attribute to the test, with a particular focus on whether the Golden Ratio can be regarded as a key factor for a superior compositional order in computer-generated abstract art.

Compositional algorithms have been conceived with inspiration from the systems of ordering and composition employed in the De Stijl movement [1], and coded by means of Processing.js, a Web-based version of Processing, an open-source programming language originally developed at MIT Media Lab [2].

The basic idea is to produce variants of algorithmic compositions in 2D and 3D space, some of which based on the Golden Ratio, presented on a page of a website. Viewers, unaware of the tested hypothesis, are asked to select and vote their aesthetically preferred item on the sole basis of their visual experience. Thus, a database of choices is built up, providing information with which the aesthetic impact of the Golden Ratio can be verified.



A sample composition illustrating the idea: Which of the above compositions is more appealing?

Tests with similar aims have already performed in the past [3], but this Web-based proposal widens the context of the participants to include at least six countries in four different continents, which can possibly shed some light on interesting differences in aesthetic perception throughout the world.

Topic: Art

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Keywords:
Experimental Aesthetics, Golden Ratio, Grammars, Visual Perception, Web Survey

A Web-based Survey to Evaluate the Aesthetic Impact of the Golden Ratio

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Abstract

This work tackles the long-standing issue of verifying whether the golden ratio has a significant impact on aesthetic experiences. We propose a web-based experiment with generative abstract art to overcome the limitations of previous proposals, which have always been carried out with a limited amount of participants not constituting a representative sample of the population, and either with too varied artworks that have possibly distracted the viewers from the ratio issue, or with too scant rectangle-shaped cut-outs.

1. Introduction

The golden ratio is often regarded as the carrier of a strong aesthetic value in the Art World. The aim of this project is to put this attribute to the test, with a particular focus on whether the golden ratio can be regarded as a key factor for a superior compositional order in computer-generated abstract art.
Compositional algorithms have been conceived with a loose inspiration from the systems of ordering and composition employed in the De Stijl movement [1], and coded by means of Processing, an open-source programming language originally developed at MIT Media Lab [2].
The basic idea is to produce variants of algorithmic compositions, some of which based on the golden ratio, presented on a page of a website. Viewers, unaware of the tested hypothesis, are asked to select and vote their aesthetically preferred item on the sole basis of their visual experience. Thus, a database of choices is built up, providing information with which the aesthetic impact of the golden ratio can be verified.
This work is organized as follows: Section 2 illustrates other proposals in the literature that have tackled the enterprise of testing the impact of the golden ratio on the aesthetic experience of observers; Section 3 provides details on the generative algorithms that have been employed to create the designs for the experiment; Section 4 illustrates the set-up of the survey and the Web-based procedures; Section 5 presents and discusses the results of the experiment; finally, Section 6 concludes and traces the guidelines for future work.

2. Related work and motivation

A number of tests with a similar aim have already performed in the past. Let us quickly present some of these experiments and point out the procedural differences with our approach to shed light on our contribution to the existing body of work.
Ajluni et al. have conducted an on-site survey, exposing 105 adult female subjects to specific paintings in two museums in Paris [3]. The artworks used in the experiments were divided in three pairs of paintings, one pair at the Museé d'Orsay and two at the Centre Pompidou. Each pair was composed by one painting containing the golden ratio (the test painting), and another without such feature (the control painting). The test and control paintings were by different artists, and they were chosen on the basis of the researchers' judgment on similarities in artistic style, and also on their relative distance within the museum, to enable the test subjects to compare them quickly. The results turned out to yield little significance, and no support to the hypothesis that the golden ration makes a difference in the aesthetic experience was found.
The effort of the authors has been undoubtedly valuable, but let us shed some light on the critical parts of this experiment that, in our opinion, may even undermine the scientific character of these negative results.
Let us take a look at one of the three pairs that have been used in the survey, more precisely, George Seurat's Le Cirque (Figure 1) and Paul Signac's Femme à l'ombrelle (Figure 2), both in the Museé d'Orsay. The former was the test painting featuring several parts fitting the golden ratio, whereas the latter was the control painting.

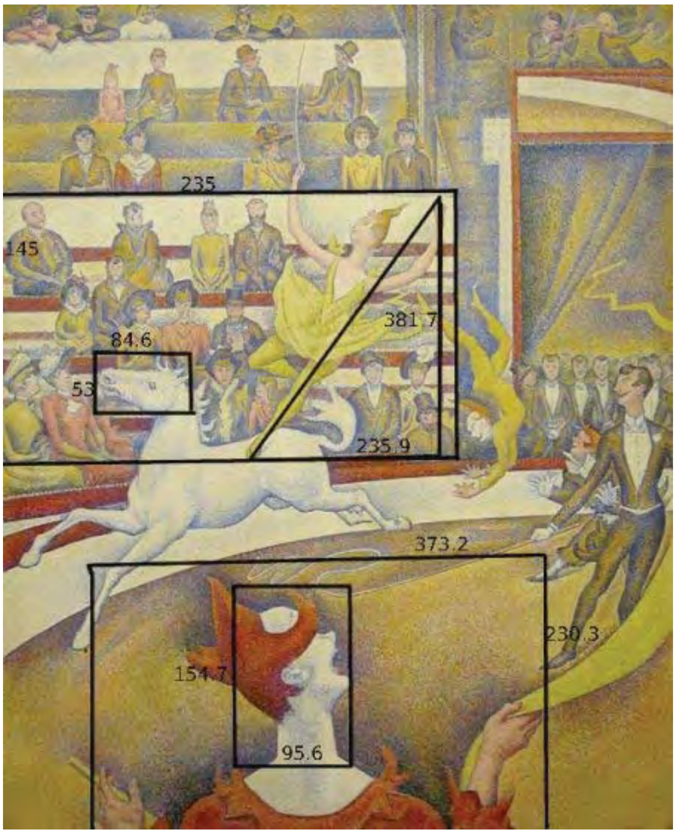

Figure 1: "Le Cirque" by Georges Seurat (1891) with golden ratio highlights by Ajluni et al. [3].

Figure 2: "Femme à l'ombrelle" by Paul Signac (1893).

According to the authors, the control painting was selected on the basis of similarity, to allow only for the mathematical accuracy of the composition to be tested during the survey. In other words, the artistic style, the color palette and the use of human figures had to be consistent between the artworks in each pair.

We are compelled to point out that the similarity between these two paintings are not enough to ensure that the only feature under test was the golden ratio factor which, according to the tested hypothesis, was to give Seurat's work an edge over Signac's. We can determine at least three factors that differentiate the two artworks other than the golden ratio: color intensity, composition with respect to the human body, and realism in depicting facial expressions. Signac's work (Figure 2) is characterized by intense colors, in strong contrast with each other: our eyes are particularly focused on the significant difference between the umbrella's orange and the dress' green, and between such green and the skirt's violet; Seurat's work (Figure 1), on the other hand, presents a much milder palette, and even very different colors next to each other like the performers' yellow and the curtains' blue do not lead to a strong contrast because the areas for each color are much smaller and they tend to blend if observed from a usual museum visitor's distance. Signac's work is clearly focused on a single womanly figure from up close and her face is depicted with a significant amount of realism, as shown by the shadows around her eyes, whereas Seurat's painting features a number of persons from a distance, and their facial features are only sketched and linear, like in a graphical illustration. The fact that both painters

used pointillism (i.e. a painting technique that uses dots of colour) is not enough to allow us to exclude the possibility that the above-mentioned differences between the two paintings may have influenced the judgment of the subjects. The issue in this test is the too rich variety of criteria the subjects can base their judgment upon.
Let us illustrate another test from the literature, affected by the opposite problem.
Dumitrescu presents an experiment carried out in a technical university for the discovery of the perfect proportion of rectangles, and the evaluation of the parameters that might influence the perception of such proportion [4]. The author interestingly decides not to show any golden rectangle in the experiment, but a variety of rectangles with 5 different length/height ratios: 1, 1.5, 2, 2.5, 3. Moreover, the length of rectangle would always be the larger size, so that the rectangles would be presented as horizontally oriented. The experimental procedures included some communication with the subject on the aim of the experiment and on the notion of the golden ration without revealing its actual value and then an evaluation on a qualitative scale from "totally bad proportionate" to "perfectly proportioned" of some rectangular colored cardboard cutouts (Figure 3).

Figure 3: cardboard rectangles used in Dimitrescu's experiment [4].

57 students took part in the experiment and it was observed that the highest mean score belonged to ratio 1.5, the nearest to the actual value of the golden ratio (1.618).
We argue that this test presents at least three shortcomings. Firstly, we do not have enough detailed report on the communication phase of the survey, but nonetheless we fear that the initial discussion may have had an influence on the subjects, by drawing their attention on the issue on proportions and making them more careful and biased toward an intermediate ratio. Secondly, it is arguable whether a small piece of colored cardboard can actually constitute an aesthetic experience. Finally, the age and the cultural background of the subjects, who were all students at the same technical university, seem to be too restricted to give the results a definitive significance.
It is very interesting to notice how Ajluni's and Dimitrescu's experiments are on opposite sides in several aspects: the former does not provide any explanation and is based on actual artworks, whereas the latter starts with an explanation phase and

focuses only on the pure geometrical form of rectangles. As shown in the following, our proposal lies in between, to avoid the issues that seem to be affecting these works.
A work that stands out in the literature is the experiment conducted by Russell in the Department of Psychology at the University of Aberdeen [5]. Two studies where conducted: the first one was similar to Ajluni's, based on paintings to be selected by a number of subjects, which did not yield any conclusive result, arguably because of the variety in shape, orientation, subject matter, and technique characterizing the artworks in the survey. The second experiment is undoubtedly more interesting, because it was based on a method of production, first proposed by Fechner, a pioneer in experimental psychology [6]. As illustrated by Russell, "subjects were required to produce the most pleasing rectangle under one of four between-subjects instruction conditions: 'horizontal rectangle', 'vertical rectangle', 'head-and-shoulders portrait painting', and 'landscape painting'." [5, p.1417] Although the results showed that the productions in the first two categories were somehow approximating the golden ratio, the last two yielded figures that left it out of the 95% confidence limits for their mean values. Moreover, the 176 participants were all students of the same class of Psychology, which cannot by any means be considered as a representative sample of the population. Finally, we cannot help questioning the rather mysterious concept of a "pleasing rectangle", although we are well aware that our proposal may be subject to the same criticism.
We aim at overcoming the main shortcomings of the proposals illustrated so far. Firstly, we place our experiments in the halfway between the scant aesthetic experience of a single rectangular shape and the distracting over-stimulation given by the variety of artworks from the past. As illustrated below, we do so by providing subjects with abstract compositions of rectangles based on a generative algorithm. Secondly, we overcome the numerical limitations of face-to-face experiments and intend to involve the biggest possible number of participants by setting up our experiments on a webpage able to reach any person in the world with a computer connected to the Internet.

3. Generative design for the experiment

The main idea is to present a subject with two very similar compositions, one comprised of rectangles characterized by the golden ratio. The ratio only intervenes in the production of the rectangles and not in their composition. The graphical style is loosely inspired from the paintings of the De Stijl movement.
The generative scripts were initially conceived in Processing [2] and successively translated into Java to guarantee a display of the composition independent from the browser in use.
Three different composition generators were created.
Generator #1 aims at generating simple, sparse, and mostly non-overlapping compositions. The rectangles have no fill colors and the background is white (Figure 4). The relevant script takes up a random range of numbers from the canvas' width and height to derive the respective x and y coordinates, which are checked against an array of previously declared points to avoid excessive overlaps, and then the composition is produced. The other image is built on the sole basis of the coordinates and the widths of the rectangles of the first composition, so that the only discriminating factor between the two compositions is the ratio of their rectangles.

One and only one of the compositions randomly pick the golden ratio, whereas the rectangles in the other are characterized by ratio 2.1.

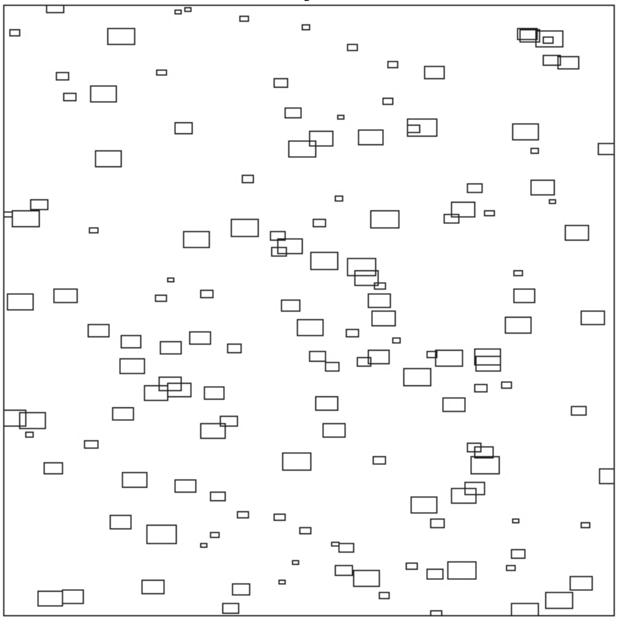

Figure 4: a composition by Generator #1 (variant with golden ratio).

Generator #2 adds a color filling the rectangles, each of which is assigned a random alpha value that determines its transparency. The script does not check their positions against previously defined points, so the chances for overlap are increased (Figure 5).

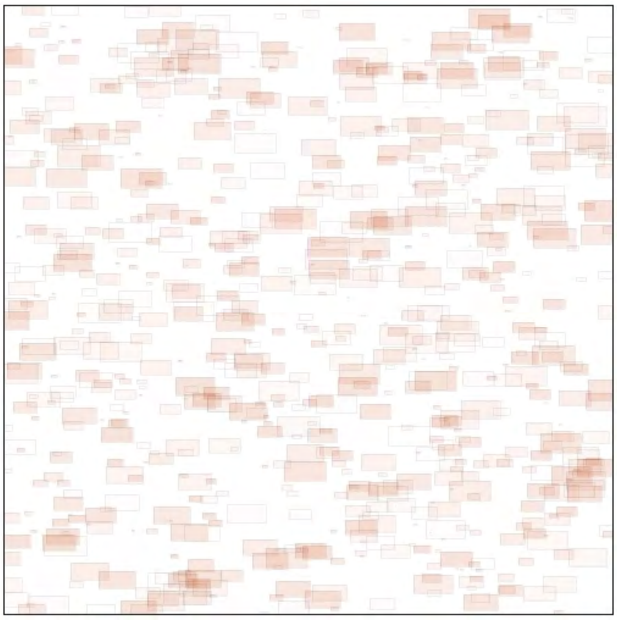

Figure 5: a composition by Generator #2 (variant without golden ratio).

Generator #3 creates larger overlapping rectangles. Variety is increased by an additional loop of rectangle generation. The first loop generates larger rectangles with a set of darker alpha values over a yellow background, whereas the second loop creates a background filling with smaller yellow rectangles with varying alpha values and a denser set of population points (Figure 6).

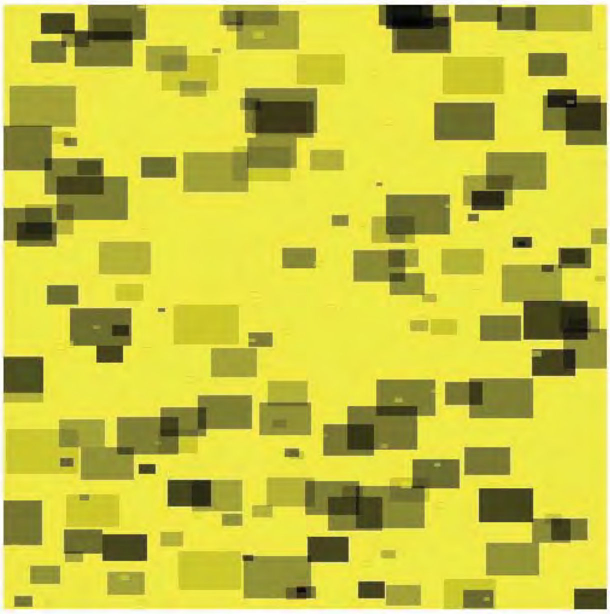

Figure 6: a composition by Generator #3 (variant with golden ratio).

4. Web application for the experiment

The online tester (OT) was developed in the form of a web application that does not require any specific software on the subjects' side but a common AJAX-enabled web browser. OT is fully Java-based with very ordinary requirements on the server side; it runs on Apache Tomcat application server and data are stored in a MySQL database.

The software architecture is flexible enough to enable us to integrate different image generators, each one based on a specific technology and a custom algorithm, and to freely embed them into binary questions, making OT a valuable support also for future web-based aesthetic experiments.

We have set up a website at cs.unibg.it/GenerativeTest to host OT. The interface guides the subject through the test. After a splash window, OT shows two compositions from Generator #1 next to each other: one with golden ratio rectangles, one without. Their positions (left or right) are randomly set. Each composition is accompanied on its upper side by a button that allows the subject to select it to express their preference (Figure 7). A click on any button immediately leads to the following pair, by Generator #2. The structure of this new page is identical to the previous one, and a click on any preference button leads to the last pair of compositions, by Generator #3. For each answer, not only OT stores the selection, but also the position of the selected image (i.e. left or right) to evaluate the impact of the presentation layout. After the last selection, the subject is offered the opportunity to retake the test with newly generated compositions, or to conclude the experiment, after which OT stores the subject's computer's IP address and its localization (the subject's country), obtained by querying a publicly available online service [7].

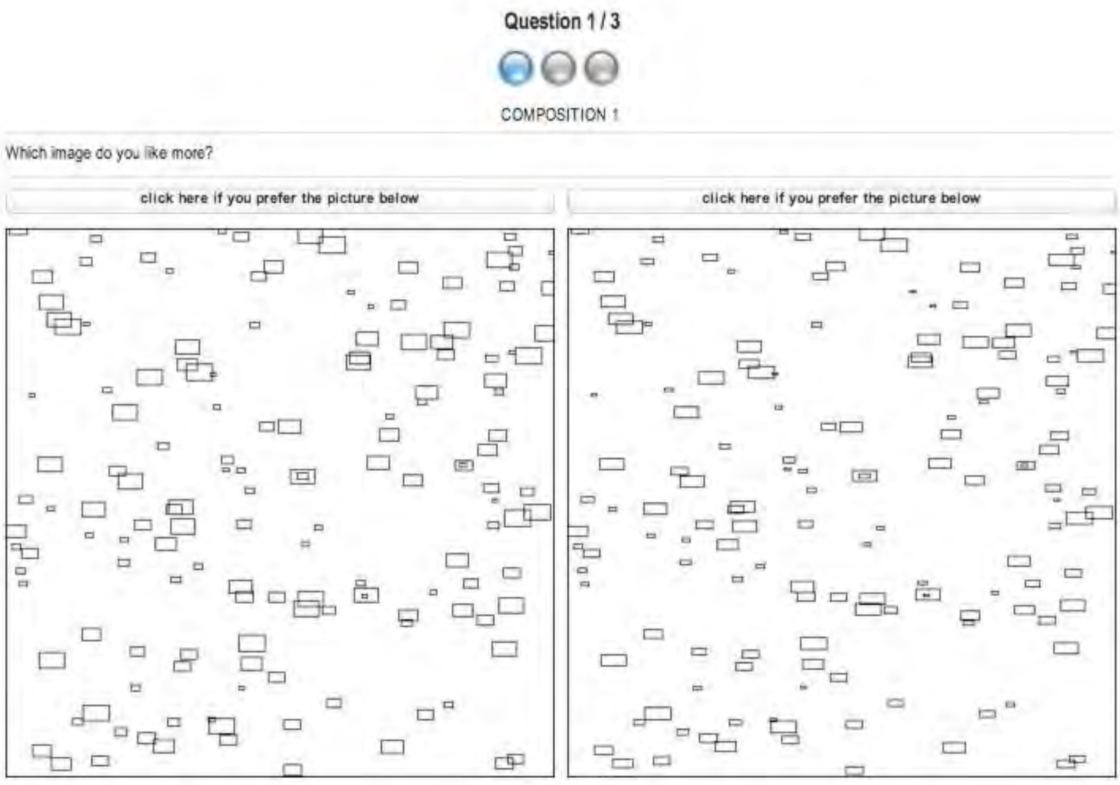

Figure 7: a screenshot of the Generative Test

5. Results of the survey

At the time of writing, 244 subjects from 20 different countries have taken the test (Figure 8). They were recruited via mass emails and social networks and blogs such as Facebook, Twitter, and Tumblr.
Two surprising results have emerged, which call for further work on OT to achieve more significance in our experiments.
Firstly, the three generators have produced significantly different outcomes:

- in the compositions from Generator #1, the golden variants have been selected 146 times (out of 244), with a p-value of 0.0013 (i.e. there's a probability of 0.13% to obtain these results in case people were choosing the compositions randomly);
- in the compositions from Generator #2, the golden variants have been selected 129 times (out of 244), with a p-value of 0.20, which shows that the result is much less significant than in the previous case;
- in the compositions from Generator #3, the golden variants are actually losing against the non-golden variants, which were selected 144 times (out of 244).

In other words, we are not allowed to draw any conclusion about the influence of the golden ratio, possibly because some other factor is affecting the subjects' choice. One hypothesis is that in the sparse compositions from Generator #1 the bigger dimensions of the golden-ratio rectangles provides a fuller and thus more appealing picture. Following this line of reasoning, we would be able to explain the failure of the compositions from Generator #3, which are comprised of larger rectangles and hence look more cluttered in the golden-ratio variants.

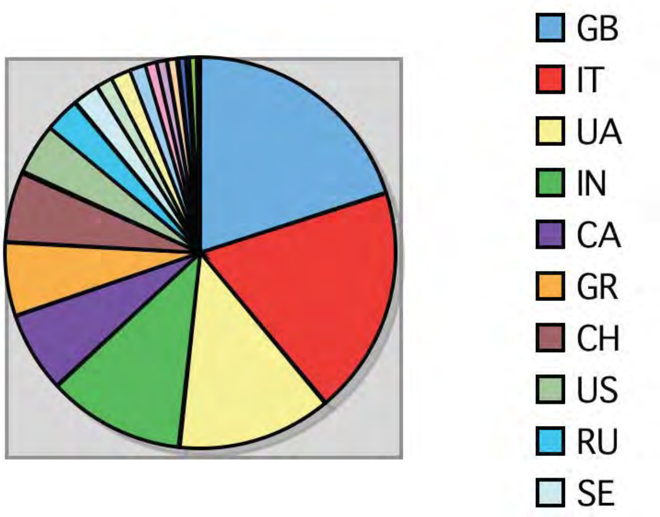

Figure 8: composition of subjects' countries (Nov. 2011)

Even more surprising was the result of the analysis on the position of the winning compositions: out of 732 tests, the composition on the right was selected 415 times, with a p-value of 0.000165. It is clear that the right-hand side plays a significant role that we cannot neglect in our future endeavors.

6. Conclusions and future work

This work was aiming at analyzing the influence of the golden ratio on aesthetic experiences, and intended to go beyond the results of previous experiments in the literature that were seen as too simplistic, in that they were based solely on rectangular cut-outs, and on face-to-face trials with a limited number of subjects. To tackle this issues, we have brought the experiment on the Internet in the form of a website, and created some abstract compositions. Our results so far seem to show us that we are still far from a conclusive result, in that with the proposed procedure we may have bumped into two new issues: ergonomic factors influencing web users, and the influence of compositional factors on their aesthetic experience.

Acknowledgments

We are very grateful to dr. Enrico Perelli Cippo and Prof. Marco Colombetti for very interesting and fruitful discussions.

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Paper: ***How to walk through walls! Generative solution to naturalistic planting design.***

Topic: Planting Design

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Abstract:

Planting design has reached a wall, garden designers are un able to assimilate all the necessary information to allow them to create ever changing and fresh planting designs particularly in **naturalistic** planting schemes. In turn Gardeners are unable to layout the plants corresponding to the highly **complex** scheme's which have been devised laboriously by garden designers.

There is a solution;

The garden designer formulates the garden plan with the desired volumes paths etc. lays out the planting pattern or movement across the site. And fills this pattern with code… **algorithm's** which **generate** a series of commands for the gardener to follow without dictating exactly which plant goes where. Leaving room for **happy accidents** and unpredicted plant combinations.

The essay underlines the history behind methods of planting plans, highlights their limitations and shows with a tried and tested garden the **simplicity** of the algorithmic planting scheme, and finishes with a proposition for the next paper on generating plant selections using a generative approach to the infinite choice of plants.

Plants laid out by the gardener following algorithm.

References:
[1] Hansen and Stahl, "*Perrenials and their garden habitats*", Cambridge University Press, Australia, 1993
[2] Nigel dunnett and James Hitchmough, "*The Dynamic Landscape*", Taylor and Francis, Abingdon, 2004
[3] Catherine Heatherington and Juliet Sargeant, "*Planting Design a New Naturalism",* Packard Publishing limited, Chichester, 2005

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Keywords:
Planting design, naturalistic, complex, algorithm, generative, happy accidents, simplicity.

Walking through walls - Generative solutions to naturalistic planting design.

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Abstract:
Planting design has reached a 'wall', garden designers are unable to assimilate all the necessary information to allow them to create ever changing and fresh planting designs particularly in **naturalistic** planting schemes. In turn Gardeners are unable to layout the plants corresponding to the highly **complex** scheme's which have been devised laboriously by garden designers.

There is a solution;

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The essay underlines the history behind methods of planting plans, highlights their limitations and shows with a tried and tested garden the **simplicity** of the algorithmic planting scheme, and finishes with a proposition for the next paper on generating plant selections using a generative approach to the infinite choice of plants.

Plants laid out by the gardener following algorithm.

Introduction

Throughout history in the world of gardens it has always been man versus nature, gardeners are constantly working to control natural resources to allow him to create an ideal. The balance between organized and spontaneous planting has been in continual flux.

Whether we are trying to tame and organize it as at Versailles

or whether we let it take over and allow it to inhabit its' natural environment.

How can we successfully achieve a balance?

As we have evolved creatively and technologically we are constantly looking back to nature for inspiration, be it in the increasing number of organic shapes used in architecture,

or the generative approaches used to replicate the natural phenomena such as flock patterning.

The sciences continue to uncover the myriad of interrelated processes that make up the natural world. In Ecology plant communities and their symbiotic structures are creating much debate in the world of planting design. How to create sustainable plant communities in the contrived arena of the garden.
The more complex our understanding of nature, the more aware we become of how intricately interconnected the world in which we live is. In the domain of Garden Design, this desire is clearly seen in the increasing demand for naturalistic, complex gardens.

We have come from fearing nature and its uncontrollable power, trying to keep it at bay with walls,

to trying to master it in the formal, high maintenance gardens of the renaissance period, which to this day have created a destructive relationship between man and nature, through industry, agriculture and the depletion of natural resources.

Recent environmental awareness has created an understanding that natural resources now need our protection; diversity is something to be celebrated. Creating 'contemporary' planting schemes means creating complex sustainable communities which are suited to the environmental constraints of the garden. The ever changing nature of these schemes is an underlying mechanism within the plant communities and therefore is part of their beauty.

It is at this point, that our understanding of ecology and plant communities reaches a 'wall'. For any one area in a garden there are innumerable options as to which plant can be used where depending on a series of variables – soil type, flowering season, origin, habitat, height, width, colour, frost resistance, speed of growth, competitive nature, shade, sun, longevity, maritime or forest to name but a few. A garden designer cannot possibly compute all these variables in his head and retain the quantity of plants that could thrive in that particular environment as a result. Whilst databases have made progress in recent years, there is still no one solution which allows us to enter all the relevant data and produce a list of possible plant choices per chosen area. One problem with these databases is that if too many variables are entered, the result is zero options, it becomes too exclusive, it is non-intuitive. Another problem is that the information available is very limited and at times inaccurate, being drawn from the individual experience of the author eg; a plant grown in a Mediteranean climate could reach twice the height of exactly the same plant grown in Scotland, but only cited as being that of when it grows in one of the areas.

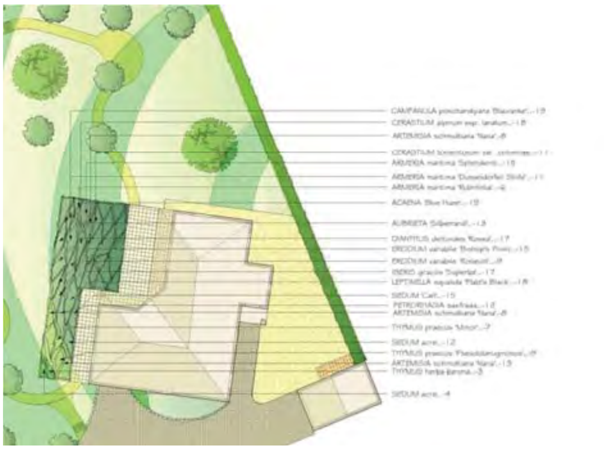
There is no satisfactory solution to which plant goes where, other than hard earned experience from a limited palette of plants..

Once we acknowledge that we do not have the capacity to know more than a finite number of plants and their related habits without having a support that as yet does not exist, and we have made our plant selection using the tools available to us, the next issue is how to communicate our decision for implementation?

The garden designer starts the process of plant selection with the site; laid out paths, sitting areas, areas of low vegetation, areas for screening, etc. Coupled with all the environmental constraints of weather, exposition, soil etc.

Once these things are mapped out on the plan the next issue is to decide how the plantings are to be laid out. What rational leads to the pattern of vegetation laid across the garden space, is perhaps a subject for further study in the generative world to create ever changing and evolving plant community patterns?

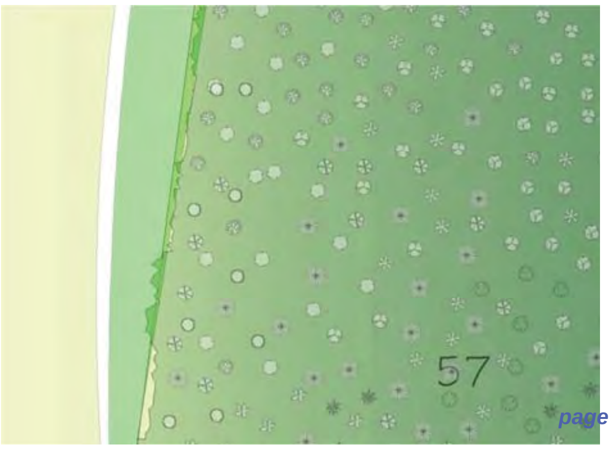
Once this pattern has been imposed a planting plan is created. The planting plan shows the contractor how and where to place each individual plant.



Traditionally designers would produce a planting plan made up of blocks of vegetation; big groups of mono species filled the available space. As you can see such schemes are impractical once the diversity is increased. The Plan soon becomes laden with tabs and markers and the groups are hard to formulate on the ground.

In nature there are very few instances of mono specific communities, they are usually associated with other companion plants which go to make up a more stable ground cover.

The next step was to place plants in a random or ecologically inspired configuration, lettered symbols attached to labels created a matrix of plants, closer resembling communities found in nature. However these plans were hard to read and left little room for interpretation as they required painstaking interpretation.



This scientific approach was replaced with a pictoral solution; this gave the gardener a better feel of the desired pattern of the planting, in this instance dispersed and irregular. However in the field the decision of which plant goes where is difficult to translate.

Garden designers looking back in history became aware of ecological studies for revegetation where the esthetic result was second to the pattern of natural regeneration.
Studies have shown that naturalistic schemes with controlled planting layouts have no more esthetic value than a more flexible formulaic approach, where the gardener decides where the plant goes within certain guidelines.

The garden designer formulates the garden plan with the desired volumes, paths etc. lays out the planting pattern or movement across the site. And fills this pattern with code… **algorithm's** which **generate** a series of commands for the gardener to follow without dictating exactly which plant goes where. Leaving room for **happy accidents** and unpredicted plant combinations

The designer is able to specify a greater variety of plants and by stating the quantity per group of each plant variety (no more than x and no less than y), as well as the planting distance between individual plants it becomes simpler for the gardener to layout the plants.

The value of this approach to plant choice and layout is that it generates unpredictable solutions in each and every case, creating a more diverse range of plant communities that can be applied to different garden situations. The potential for variations within naturalistic planting, provides endless combinations on an ecological and esthetic level. The use of this model on an individual scheme which sets its own environmental restrictions allows the designer to deal with the vast amount of choices available in a simple way, allowing for a maximum amount of creativity within the ovewhelming complexity of the natural world.

A composite plan may be valid where in some areas of the garden structural species are laid out in a decisive way and then the understory of perennial, annual and sub shrubs are cast across the site in a formulaic manner using a clearly defined set of rules.

In this way the designer is able to create highly complex garden plant communities which easily translate on to the ground.

Now that there is an available solution to the laying out of plant communities in the garden, more work needs to be done to accumulate, process and produce plant choices, reaching into the mass of information available and creating a mechanism to generate original, sustainable, interrelated plant communities.

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The work *is* the artist.

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Four domains should be established when it comes to personal environment: The micro-environment (private space limited to the individual which includes his immediate personal and familial space), the meso-environment (a share proximity, neighborhood, workplace and public area), the macro-environment (public, organized, space, (city, village or rural area), and the global-environment (everything that surrounds the previous three domains, such as a society and natural resources). Men are at the center of an environmental system that constantly impacts their behaviors. Artists are not spared by this passive influence. Stanislas Dehaene demonstrated such a phenomenon with the letters of the alphabet [1], showing that the plasticity of the brain allows it to adapt to "new" functionalities. Surrounded by shapes and symbols, humans created letters that resembled these surroundings [2]: "*It is thus not our brain that evolved to the task of reading, but reading that adapted to our brain."* This is how neuronal recycling was created; man created the shape of letters by copying what he liked to look at. Because he is in the middle of his environment, it is obvious to find elements of the surrounding in his work. The artist's brain creates, while influenced by its own environment. Cézanne, without knowing it, simplifies his paintings to the limits of abstraction. This is accomplished by an emphasis on brushstrokes over details. What made Cézanne successful in his attempt was that our brains are particularly keen on strokes and lines (something Cézanne probably did not know). The role of the golden number is a value/ratio, which defines esthetics. This ratio, present in nature, is found in many architectural and pictural works. Eye movements studies, show that subjects are attracted to the area delimited by this ratio. This was clear in the painting of Francisco Goya's "May 3rd 1808." What is even more intriguing is the resemblance existing between the work and its creator. At the center of his environmental sphere we can assume that the greatest influence over an artist is exerted by his own image and then by the one of his immediate acquaintances (family or friends). Several examples can help demonstrate a relationship between the artist's physique and his work. Claude Monet's beard resembles the willow's reflections in the water. Piet Mondrian has a face that is as grave as are his lines; Bernard Buffet and Fernand Leger both look like the characters they are depicting. Gerard Garouste states: "I am my best model". Roy Lichtenstein seems to find his own self in his works. Just as couples end up resembling each other [3], the work becomes an extension of the artist; to the point that the work becomes the artist?

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Art, eye movement, brain, neuronal recycling, perception.

The work is the artist.

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The environment of the artist.

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Neuronal recycling.

Stanislas Dehaene demonstrated such a phenomenon with the letters of the alphabet [1], showing that the plasticity of the brain allows it to adapt to "new" functionalities. Surrounded by shapes and symbols, humans created letters that resembled these surroundings [2]: "It is thus not our brain that evolved to the task of reading, but reading that adapted to our brain." This is how neuronal recycling was created; man created the shape of letters by copying what he liked to look at.

Neuronal recycling and art the example of Cézanne.

Because the artist is in the middle of his environment, it is obvious to find elements of the surrounding in his work. The artist's brain creates, while influenced by its own environment. Cézanne, without knowing it, simplifies his paintings to the limits of abstraction. This is accomplished by an emphasis on brushstrokes over details. What made Cézanne successful in his attempt was that our brains are particularly keen on strokes and lines (something Cézanne probably did not know). Maybe that perceiving his environment as geometric will be responsible of Cézanne's famous axiom « treat nature by the cylinder, the sphere, the cone » ?

The use of the golden number in art.

The role of the golden number is a value/ratio, which defines esthetics. This ratio, present in nature, is found in many architectural and pictural works. Eye movements studies, show that subjects are attracted to the area delimited by this ratio. This was clear in the painting of Francisco Goya's "May 3rd 1808."

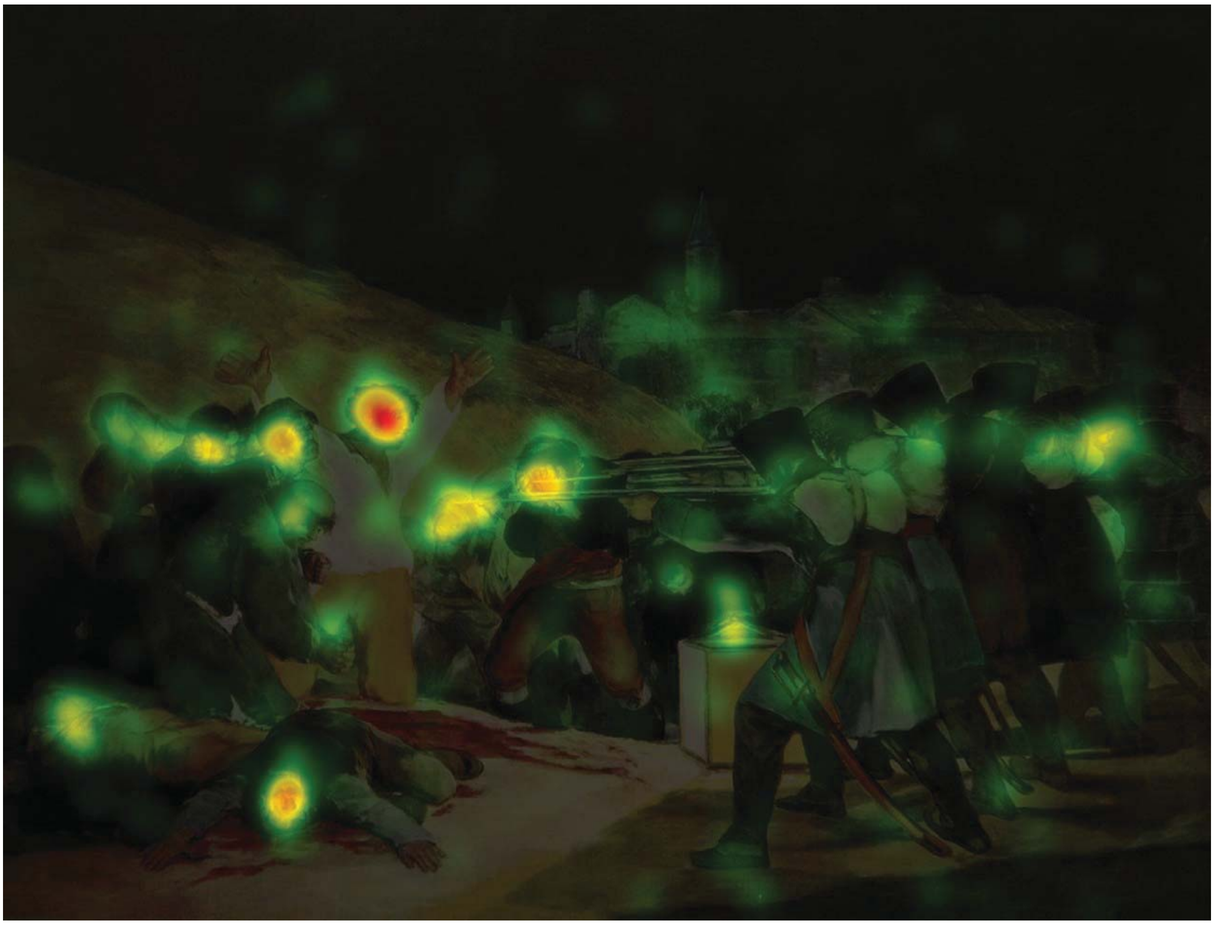

Fig 1 : Hot spot in red (100 % of subjects have seen this spot) for 60 sec.'s visitors.

The use of symmetry to seduce.

There is a wonderful sentence says by Andreas Speiser in 1909, during a walk: « *It may be true that mathematics is the source of art* ».In the same way that the symmetry filled world, the artist is sensitive to the attributes of beauty. He will create with the ulterior motive to mimic nature and to seduce. The famous drawing of human proportions in a circle by Leonardo da Vinci, according to the description of Vitruvius, shows that the human body can be placed symmetrically in a circle and a square. Vitruvius proposes as a model of proportion, the body of man.

Similarity work – artist

What is even more intriguing is the resemblance existing between the work and its creator. At the center of his environmental sphere we can assume that the greatest influence over an artist is exerted by his own image and then by the one of his immediate acquaintances (family or friends). Several examples can help demonstrate a relationship between the artist's physique and his work. Claude Monet's beard resembles the willow's reflections in the water. Piet Mondrian has a face that is as grave as are his lines; Bernard Buffet and Fernand Leger both look like the characters they are depicting. Gerard Garouste states: "I am my best model". Roy Lichtenstein seems to find his own self in his works.

Couple work – artist : an old couple.

Just as couples end up resembling each other [3], the work becomes an extension of the artist; to the point that the work becomes the artist?

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[3] Adelmann, Pamela K.,Murphy, Sheila T.,Niedenthal, Paula M., Zajonc, Robert B. Convergence in the physical appearance of spouses (1987), Motivation and Emotion, VoL 11, No. 4, 1987.

Jennifer Galanis
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Paper: **Disorder Disguised as Order**


Topic: Mathematics

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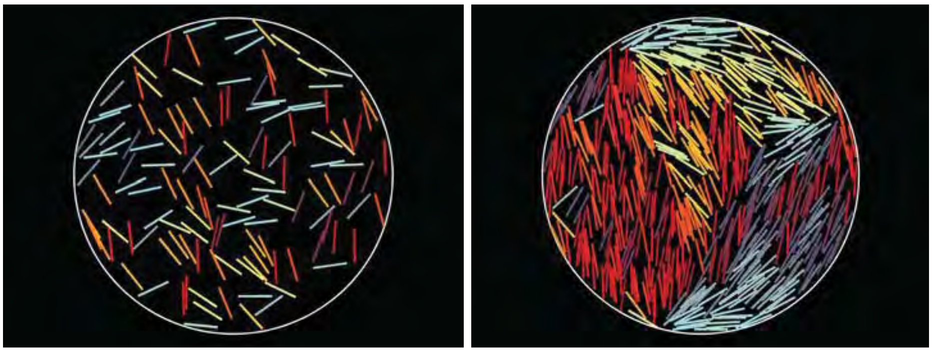
Abstract:
The scientific word “entropy” describes the extent of randomness or disorder found in nature. From our experiences (confirmed by the second law of thermodynamics), disorder, in general, increases. However, entropy can sometimes disguise itself as order to the human eye. We describe this principle and propose an entropy-based approach that opens the possibility of computer generated patterns from spontaneous particle self-assembly.

This approach is based on the idea that there can be multiple types of disorder that compete with each other to achieve the maximum total entropy. For example, rod shaped objects possess two types of disorder: 1) disorder in their position (where they are in space), and 2) disorder in their orientation (which way they are pointing).

The maximum total entropy may not occur when all individual types of disorder are themselves at a maximum. When there are too many rods in too little space, the rods experience significant crowding, and it is not possible for both types of disorder to be high. In fact, the maximum total entropy occurs when positional disorder “wins” and orientational disorder “looses”. As a result, rods can be located anywhere in the space but are all pointing in the same direction. It is easier to see the loss of orientational disorder than the gain of positional disorder, giving the false appearance of increased ordering.



We will demonstrate this remarkable effect with rods as well as with other shaped particles by using images and movies from experiments and computer simulations. The images and movies emphasize that disorder can sometimes disguise itself as order to human perception.

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[1] J. Galanis et al, “Spontaneous patterning of confined granular rods”, Phys. Rev. Letters 96, 028002 (2006).
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Keywords:
Entropy/randomness, order-disorder transition

Disorder Disguised as Order: the Science of Randomness

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Abstract

The scientific word *entropy* describes the extent of randomness or disorder found in nature. From our experiences (confirmed by the second law of thermodynamics), disorder, in general, increases. However, entropy can sometimes disguise itself as order to the human eye. We describe this principle and propose an entropy-based approach that opens the possibility of computer generated patterns from spontaneous particle self-assembly.

The approach is based on the idea that there can be multiple types of disorder that compete with each other to achieve the maximum total entropy. For example, rod shaped objects possess two types of disorder: 1) disorder in their position (where they are in space), and 2) disorder in their orientation (which way they are pointing).

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We will demonstrate this remarkable effect with rods as well as with other shaped particles by using images and movies from experiments and computer simulations. The images and movies emphasize that disorder can sometimes disguise itself as order to the human perception.

1. Can We Identify Disorder?

Most of us have an intuition about disorder or randomness that stems from a variety of experiences, such as the concrete example of rolling dice at a casino, to the enigmatic behavior of the stock exchange, to the banal battle against a messy desk. Despite our hubris, scientific research repeatedly demonstrates that humans are, at best, mediocre at both generating and recognizing randomness (although with the proper training, we can improve our abilities [7]). This need not be cause for despair, as flawed human perceptions of randomness can be turned into an advantage and harnessed as another tool in the generative artist's arsenal of methods.

On a scientific level, the word *entropy* describes the extent of randomness or disorder found in nature. Entropy exists beyond our faulty judgments as a quantity that can in principle be measured and is related to the probability of observing a particular event. Since the probability of a given event is proportional to the number of ways of that event can be generated, you are most likely to observe events that are more probable. The fancy phrase *maximizing entropy* is scientific jargon for *the most probable outcome* (or *the most disordered*).

Based on what we have discussed thus far, we pose the following question:

Which image in Fig. 1 shows maximal entropy (is the most disordered)?

Fig 1: *Two computer generated images of rods in a circular space. Question: Which image is the most disordered? Answer: The image on the right! Read on to understand why.*

Both images in Fig. 1 contain equal numbers of non-overlapping rods, whose position and orientation in the equivalent circular spaces were determined via the same random number generator. The color in these images identifies the direction in which the rods are pointing, clearly highlighting a dramatic patterning difference between the two images. Intuition supports the image on the left as the answer to the question. The rods seem to point haphazardly (randomly) in many directions. In contrast, the image on the right appears structured (ordered), with large groups of neighboring rods that are, at least locally, aligned.

The correct answer, dictated by entropy, is in fact the image on the **right**! How could this possibly be the correct answer? The *trick* in this question resides with our faulty eyes. The **total** entropy in this example is composed of two subtypes of disorder. Our eyes focus readily on one type, entropy in rod orientation, while overlooking the other type, entropy in rod position. To maximize the **total** entropy, these two subtypes of disorder can compete [2,3,5,6]. And obviously in this image, the entropy in rod position *won* while that of orientation *lost*.

This example exposes the very curious and counterintuitive idea that entropy induces particles to *organize* themselves (visually of course, as the particles are in reality maximally disordered). This *self-assembly* process opens the possibility of producing complex and organic patterning that can be simply created with a random number generator. In the remainder of this manuscript, we will elaborate on how entropy can produce *order* as well as the methodology for generating similar images.

2. Basic Probability: Non-Interacting Dice (or a Single Die)

To answer the question from the last section, we start from a familiar place and gradually build the complexity. We begin with dice. Traditionally, a die is a cube shaped object with the numbers 1 to 6 designated on the faces. If the player is not cheating and the dice are *fair*, we know that, with any particular roll, the number that appears on the side facing up is random. In other words, the outcome of a particular roll of the die is not affected by what happened in the previous rolls. We also expect that all the numbers are equally probable, so that the chance of rolling a 1 is the same as a 6, or a 4, etc.

Happily, we do not have to take these assumptions on faith - these properties are readily measurable (to the demise of many cheating gamblers). How is this done? Simple, record the number that appeared for each roll. Figure 2 shows typical examples of such recordings for one, ten, and ten thousand rolls, where a computer both *rolled* a virtual die and recorded the outcome.

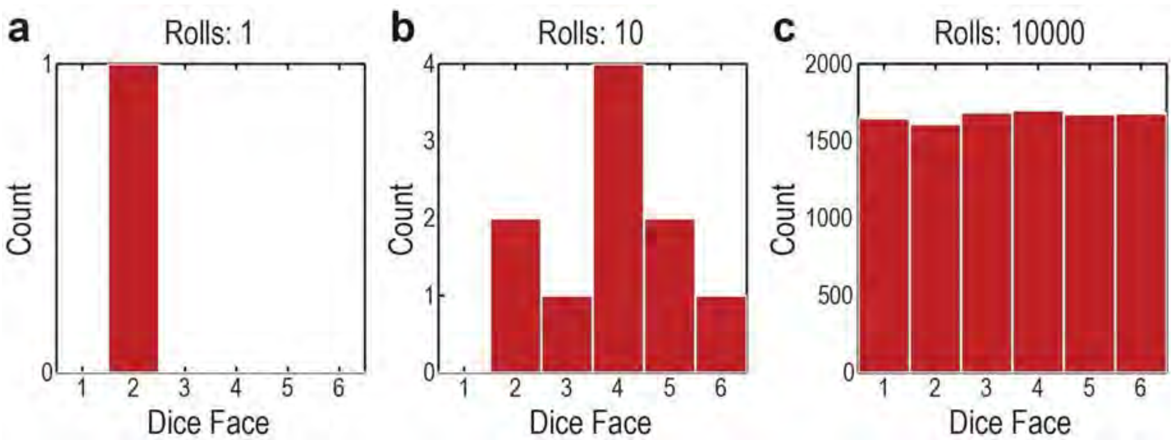

Fig 2: *The behavior of non-interacting dice (or a single die). Recording the number of times each face appeared after one (a), ten (b), and ten thousand (c) rolls. A fair roll of the dice, where all numbers are equally probable, only emerges clearly after a large number of rolls.*

Although we expect that the appearance of all numbers on the die are equally probable, this is not always what emerges from a sample of rolls. The distribution of numbers in Fig. 2(b), for example, is not equal, as the number 4 seems more likely than the other numbers. Moreover, the number 1 has not even shown up at all. Before we denounce the computer for cheating, we must recognize an important point. The true probability distribution only manifests as an outcome of an **excessively** large number of rolls. By inspecting Fig. 2(c), we can feel confident that all numbers on the die are equally probable.

3. Thinking Geometrically: Non-Interacting Rods (or a Single Rod)

We now transpose the ideas from dice to rods in a particular space. Analogous to the roll of a die, we can *toss* the rod into the space. We can pick any space, but for ease of visualization, we choose a two dimensional space. For example, Fig. 3(a) shows a single rod existing in a circle. Instead of thinking in terms of pure numbers as with dice, we must now think geometrically. There are two things that can be random when you toss a rod in a particular space: a) disorder in position (where is the midpoint of the rod located?) and b) disorder in orientation (which way is the rod pointing?).

Similar to our expectations with numbers on a die, we expect that the midpoint of the rod can be located anywhere in the space and that the rod can be pointing in any direction. In other words, we expect an equal probability for all **possible** positions and an equal probability for all **possible** orientations. The word *possible* is used because rod positions and orientations are restricted when considering a *hard* wall, where the rod cannot cross the boundary. The interaction of a rod or rods with boundaries can produce interesting patterning (see, [5] and [6]); however, these effects are beyond the scope of this article. For simplicity, we will focus on what happens everywhere in the space, **except** those areas close to the boundaries, marked by a dashed circle in Fig. 3(a).

Equivalent to dice, we can determine if indeed the outcome of a toss matches our expectations by recording where the rod landed in the space. Figure 3(b) shows the recording of 100 virtual tosses of a rod in a circle by a computer. From these types of recordings, we can measure the probability of various outcomes, recalling from the previous section that we need an excessively large number of tosses to accurately determine the probabilities.

Beginning with positional disorder, we are interested in the location of the rod midpoints, as shown for a particular recording in Fig. 3(c). By eye, it seems that the rod is tossed uniformly throughout the space, but we can be more quantitative by taking a measurement. There are many ways to measure the distribution of the midpoints, and here we choose a simple heuristic method. Using a grid, we partition the circle into tiny boxes and count the number of midpoints in each box. Figure 3(d) readily shows that each box contains about the same number of rod midpoints.

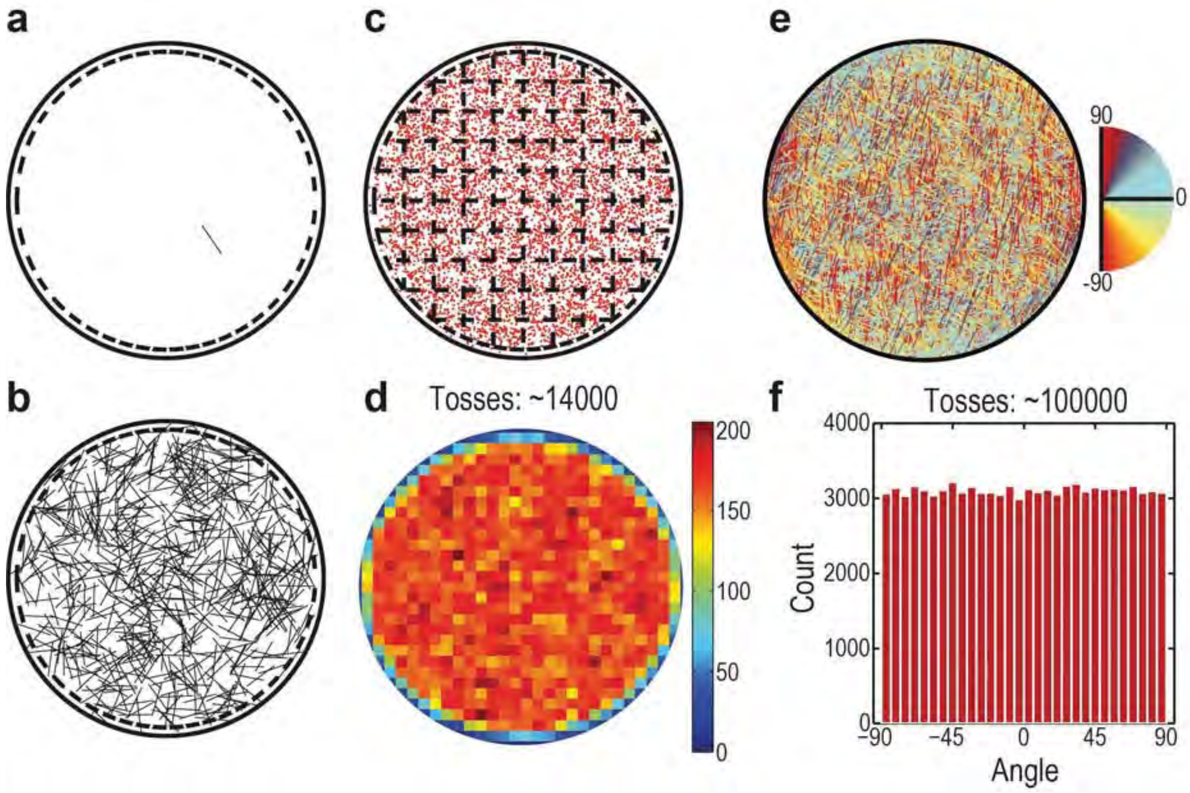

Fig 3: *The behavior of non-interacting rods (meaning they can overlap) or a single rod tossed many times. (a) A single rod in a given space (excluding the boundaries marked by the dashed circle) can have its midpoint located anywhere and its long axis pointed in any direction. (b) An example recording of 100 rod tosses. By looking at just the midpoints of the rods (c), we can divide the space into small boxes (grid) and measure the probability of finding the midpoint in each box. For example, (d) indicates the count in color, showing an equal probability of finding rod midpoints anywhere in the circle. (e) Similarly, we can see by eye that rods are pointing in all directions by coloring the rods depending on their orientation. Graph (f) illustrates the count of rods pointing in each direction.*

Now checking the disorder in rod orientation, Fig. 3(e) shows a recording where color corresponds to the direction a rod is pointing. For example rods are colored blue if they are pointing left and right on the page, and red if they are pointing up and down on the page. Again it appears as if the color variation in the rods is fairly uniform throughout the space; however, we can quantify this with a measurement. We can choose any coordinate axis to define our angles. Here, we chose our reference angles as that in Fig. 3(e). Figure 3(f), shows that the rods indeed have an equal probability to point in any direction.

4. Adding Complexity: Interacting Dice

Thus far, we developed a good understanding about what happens with single objects (one die, one rod). Now lets increase the complexity and have several interacting objects. Suppose you have two dice. And instead of being interested in the number each die gives with a roll, you are interested in the sum of the numbers. By looking at the sum, you have in essence created an interaction between the dice. It is important to remember that the outcome for each individual die is random, as discussed earlier.

However, the interaction (the summed numbers) does not yield an equal probability for all possible outcomes. For example, there is only one way to get the number 2. Both die must roll a 1, or in more compact notation (1,1). In contrast, there are six ways to roll a 7 - the dice can be (1,6), (2,5), (3,4), (4,3), (5,2), and (6,1). Therefore for any given roll of two dice, you are more likely to obtain a 7 than a 2. In other words, the probability of a particular number from the summation is proportional to the number of ways that you can obtain that summed number.

The more dice you have interacting together, the stronger the preference for a small range of numbers compared with the entire range of possible numbers that can be rolled. This effect is easily seen in Fig. 4, where the probability of outcomes are given for two, ten, and one hundred interacting dice. To be more specific, even though it is possible to roll 100 from one hundred dice in a *fair* roll, the chances of you actually obtaining that number are infinitesimally small (one way out of 6^{100} possibilities). In contrast, there are a large number of ways to roll a 350, the most probable number. The number that has the maximum probability is said to have the maximum entropy.

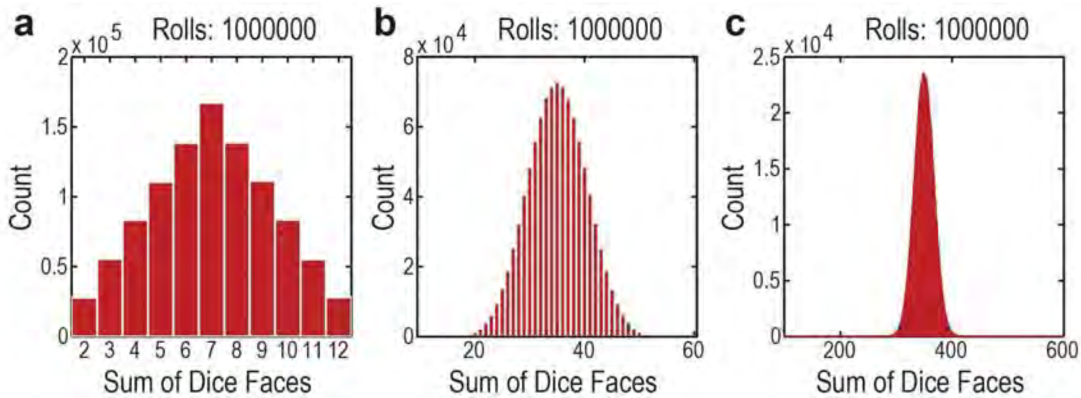

Fig 4: *The behavior of interacting dice. For this interaction, we simply sum the numbers from all the dice for each roll. While the number rolled for each individual die is equal (Fig.2), the inclusion of an interaction (summation) can result in an unequal probability for all possible outcomes, as is shown for the summation of two (a), ten (b), and one hundred (c) dice.*

5. An Answer to the Question: Interacting Rods

We can define a simple interaction between rods by saying that rods cannot intersect, or be located at the same place at the same time. This results in a geometrical restriction between rods. To see how this occurs, let us begin with one rod and fix it in a particular position and orientation. We could have, for example, the rod pointing left-right on the page, similar to the red rod in Fig. 5(a). Now you bring another rod, for example the green rod in Fig. 5(a). You fix the second (green) rod's orientation, but allow it to exist anywhere in the space, provided it does not intersect the first (red) rod. For a particular angle between the two rods, there is a little chunk of the total space that the midpoint of the second rod cannot occupy because the first rod is there. This little chunk of space is called the *excluded area* (or *excluded volume* if the space is three dimensional). Three different examples of *excluded area* are shown as blue boxes in Fig. 5(a) for three different angles between the rods.

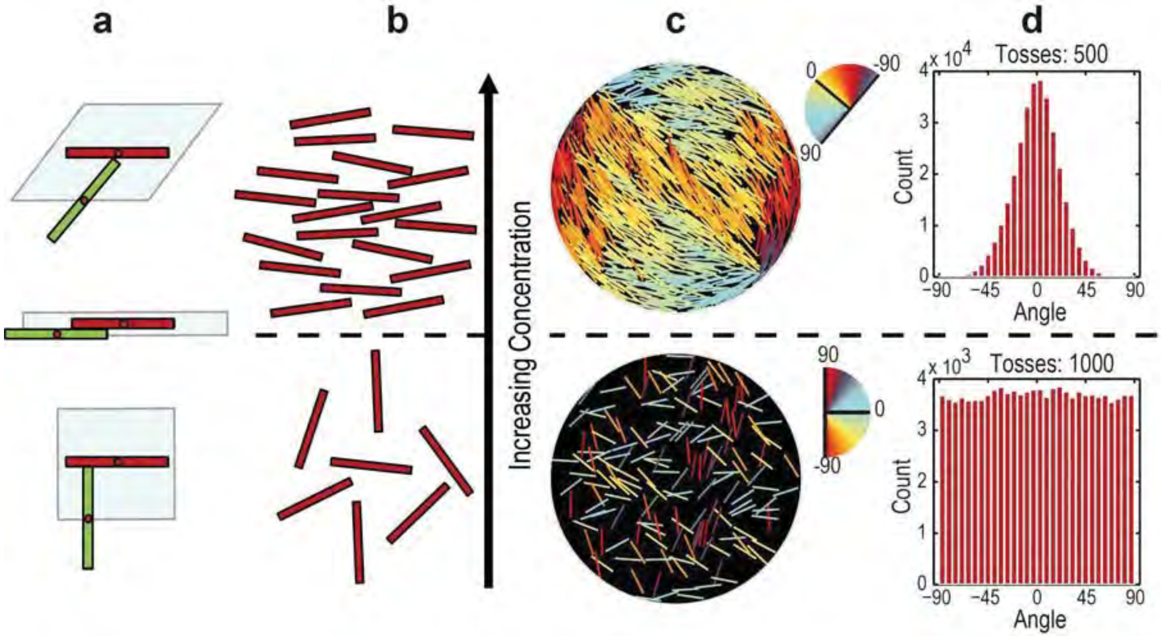

Fig 5: *The behavior of interacting rods. For this interaction, the rods cannot overlap, which creates a space (a, light blue box) that the midpoint of one rod (a, green rod) cannot be located because another rod (a, red rod) is present. The size of this excluded space depends on the angle between the rods, where parallel (a, center) and perpendicular (a, bottom) rod orientations give the least and most, respectively, excluded space. (b) A schematic drawing illustrating that excluded space becomes more important at higher rod concentrations. After a certain concentration (dashed line), rods loose orientational entropy. The change in orientational entropy can be seen in images of rods from simulations (c) and by measuring the probability of finding the rods pointing in a particular direction (d) for high (top) and low (bottom) rod concentrations. The simulations (c) are quasi-two-dimensional, where the thickness out of the page of the circular space is four times the rod diameter.*

In order to understand the implications of excluded area, lets digress for a moment and return to dice. Suppose you engineered a way to modify a die so that, for example, the number 5 was never rolled but the probability for all other numbers remained equal. Unlike the 1/6 probability for rolling a particular number for a regular die, your modified die would have a 1/5 probability for rolling a particular number. Now, you have a better chance at guessing the number that might appear with your modified die. In other words, you have decreased the disorder associated with rolling dice.

The analogous idea with a rod is a restriction in geometry. If you arranged a little section of space in such a way that a rod from a toss never landed there (for example with an excluded area), you have decreased the disorder in the rod position. By looking at Fig. 5(a), you can get a sense from these cartoons that the excluded area depends on the angle between the rods, where the smallest excluded area occurs when both of the rods are parallel to each other (0 degree angle), while the largest occurs when the rods are perpendicular to each other (90 degree angle).

Ah ha! The amount of excluded area (related to positional disorder) is connected to the angle between the rods (related to orientational disorder). Therefore, positional and orientational disorder are linked. In other words if you forced all your rods to point in the same direction (decreasing orientational entropy), you reduce the excluded area and increase positional entropy. And conversely if you imposed an equal probability for all angles of rods (increase orientational entropy), you increase the excluded area and decrease positional entropy. The **total** entropy is, therefore, not simply maximizing the positional and orientational entropies independently, instead both entropies must be considered **simultaneously**.

When would you expect these two types of entropy to compete? Obviously, when there are very few rods in a very large space, the chances of any two rods coming close enough to *feel* each other's excluded area are quite low. Therefore, positional and orientational disorder appear to be both maximized, and it is as if the rods can be approximated as non-interacting rods. A single *toss* of interacting rods in this dilute regime can be seen in Fig. 5(c, bottom). We can use the tools from the previous sections to measure the orientational entropy. Figure 5(d, bottom) show that there is no preference for any particular orientation.

At the other extreme, when a large number of interacting rods are confined to a relatively small space, the rods strongly *feel* each other's excluded area. Positional entropy competes and wins against orientational entropy, and the rods spontaneously align. An example of this extreme is shown in Fig. 5(c, top). Here, the rod alignment is visually striking. But again, we can measure this, as shown in Fig. 5(d,top). For convenience, we chose our reference angle (zero) to be the direction where most of the rods are pointing. It is very obvious that not all angles are equally probable, and that most of the rods prefer to be aligned along the same direction. In between the two extremes in rod concentration, there is a certain concentration where the rods transition in their patterning, depicted schematically by the dashed line in Fig. 5(b).

6. How Do You Obtain the Images?

How do you obtain an image like the one in Fig. 1(right) or 5(c)? These images are, in fact, the product of Monte Carlo simulations. Since there are many excellent tutorials on how to perform Monte Carlo simulations [1,4], we will only outline the essentials here.

We begin by constructing an image like the one in Fig. 1(left). To construct such an image, we start with a space (example, a circle), and we ask the computer to sequentially toss a particular number of rods into the space (randomly pick the location of the rod midpoint and rod orientation) with the rule that rods cannot intersect other rods (or the boundary). In principle, rod arrangements like Fig. 1(left) are a viable configuration for our interacting rod model; however, it was constructed *artificially*. Each rod tossed into the space only interacted with the rods that were already present in the space. For example, the first rod tossed did not interact with any other rod. The second rod tossed interacted only with the first rod. The third rod tossed interacted only with the first two rods, etc. At this point, we do not really know if entropy is indeed maximized or if we are at an extraordinarily unlikely pattern (like rolling a 100 with one hundred interacting dice).

We can solve this problem by asking the computer to now take each rod and randomly move it, with the only criteria that the rods cannot overlap. Now, the rod that is being moved interacts will all the other rods present. Once every rod in the space has been moved (or attempted to move) once, the new configuration can be considered as a new toss. As the computer progresses with an extremely large number of tosses, the rods spontaneously *find* the most disordered arrangement.

7. More Possibilities

Using the specific example of rods, we showed that there may be several subtypes of entropy that contribute to the total entropy. We demonstrated that if the entropy subtypes are linked to together, these subtypes may compete, where one *wins* and the other *looses* in order to obtain the maximum total entropy. Since our eyes cannot detect all forms of entropy equally, it falsely appears as if the total disorder decreases as structure emerges from randomness.

What has been described with rods is by no means limited to just rods. The only requirements are that at least two different types of disorder compete. This situation can be created with various shapes (ex. spheres, rods, wedges), with different sizes of the same shape (ex. big and little spheres), or with combinations of different shaped objects (ex. rods with spheres, Fig. 6). It is not easy to determine what the pattern will be before running the simulation, and in fact, this is an active area of current scientific research. For example, the patterning behavior of rods discussed here is exactly what occurs with liquid crystals and is fundamental to the functioning of LCD based electronics. Aside from exploring unknown intellectual territories and developing technological devices, the movies generated by such methods can be a visually mesmerizing combination of order and disorder.

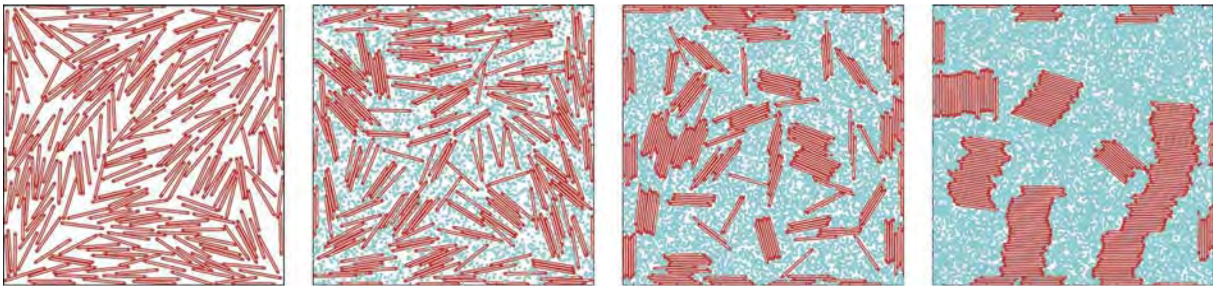

Fig 6: *The competition of various entropies occurs in many places. The images contain mixtures of rods (red) and spheres (blue), where left to right shows zero to increasing numbers of spheres for a constant rod number. As sphere number increases, the entropy of the spheres wins while the entropy of the rods looses in order to obtain the maximum total entropy.*

Acknowledgements

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Jian You, Li

Paper: **Generic Product Feature Analyze and Reverse Application for Form Generation.**

Topic: Industrial Design

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Abstract:
The several similar operation model of generative design for product design was submitted for years, but need more practical cases to discover the detailed steps and relationship for suit for specific design problems for interested designers or learners to follow.
A generative system usually includes a generative model, but most methods have different aspects and ways to build this potential core. The way that how the generative designer build the generative model also influence the generative performance of the system.
Learn from the biological evolution, we can find the particular part, such as a bone or organ exists in different species' bodies but develop with different functions. We can regard the revolution as the god's idea development, and reverse this design process.
We build a generative model that can evolve into 5 different models, and each model presents a unique type or feature from each other. A multi-dimensional solution array can be extended by these models, and probably includes potential ideas inside. The method to build the generative design, multi-dimensional solution space and its potential to bring more ideas for a specific product will be demonstrated in this paper.

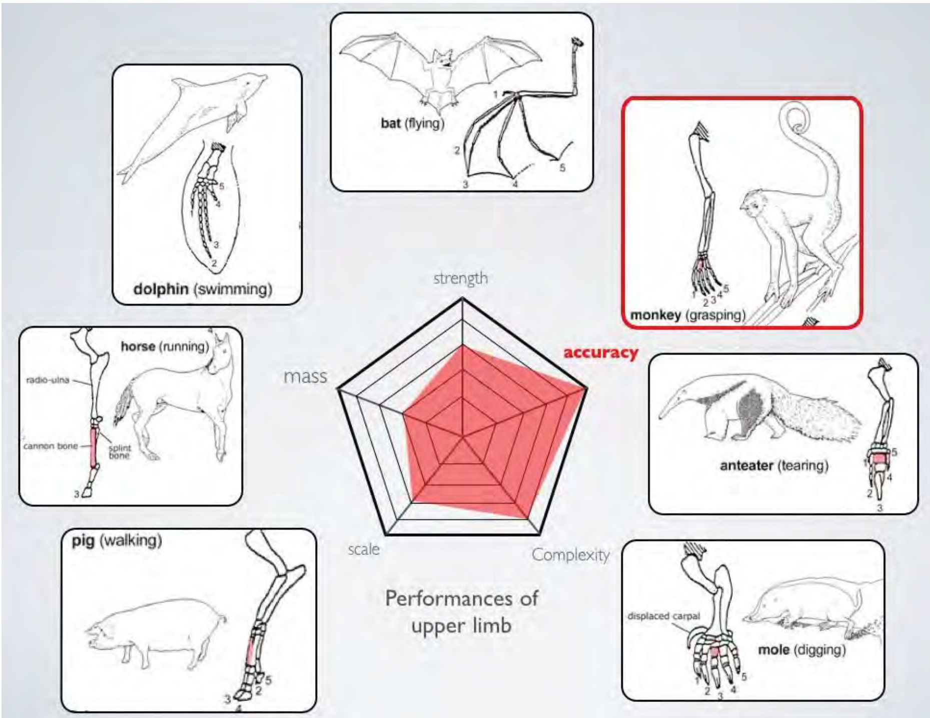

Image of Multi-Dimensional space of upper limb's evolution.

Contact: email

Keywords:
product design, generative design, generative model.

Generic Product Feature Analyze, Multi-dimensional map and Topological Extraction

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The practical applications of generative design for product design have already been archived by few design studios, but most of them focus on the special features of the generative design, such as complex fabrication and irregular construction. However, the idea productivity is the major applying value of generative design for product investigation, but the application is still developed in the experimental stage so far. Although there are several operative models were submitted, but need more detailed description of procedure steps. In this paper, we discuss the state and barriers of generative design's application in the product design, and submit a method to build the generative model inspired from the concept stage of current design process.

1. Introduce-Comparing the Developments in Architecture and Product Design.

Since the generative design evolved from the generative arts to be a unique design tool, generally, the product design is regarded as one of the applied areas, but its development in product design is far behind to its situation in architecture obviously.

In the architecture, generative design gathers rapid development relatively, especially from the promotion of the free form and digital fabrication, the designers rely on the dynamic model that can reflects the conditional adjustment instantly to review and evaluate the mass complex results efficiently. The dynamic function is very similar the parametric design in the industrial design by an operative definition. The parametric design didn't drive a critical effect in the industrial design as in the architecture, because it has been integrated in the very early period of CAD history and didn't influence the design method.

Although the digital fabrication is also emerging on the few product design as a new trend element, but it was usually applied for its special aesthetic appearance and based on the recent technical improvement of RP manufacturing. Meanwhile, not only applied on the architecture, the irregular or bionics construction also appears on the furniture, lighting and interior design to archive the special balance by the algorithm's computation. But the application of digital fabrication and irregular construction doesn't suitable for the most regular manufacturing technology and means high cost, then become a few special cases.

However, the major value of generative design to be applied on the product design should be its potential of exploring possible ideas efficiently, but the operative process is still in the early development.

Fig 1: The wide applications of digital fabrication and irregular construction on the furniture, lighting even fashion design.

2. The Models for Generative Design

2.1 The barriers from the requirement about programming ability

The basic definitions of generative design were submitted in recent years, and the one of obvious features is that designer doesn't deal with the result of generative system directly, instead of changing the parametric input or the construction of algorithm to influence the final shapes or forms. The generative design is a design method that its output is generated by a set of rules or an algorithm [1]. Its interactive module that provides control and choices for the designer to guide the selection of desired solutions [2]. The models are shown as the Fig 2.

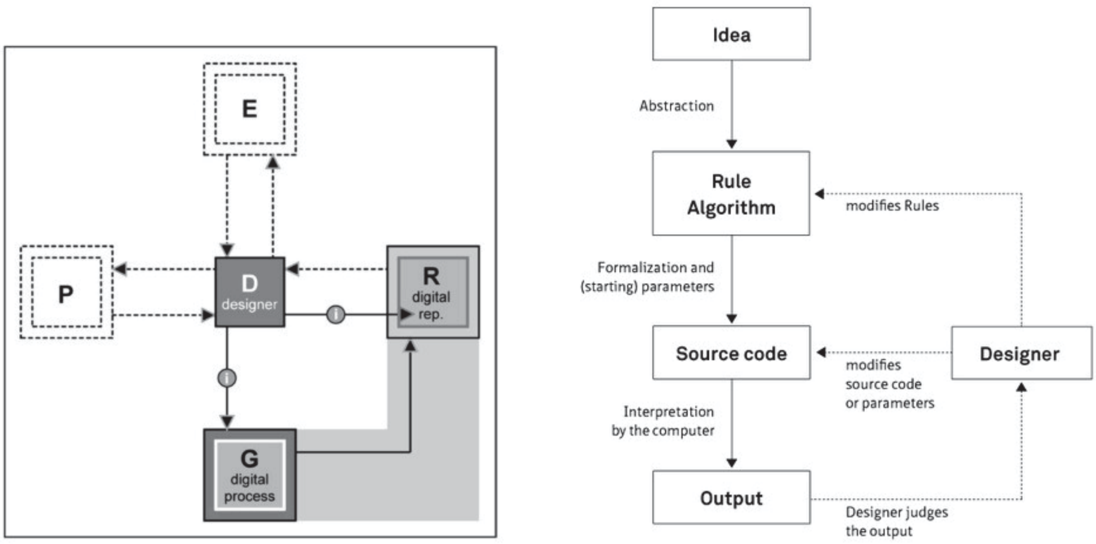

Fig 2: Left, the generative model, Rivka Oxman, Design Studies, 2006; Right, the process for creative generative design, Book, Generative Gestaltung, 2009.

The generative system's solutions probably include thousands, and every time an adjustment of algorithm or a new parametric input may cause a change to whole solutions. The new interaction of design method brings some barriers to designers. The designer can't operate the results directly in the method definition, and this against the traditional sense that designer can modify the result. If they want, the designer needs the programming ability to execute the control in the process, and most designers lack the related training in their background. The design method is based a basic condition of designer, the programming ability, and designer can't proceed designs by the original skill learned from their school. Although while defining the generative model, that need rich design experience about operating geometrical objects, such as fundamental data of curves and surfaces, but the knowledge still needs to be transited into the algorithm by programming.

This situation is very similar the web designer confront before. In the early period, the designing website needs aesthetic elements as most art jobs, and web designer's task is how to apply digital media and transit their creation to be the web materials. When the websites was developing toward to the better interactive service, the editing script provides the designers more power to improve the website's interactive performance. Therefore, the programming script became the priority for the web designers to learn, and now the training already been integrated into the interaction design course as other original art training.

The product design is confronting the same transition, too. Due to the visualized programming tools are emerging and got great progress, such as grasshopper, and make more architects and industrial designers able to apply the generative design technology. But the application and complexity of product design are not so simple. In the different phases of product design process, the performance and importance of generative design have not been verified yet, and several specific models about the product design process were submitted.

2.2 Further models for product design

More and more researches are focusing on the education and design method of product design, and this shows the development of generative design is growing in this field. These researches improved the general definition of general generative design model into a precise level for applying on the product design from other applied fields [3][4]. These models have similar steps about building the generative model, generating variants and selecting solutions, and the model construction for product design is almost stable.

Although these models gave a clearer procedure than before, but most designers or researchers still have problems to follow the steps and build their first generative model or system. Because detailed knowledge for applying the generative design need to be developed. For example, how to evaluate that the design target or what kind of product is suitable for applying this method, or how will the operation process change based on the different applied product.

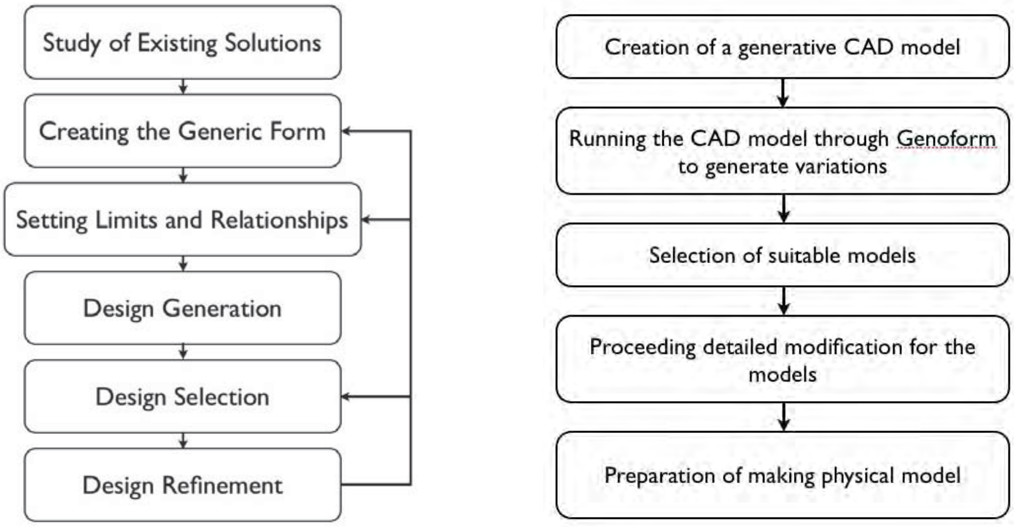

Fig 3: Left, the practical model of generative design for product design, Anandasivam and Bonllo, 2006; Right, the work process of course project, Teaching Generative Design Strategies for Industrial Design, Sivam Krish, 2010.

Besides, the barriers also come from the field and people. Many industrial designers noticed this emerging tool and design method, but most of them usually lack of correct knowledge about it than other people of architecture or graphic design. Even they have, not like the architects have highly interested in learning and using the new technology, they regard this trend as an invasion that is possible to replace their job by the system. Furthermore, even they have the patient to study how to build the generative system, despite of the reusability and productivity of generative design system, they like to compare it with the traditional design method, and query the benefit from the system results. Because building a generative system takes so much time to archive, repeat test and optimize the algorithm, and no mention they need to supplement enough programming ability firstly.

3. The Generative Model

In the model of left side of Fig 3, the first 3 steps descript how to build the generative system, included the study of existing solution, but what information or rules should be study from the existing solution is an indefinite notion. The detailed operation depends on the real situation. Several questions are necessary for designers to consider before they decide to engage in applying the method. For example, what kind of variant range I want my system can reach? Do I have enough knowledge to set the limit and relationships? The performance of generative system is decided by how the designer integrate their knowledge and experience, just like the expert and beginner have different performance in the sketch stage. If the designer didn't have clear cognition about the design object and their expected effect of the system, the building generative system will become an exhausting and frustrating task. A set of preparation should be considered by the designer and will help them to judge the possibility to continue building a generative system.

3.1 Evaluation

The products in different phase of Product Life Cycle get activated though product design, and different industry involves various market situation and strategies. Not every product is suitable for applying generative design, so how to evaluate the product is suitable for applying generative design?

(1) **Complexity of product architecture:** As the complex form fabrication applying on architecture and furniture, generative design has the advantage to execute computational procedure, but the complexity doesn’t mean only the product has bionics appearance. The suitable product should include enough components or elements to consist the whole construction and provide enough permutation to establish a solution space that difficult to be developed by designer.

(2) **Unity of idea variants:** In the concept stage of product design, the designer usually develops different approach to satisfy the requirements of creativity, cost down or any design strategy, and few ideas may come out with a total new approach. For example, Dyson’s vacuum cleaner used a different airflow principle to keep high suction, and its construction involved to many components that regular vacuum cleaners don’t have. This highly creative idea is almost impossible generated by current generative system’s capability and AI. The different framework of product usually generated by a new generative model or system, so such a system needs to include several generative models. Few optional features or components are acceptable for a single generative system, and could be archived by logic judgement of the algorithm.

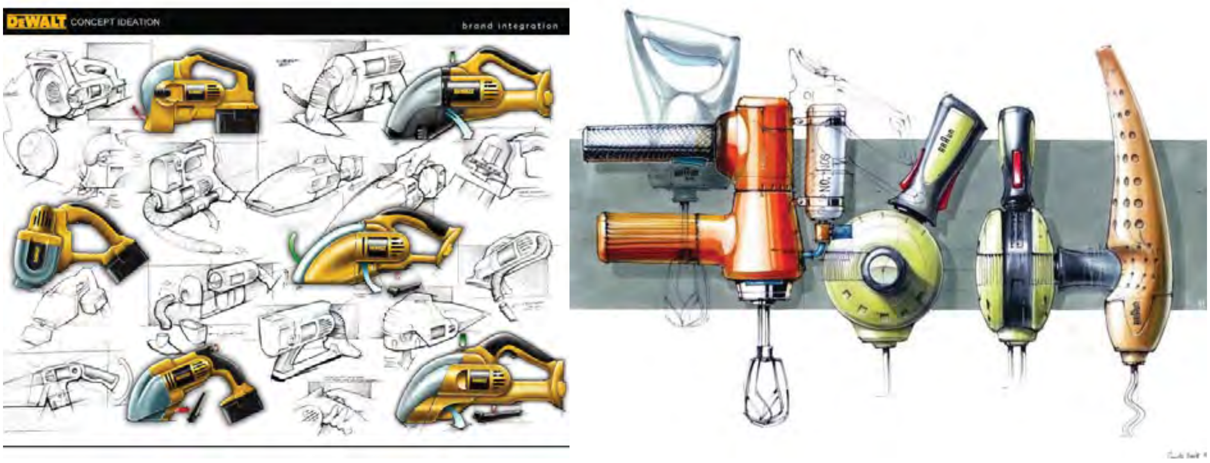

Fig 4: The different idea sketch with the same construction.

(3) **Cost and benefit:** Most experienced designers can generate enough idea variants of a simple product as the generative system, maybe the quantity of solutions from generative system would higher than human designers’, but the valid ideas will be very limited by the product’s simple framework. However, even building a system to generate a simple product still takes necessary time to define and program, and usually longer than idea

sketch stage. Unless elemental toolkit or package of generative design are developed and can be applied rapidly, or a simple, highly restricted and matured product has low benefit to apply the generative design.

(4) **Available Knowledge** for building the relationship and limits: A system' generative mechanism is consist of many defined relationships between parameters and procedure orders, so the mechanism can execute a set of process to keep the variants match the predefined rules. Enough relationships can maintain the system work well and generate feasible results, but a system lack of enough inner connections may crash often or generate invalid solutions, such as over simple or poor defined. These relationships are based on the various knowledge of ergonomics, manufacturing and materials, and designer need transit these knowledge into the algorithm or associative modelling. The product with rich knowledge resource has better opportunity to form a successful generative model.

After review these conditions, the possibility of product to be built its generative system should has a basic confirmation. Although these conditions probably cause the contradictions from each other, for example, sometimes the unity of idea variants or rich relationship resource means high restriction of idea development, but designer needs to balance these conditions while building the system to keep the system work as he expects.

3.2 The generative model

Several models mentioned about the generative model, the core of a generative system, and it is the most difficult part in the building process. The generative model can be expressed in different way depends on the programming tools, and usually presented as a parametric model. The visual programming tool provides more logic judgmental and computational function, and enables generative model to overcome a parametric model.

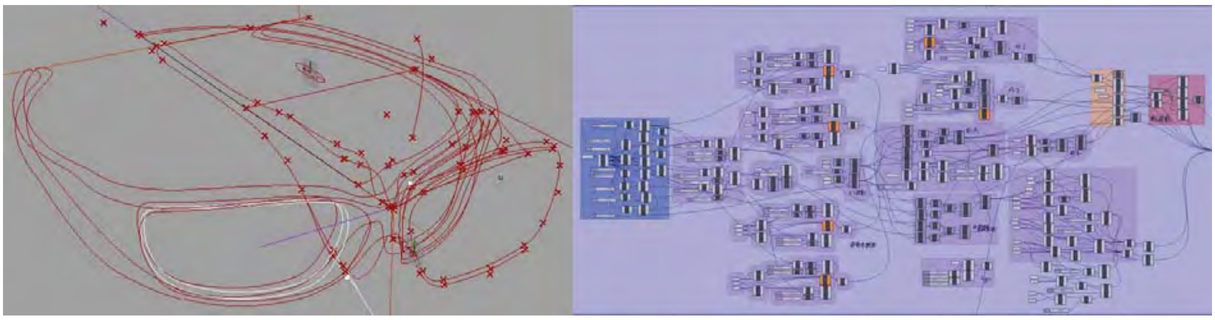

Fig 5: The generative model of sunglasses product and its visual program in Grasshopper.

The generative model is a prototype that has the potential to evolve into variants under the generative mechanism step by step. The steps to build the generative model are very similar to the most modelling process in product design, but every step is programmable and parameterized, and able to connect several optional steps. Therefore, when designer builds the model, he needs to consider about all possibilities in every step, and every step must be very fundamental and necessary. That makes building generative model becomes a time-consuming task and requires an interdisciplinary background combines both design and programming ability.

The knowledge resource of a product should be analyzed, classified and organized before building generative model. The engineering information can help guild the connections rapidly at the same time.

(1) Ergonomic: Most product are involved with the human and using behaviour, and the dimensions of human body are the best materials to applied on setting the optimized feature size of generative model. The dimension usually indicates a direct geometric relationship between components. For example, the 3 points of a bicycle, the seat, handle and the lowest point of gear cycle decides the performance of riders, and their geometric relationship and range are easy to transit into the parameters and input range of generative model.

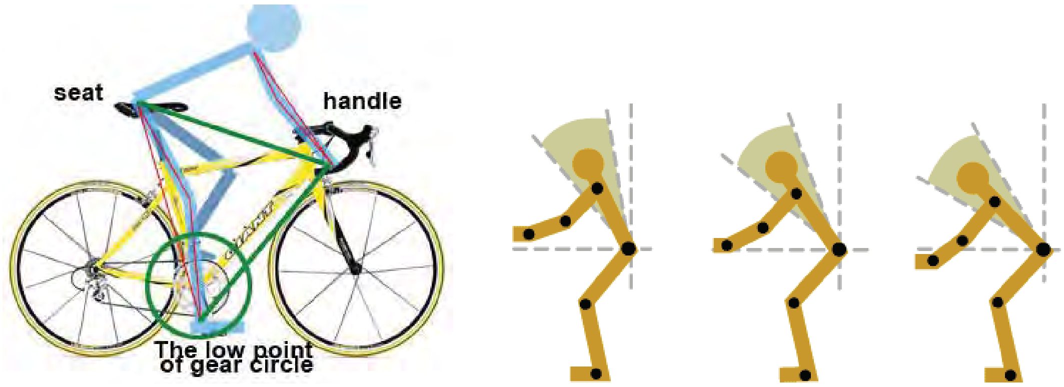

Fig 6: The 3 points of a bicycle riding ergonomics and 3 ideal poses.

(2) Manufacturing and materials: Many limitations and rules come from the manufacturing and materials, although the information probably won't be considered in the concept stage, but sometimes they can prevent the system generates the wrong results can't be made or cost high. The maximum casting size or the material thickness are available information to be integrated into the generative model and improve the feasibility of result.

(3) Component placement: In most product design cases, especially related to the electronic device or electric machinery, the placement of inner components is an important issue between engineer and designer. The engineering task is also easy to be defined into the generative model by algorithm and can be developed into a smart arranging AI to match different considerations. For example, the generative model can give several arrangements based on a tiny or comfortable-to-use placement.

(4) Frequent used preference: During designing product feature, designers usually has their unique method to sketch in their style, and they have their order and curve preference depends on the component placement or product language. The information of product requirements forms the input before designer's sketching and the output they react is their sketch. We can regard

the sketching behaviour and thinking as a sub generative system, and the sub system can be predefined as a macro instruction and can be applied in different generative system or design cases.

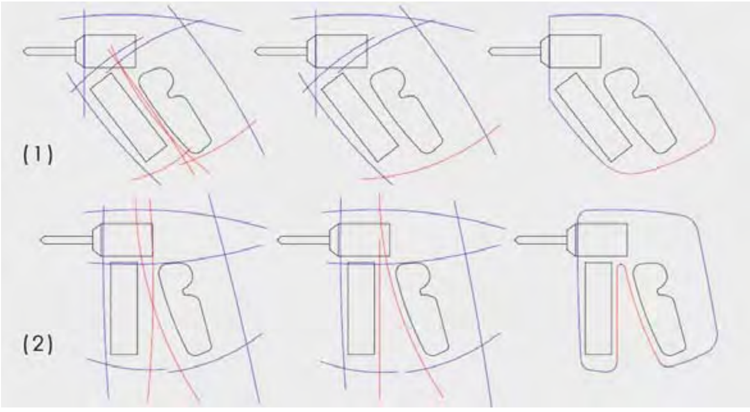

Fig 7: A programmed procedure to generate sketch for power tool design.

Many visual programming tools equip the modelling script functions, and can program above engineering knowledge or parametric preference into a packaged command or macro. The concept is very similar the program tool of Information Technology, and designers don't have to start a generative system from zero and save time to focus on the creative task of a design.

4. The Reversing Analyze from the Sketch

Although the above skills are provided, it's difficult to start building a generative system under a blur notion for most designers, because the way to build the system may very different for other purposes from the demonstration. The designers need a visual tool, and the idea inspired us to combine the traditional concept stage into the building system to help the early stage of setting generative model.

This method requires designer to develop at least 3 to 5 idea sketches in a case, and these sketches should qualify the requirements of product framework's complexity and unity in the 3.1. Every component, parameter and framework of product should be identified from the every sketch, and define their range and relationship. According the sketches, the designer can build a parametric model includes these factors and can transform into each one, then their difference in the parametric input range and feature setting can be recognized. We will use the 3 to 5 sketches to present different types in the designer's mind and construct a multi-dimensional solution map for topological controls. Then we can extract other solutions from the map for evaluation or improve the map structure.

4.1 Pilot sketch

The sketch is always the first choice for a designer to express ideas rapidly. Before the designer start the sketch, he already considered many details and express his concern in the drawing. If we could recognize and list all rules in the designer's mind, that would be dozens. Therefore, we extract the critical factors only from the sketch, and use them to be the reference of building generative model.

These sketches are required to be distinguished from each other and present a unique and classical type among ideas. But they should equip the same framework or product architecture. In this case, we use a set of sport sunglasses to present the designer's ideas, and the 5 types present the different functional consideration as the *Fig 8*.

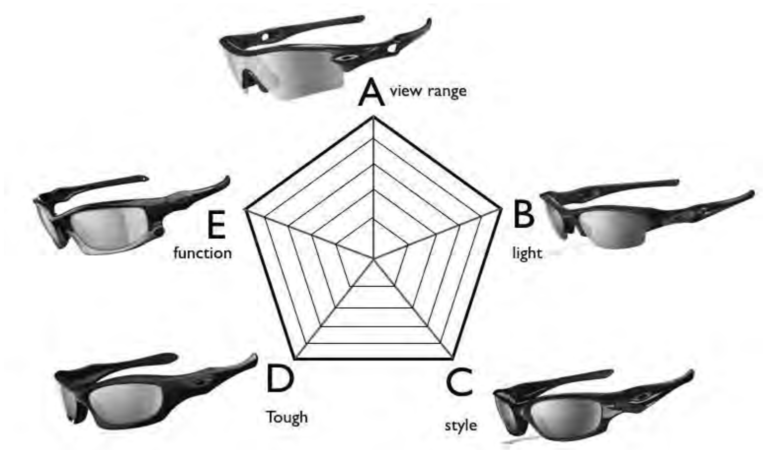

Fig 8: A multi-dimensional idea map that constructed by 5 different types of ideas.

4.2 Reversing analyze and definition

Then we analyzed the 5 types to figure out their difference of DNA, and evaluated the possibility to build the generative model for them. We listed every component and their property as *Fig 9*, and whole product includes almost 50 events. These ideas almost have the same framework and easy to build a model that can transform between them. But we found the Type A has a unique option between lens and frame, and we needs to create another model for it. We built the generative model in the grasshopper, and identified all property value range.

Fig 9: A multi-dimensional idea map that constructed by 5 different types of ideas.

4.3 Multi-dimensional solution map and topological extraction

We used the 5 types to be the corners of a pentagon and constructed a pentagonal multi-dimensional solution map with the generative model. Inside the solution map, every point has a coordinate that can be calculated by the algorithm. The coordinate will get a whole set of property data of product after decoding, and generate a new variant. An interface was designed as *Fig 10* to show the solution map and the solution image that is extracted from the map. The designer can move the extracting point on the map to search the solution efficiently, and the view window will display the 3D image of the extracted solution after decoding.

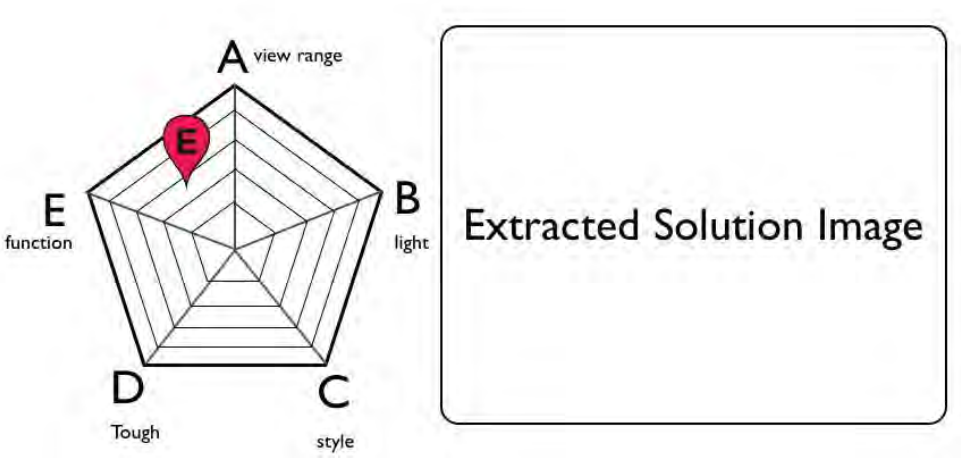

Fig 10: An interface of topological extraction on the multi-dimensional solution map.

Due to the map is 2D, every point is located at the area between 2 types and equips the feature combined the types only. Another 3D map was developed in our research for the extraction for multi-combination as the *Fig 11*, and the pentagon map become a square drill with the 5 corners.

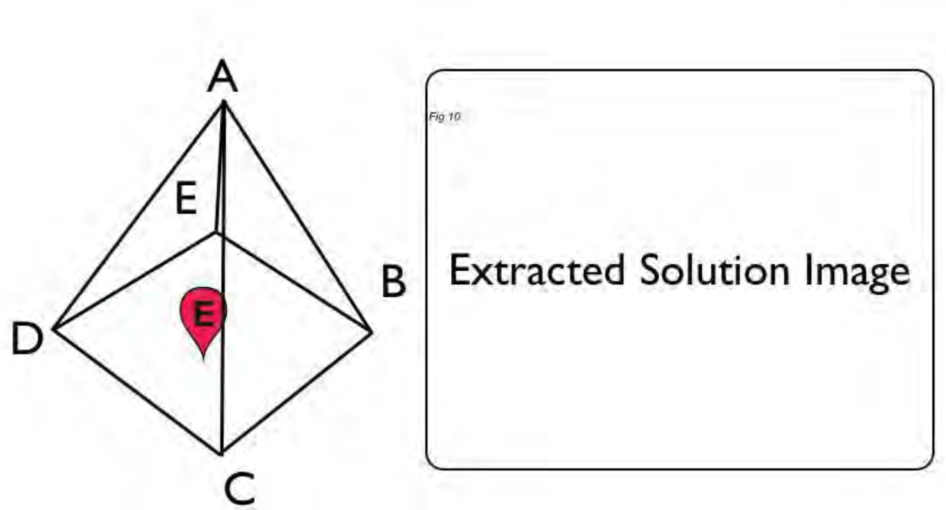

Fig 11: A 3D multi-dimensional solution map.

5. Discussion

The operation of multi-dimensional solution map and the topological extraction are still in our experimental stage to verify its function in the navigation of solution space. The extracted solutions are evaluated for their value and creativity to inspire the designer. The generative system is famous by its solution productivity, but the huge solution space becomes another issue about the navigation and designer is confused inside. The map can present easily the solution space by visual idea types and designer can search rapidly the solution that matches the condition in his mind.

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Paper: Dutch FUSION Architecture: Regionalism or Globalism?

Topic: Architecture

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Abstract:

This article is part of a research project to study Dutch architecture through the 20th century and until now with regard to regionalism and globalism. This research is carried out by means of project analysis.
This article discusses two projects recently built in The Netherlands and classified by Wilfried van Winden as Fusion architecture . Van Winden's Fusion does not refer to Asian experiments on fusion architecture; it only refers to Dutch experiments. The aim of this article is to understand what fusion architecture means and to understand whether it belongs, even if partly, to the realm of regionalism or globalism. Since people looking at these buidings mostly recall a Disney theme park (a globalist process), we introduce Disneyism and its dimensions as defined by Alan Bryman, to see whether indeed it presents similarities with Van Winden's Fusion.
The first project is Wilfried van Winden's Inntel Hotel in Zaandam. Soeters, who is responsible for the Inverdam revitalization project of Zaandam centre, invited Van Winden to design the Inntel Hotel, an eye-catching building in the heart of this town. As presented in Dutch Profiles: Soeters Van Eldonk Architects, Soeters' intention is to "design buildings in such a way that they reinforce the local identity and that they allow you to recognize where you are." At a first sight, one might say that it is a kind of picturesque regionalism. This project is the first and last illustration in Van Winden's monograph Fusion.
The second project is Geurst's Le Medi in Rotterdam, which is one of Van Winden's prominent examples. Le Medi is a housing complex following principles of a (sanitized) Moorish-Moroccan housing complex. Van Winden's monograph also starts and ends with illustrations of this project, which does not strictly follow Soeters' idea to reinforce the local identity since it refers to other countries, and tries to reinforce the identity of the people (many of whom are not originally from The Netherlands) who currently live in the area.
The article's main questions are: would Fusion provide theoretical ground and design tools toward a possible non-homogenized world (regionalism)? Is Fusion indeed a new strategy or tendency in architecture, or is it a kind of Disneyism disguised under a new name (globalism)?
Last but not least, this article questions the essence of this theoretical approach by describing and comparing the strategies taken by Geurst & Schulze in their Le Medi and Van Winden in his Inntel Hotel using both Van Winden's Fusion and Alan Bryman's Disneyism strategies.

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Keywords:
Fusion architecture, Disneyism, Globalism, Regionalism, diversity, multi-cultural society, theming

Dutch FUSION Architecture: Regionalism or Globalism?

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Premise

This article is part of a research project to study Dutch architecture through the 20th century and until now with regard to regionalism and globalism. This research is carried out by means of project analysis.

This article discusses two projects recently built in The Netherlands and classified by Wilfried van Winden as Fusion architecture. Van Winden's Fusion does not refer to Asian experiments on fusion architecture; it only refers to Dutch experiments. The aim of this article is to understand what fusion architecture means and to understand whether it belongs, even if partly, to the realm of regionalism or globalism. Since people looking at these buildings mostly recall a Disney theme park (a globalist process), we introduce Disneyism and its dimensions as defined by Alan Bryman, to see whether indeed it presents similarities with Van Winden's Fusion.

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Last but not least, this article questions the essence of this theoretical approach by describing and comparing the strategies taken by Geurst & Schulze in their Le Medi and Van Winden in his Inntel Hotel using both Van Winden's Fusion and Alan Bryman's Disneyism strategies.

1. (Dutch) Fusion Architecture

Wilfried van Winden's monograph entitled Fusion is intended as a "plea for a gracious architecture" in an open (Dutch) multi-cultural society. This multicultural society includes non-European minorities (and their first and second generations) from countries such as Turkey, Morocco, Suriname, Aruba and Indonesia. Fusion, argues Van Winden, embraces the numerous cultures and religions with the hope of creating an open society with a harmonious future for all citizens.

Van Winden believes that this open society does not need many architects imposing their aesthetics on a place, but architects who reflect on features of the place and the people who will inhabit the area of intervention. Fusion architecture reflects the way an individual and a group want to present themselves. Fusion, argues Van Winden, builds on where post-modern thinking left off and envisions a kind of diversity wherein numerous truths may coexist.

Backing such a society, the architect should make use of diverse styles according to the desire of the client and/or the atmosphere that the architect would like to create. Van Winden affirms that one must consider the connection of characteristic architectonic elements of the past or other cultures to come to a new expression. In so doing, Van Winden considers the production of buildings which makes it possible for people to identify with them.

Fusion architecture, says Van Winden, refers to an inventive mix of identities, of past and present, tradition and innovation, high and low culture. In fact, the critical regionalists had already made such references. However, in contrast to Fusion, Critical Regionalism is critical of both regionalist and globalist forces. For fusion architects, it seems that the "atmosphere" plays too substantial a role to allow them to be critical.

Van Winden argues that Fusion responds to the demand for diversity and recognition or familiarity, or, as the critical regionalists would say, over-familiarity: the picturesque.

Besides the above mentioned descriptions of what Fusion architecture means, no clear strategy is given as to what direction to take in order to produce this architecture. This paper tries to uncover the strategies for this new expression by analyzing the above mentioned two projects. And because we have a hunch that Fusion architecture has either similarities to or is just another word for the less "gracious" term Disney architecture, we mostly use the systematic research of Alan Bryman on Disneyization to analyze the projects.

2. Disneyism

Disneyization refers to the spread of principles exemplified by Disney theme parks all over the world[i]. Bryman in his *The Disneyization of the Society* argues, "…Disneyization takes up where McDonaldization[ii] leaves off", in particular in what refers to the homogeneous world, the sameness spread all over the world promoted by companies such as the McDonald's fast food chain.[iii] Both are concerned with consumerism; however, McDonaldization is rooted in rationalization and its associations with Fordism, scientific management and bureaucracy. Disneyism's roots are with a post-Fordist world of variety and consumer choice[iv].

Disneyization, says Bryman, is portrayed as a globalizing force and has four dimensions, which are: Theming, Hybrid Consumption, Merchandising and Performative Labor. However, these dimensions are not always fully expressed[v]. It seems that Bryman is particularly interested in the transference of these principles, when these principles are "reassigned to another sphere, such as a shopping mall"[vi].

Bryman avoids the term "Disneyfication" or "Disnification" because it has been too often used and discussed in a very narrow way, meaning mostly theming and hardly ever in an investigative, systematic manner. According to Bryman, "To Disneyfy means to translate or transform an object into something superficial and even simplistic". He quotes several authors to clarify how the term "Disneyfication" has been used, such as the author R. Schickel. The latter affirms that Disneyfication means "that shameless process by which everything the Studio later touched, no matter how unique the original from which the Studio worked, was reduced to the limited terms Disney and his people could understand" [vii]. The article will not avoid the term Disneyfication when referring to theming when it is appropriate, but will mostly follow the systematic approach of Bryman.

With these general definitions, the article discourses on whether the strategies and processes used in the following two cases, considered by Van Winden as Fusion architecture, are no more than cases of a Disneyization of architecture or whether one could call it either regionalism or globalism.

2.1 Theming

Theming consists of the application of a narrative to institutions or location. According to Bryman, "the source of the theme is external to the institutions or object to which it is applied."[viii] On Bryman's list below, one can see several sources which architects often draw upon: a. Place – nations, cities or even planets; b. Time – past, present and future; c. Sport – sport generally, as well as individual sports; d. Music – rock music and genres, such as Motown or country and western; e. Cinema – movies generally, as well as particular genres or influential figures; f. Fashion – clothes and models; g. Commodities – such as cars and motorbikes; h. Architecture – iconic buildings; Natural world – symbolic natural environments, such as the rainforest and savannah, as well as volcanoes; i. Literature – well known literary figures, such as Sherlock Holmes, Jekyll and Hyde, as well as fairy tales; j. Morality or philosophy – such as notions of conservation.

Often, says Bryman, a theme relies on more than one source. He gives the example of Las Vegas casino hotels using four sources to represent and reinforce the Wild West theme: a) elements of place (USA); b) time (a period in the past); c) cinema (cinematic version of the Wild West); and d) the natural world (the use of landscape features such as John Ford's use of Monument Valley).

We find the list quite comprehensive, except with regard to the source listed as Architecture. "Iconic building" seems to be too abstract to be a source. A building is iconic when it contrasts with its surroundings: be that its height, colors, materials, structure and/or form; therefore, an iconic building depends on the place (source) where it is built. A building which is iconic in one location would not necessarily be iconic in other location. In this sense, an iconic building is more a theme than a source and it may rely on other sources through a metaphor.

The above list covers diverse areas, but it covers numerous typical American sources. We believe that a look at other places and cultures would enrich the list with other sources.

2.2 Hybrid consumption

Hybrid consumption is, according to Alan Bryman, a "general trend whereby the forms of consumption associated with different institutional spheres become interlocked with each other and increasingly difficult to distinguish. What we end up with under hybrid consumption are de-differentiated forms of consumption in which conventional distinctions between these forms become increasingly blurred to the point that they almost collapse."[ix]

Forms of consumption are shopping, visiting a theme park, eating in a restaurant, staying in a hotel, visiting a museum, going to the cinema, playing or watching sports, gambling in a casino, etc. Disneyism refers to Globalism with consumption as a common denominator.

2.3 Merchandising

Bryman defines "merchandising" as "the promotion of goods in the form of or bearing copyright images and logos, including such products made under license" [x]. That could be t-shirts or mugs bearing logos. It is closely related to "hybrid consumption", because its products can be part of a hybrid consumption system.

2.4 Perfomative labor

Perfomative labor, says Bryman, is the "Rendering of work by managements and employers alike as akin to a theatrical performance park". It is a metaphor of the theatrical performance such as the terms cast members, auditioning, onstage, and backstage. "Work is a theatre" [xi].

3. WAM's Inntel Hotel, Zaandam, The Netherlands, 2006-2010












The Inntel Hotel (2006-2010) was designed by Wilfried van Winden from "WAM architecten" and the interior architect was Feran Thomassen. The Inntel Hotel is located at Provincialeweg 102, Zaandam, The Netherlands, near the train station and 16 minutes travel from Schiphol airport[xii].

The building, with its 7500 m^2 distributed in its 12 floors and bridge, has 160 guest rooms, and also has meeting and conference rooms for up to 300 persons, a bar-restaurant, a swimming pool, a Finnish sauna and a wellness center[xiii].

As mentioned above, the Inntel Hotel is part of a revitalization program carried out by Soeters in the city of Zaandam. Soeters' scheme was meant to reinstate the historical street layout, reopen a canal and restore an atmosphere of congeniality. In addition, he also designed the town hall of Zaandam using patterns of Zaandam vernacular houses, aiming to reinforce the local identity (theme).

Van Winden's hotel is used as a Fusion architecture illustration at the beginning and end of Van Winden's monograph *Fusion*.

3.1 The idea

Van Winden followed the theming sources used by Soeters which are that of place (traditional vernacular houses of the region), and time (past); in addition, he used a metaphor as a source of his design: "the hotel as a temporary home." There is also an acknowledged secondary source, art, which can be seen by the reference to Claude Monet's blue house ('het Blauwe Huis') painted in Zaandam in 1871.

The metaphor "The hotel as temporary home" might have brought Van Winden to the idea to use these houses, in their own scale, as the "temporary home".

3.2 The translation

The Hotel is mainly composed of a cube, bridge and traditional Zaans houses. The vernacular houses are sometimes ornaments cladding the building like a collage, and at other times the houses become elements interlocking with the cube in numerous ways, either enlarging the size of the rooms or creating space for small living rooms adjacent to the bedroom. The so-called Albert Heijn room, on the 12th floor, has a nook in one of the vernacular houses.

The building is a straightforward quotation of 70 vernacular Zaans houses' facades from the worker's to the notary's house stacked and interlocked into each other and as such it does not go beyond more than a playful atmosphere created by a sentimental use of traditional houses.

The interior of the building designed by Thomassen follows the same themes of place and time. Images of the past are used in great prints in a tribute to the pioneers, industrialists and businessmen who started their careers in the area as well as to the industries themselves such as Verkade, Duyvis, Honig, Lassie and the supermarket chain Albert Heijn. In the reception, a giant print of a windmill stands as a reminder that Zaandam was once the first major industrial area of the world, possibly due to the invention of the wood mill at the end of the 16th century[xiv]. On the ground floor, separating the reception and the restaurant, there are partition walls resembling in colors, materials and patterns the facades of the vernacular Zaans houses.

3.3 Reflection: Fusion or Disneyism?

Van Winden applies a narrative to the location and its history by stacking traditional vernacular houses. As mentioned above, the theme sources are those of place, time and the metaphor "the hotel as a temporary home". The straightforward use of the houses of Zaandam brings the atmosphere of a picturesque regionalism, or to be more precise, a banalization of regionalism, hence, of a "Disneyfication" of the traditional houses (and life) of the region. There is no place for criticism in the quotation of these traditional houses; in fact, workers mostly lived in poverty and their homes were in decay; but what Van Winden used is only the nostalgic, sanitized and picturesque view of the past or just the creation of a pleasant atmosphere: a fairy-tale.

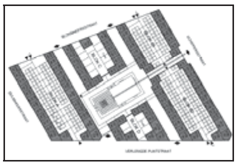
With regard to Hybrid consumption, Soeters, in the Dutch Profiles, says that to make the centrum of Zaandam successful he needs to concentrate facilities. As Bryman argues, "Hotels are often at the heart of hybrid consumption settings because the bigger they are, the more likely it is that people will be prepared to stay longer…"[xv]. The Inntel Hotel is the central point where all these kinds of consumption intersect one another. The hotel allows people to stay longer and thus consume more.[xvi]

Van Winden argues in an interview[xvii] that "the building is unique in the world because it is recognizable, yet original and sassy". In fact it is only becoming recognizable worldwide because it relies on touristic propaganda[xviii] of what is promoted as “typically Dutch” outside Holland. As far as its originality is concerned, that should be looked at again because Soeters built the city hall (2004-2009) earlier, making an interpretation of the same precedent, changing its scale and abstracting some details, while Van Winden stacked whole pieces of houses on one another.

In some ways, the building has iconic characteristics which can be easily used as merchandising material to attract tourists who want to experience the Holland of the past in an uncritical manner. All in all, the recognition is an instrument in the marketing.

The project does not manifest any perfomative labor of the kind in evidence in a Disney park. However, as Bryman mentions in his “The Disneyization of Society”, often institutions do not make use of all four dimensions of Disneyism.

4. Geurst & Schulze’s Le Medi, Rotterdam, 1999-2008



Le Medi (1999-2008) is a housing complex designed by Jeroen Geurst from Geurst & Schulze Architecten and assisted by Korteknie Stuhmacher architects. The project involved a multidisciplinary team including dS + V[xix], Woonbron[xx], Stichting Com.wonen[xxi], Delfshaven[xxii], the municipality of Rotterdam, One Architecture and XS2N.

Le Medi is located in Bospolder, Rotterdam, surrounded by four streets: Schippersstraat, Blokmakersstraat, Zeilmakersstraat and Medinastraat (see illustration above). It has a gross floor area of 15,552 square meters[xxiii] and contains 93 dwellings and an indoor parking garage on the ground floor[xxiv] behind the houses of Blocks A, B1 and B2 (see illustration below). The house size ranges from 105 m^2 to 155 m^2. There are several types of houses; all types have a flexible layout and may be extended in the future. The types include units with a private garden, houses with a terrace (above the garages), port houses, and houses with a terrace in the central courtyard.

This complex was used twice in Van Winden’s *Fusion* to illustrate what fusion architecture means.

4.1 The ideas

Its initiator was Hassani Idrissi and initially it had no precise location. Only at a later stage, this Mediterranean housing scheme became part of the urban renewal district Bospolder replacing three former blocks.

There were several objectives reflecting the parts involved in the process, the main objective being to revitalize the neighborhood.

Economic ideas: to make the area attractive for inhabitants with a middle-high income and higher education as well as to make the area attractive for the current inhabitants of a growing purchase power to remain in the neighborhood.

Ethnic ideas: to create housing complexes which mirror the multicultural population of Rotterdam. *One Architecture* together with *XS2N* “studied the possibilities for introducing Mediterranean living cultures in the Dutch city, as a way to reflect the growing ethnic diversity of the Netherlands”.[xxv]

Design ideas: to create a local identity using Moorish-Moroccan elements of architecture to express the ethnic ideas and accelerate economic developments in the neighborhood.

4.2 The translation

According to the “Kenniscentrum Stedelijke Vernieuwing” (KEI), the team involved in the development of the Le Medi selected the following set of design issues to be expressed in this “modern” Moorish-Moroccan housing scheme: a. Walled city: safety and rest; b. Water in the central space; c. Ports for access; d. Semi-private streets; e. Colors and materials.

And in addition: a. Possibility to extend the house; b. Facilities on the ground floor; c. All house types have a free plan or variation possibilities for the infill [xxvi] of the houses.

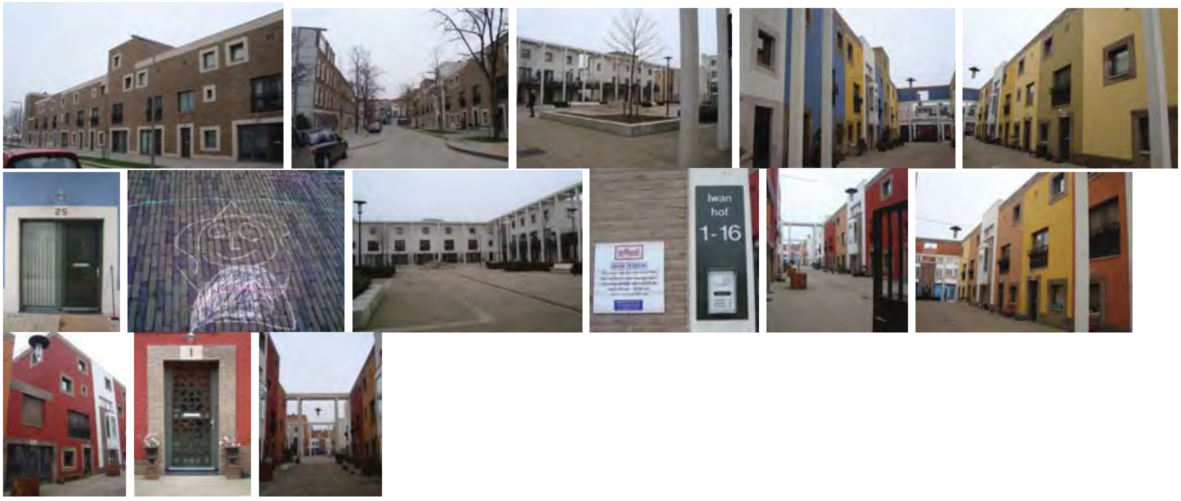
The Moroccan “walled city” is the metaphor guiding the project aiming to offer safety and rest. Contrary to the above set list, Geurst, in the interview “Dutch Profiles,” affirms that he tried to avoid the idea of a “gated community”. He preferred to refer more to Dutch Courtyard houses which have their gates open during the day and closed at night. It seems that Geurst recognized the risk of designing a housing complex which could become stigmatized in the near future or considered sham architecture. It might also be that by compiling this set list he realized that Dutch Courtyard houses also show this characteristic, and thus one did not need to look so far from home.

This “walled city” is accessible via five ports. The main port is on Schippersstraat. This “Moroccan” port is here transformed to avoid an overdose of iconography[xxvii]. The original horseshoe section is transformed into a parabolic section. It leads the person towards the geometric, symmetric square with a fountain in the middle. Two secondary ports face Blokmakerstraat and the last two face Medinastraat.

Iwanhof (Iwan Court) and Agadirhof (Agadir Court) are in fact two small streets and they could be seen as the continuation of one another. Iwan Court starts at a port which gives access from Medinastraat; and Agadir Court starts at the port which provides access to Blokmakersstraat; Iwanhof and Agadirhof meet each other at the east side of Oasis Square.

Kasbahhof, parallel to Agadirhof, is accessed via the second port that gives access to Blokmakersstraat and ends at the west side of Oasis Square. The last port, the second at Medinastraat, gives immediate access to the west side of Oasis Square.

The houses of these “courts” are bright and colorful, with Iwanhof and Agadirhof in red, white, and orange, and Kasbahhof in yellow, white, and green.



These Courts were previously public streets giving access to the house-units of the three demolished blocks. Nowadays the streets are semi-public areas and access is for pedestrians only. During the evenings and on Sundays access is for residents and their visitors only.

The housing complex is designed as a building block or urban assembly to fit in its direct environment, having houses facing the public streets.

Garages are provided on the back of the houses and accessed via Blokmakersstraat and/or Medinastraat. On the ground floor, the house type adjacent to the garages has one room which can be used, for example, as an atelier or a lounge-kitchen (woonkeuken). The living rooms are on the first floor and the back yard is raised above the garage.

Le Medi relates to the outside world as a block surrounded by extant blocks by size, colors and materials.

4.3 Reflection: Fusion or Disneyism?

From the interviews that Sabine Meier conducted with the inhabitants of Le Medi, it became clear that the second and third generation of immigrants (70% of the inhabitants) are more interested in safety and comfort than living in a themed neighborhood[xxviii]. The Dutch autochthones are those who appreciate the reference to other cultures and enjoy it and find it authentic.

This Moorish-Morocco project symbolically aims to reinforce the multicultural society of Rotterdam, having the theme sources of place and history. Geurst shows a concern in not producing a pure décor or architecture with no meaning. He uses colors and ornaments from Mediterranean countries, but shows also a concern in limiting iconography such as with the use of a horseshoe shape as the Arabic Port for Le Medi Ports. In fact, he preferred to refer to the urban Dutch Port which marks the entrance of a neighborhood (Amsterdam School)[xxix].

Exotic houses attract the consumer. The municipality, the district, housing corporation and association are working together in the revitalization of the area of Le Medi. The building of exotic houses and environment is a way to “invite” the growing local middle class to stay rather than moving out of the city. These powerful purchasers will consume more in that neighborhood and prevent the area from sinking into decline. The house complex is placed in an area which, when safe and restful, may be attractive due to the facilities and services around it. In other words, the house complex is placed on the central point of a hybrid consumption system.

Metaphors are also used in the marketing of these houses. But despite the fascination created due to theming, almost every respondent of Meier’s interview cites the branding a "sales gimmick" such as the use of the metaphor of Oasis, a place which offers protection in the middle of an “inhospitable” environment; the desert (Bospolder-Tussendijk); or the North-African Kashba: romantic, aesthetical and sanitized North African houses which with their bright colors remind the buyer of their sunny vacation destinations.

However, this Moorish Moroccan image, different from others in the regular housing stock alongside the services and facilities on offer (private garage, market, public transport), might play an important role in their merchandize system.

Also in this case there is no interest in using performative labor. Perhaps in this project there is even a certain aversion toward it since it could stigmatize the area.

5 Comparison and Insights

Do these projects (and not the architect’s oeuvre) use the same strategies?

Theming is carried out at the **Inntel Hotel** using a tinkering strategy (stacking and interlocking the traditional vernacular houses of Zaandam); and it is done with no critical consideration, or, in other words, with the banalization of the history of the region in the past; while theming is carried out at **Le Medi** through the recollection of characteristics of diverse places as well as the (slight) transformation (main port) and recombination of these characteristics[xxx]. The Le Medi strategy left open the possibility of combining with modern techniques and modern references such as the variations of plan layout which are reminiscent of Le Corbusier’s free plan and John Habraken’s SAR method.

Using Bryman’s Disneyism as an analysis tool, it becomes clear that the two projects have some notable differences. So, one might see that theming is done at the facades and interior of the **Inntel Hotel** while theming is kept inside the urban assembly of **Le Medi** housing scheme.

Theming at the Inntel Hotel does not support any extraordinary functional innovation. The hotel, functionally, remains an average hotel Disneyfied for contextual and economic reasons. **Theming at the Le Medi** also shows a sanitized view of the actual Medinas. However, its composition seems to offer the rest and safety promised to the buyers as well as flexibility and adaptability which is essential in modern societies. One may say that it seems to be more meaningful than the Inntel Hotel. However, if Dutch cities were to be populated by these housing schemes, the country would sooner or later be transformed into a Magic Kingdom with its Main Street connecting all its little kingdoms, many with gates which would be closed during night time. In other words, it seems clear that if this practice becomes generalized, the city will lose in its publicness and, in a drastic scenario, the city would become fragmented into ghettos instead of reaching the desired harmonious multi-cultural society.

The Inntel Hotel, in a sense being an iconic image (when disconnected from its urban context), becomes a merchandising instrument attracting tourists eager to experience the cozy Holland of the past in an uncritical manner. The hotel supports another dimension of Disneyism, namely Hybrid Consumption by making possible the prolongation of the stay of consumers on the site with its theatres, restaurants, cinemas etc. **The Moorish-Moroccan** image of Le Medi brings diversity into the regular housing stock. It is meant to attract well educated and high income second-generation Dutch immigrants to remain or go back to the cities and with their purchasing power to improve the economy of the particular neighborhood. In and around the housing complex, the services (such as private garage, markets and public transport together) work as a merchandize instrument.

In the case of theming, the Inntel Hotel uses as its sources place and time, or more precisely, an (autochthone) history of the place. Vernacular Zaans houses are quoted to create a picturesque regionalism, easy to recognize and leaving nothing to the imagination.

However, if we consider the actual (desired) multi-cultural society and match identity with culture, one could say that the Inntel Hotel shows all but not a mix of identities, neither as a building nor in relation to the city. There is only a mix of identities if we match identity with social classes. But then, the identities expressed refer to social classes of the “autochthone” Dutch society in the past; The result is more on tradition than on innovation and seems to be more part of a “light” chauvinism than multi-culturalism.

Le Medi is a design to mirror the multi-cultural society, the identities of immigrants who are currently part of Rotterdam which has 175 nationalities and wants to place this fact in a positive light. Theming in Le Medi has the same sources as the Inntel Hotel, place and time. However, it does not refer to the history of the place Bospolder, but to (historical) places of origin of ethnic groups who currently live in the neighborhood. The precedents of the two projects have a different origin, but both try to define or redefine the local identity.

It is interesting to note that the use of Moorish-Moroccan characteristics is not so far from some typical Dutch configurations as the Dutch “hofjes” (courtyards, such as

Begijnhof in Amsterdam). Also the port, which in Le Medi was intentionally not so iconographic as it could have been if it had the section of a horseshoe, is also seen in Dutch neighborhoods; and the free plan, the possibility to extend the houses over time and the parking facility as well as rest and safety are all concerns for typical Dutch configurations.

The ornaments are typically Moroccan, but the site configuration is also found in The Netherlands. Hence, Le Medi deals with the multi-cultural society in Rotterdam but is also concerned with a kind of integration of the groups avoiding the possible stigmatization of the area.

Do these projects belong to a Fusion or Disney architecture? Fusion shows few aspects of the designs because it considers neither the four dimensions of Disneyism nor other systematic approaches to precedents (theming sources) and it does not provide tools to work with themes (recollection models). Thus, if it is used with no criticism, it could be compared to Disneyfication. All in all, Fusion seems to be an unnecessary “new” term. The gracious architecture can be analyzed in depth in all its dimensions using the systematic research of Alan Bryman on Disneyism.

Bryman’s tools were used in the analysis and comparison of the strategies taken during the design process of these two projects and showed that these two projects belong to the realm of Disneyism. However, the design composition, the method of recollection of precedents (quotationism and syncretism) and the use and adaptation of the precedents were carried out in different ways.

According to the results of these two cases, one would say that even when Fusion expresses a regionalism, involving history and identity, it is often a banalization of regionalism. Its characteristics concern a Disneyization of the architecture, and therefore, it is in the realm of globalism.

6. References

[i] Though very well exemplified by Disney theme parks, says Bryman, it precedes the constructions of the parks. Alan Bryman in his The Disneyization of the Society avoids the use of the term Disneyfication because this term became a straightforward synonym for shallow products, which makes it difficult to analyze the phenomenon in a neutral tone.

[ii] Ritzer, G. 1993. The McDonaldization of Society. Thousand Oaks, CA: Pine Forge (quoted by Bryman)

[iii] However, Bryman goes back in saying that there is also a kind of Disneyization allied to the McDonald Company.

[iv] Alan Bryman, 2004. The Disneyization of Society. India: Sage Publications Inc. p. 13

[v] Alan Bryman, 2004. The Disneyization of Society. India: Sage Publications Inc. p. 175

[vi] Alan Bryman, 2004. The Disneyization of Society. India: Sage Publications Inc. p.12

[vii] Schikel, R. 1986. The Disney Version: The Life, Times, Art and Commerce of Walt Disney, revised edition, London: Pavilion (quoted by Bryman)

[viii] In disneyfication, theming has been criticized as being a shallow version of reality, from the literature or any source that has inspired it. It is a “sanitized” or “trivialized” version of their source. (pp. 5-10)

[ix] Alan Bryman, 2004. The Disneyization of Society. India: Sage Publications Inc. p. 57

[x] Alan Briman, 2004. The Disneyization of Society. India: Sage Publications Inc. p. 79

[xi] Alan Briman, 2004. The Disneyization of Society. India: Sage Publications Inc. p. 103

[xii] "Het Inntel hotel Amsterdam Zaandam ligt op een absolute toplocatie vlakbij het NS station in de historische stad Zaandam. De directe treinverbinding brengt u in 12 minuten naar Amsterdam Centraal en in 16 minuten naar Schiphol" (http://www.hotels.nl/nl/zaandam/inntelhotel/).

[xiii] "Het is eigenlijk meer een uitgestrekt complex dan een gebouw. Het beslaat 7.500m2, is 12 verdiepingen hoog en herbergt 160 hotelkamers. Het tweede wat me opvalt, is de slordige afwerking. Behoorlijk wat dode hoeken, loze muren en andere onvolmaaktheden. Vorm volgt hier duidelijk niet functie. Het derde opvallende element is de locatie zelf. Wie verzint het om hier in Zaandam zo'n enorm hotel neer te zetten? Het gebied rond het station is een tamelijk troosteloos gebied: halfbakken, verloren industrie in een scheefgegroeid provinciestadje. Wanneer een toerist kan kiezen tussen dit, of een hotel aan de Prinsengracht in Amsterdam, dan kiest hij toch liever voor het origineel?" NAi, HEILIGE HUISJES, Opinie, Architectuur en stedenbouw, Jorn Konijn, 21-04-2010 http://www.nai.nl/content/681004/heilige_huisjes

[xiv] InntelHotel Folder: "Slapen in een Historische Setting!"

[xv] Alan Briman, 2004. The Disneyization of Society. India: Sage Publications Inc pp.67-8

[xvi] In a capitalist society, these activities do not seem to have a direct negative influence on the whole, since they do generate jobs and sources of income for the inhabitants.

[xvii] Inntel Hotel Folder: "Bijzondere architectuur met gestapelde Zaanse Huizen

[xviii] An already existent merchandise of Holland associated with its traditional houses, tulips and windmills

[xix] The name is used as shorthand for "Town Planning and Housing"

[xx] Woonbron is one of the largest housing corporations in the Netherlands and works in the South Wing of the Randstad. Woonbron serves some 50,000 households. htpp://www.woonbron.nl/

[xxi] Com.wonen is a housing association with over 31,000 homes. http://www.comwonen.nl/

[xxii] Delfshaven is a district of Rotterdam on the right bank of the "Nieuwe Maas" River.

[xxiii] htpp://wwww.architectuur.nl

[xxiv] KEI Centrum - http://www.kei-centrum.nl/

[xxv] One Architecture: http://www.onearchitecture.nl/projects/le_medi/

[xxvi] As proposed by John Habrakens in for example: *Supports: an Alternative to Mass Housing*, U.K., Urban International Press, Edited by Jonathan Teicher. Reprint of the 1972

[xxvii] Meier, S. 2009. "Le Medi: Mediterraan gevoel te koop in Rotterdam. Over de aantrekkingskracht van gethematiseerde woningbouw voor de nieuwe stedelijke middenklasse". Sociologie, jg. 5, nr. 2, pp. 277-299

[xxviii] Sabine Meier and Arnold Reijndorp. 2010. Themawijk, wonen op een verzonnen plek. Bussum: Thoth publishers

[xxix] Sabine Meier and Arnold Reijndorp. 2010. *Themawijk, wonen op een verzonnen plek*. Bussum: Thoth publishers

[xxx] About the use of design precedents: K.Moraes Zarzar. 2003. *Use and Adaptation of Precedents in Architectural Design,Toward an Evolutionary Design Model*. Delft: DUP Imprint: Delft University Press; K. Moraes Zarzar and A. Guney (edts.). 2008. Understanding Meaningful Environments: Architectural Precedents and the Question of Identity in Creative Design. Volume 4: Research in Design Series. Amsterdam: IOSpress-Delft University Press

Kevin McGuire

Paper: **A Turing Test for Generative Art**

Topic: Philosophy of Mind

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References:
[1] G.Matteo Codignola, "Generative Recognizable Codes from Gaudi'", Generative Art International Conference, Milan, 2000
[2] Joseph Weizenbaum, "ELIZA — A Computer Program For the Study of Natural Language Communication Between Man And Machine", Communications of the ACM 9 (1), USA, 1966
[3] Alan Turing, "Computing Machinery and Intelligence", Mind, Oxford University Press, England, 1950

Abstract:
When we produce generative algorithms whose output closely matches the style of a particular architect [1] or artist, what exactly is it that we think we are doing? Do we believe we are simply mimicking the architect, producing shallow results that have the surface qualities of the architect but no substance, much as a parrot might speak words [2] but there is no meaning? Is it "mannered"? Or do we believe we are somehow capturing something deeper, a kind of partial working copy of the architect's brain and their creative essence?

How can we even begin to have this discussion?

In the area of Artificial Intelligence, there is the concept of the Turing Test [3] which allows us to discuss when we believe a computer program is behaving "intelligently". The Turing Test is not a real test, but rather a rhetorical framework in which one can disentangle the discussion around artificial intelligence.

We can apply a similar philosophical framework to the problem of generative art. By applying an equivalent to the Turing Test, we can discuss topics like mimicry, forgery, functional correctness, topological similarity, branding, signature style, whether a machine can be creative, and whether a machine can create art.

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Keywords:
Artificial intelligence, imitation, creativity

A Turing Test for Generative Art

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Abstract

When we produce generative algorithms whose output closely matches the style of a particular architect or artist, what exactly is it that we think we are doing? Do we believe we are simply mimicking the architect, producing shallow results that have the surface qualities of the architect but no substance? Or do we believe we are somehow capturing something deeper, a kind of partial working copy of the architect's brain and their creative essence?

How can we even begin to have this discussion?

The Turing Test is a rhetorical framework helpful in disentangling the discussion around artificial intelligence. By applying an equivalent to the Turing Test to the questions of Generative Art, we can discuss topics like mimicry, topological similarity, branding, signature style, whether a machine can be creative, and whether a machine and create art.

1. Introduction

When we speak of generative art in terms of genetic codes [1], it is sometimes not clear how literally we should interpret the notion of genetic content. We understand that by using a generative approach we produce a family that conforms to the rules of the algorithm, a family whose form has origin in the genetic material. But what do we believe we've actually captured in that algorithm?

Codignola [2] demonstrated a system that could produce results that remarkably resembled the work of Antoni Gaudi. What exactly do we believe he did? Was this just a kind of shallow mimicry [3], a surface resemblance to some of the obvious qualities of Gaudi? Or might we consider him to have captured something deeper, something that by so closely mimicking the subject, could be thought to be equivalent to it?

2. The Turing Test

This is a difficult subject to unravel because of all the elements involved: the metaphor of genetics, encoding of form versus encoding of origin of form, perception, objective notions of morphological similarity, subjective notions of aesthetics, the hand of the human who created the generative system, and finally, the role of the artist versus the role of the audience.

These problems are similar in many ways to the problem of discussing whether machines can think. In order to discuss whether a machine can think, one must first define what it means to think; to discuss what it means for a machine to be intelligent, one must define what it means to be intelligent. But these subjects are just as intractable.

In 1950, Alan Turing proposed a thought experiment which he referred to as “the imitation game”, now referred to as the “Turing Test”. There are three elements: the machine, a human subject, and an experimenter. The experimenter is physically separated from the machine and the human subject by means of a keyboard and screen, so that his only interaction is via a set of typed questions and answers. The machine is constructed in such a way as to try to mimic the behaviour of a human. The experimenter does not know whether they are interacting with the machine or the human. The goal is to see whether the experimenter can tell the difference between the two, detect the fact that they’re interacting with the machine. The machine “wins” the imitation game if the experimenter cannot tell the difference.

In so doing, Turing replaces the intractable question, “What is intelligence” by a more tractable one, “Are there imaginable digital computers which would do well in the imitation game?” [4]. Essentially, it merely claims that one can consider the machine to be intelligent if it behaves in such a way as to be indistinguishable from an intelligent being, if it convincingly mimics a human.

3. The Turing Test applied to Generative Art

A direct application of the Turing Test to Generative Art would be to replace “intelligence” with “art”. Thus instead of asking “Can machines think?” we’d ask, “Can machines create art?” But this line of inquiry won’t get us far. While as we believe we can describe intelligent behaviour in terms of it being indistinguishable from that of a human, and in so doing, define intelligence as “that which humans exhibit”, no such definition for art is at the ready, except for the trivial and circular definition “it is the thing that artists create”. That is, we cannot talk about when a machine has sufficiently mimicked the creation of art because we can’t even answer the question for humans.

Instead we’re going to narrow the imitation game to creative output and make the question more tractable. It becomes:

> “Can machines produce artefacts which are indistinguishable from the creative output of a human?”

Indeed, Codignola said with respect to his work on generating form according to Gaudi,

> *The next step was to verify the exact working of the new generative codes by means of 3d scenaries, that are recognizable as "Antoni Gaudì specie's architecture"*

Where “recognizable” is the key for our purpose. To make the discussion more concrete, we’ll pick some specific outputs and humans.

4. Spot the BMW

For this thought experiment, let us suppose that a very clever industrial designer has programmed a generative algorithm to produce different styles of cars. The program consists of a single setting: a dial for different brands of cars. The output is a set of drawings of cars of that brand, minus tell-tale giveaways such as hood ornaments or other emblems.

We set the dial to “BMW”. Do we believe the output can be considered “drawings of BMWs”? Has the program mimicked what a BWM designer does? Who better to ask than the man on the street!

Imagine we take the drawings and mix them in with real studio drawings taken from the design centres of other car manufacturers, drawings for cars not in production. We do this to level the playing field and ensure all the cars are unfamiliar to the subject. We ask passer-by’s which car is the BMW. One might reasonably argue that any inability to spot the BWM may be the fault of the subject (they’re just not good at it), not of the generative machine. Therefore we’ll create a control group which contains real studio drawings from BWM, again of cars not in production. Since the generative machine may happen to produce drawings which match existing cars and it would be trivial for people to spot those, we will similarly remove from the generated set any which are easily identifiable as existing models.

If passer-by’s pick the generated BWM with about the same frequency as the studio BWM from the control group, we can reasonably claim that we’ve mimicked what BMW designers do.

We’ve also captured “What it means for something to look like a BMW”. We claim this because, after all, the concrete purpose of branding is to exactly achieve that reaction: immediate recognition on the part of the public that that artefact is of that brand. Therefore if the general public can’t distinguish BWM designer drawings from generated drawings, we can conclude that the generative system is mimicking BWM designers. This of course is bad news for the designers who work at BMW, since their jobs are no longer required.

4.1 Argument: Such rules cannot be written down

This argument says that we could never construct the generative algorithm in the first place, that what it means for something to look like a BWM can’t be written down. I’ve never worked at BMW, or any other car manufacturer for that matter, but I’m going to hazard to guess that during one’s career at BMW one gets better at designing BWMs. Thus there's some externalized transfer of knowledge from experienced designers to new designers. Did no one think to write it down?

In any event, the same argument might be made for the Turing test, that the rules for intelligent behaviour can't be known. Turing avoids this completely by simply defining the criteria under which we might agree that a machine behaves intelligently without specifying how such a machine might be constructed, although he does conjecture that given advances, such a machine could plausibly be built someday. The same can be argued for the BWM generator. The thought experiment is one of mimicry: if the machine can produce an outward result that is indistinguishable from the human's, we can objectively ascribe to the machine the label of being capable of that behaviour in the same way we ascribed it to the human. In the Turing test it's about intelligence, in our case about design and art.

4.2 Argument: Being a good BWM designer is about more than just producing cars that look like BMW's

We didn't say that we'd produce *nice* BWMs, or ones that could be sold successfully, simply that they'd be recognizable. In Turing terms this might be phrased as, "While we might produce a machine that appears to be intelligent, we wouldn't necessarily want to be friends with it". So we concede that recognisability is a necessary but not sufficient condition. It seems the BMW designer jobs are safe, at least for the time being.

Or are they?

5. Discovered, Gaudi's lost sketches!

For the next thought experiment, we will claim that we've discovered a previously unknown sketch book of Antoni Gaudi (say, buried away in his mother's attic). In truth no such book has been discovered; instead we have a generative system which produces drawings which resemble the work of Gaudi.

In this version of the test, we will send the images from "the sketch book" to an esteemed panel of architectural historians, architects, and other experts. What if they cannot tell the difference? What if they believe these to be images produced by Gaudi himself? In that even we would claim that we've successfully mimicked Gaudi. Who could say otherwise?

We are so pleased to have our Gaudi generator, the first thing we might do (after apologizing to the experts for duping them), is to apply it to the job of completing the Sagrada Familia. How wonderful it will be, that we can finally complete Gaudi's work, *as if he had been there to complete it himself!* [5]

Now surely the work of Gaudi is the culmination of his life, his experiences, his knowledge, his passion. Thus, if the results are Gaudi'esque, is not the machine too? Haven't we encoded something of what it means to be Gaudi, the human, his life, his experiences, etc.? Have we created a kind of partial working copy of Gaudi, in a box?

5.1 Argument: Art is the sole domain of a conscious entity, the sole domain of humans

Turing addresses a similar argument in terms of consciousness as a requirement for intelligent behaviour. He cites Professor Jefferson's Lister Oration for 1949 as an example of such an argument:

> Not until a machine can write a sonnet or compose a concerto because of thoughts and emotions felt, and not by the chance fall of symbols, could we agree that machine equals brain—that is, not only write it but know that it had written it. No mechanism could feel (and not merely artificially signal, an easy contrivance) pleasure at its successes, grief when its valves fuse, be warmed by flattery, be made miserable by its mistakes, be charmed by sex, be angry or depressed when it cannot get what it wants. (445/6)

Turing argues that the only way to know if an entity is conscious or not is to be that entity. He also provides a little “viva voce” dialog to illustrate the kinds of responses that one would naturally interpret as pleasure, anger, etc., and from which one would reasonably conclude that the entity has emotion. Any entity that behaved such would be considered to have those emotions, machines included.

We can extrapolate from this that any machine that can mimic the full gamut of human emotions is theoretically capable of producing art.

6. Conclusion

We’ve posed the question, “Can machines produce artefacts which are indistinguishable from the creative output of a human?” and applied a variation of the Turing test as a way to frame the discussion.

While we’ve avoided defining art, we’ve argued that we cannot discount the possibility of machines producing it. We’ve also argued that the more we are capable of mimicking the output of a specific artist or architect, the more we have captured something about what it means to be that artist or architect.

This line of reasoning is likely emotionally bothersome for some. The notion that we may replace specific artist/architects with computerized versions has a kind of “Invasion of the Body Snatchers” [6] feel to it that somehow reduces our very notions of humanity. However, if the goal of Generative Art is to codify creative output, to “generate” “art”, we must question what qualities we’re willing to ascribe to the generator, and the extent to which they should or should not differ from those we ascribe to creative acts of humans.

Is generating Gaudi to know him? Or on more practical terms, who do you assign the output copyright to, the programmer, the computer, or Gaudi?

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Laurel Johannesson | *Paper:* **THE NARKISSOS PROJECT**

Topic: Interactive Art

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Abstract:

This paper provides an overview of the prototype and the background to the concept of The Narkissos Project, an interactive image and sound art installation.

While my previous work has related to my own visage and the effect of the watery surroundings that I place myself in, The Narkisssos Project casts the viewer as subject and seduces them into interacting with their own watery "reflection" through the familiar sensations of touch, vision, and sound. In The Narkissos Project, the spectator's transition into another world happens through touching their own fictitious face and moving pebbles to disturb the water's surface both visually and aurally. Touch is the interface into the virtual world and the mediator of different languages and perceptions. To touch a water surface, to influence a mirror, to make sound when moving something are reactions which correlate with reality. I place the viewer as voyeur and at the same time subject, inside a shifting ground that contains both figure and water as one amalgam. The point of view is from outside looking in and under, operating in a kind of *lussuria ossidionale*; as sublimations of unattainable acquisition, just out of reach by the nature of our imperfect vision into water. As the viewer gazes at the pool before them, an image of their face is captured. As they begin to interact with the virtual watery pool by moving pebbles around on the surface of the interactive tabletop, the sound of water is produced. The viewer can create their own soundscape by moving a single pebble to another location or by sweeping a number of pebbles across the surface. At the same time as this soundscape builds, the viewer will begin to notice some subtle changes in their appearance. At first they will metamorphosis into a younger more beautiful version of themselves and then perhaps they will subtly begin to become less attractive. Finally, the viewer who interacts and continues to gaze at themselves for "too long" will ultimately begin to fade and disappear.

Image of Narkissos Project Prototype

References:

Jain, A., Thormahlen, T., Seidel, H., Theobalt, C. *MovieReshape: Tracking and Reshaping of Humans in Videos.* ACM Transaction on Graphics (TOG) – Proceedings of ACM SIGGRAPH 2010, Volume 29, Issue 5, 2010.

Leyvand, T., Cohen-Or, D., Dror, G., Lischinski, D. *Data-Driven Enhancement of Facial Attractiveness.* ACM Transactions on Graphics (TOG) – Proceedings of ACM SIGGRAPH 2008, Volume 27, Issue 3, 2008.

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Keywords:
Art installation, fine art, image capture, morphing, performance, sound, tactile interface, tangible interface, touch feedback.

The Narkissos Project

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Abstract

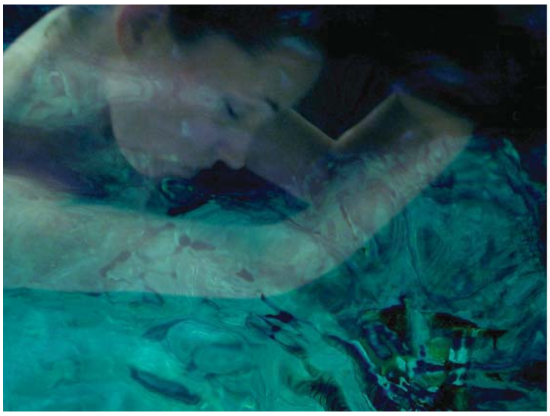
This paper provides an overview of the prototype and the background to the concept of The Narkissos Project, an interactive image and sound art installation.

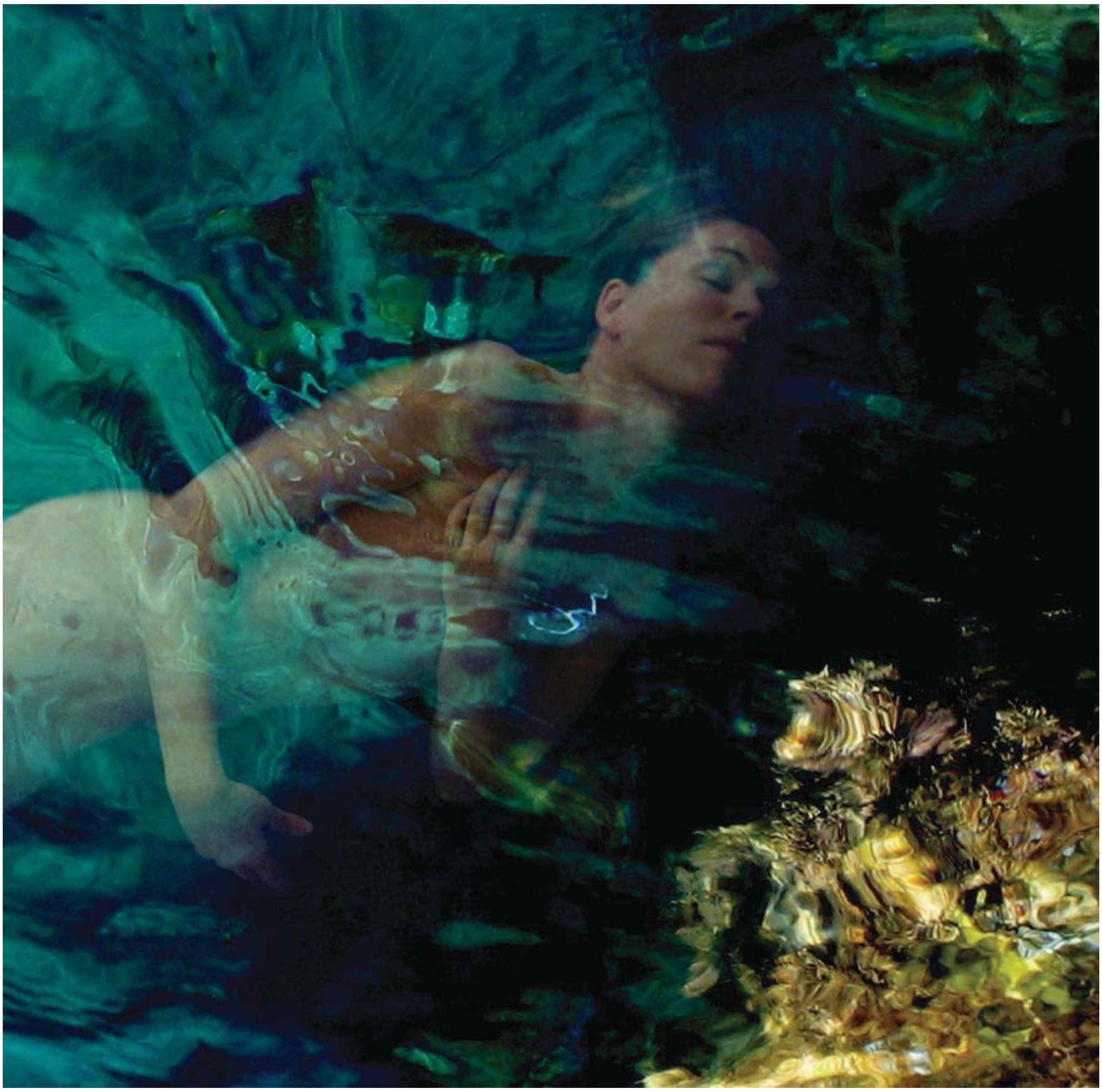
Keywords

Art installation, fine art, image capture, morphing, performance, sound, tactile interface, tangible interface, touch feedback.

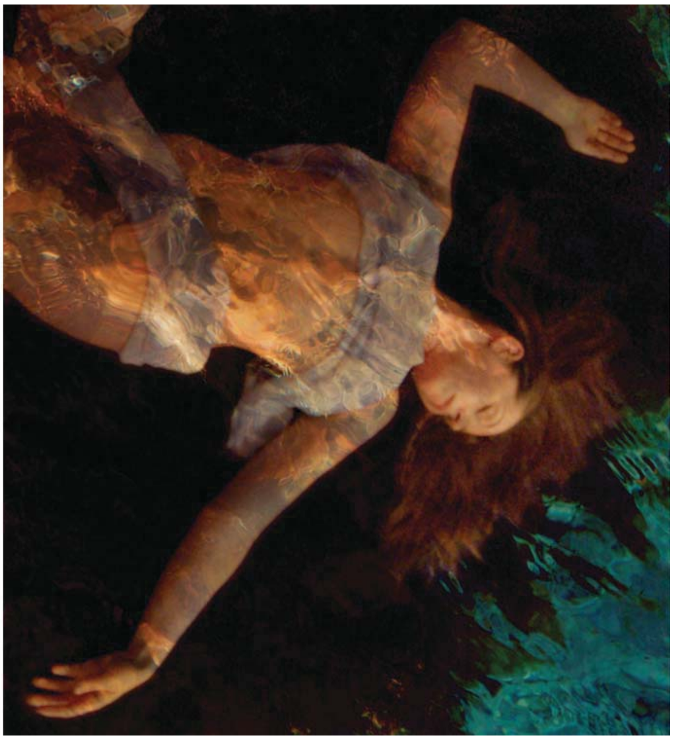
1. Introduction

This project relates to the themes present in my ongoing artistic practice. Thematically my work is dependent on water and my body's relationship to it. Water seems to have been synonymous with creation for time immemorial. My work alludes to a fundamental memory that lurks in our psyche surrounding life origins from ubiquitous water sources. My images concentrate around my own body integrations into naturalized settings that are shallow depths of water along shorelines. I seek out specific locations that reveal minimal, but absolute characteristics of the water in each country that I work in. In some instances my presence relies not so much on my being seen, as it does on my almost not being seen. As the figure assumes to take on characteristics of the surrounding qualities of light or shadow, textures of rock or submerged surfaces ; one might ask if the figure is truly present at all. Or is it merely a mirage swimming up from our imagination, like so many sailors' accounts of sighting the elusive form of their desire.





Figures 1-3: Images of previous work. "Metamorphosis" and "Thirst" Series'. Laurel Johannesson, 2005-2007.

Figures 4-5: Images of previous work. "Metamorphosis" and "Thirst" Series'. Laurel Johannesson, 2005-2007.


Figures 6-7: Images of previous work. "Metamorphosis" and "Thirst" Series'. Laurel Johannesson, 2005-2007.

While my previous work has related to my own visage and the effect of the watery surroundings that I place myself in, The Narkisssos Project casts the viewer as subject and seduces them into interacting with their own watery "reflection" through the familiar sensations of touch, vision, and sound. This paper will explain the conceptual underpinnings of the project as well as the medium-fidelity prototype.

2. The Myth of Narcissus

Narcissism can be traced back to the originally mythological narcissistic figure that since antiquity has been interpreted as a parable for self love.

Figure 8: Narcissus is first documented in fresco paintings in Pompeii.

Νάρκισσος (Narkissos or Narcissus) was a young man from the town of Thespiai in Boiotia. A son of the river-god Kephisos and the fountain-nymph Liriope, he was known for his beauty, and attracted many admirers. But in his arrogance, he spurned them all. The suffering of two, however, brought down upon him a deadly curse. First there was the nymph Ekho--a girl cursed by Hera to repeat only the last words of what was said before. When she was rejected by Narkissos, Ekho faded away in her despair leaving nothing behind but the haunting voice of her echo.

The other admirer was the youth Ameinias who became distraught when Narkissos rejected him and slew himself before his door, calling on the goddess Nemesis to avenge him. His prayer was quickly answered, when Narkissos fell in love with his own image reflected in a pool. Gazing endlessly at the reflection, he slowly pined away and was transformed by the nymphs into a narcissus flower. [1]

In Ovid's *Metamorphoses*, he speaks about the dialectic of identity and difference, contrast and assimilation metaphorically in the figure of Echo and the pond in which Narcissus mirrors himself. A mirror, by inverting reality and showing something that is there and at the same time not there, raises the same problems of presence and absence.

The motif of Narcissus seems to have disappeared from artwork for around one thousand years. It was picked-up again in the Renaissance. *Narciso* painted by Caravaggio, is a young man addicted to the ecstasy of his reflection on the water. [1]

Figure 9: Narciso. Caravaggio. 1594-*96*

Figure 10: Echo and Narcissus. Poussin. 1628-30.

Figure 11: Echo and Narcissus. Waterhouse. 1903

Oscar Wilde in *The Picture of Dorian Gray* (1890) describes the story of narcissistic self destruction. An ideal of youth and beauty leads to a life in beauty and the deprivation of reality. [5]

Albert Lewin's 1945 film, *The Picture of Dorian Gray* uses a painting as its centerpiece. The protagonist trades places with a portrait of himself and as a result, the painting grows older while Dorian Gray remains young.

Figure 12: Actor, Hurd Hatfield with the aging portrait of his character Dorian Gray. The Picture of Dorian Gray, 1945.

Figure 13: Film poster from "The Picture of Dorian Gray", 1945 with the caption "Youth's adventure in living."

3. The Narkissos Project

In The Narkissos Project, the spectator's transition into another world happens through touching their own fictitious face and moving pebbles to disturb the water's surface both visually and aurally. Touch is the interface into the virtual world and the mediator of different languages and perceptions. To touch a water surface, to influence a mirror, to make sound when moving something are reactions which correlate with reality.

I place the viewer as voyeur and at the same time subject, inside a shifting ground that contains both figure and water as one amalgam. The point of view is from outside looking in and under, operating in a kind of *lussuria ossidionale*; as sublimations of unattainable acquisition, just out of reach by the nature of our imperfect vision into water.

As the viewer gazes at the pool before them, an image of their face is captured. As they begin to interact with the virtual watery pool by moving pebbles around on the surface of the interactive tabletop, the sound of water is produced. The viewer can create their own soundscape by moving a single pebble to another location or by sweeping a number of pebbles across the surface. At the same time as this soundscape builds, the viewer will begin to notice some subtle changes in their appearance. At first they will metamorphosis into a younger more beautiful version of themselves and then perhaps they will subtly begin to become less attractive. Finally, the viewer who interacts and continues to gaze at themselves for "too long" will ultimately begin to fade and disappear.

Figure 14: Screen capture of participant interacting with The Narkissos Project.

Figures 15-18: Screen captures of participant interacting with The Narkissos Project.

Figure 19: The face of the participant interacting with The Narkissos Project begins to morph into a more youthful and then a less attractive reflection of themselves and finally begins to disappear.

3.1 Sound Component

The sound created by the participant is made up of recorded samples that I collected in caves and along shorelines in Greece. Drips, drops, echos, swooshes. The more pebbles in play, the more sound combinations created. Different motions and combinations and of pebbles will generate different results.

3.2 Water Component

The interactive water layer consists of video footage also shot in the Aegean Sea. As the participant interacts the placement of the pebbles will trigger a pooling action that will disperse the water layer in relation to the size of the pebble.

3.3 Tangible User Interface

The pebbles collected along shore lines in Greece act as the tangible user interface for the sound and related visual effects. The pebbles will not have specific properties attached to each individual object but will however have general characteristics related to their size. Smaller pebbles will trigger softer and higher pitched sounds. Larger pebbles will correspond to louder and deeper tones and will disperse more water. The more pebbles in action, the more complex the sound.

Figure 20: Tangible user interface pebbles.

3.4 Morphing Component

After a short period of time the participant's face will subtly morph into a more attractive (or seemingly younger) version of themselves. After more interaction the viewer may notice a subtle aging. This could be achieved by incorporating morphing software. Some potential approaches to this aspect of the interaction are described in the paper *Data Driven Enhancement of Facial Attractiveness*. [4]

In addition, *MovieReshape: Tracking and Reshaping of Humans in Videos* could point to potential solutions for this aspect of the project. [2] The concept of the golden ratio will be utilized and I will continue to explore and develop this aspect of The Narkissos Project.

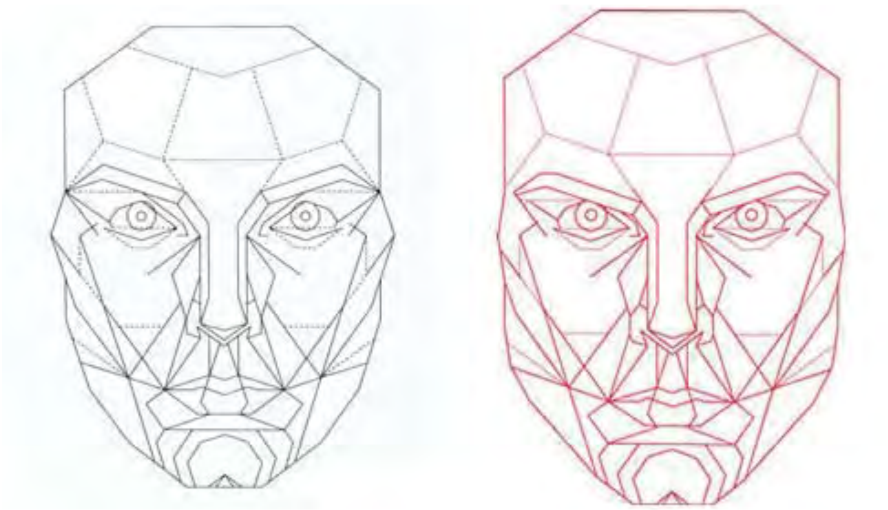


Figure 21: Golden Ratio – Female and Male

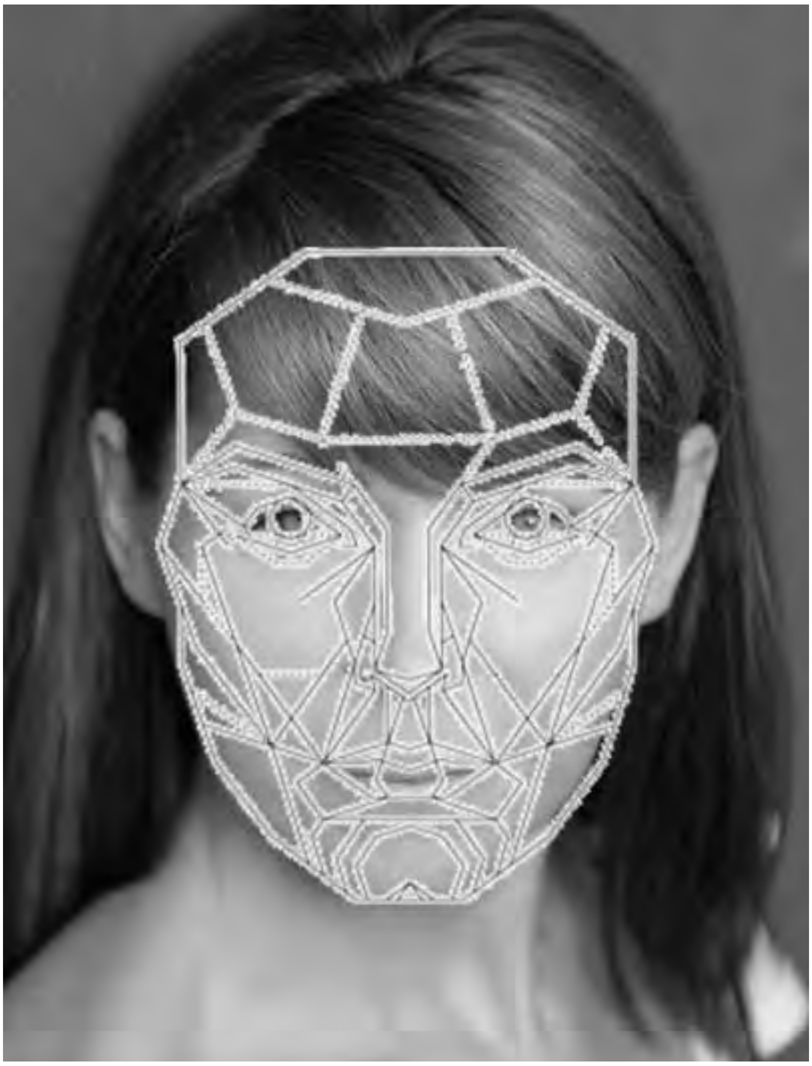


Figure 22: Portrait of the artist with the golden ratio applied.

4. Strengths and Challenges of the Narkissos Project

Although the project is conceptually sound, the greatest perceived challenge is in regard to the morphing aspect. While research exists regarding video and still image morphing, it will require a great deal of refinement in order to be effective within the parameters of the concept. The morphing must remain subtle and delicate in order to retain the likeness of the subject.

The simplicity of the tangible user interface will encourage viewers of all ages to interact. No fine motor skills, musical skill, or artistic talent are necessary to quickly become engaged with the interaction. The sound emitted will be harmonious by default. Visual clues in the way of water dispersion created by pebble placement will relate directly to the sound.

Finally, the fascination of watching one's self transform combined with tangible user interface controlled sound will entice even the novice narcissist into a brief trip into the watery abyss.

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Marcin Brzezicki

Paper: **Designer's controlled and randomly generated moiré patterns in architecture.**

Topic: Architecture

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Abstract:

The paper presents graphical and formal possibilities of moiré patterns in architecture in different contexts. The paper distinguishes between randomly generated and designer's controlled (influenced) moiré patterns. Some mathematical methods can predict, under certain limitations, the geometric properties of moiré. Those 2D Fourier transformation-based methods would not be considered in the paper, but the basic notions, could be taken from strict mathematical theory of the moiré phenomenon. A short, straightforward, vector-based explanation is given at this point.

In the first group of patterns paper presents carefully selected cases of moiré generated by various periodic and not periodic gratings, grids and dot patterns using the examples from recently completed buildings. Stiff, rigid superposed layers like screen-printed glass, or perforated metal sheets do produce predictable results in a greater extent, while the soft, distortable layers, like fabrics, canvases, loose meshes generate the shapes that are almost impossible to estimate. A link between the images of component superposed layers, their frequency, and superposition angle with the resulting moiré pattern is researched here.

In the second group of patterns paper shows the cases where the designer, by the proper arrangement of component image layers, can consciously influence the result of generated moiré pattern. Two basic techniques are described at this point: moiré fringe multiplication, and moiré magnification. The former allows to control the moiré frequency, by regulating the frequency of component layers (e.g. obtained moiré pattern is doubled with the doubling of the reference gratings, dot-screens etc.). The latter describes a special case of the (1,0,-1,0) moiré type, that shows striking phenomenon of blur and magnification of dots of any given shape lying on layer A, by superposition of layer B with tiny pinholes of identical period at a small angle of difference. The moiré image is showed by sampling any-shape dots of layer A, through a holes in layer B. The results could be obtained by superposing white and black dot-screens as well, but the moiré pattern generated depend on the color and could be produced in inverse video.
In addition, this chapter describes a method of obtaining visually appealing moving images (up to 7 frames) by the usage of properly designed component layers A and B. This could be used to obtain the illusion of movement on the facades that do not contain any real movable parts, but are observed in motion (e.g. from passing car, train etc.). The ease of application allows this phenomenon to be used both in public and commercial buildings. A selection of author's designed exemplary façade's patterns is presented in the paper.

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Keywords:
moiré pattern, architectural design, perforation perception, façade

Designer-controlled and randomly generated moiré patterns in architecture

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Premise

This paper presents graphical and formal possibilities for the use of moiré patterns in various architectural contexts. The paper distinguishes between randomly generated and designer-controlled (influenced) moiré patterns. Under certain limitations, some mathematical methods can predict the geometric properties of moiré patterns. However, in consideration of the recipients of this paper, a straightforward, vector-based explanation will be provided.

In the first group of patterns, the paper presents carefully selected cases of moiré randomly generated by various periodic and aperiodic gratings, grids and dot patterns using examples from contemporary architecture.

In the second group of patterns, the paper discusses instances of designers' conscious influence on a generated moiré pattern by properly arranging component image layers. A link between the images of component superposed layers, their frequency, and the superposition angle with the resulting moiré pattern is researched here. In addition to describing the conditions of excellent moiré visibility, the complex cases of moiré fringe multiplication and moiré magnification are also presented.

The paper then presents a method of obtaining moving images that are visually appealing (up to 7 frames) through the use of properly designed component layers followed by a selection of author-designed exemplary façade patterns. It concludes with a discussion of the influence of the physiology of the human eye on the perception of moiré patterns.

1 Introduction

Although one cannot determine the beginning of the conscious recognition of moiré, a detailed examination was carried out by Lord Rayleigh in 1874. The name of the effect can be traced back to the 1800s, when French craftsman weavers produced thin silk fabric by passing the cloth "through rollers that have a rippling pattern which resembles a large series of water stains" [13]. Superimposed layers of watered cloth called moiré produced an additional rippling illusory pattern absent in the component textiles. The name of this very popular fabric became the name of the phenomenon.

From a strictly scientific point of view, moiré patterns are produced when "repetitive structures (dot screens, gratings or grids) are superposed or viewed against each other." [2]. Moiré patterns show great sensitivity to the slightest change, such as distortion or angle rotation. This means that even a very little modification of the position or rhythm of component repetitive structures produces striking changes in the resulting pattern. This is why this phenomenon is widely exploited in many fields, such as optometry, metrology and counterfeiting protection (securing documents). Once processed by the appropriate software, moiré fringes can provide accurate spatial data relating to any subject (e.g., historical objects, artifacts, physical evidence in court cases).

Aside from the above examples, moiré patterns are considered to be an undesired byproduct of two or more superposed repetitive structures. Destructive results of this phenomenon might be found in a color picture reproduction (where dot screens are superposed under specified angles) or in various applications of perforated or meshed surfaces (where unintentional moiré patterns can easily destroy the desired formal results). Over time, certain mathematical approaches have been applied to the understanding and avoidance of the appearance of moiré patterns. The most recent is an application of Fourier theory that began in 1960s and 1970s.

2 Scope of this paper

This paper presents the formal possibilities of the use of moiré patterns in different architectural contexts. The paper distinguishes between randomly generated and designer-controlled (influenced) moiré patterns. The attitude presented in this paper is strictly visual (as the aspects of an image are most appealing to architects), thus some mathematical rules expressed graphically must be explained to understand how the patterns are created.

3 Moiré patterns in architecture – conditions of formation

The concept of moiré fringes is associated with the phenomenon of overlaid repetitive structures. In its literal, mathematical sense, moiré means an arrangement of fringes formed by two overlapping periodic or aperiodic structures rotated at an angle or subjected to deformation. This phenomenon can be associated with optical interference – local strengthening and weakening of the electromagnetic wave – though its mechanism is different. That is why moiré and interference phenomena are often confused.

Moiré fringes in architecture can result from various circumstances: superposing repetitive structures with different frequencies (rhythms), imposing grids (shutters, grilles, perforated steel sheets) or arranging repetitive structures layers (e.g., in curtains and drapes). In specific cases, moiré can only be observed when the structures involved are positioned along the observer's line of sight (e.g., corners of buildings where there is an imposition of grids located perpendicularly; see Fig. 3). Moiré patterns can emerge even when the repetitive structure is laid over its virtual image or the shadow it casts (shutters over a glazed façade, or over a smooth wall). See a detailed description in chapter 6.

The special case of a transparent surface with periodic overprint (such as silkscreen) could also be considered a repetitive structure with all the resulting consequences, including the potential for creating moiré by way of superposition. Depending on the specific case, a repetitive structure can be a flat or three-dimensional physical object (such as bridging grille bars, railings or the warp and weft of fabric).

4 Randomly generated moiré – case studies

The occurrence of moiré patterns can be predicted; however, their appearance on a building is often random, undermining the visual effect intended by an architect. The prediction of moiré formation is difficult at the design stage. Resulting optical effects are therefore equally surprising for architects and investors. Thus, it is important that designers know the mechanism of formation of moiré patterns to use this knowledge consciously.

Randomly generated moiré patterns occur commonly in architecture, but only in selected cases do they enrich the aesthetics of the architecture. These exquisite examples require a detailed discussion.

Fig. 1. Rue des Suisses Housing, Paris (arch. Herzog de Meuron, 1996-2000). Photo by author.

Subtle moiré patterns are visible on the façade of a 7-story residential building located at the Rue des Suisses in Paris [Fig. 1]. The outside envelope of the building is designed as a system of screens-shutters covering the full height of the building. The individual elements are 412 mm in width and one story in height. The folding screens are made of aluminium sheets perforated with square holes. Screens in a folded position are placed perpendicular to the plane of the façade, thus creating clearly defined, though irregular vertical divisions. Unfolded screens "(...) create the impression of several compressed layers of materials: shutter, balustrade, the space of the balcony and the dark aluminium glass wall of the dwellings (…)", thus creating a delicate but visible moiré [12]. Looking closely, we see the detail – continuous perforated pleated sheets that "ripple like corduroy; fully unfolded" [6].

Fig. 2. Headquarters of the Technology Incubator in Krakow (arch. ns moon Studio, 2007). Photo by author.

Clear moiré fringes that appear on the Headquarters building of the Technology Incubator in Krakow were not planned by the architects as part of original design. Instead, they were the result of budgetary constraints. Strips of stainless steel mesh were mounted perpendicular to the façade by the means of two supports cantilevered from the façade. Moiré patterns are formed where multiple layers of the mesh are superposed on each other [Fig. 2]. A zone of dynamically changing transparency and flickering moiré is created around the building. Due to the different configuration of the meshes, moiré patterns change with every step the observer takes. The fringes on the building appear to move, though they are known to be immobile [11]. The results are spectacular when the layers of mesh are seen through the windows against the sky or when a strong wind tugs and deforms the meshes. The envelope of the Technology Incubator in Krakow is undoubtedly one of the most creative façades built in Poland after 2000.

Fig. 3. Messe Graz Halle A (arch. Florian Riegler, Roger Riewe, 2002). Photo by author.

To reduce the large volume of the newly erected, two-story exhibition Halle A of Messe Graz [Fig. 3] and to emphasize its spatial independence, a nearly 300-m concrete wall of the building was covered by the envelope of delicate mesh panels. This technical decision resulted in a unique "(…) gleaming, silver shell, which is very different in its monochrome homogeneity (…)" [4]. The unintended moiré is most visible from the corner of the building where the meshes from the perpendicular facades interact. The rectangular panels of shell are manufactured from diagonally pre-pressed steel mesh. Because panels are not planar but diagonally divided into two independent planes, the resulting moiré is even more diverse and flickering [10].

5 Designer-controlled (influenced) moiré patterns

In contrast to the previous examples of random generation, fringes of moiré can also be “planned” to some extent. The designer can consciously influence the result of the generated moiré pattern by properly arranging component image layers. These layers might include grating, square grids or dots, or they might be composed of different periodic structures (like grating and circular patterns that produce square-like moiré patterns).

In the case of an individually designed moiré, the preparatory phase usually requires an extended design-check stage including the construction of reduced-scale models to verify if the desired moiré pattern appears or not. An excellent example of a properly conducted design phase is the Center of Creative Arts Elementary School for Girls in Brisbane, a building that attracted worldwide attention for a façade that generates unique moiré fringes [5].

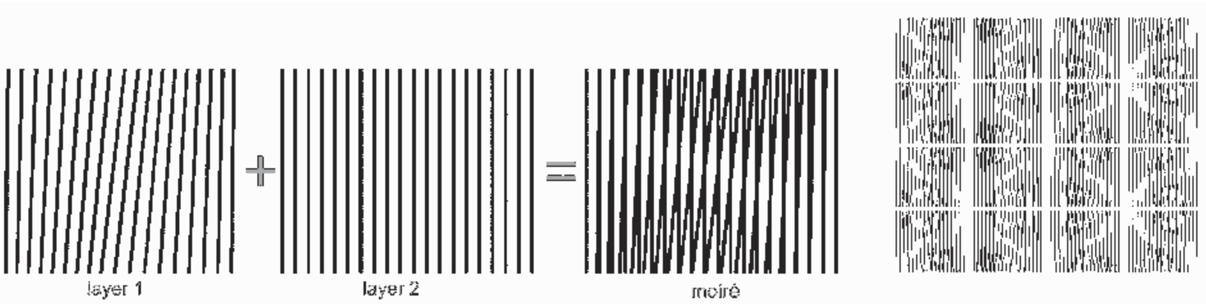


Fig. 4. The principle of moiré generation at the Center of Creative Arts Elementary School for Girls in Brisbane (arch. m3architecture, 2007). Illustration by author.

The school’s western double façade is windowless, with only black vertical stripes painted on a white wall. The solid wall provides a background for the shading screen made of black-coated aluminum slats. The elements lean from left to right at a slightly changing angle, so that the slats overlap with stripes and form a unique moiré [Fig. 4]. With a change of the observer’s position "(...) the building appears to melt and wobble in circular waves as the viewer passes (...)" [7]. A pre-planned motion effect proved to be illusive in that dwellers of neighboring buildings asked the architects and contractors how the elevation is motorized and whether it will make noise.

A prototype of Brisbane’s moiré façade several meters wide was shown at the exhibition titled “Place Makers: Contemporary Queensland Architects” organized by the Queensland Gallery of Modern Art. This large 1:11 scale model was manufactured using two layers of glass with stripes of black adhesive tape. It proved to be a perfect presentation of the project idea as the model involved the viewer in the process of moiré reception.

Due to the expense of model construction, computer simulation can be helpful tool. However, it should be taken into consideration that the effects caused by the screen’s structure itself can cause moiré patterns appear. The moiré patterns on computer screens are caused by the mask (electrical conductors) on the front surface of the LCD interacting with the digitizing of the image. Additional causes of moiré might be a periodic structure of the CCD matrix of the camera or scanner. Therefore, the theoretical prediction of moiré should be followed by practical verification to guarantee proper results.

There are three main parameters that characterize any moiré: **frequency, angle** and **intensity** (also called amplitude) [1]. For the sake of ease, a simple binary (black and white only) grating is used in the following examples.

5.1 Regulating frequency - moiré fringe multiplication

The frequency of moiré is often replaced by pitch (or step). Pitch represents a reciprocal of the frequency and describes the distance between adjacent fringes of the moiré, while the frequency describes how many lines or dots appear per specified unit of length [9]. The parameters given above can either describe the resulting moiré or the features of the component layers.

Moiré fringe multiplication is a technique initially developed for a more detailed analysis of surface deformation This technique originates directly from the principle that changing the frequency of component layers can influence moiré frequency as well (e.g., the resulting moiré pattern might double with the doubling of the component periodic structures).

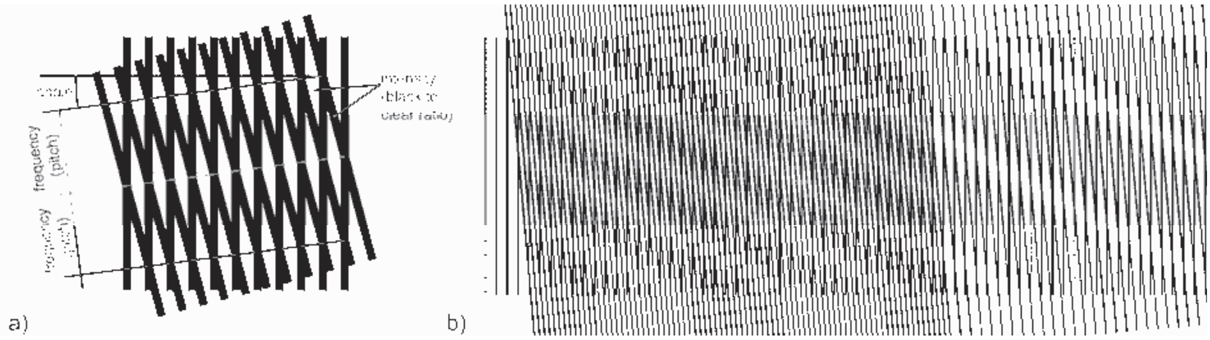


Fig. 5. Example of basic moiré parameters (a) and moiré fringe multiplication (b). Illustration by author.

Moiré fringe multiplication is the simplest and safest way for the designer to influence a moiré pattern. This is not only the simplest method, but is also the most predictable method because the effect of frequency change would be visible from every point of view and every perspective regardless of the shape of the pattern, provided that the component layers superpose.

5.2 Regulating the angle of moiré

Rotating component gratings is another way to create moiré. The resulting angle of the moiré always depends on the angle α between component gratings. If we consider a grid of intersecting lines, a rhomboidal cell net could result from superposition. Space (white fringe, or bright fringe, clear spaces) in the moiré pattern corresponds to the small diagonals of this rhombus; "black" fringe is formed by intersecting lines at the ends of its larger diagonal. As the diagonals are the bisectors of the sides of the rhombus (a, b, c, d), a fringe appears at an angle equal to $\alpha/2$ perpendicular to the gratings of each pattern. "The sharper the angle α, the stronger the moiré pattern becomes" [8].

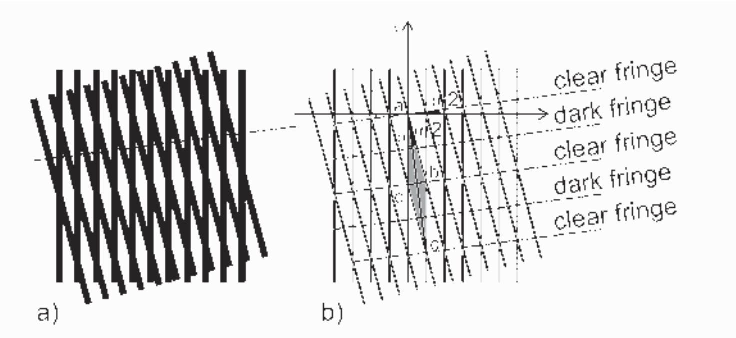


Fig. 6. Rotated binary grating showing the principle of moiré generation. Illustration by author.

A special feature of grating-originated moiré must be mentioned here to complete the picture. It was observed that at certain specific angles, moiré does not occur. This happens when two gratings are positioned perpendicularly to each other to create a square cell net, or when three gratings are rotated by an angle of 120 deg. to create an equilateral triangular cell net. This condition is called a moiré-free state [2]. In selected cases, a moiré-free state proved to be very unstable because "slight deviation of the angle or in the frequency of any of the superposed layers may cause new impulses" [2], causing moiré to reappear. The theory explaining this phenomenon is derived from Fourier's moiré analysis, and its full explanation lies beyond the scope of this paper [2].

Rotating the grating can be an effective method to influence the form of moiré patterns because only a slight rotation is necessary to cause a substantial change in the resulting moiré pattern. This method could also be creatively applied to achieve certain formal results when one or two of the component gratings are curvilinear.

5.3 Regulating moiré's intensity

Intensity is a parameter strongly associated with the ratio of clear spaces to black bars in the component gratings. Intensity is also called amplitude (according to signal theory, the "amplitude" of impulse represents the intensity of that periodic component layer). It should be noted that even when all the component layers are black-white only (binary, with the intensity 0 and 1) …" their moiré still may contain intermediate values" [2]. The local intensity of moiré patterns created by the binary gratings depends on the clear to black balance at given point of the image, the value of intensity "represents the average ratio of white (clear space) per unit area" [2]. In terms of optical phenomena, the intensity of moiré can easily be translated to the reflection coefficient (average reflectance) (e.g., an equal area of white and black in a sample boundary would mean 50% reflectance).

Fig. 7. Local reflectance of moiré is determined by the amount of white (clear space) per unit area. Illustration by author.

If the grating bars and spaces have equal width, bars fully overlap at the point of intersection (two identical stripes are exactly on top of each other). At this point, a bright moiré fringe appears. Where the two bars are side by side, a dark bar fills the white space completely. At this point, a black moiré fringe appears. Between bright and dark fringes, all intermediate stages of the moiré's intensity (or reflectance) are present. The intensity of moiré varies between 0.5, where the bars overlap, and 1.0, where they are located next to each other.

Component layers with various intensities (different black bar to white space ratios) can create moirés of different intensities, but the following general principle can always be applied: the greater the intensity of the component layers, the greater the intensity of the moiré.

5.4 Conditions for excellent moiré visibility

Based on the previously explained general principles and laws of moiré formation, certain conditions may be identified that must be met by the component layers to obtain the best moiré visibility.

The conditions for excellent moiré visibility, based on [9], are as follows:
- the width of the black bars and spaces in component gratings are equal,
- the angle of intersection of the two gratings is small (e.g., 3° or less),
- the ratio of the pitches (frequency) of the two gratings is small (e.g., 1.05:l or less).

5.5 Complex cases of moiré

Complex cases of moiré require strict mathematical analysis and careful preparation of the component layers; in return, unique fringe patterns can be attained. To achieve certain patterns, preparation of complex various curvilinear gratings might be required, such as parabolic- or arg sinh (x)-shaped cosinusoidal grating. Although the superposition of such gratings might create visually appealing shapes, the range of possible designs is limited.

There are few cases of complex moiré in which the results of component layer supposition can be "programmed" with much greater precision by making the desired shapes appear by layer superposition.

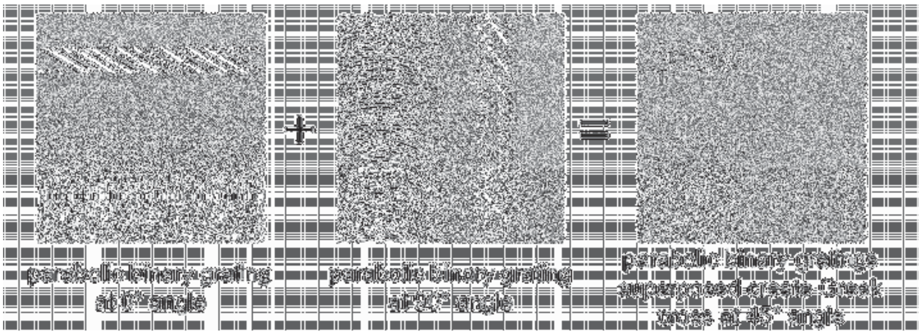
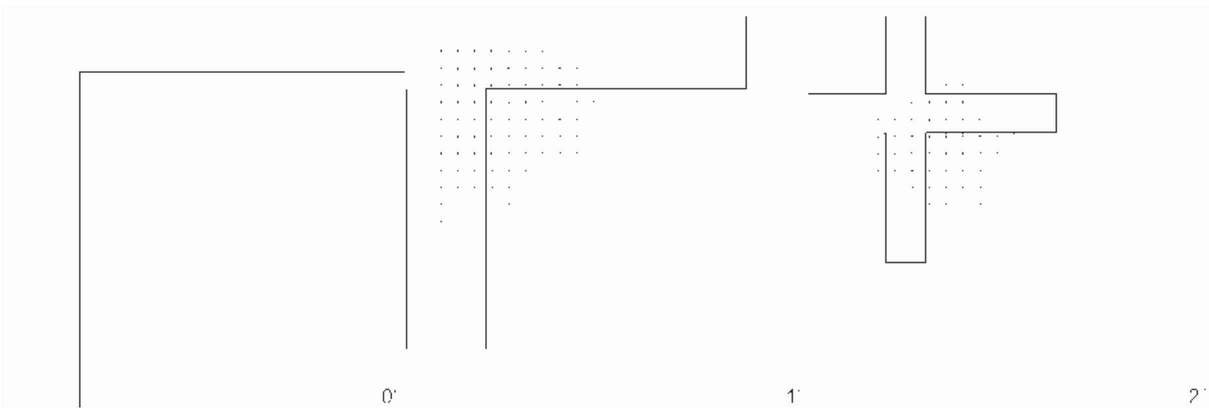


Fig. 8. Superposition of two perpendicular parabolic gratings creates visible moiré in a form of a hyperbolic, cosinusoidal grating that recalls a Greek cross. Illustration by author.

5.5.1 Moiré magnification

A special case of moiré type (1,0,-1,0) shows the striking phenomenon of image blur and magnification. Let us assume that component layer A (located below) consists of regular array dots of any given shape. If this layer is superposed with opaque component layer B that has tiny pinholes of identical frequency as the dots on layer A, the moiré pattern will arise by sampling the any-shaped dots of layer A through the holes in layer B. When layers are superposed with an angle of zero as the starting position and this angle is gradually increased, a magnified and blurred dynamic image of the sample dot is made visible. The ratio of this magnification depends on the angle of superposition. However, a general rule could be formulated that the larger the angle is, the smaller the magnification factor.



(figure continues on next page)

Fig. 9. Image blur and magnification showed by a special case of moiré type (1,0,-1,0). The sample dot is the shape "+". Illustration by author.

The unique property of this type of moiré was discovered and described relatively recently with the introduction of computer techniques. Exploring the possible application of this moiré effect, Armidor writes that this "moiré effect can be used in certain applications as a "virtual microscope" for visualizing the detailed structure of a given screen" [2]. There is great potential in the careful application of this technique in architecture. The shape of the so-called sample dots can be custom-specified, which makes this technique a powerful tool of branding or marketing. Using properly designed component layers in a form of optical filter allows the user to display dynamically changing images without actually using any moving parts.

5.5.2 The illusion of motion. Stop-motion by proper arrangement of moiré layers

Stop-motion is a well-known animation technique in which the manipulated object is repositioned or rearranged in small increments and then photographed. Individually photographed frames are played sequentially, creating the illusion of movement. This classic animation technique could be re-interpreted and re-applied using moiré principles.

To achieve the effect of virtual motion, the top component layer should consist of vertical binary grating with the appropriate ratio of dark bars to clear spaces. The ratio is based on the number of frames (e.g., if planned animation is 7 frames, the width's ratio of dark bars to clear spaces should be roughly 6 to1. The bottom component layer is designed to show successive frames of animation through the gap between the dark bars of the top layer (see Fig. 11). The bottom layer picture is usually obtained by properly cropping successive frames. The process of preparation requires a high degree of precision for which CAD software is an asset.

The illusion of movement is obtainable by passing the top layer over the bottom layer, but similar effects may be accomplished without the use of any moving parts or mechanisms at all. This involves the creative exploitation of the motion's relativity principle. If the two component layers are static, parallel, and positioned at a proper distance, the moving observer would perceive the relevant parts of the further layer through gaps located in the closer layer.

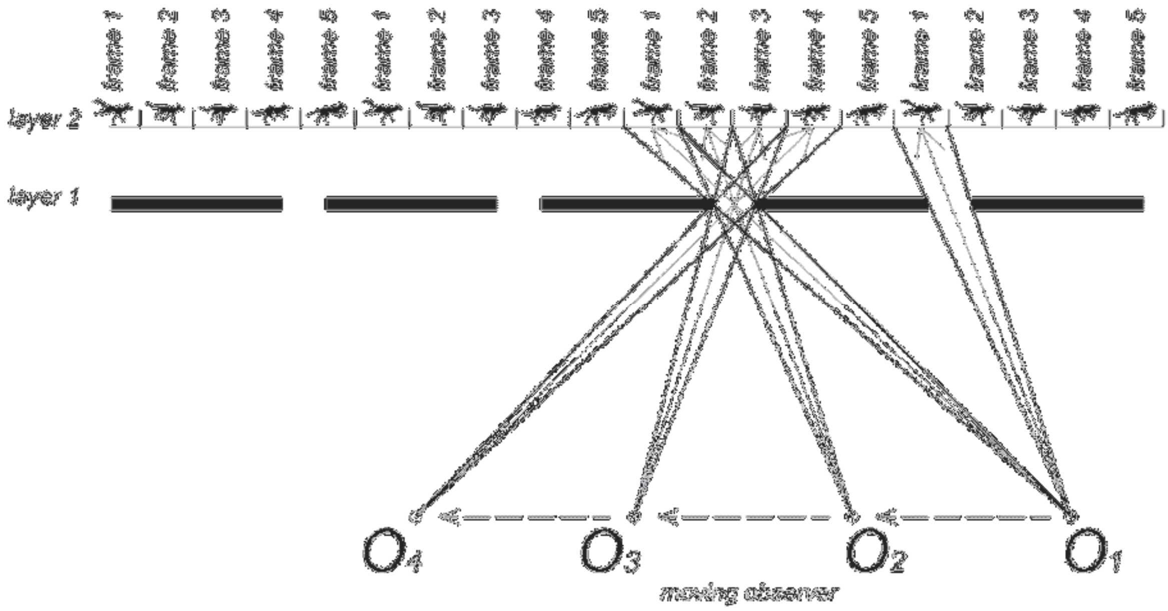


Fig. 10. The principle of the construction of the illusion of motion achieved by proper arrangement of superposed layers. Illustration by author.

The proper speed causes the successive frames to appear so quickly that the illusion of motion occurs. In a design, the reverse logic could also be used by adjusting the parameters of layers to the speed of a moving observer (e.g., traveling in a train or in the car on the highway).

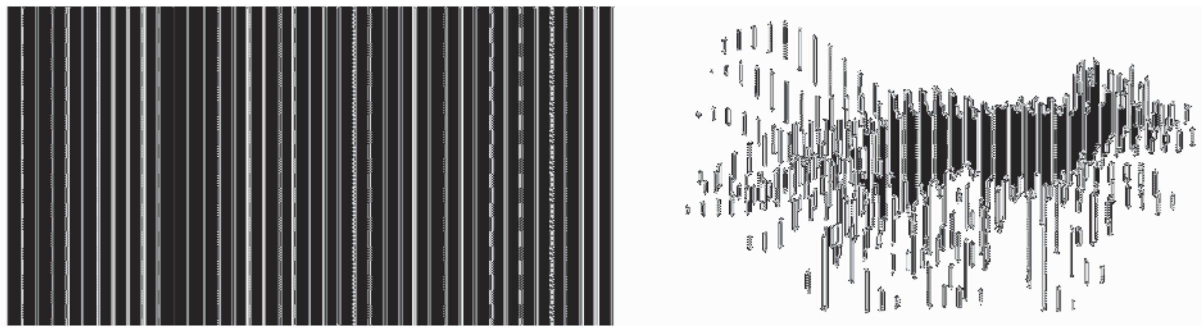


Fig. 11. The samples of component layers: the upper containing binary grating (left) and the lower containing the compiled image of a running wolf (right). Illustration by author.

6 The influence of human eye perception

It is relatively easy to predict the results of component layer superposition in orthogonal projection (as analyzed above). In architecture, however, the issues of moiré must be approached from the position of human perception.

The most distinct feature that differentiates perspective from orthogonal projection is that the objects get smaller as their distance from the observer increases. In this way, two identical periodic structures with the same frequency, which would not create any moiré from an orthogonal point of view, can create visible moiré by perspective projection. A component layer with a periodic structure positioned further away from the observer will be virtually “rescaled”, and its frequency will be changed. The moiré would appear as a result of the interaction with the component layer positioned closer. All efforts made by designers to exhibit moiré should be preceded by an analysis that considers the properties of perspective projection. In practice, the phenomenon may occur in any case of the superposition of multi-layer mesh or perforated panels but also in the case of periodic structures and their shadows or mirrored reflections. The formation of moiré can come as a surprise to a designer, especially in the case of the last two examples listed, and it may have a significantly negative effect on the project. However, it can also be creatively exploited.

The resolution of human sight must also be considered when dealing with moirés on an architectural scale. Curcio et al. [3] derived 77 cycles per deg. (the cycle is a pair: grating and space). This means that in a one deg. segment of a visual field, an observer is able to distinguish approximately 30-70 lines depending on the individual abilities and lighting conditions. Because the resolution is constant, the number of perceived details varies in relation to the distance from the observed object. The farther away the object, the more blurred the details are, and the fine meshes and gratings seem to be more uniform. The periodic structure is indistinguishable and the mesh appears to be semitransparent.

In some particular cases, the observer is located far enough from the superposed objects that the recognition of periodic structures is not possible, but simultaneously close enough that the moiré resulting from their interaction becomes visible. In these situations, moiré fringes appear suddenly, on virtually uniform transparent surfaces.

Another important feature of human vision is sensitivity to light. It is not linear, but, as with human hearing, it is logarithmic. This is verified by the comparison of human reception of brightness with the actual reflectance levels present in moiré patterns and is calculated on geometrical basis (as a ratio of white to black fringe). Both the intermediate stages of the moiré’s intensity and the contrast are perceived differently than indicated by the sole reflectance values [2].

7 Conclusions

The author hopes that with the guidance presented in the paper, architects might change their attitude toward the unique phenomenon of moiré. Instead of regarding moiré as a disadvantage, they could consider the potential of its creative exploitation. The moiré phenomenon should not be thought of as a closed chapter or limited in its range of options. New fringe patterns can be generated on-demand, based on custom-designed component layers and dynamic points of view. The possibilities are endless, limited only by the imagination of the designer and acceptance of the client.

The proper use of moiré in architecture should be thought of well in advance because in select cases, the results are difficult to predict at a reduced scale. The design process requires mathematical calculations, tests, and construction of reduced-size prototypes. Sometimes on-site analysis is required to verify the achieved results. Moiré could easily destroy the designer’s original intention but, if properly arranged, could enrich a building with unique artistic quality, exceptional branding, or virtual moving pictures.

8 Acknowledgments

I am pleased to acknowledge Prof. P.W. Fowler’s (The University of Sheffield) contribution of conceptual support.

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Paper : **TERRITORIES, BOUNDARIES, AND CONNECTIONS**

Topic: Architecture

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Abstract:
Reading Frei Otto's very stimulating book [1], I was incited to pursue investigations I exposed at GA2005 [2] about distance maps and other ways of generating territories. Frei Otto is well know for his work on lightweight structures and constructions inspired by nature, but in this book he explores more fundamental topics about space, how it is occupied and how places are connected. His main preoccupation is about town planning, but his experiments and reflections go far beyond that field.
Frei Otto does not use computers and his book is illustrated by rough sketches and photos of simple experiments involving magnetic needles and polystyrene chips floating on water, soap bubbles, flowing sand, and so on. But those processes may be simulated by algorithms, such as the ones I experimented in my previous paper [2].
This paper will explore dynamic processes leading to the formation of territories, and of boundaries between them, and to connections between points. Those topics involve once again the notion of dimension, and the relationship between dimensions. They imply also questions of duality and reversibility between centres and junctions, and between boundaries. The question of whether and how those processes are generative will also be at the core of my theoretical reflection.
This paper will be illustrated by works of the author, and also by some works of her students.

References:
[1] Frei Otto, "*Occupying and Connecting.* ", Edition Axel Menges, Stuttgart/London, 2009
[2] Marie-Pascale Corcuff, "*Generativity and the Question of Space*", GA2005, www.generativeart.com

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Keywords:
Occupation of space, distance maps, Voronoï diagrams, boundaries, connections, path systems

Territories, Boundaries, and Connections

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Abstract

Reading Frei Otto's very stimulating book [1], I was incited to pursue investigations I exposed at GA2005 [2] about distance maps and other ways of generating territories. Frei Otto is well know for his work on lightweight structures and constructions inspired by nature, but in this book he explores more fundamental topics about space, how it is occupied and how places are connected. His main preoccupation is about town planning, but his experiments and reflections go far beyond that field.
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1. Groundings: Frei Otto's research

1.1 An architect inspired by nature

Frei Ottto, born in 1925, is a German architect and engineer, well known for his lightweight tensile and membrane structures, like for instance the cable net of the Expo '67 German Pavillon (Montréal, Canada), or the roof of the Munich Olympic Arena (1972, with Günter Behnisch). As such, he is in the tradition of great constructors like Felix Candela or Pier Luigi Nervi, or architects like Buckminster Fuller with whom he bears some similarities. His architectural vision has left his mark on the 20th century, and was a strong influence on younger architects, like Shigeru

Ban, with whom Otto collaborated on the Japanese Pavillon of Expo 2000 (Hanover, Germany), which has got a roof made entirely of paper.

Frei Otto «is a technician, artist and philosopher in one, and his central concern is for a new and all-embracing link with nature in building» [1]. One must say also that he is a true architectural «researcher». He founded in 1961 the research team *Biologie und Bauen*, and in 1964 the *Institut für Flächentrageweke* at the *Tescnische Hochschule in Stuttgart*, where he and his team experimented with models inspired by natural structures, in collaboration with biologists like Johann-Gerhard Helmcke. The result of this research was for instance the self-standing bell-tower of a church in Berlin-Schönow which was referred to the skeleton of a diatom. His exploration of natural forms does not only concern biological structures, but also phenomena like the formation of bubbles.

Otto's concern in nature was surely grounded, at least in part, in his reading D'arcy Thompson's famous book [2], which has been so influencial on so many biologists, mathematicians, artists, and architects (Louis I. Kahn, for instance). It is remarkable that the only reference, outside of self-references (including his Institute), in Otto's book [1] is precisely Thompson's book, though with no precisions on how Thompson's ideas are exploited. Thompson insisted on physical laws and mechanics as determinant on the form and structure of living organisms. It is then not surprising that architects may be interested by his work.

In *Occupying and Connecting. Thoughts on Territories and Spheres of Influence with Particular Reference to Human Settlement* [1] (Fig. 1), Frei Otto does not particularly look for ideas for constructive structures, but, as the very explicit title of his book says it, he explores very fundamental topics about space, how it is *occupied* and how places are *connected*.

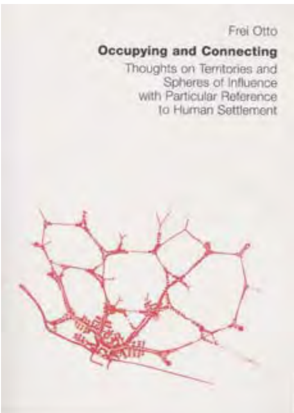

Fig. 1: Frei Otto, Occupying and Connecting [1]

1.2 Frei Otto's method

Otto's method consists in observation, speculation, and experimentation. He observes how phenomena happen in nature, either as the result of the behaviour of living organisms, or with inert materials responding to physical laws, and also how such phenomena occur when human beings intervene. Those phenomena are described with words, and also with rough sketches. Even by those means, Otto speculates on the interpretation of those phenomena. This speculation is continued by the setting of experiments that are supposed to simulate the observed phenomena. In [1], Otto examines essentially three types of phenomena: there is what he calls «occupation», but which concerns actually two topics: the *distribution* of points, and the definition or formation of *territories*; and there is the issue of *connections*, or paths. I shall explain his method on some of these topics which have particularly retained my attention, and on which I have worked later on.

Distributions

Frei Otto begins his book by observing and describing (with words an sketches) how «objects», considered as «points», occupy lines, surfaces, or 3D spaces. Those «objects» may be birds on a wire, fog dew on spider webs, trees in a wood, birds in a flock, water droplets in a cloud, and so on. He distinguishes first between random occupations, which he does define much, and planned occupations.

But more accurately he observes that two «forces» are at stake in any process of occupation: he qualifies some occupations as «distancing» (which could have been called «repulsive»), others as «attractive», and remarks that many occupation mechanisms are both attractive and distancing. Those types of «occupations» (i. e. distributions) are illustrated with sketches.

Attraction and repulsion are present in two physical forces: magnetism and static electricity. Those are the forces that Otto uses in his experiments.

In order to obtain «distancing» distributions of points, Otto's experimental apparatus is a basin of water in which «small rod magnets float (...), each with the same pole uppermost. The magnets repel each other and move away from each other. (...) They adopt a form of occupation which can be described as distancing. (...) Beneath the water, a template marks the surface which can be occupied.» ([1], p. 16). Otto experiments with different shapes and different numbers of needles (Fig. 2).

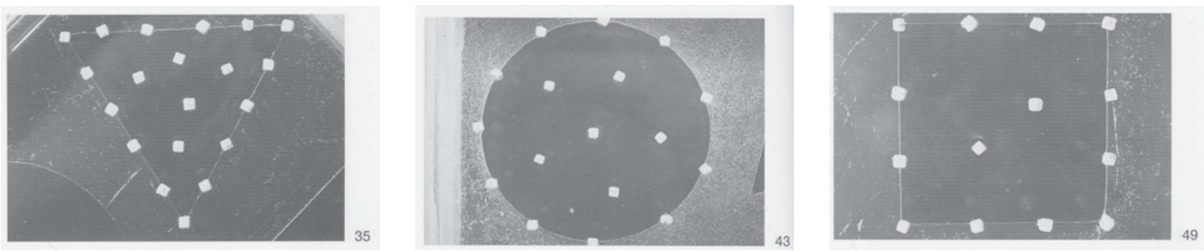

Fig. 2: [1] pp. 21, 22, 23

Attractive occupations are experimented with small soap bubbles. But when trying to experiment both attractive and distancing occupations (with magnetized needles and bubbles) Otto realized that the attractive force between the bubbles was too strong and pulled the needles with their rafts of bubbles. He then used magnetized needles and polystyrene chips (Fig. 3). He also used iron dust with magnetised needles.

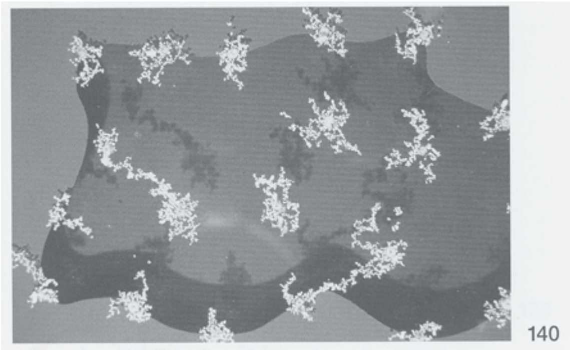

Fig. 3: [1], p. 45

1.2.2 Territories

Very soon in his book, Frei Otto relates the distributions of points to «territories», whose formation is described in these words: «one demarcates the territory by the perpendicular bisectors of the nearest points» ([1], p. 10), and a sketch (Fig. 4).

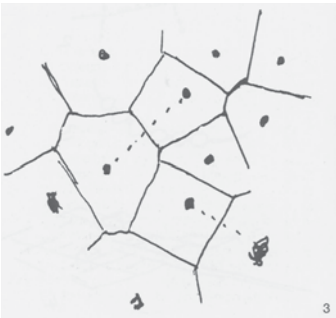

Fig. 4: [1], p. 10

Concerning the formation of territories, Otto describes a particular process in those words: «(...) seeds fall on five points. The occupied areas soon come into contact with each other, until the available surface is completely filled.» [1, p.32]. Even if it is not impossible to actually observe such a phenomenon, it is improbable that this observation was an actual one. Otto supposes that the «territories», which are the areas where some hypothetical plant has expanded from one seed, grow as concentric circles. Even more, he supposes that each circle he draws corresponds to the growth in one year. Otto draws three sketches: in the first one, 5 points (A-E) are marked inside a shape, each being the centre of three concentric circles. Territories issued from A, C and D, are already touching, and Otto draws a dotted line at the frontier. In the second sketch, all five territories have reached each other, and also the edge of the shape. The last sketch shows the end of the process, until the shape is completely covered, and even the border eventually crossed over (Fig. 5).

Fig. 5: [1], p. 32

Otto draws also a sketch (Fig. 6) of an experimental apparatus used at his Institute to study the expansion of territories, the «so-called sand flow apparatus»: «A flat box is filled with sand. It has holes in its bottom arranged in a pattern. The sand trickling out leaves craters and forms growing cones of debris.» [1, p.32]

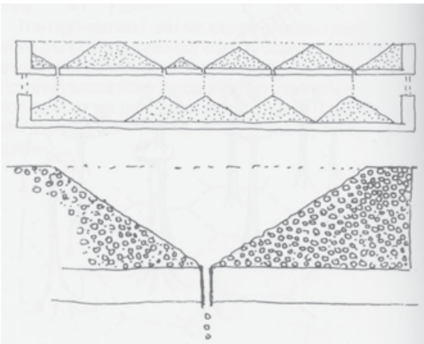

Fig. 6: [1] Ill. 89-90, p.32

1.2.3 Connections

Regarding connections, or paths, which I did not analyse so much as territories and distributions, one may remark first, that boundaries of territories are themselves possible connections (between junction points of those boundaries): in the examples given p. 51 in [1], Otto displays a section of dragonfly's wing, a maple leaf, a crack pattern, a soap bubble raft (which are all rather examples of boundaries) together with a thread model, a road network, or a minimal path network. Working on territories is then a way of working on connections, at least when connections generate closed units.

It is, for that matter, in this part, that Otto experiments with inkblots, or other drippings, which we would have awaited in the part about the formation of territories. The experiments dedicated to connections involve thread (dipped in water), and the «soap bubble skin apparatus».

1.3 A generative method: from material to digital experimentation

Observing natural processes and trying to reproduce them with some device is the starting point of a generative method. Frei Otto may not be qualified as a «generative» architect, but his observation of nature and his experiments may inspire some generative processes.

In his book, Otto ignores absolutely computer simulations. It is obvious, though, that many of his observations and experiments have their digital counterpart. Reading his book, I recognized some of my previous attempts, and I was induced to pursue them, or to imagine some new ones. In the next part, I shall display those experiments, which follow rather closely Frei Otto's exploration.

2. Experiments

1.1 Distance maps

Territories issued from sites, or «centres», are easily obtained by calculating a *distance map*. Let's remind the principle of a distance map: given a bitmap, in which some points, called centres, have been chosen, one gives to each pixel of the bitmap a level of grey according to its distance from the nearest centre. If we translate this level of grey into an altitude in a mesh, we get the result of the sand-flow apparatus. If we want to give a representation more alike Otto's sketches (Fig. 5), we can apply to pixels a level of grey which is calculated as a function based upon the sine of the distance from the nearest centre. In the next figures, the distribution chosen is practically the same as the one in Otto's sketches.

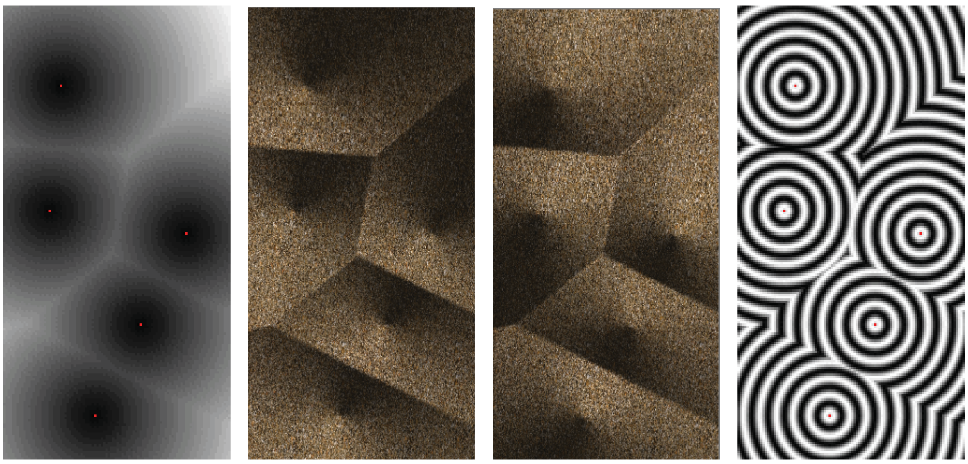

Fig. 7: distance map for 5 centres; sand craters and heaps; sinusoidal distance map

Distance maps may be related to medial axes (*cf* [2]), but also to Voronoi diagrams, anyway when centres are scattered, and not grouped. Otto does not mention this reference, though one of his first sketches (Fig. 4) and the description he gives («one demarcates the territory of an object by the perpendicular bisectors of the nearest points») are roughly the definition of Voronoi diagrams.

Though Voronoi cells are discernible in distance maps by the whitish lines that delineate them, and by the crest lines in the «sand flow» representaiton, one can get them more clearly by slightly changing the way of calculating the map: instead of affecting each pixel with a level of grey, one affects it with a colour corresponding to the nearest centre.

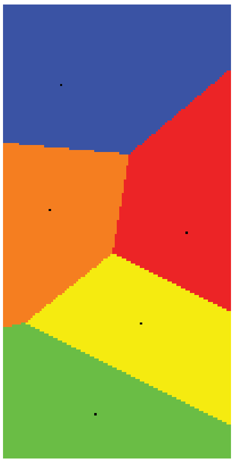

Fig. 8: Voronoi diagram for the same 5 centres

All of these experiments I had already done for my previous paper [2]. But Otto suggests two time-related variants, which I had not thought of. Distance maps are not processes evolving in time, like cellular automata for instance. In a way, time is translated into distance, and as distances are fixed at the start, distance maps only show a state of things. However, one can simulate a time-related effect by changing the way distance is calculated, as we shall see.

The first variant Otto suggests is to delay the start of growth for some centres: «If point A initially occupies its own territory, B follows, time-displaced, in year 3, C in year 6 and D is added in year 10.» ([1], p. 33) (Fig. 9)

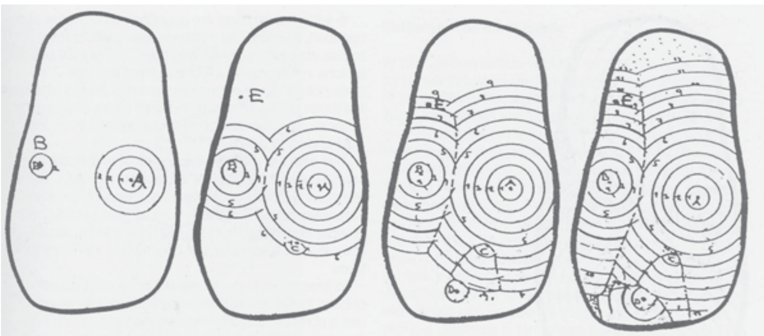

Fig. 9: [1], p. 33

Here we acknowledge that the concentric circles correspond for Otto to years of expansion. This can be simulated in the sand-flow apparatus: « A time lag in the flow is created by inserting small tubes of different heights into each hole.» In the same way, in the computing of the distance map, one can affect to each centre a number which will be *added* to the distance to this centre, when determining which centre is the nearest (Fig. 10):

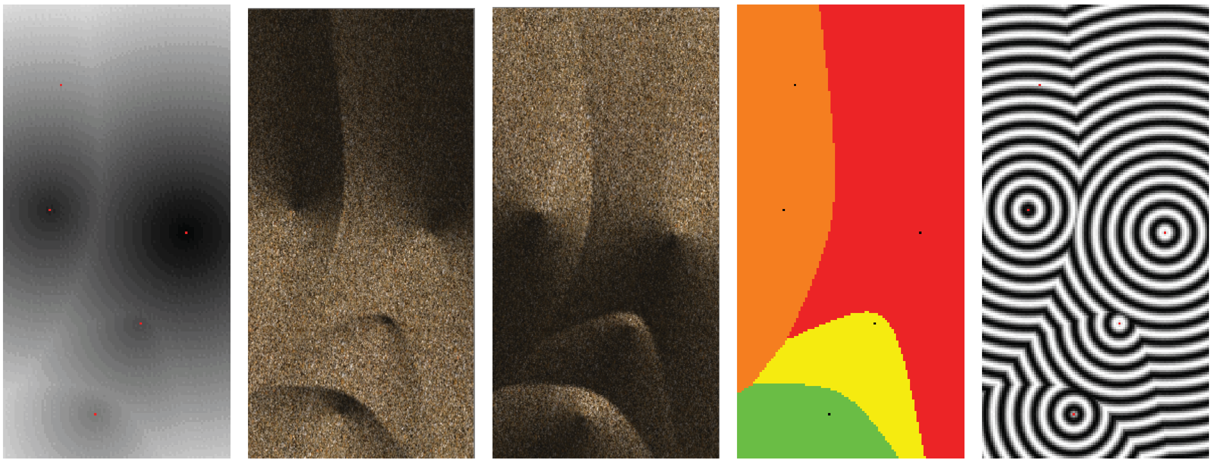

Fig. 10: distance maps, sand craters and heaps, and Voronoi diagram with time-lags

The second variant considers different speeds for the different centres. Otto sketches concentric circles more or less close to each other.

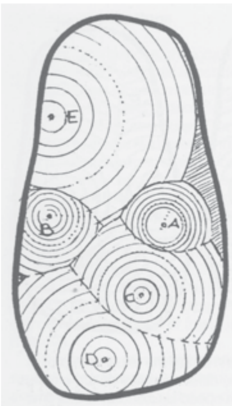

Fig. 11: [1], p. 34

He claims first that «speed of distribution can be adjusted by variations in the diameter of hole or tube» ([1], p. 34]. But then he admits that «this form of territory expansion can not be simulated with the sandbox, but diagrammatically and by means of computation.» (id). Indeed, it is easy to simulate different speeds by affecting each centre with a number, with which we *multiply* the distance from this centre, when determining which centre is the nearest (Fig. 12):

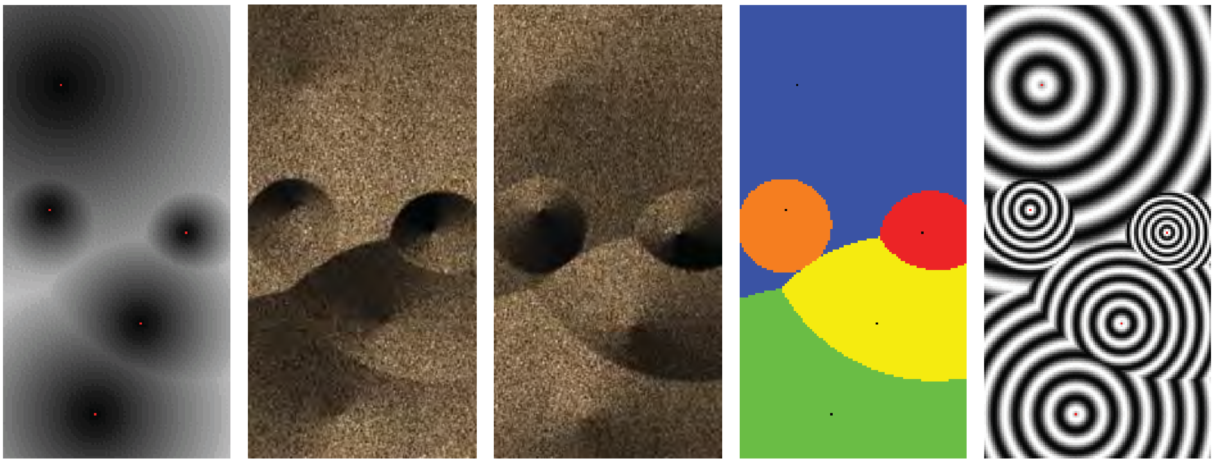

Fig.12: distance maps, sand craters and heaps, and Voronoï diagram for 5 centres with different speeds

Returning to distance maps with no time related differences, we can remark that boundaries of Voronoï diagrams provide us with an interesting net of connections between points, those points being the junctions between cells (Fig. 13):

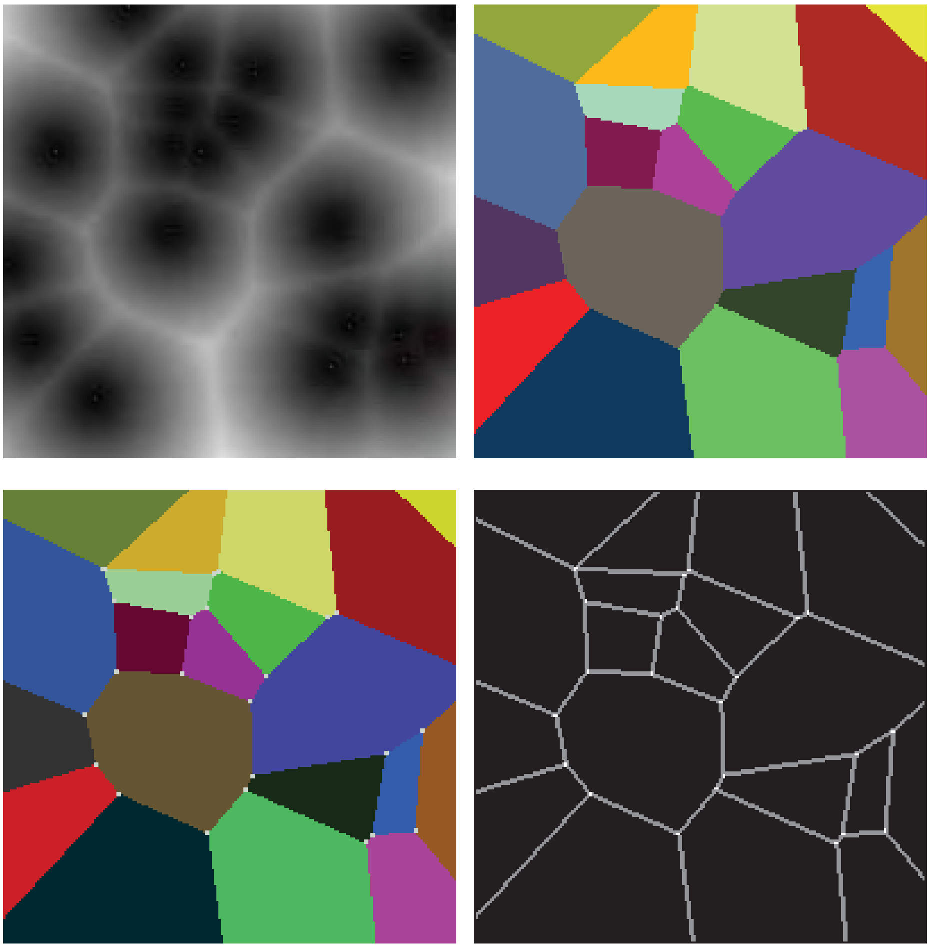

Fig. 13: distance map for a given set of 20 points, Voronoi diagram, junctions and connections

If the junctions of the Voronoi diagram of a set of centres was the dual of this set of centres, i. e. if the junctions of this first Voronoi diagram generated a new Voronoi diagram whose junctions were the first set of centres, then we would have a good way to generate connections between centres. It is the case only with regular configurations corresponding to regular tessellations of the plane (see [2]). But, unfortunately, in common cases, the junctions of the diagram of Voronoi generate a new diagram whose junctions are not the first set of centres.

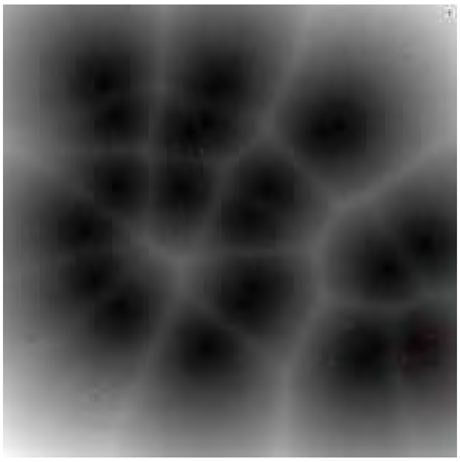

Fig. 14: distance map of the junctions found in Fig. 13 (in red, the original centres)

2.2 Minmax algorithm

The experiment described by Otto for distancing occupations (see 1.2.1 and Fig. 2) is a dynamic rearrangement. We don't know if the magnets are all put at the same time in the water, or if they are put one by one, but in any case it is obvious that they all move till they attain their definitive disposition. I preferred to simulate a more static as well as progressive one: my «magnets» are put one by one, each of them trying to be as far as possible from the ones already there. The simulation of this distancing mechanism is made by finding the pixel for which the minimal distance from «centres» already there is maximal (minmax algorithm). Fig. 15 shows the result of the algorithm with 10 centres and Fig. 16 with 50 centres. Distance maps are calculated, in order to better compare the distributions.

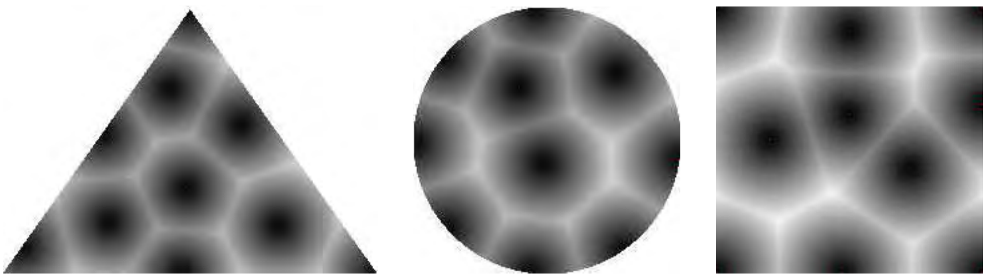

Fig. 15: minmax algorithm for 10 points

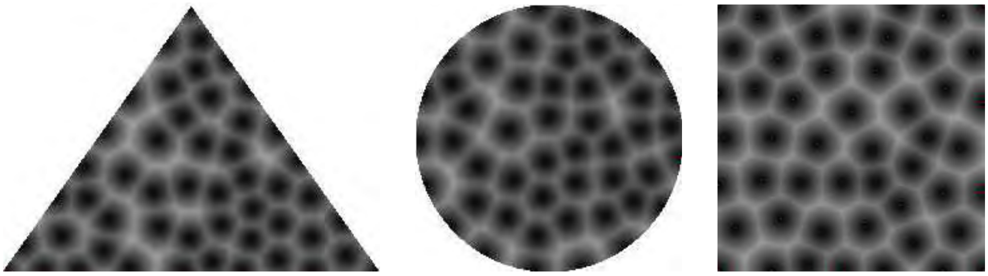

Fig. 16: minmax algorithm for 50 points

We see that, though not absolutely regular, the distributions we obtain are very near from a grid of equilateral triangles; the territories, as shown by the distance maps, form an hexagonal tiling. The more centres are added, the more equilibrated the distributions are. In any case, the distributions are very different from random ones (Fig. 17)

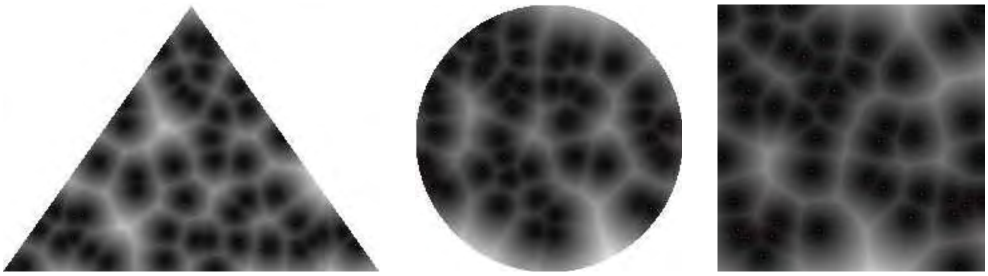

Fig. 17: random distributions of 50 points

2.3 Aggregations

In order to experiment attractive occupations, Frei Otto uses polystyrene chips attracted to each other by static electricity. The images of his experiments (Fig. 3) remind us of the various occurrences of forms which can be related to the well known diffusion-limited aggregation model, and its variants.

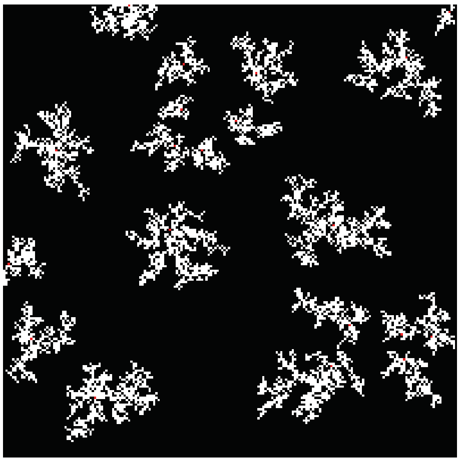

Fig. 18: DLA-like aggregation for a given set of 20 points

In this variant, «cells» are created at random and «walk» randomly till they attain an occupied cell. They then aggregate themselves to this cell (in their previous position in the random walk). One result based upon the same distribution of 20 points than in Fig. 13 is shown Fig. 18.

Returning to Otto's initial example, using this way of generating territories seems more adequate to his description of plants growing from five seeds (Fig. 19):

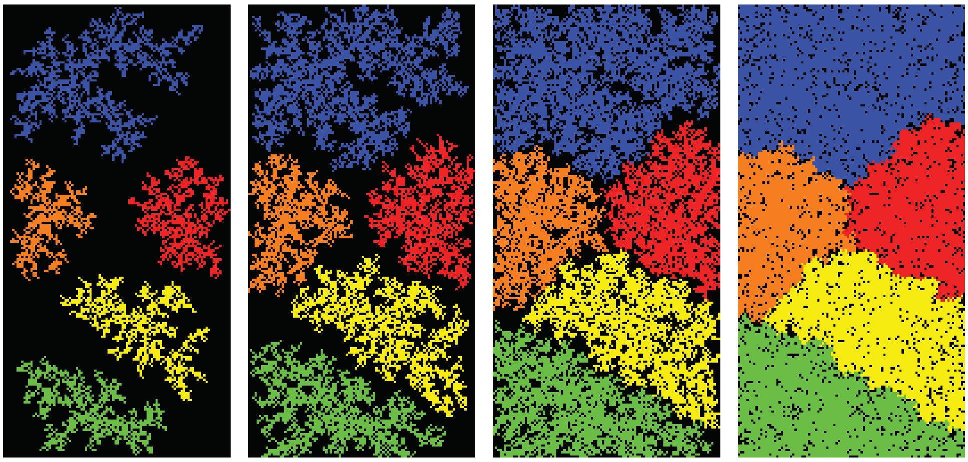

Fig. 19: DLA-like aggregation for a set of 5 points

And territories get to fill completely the space, with boundaries not very different from those obtained by distance maps.

3. Further developments and reflections

3.1 More about distance

Euclidean distances versus other distances

Most of the previous experiments are based upon distance: distance maps determine the «nearest» centre, the minmax algorithm the maximum of minimal distances. The Euclidean distance has been used. But it is possible to imagine other distances: the so-called Manhattan distance, for instance, which is very simple (distman (p1,p2)=abs(x1-x2)+abs(y1-y2)), gives a different distance map (Fig. 20) for the same set of points than in Fig. 13:

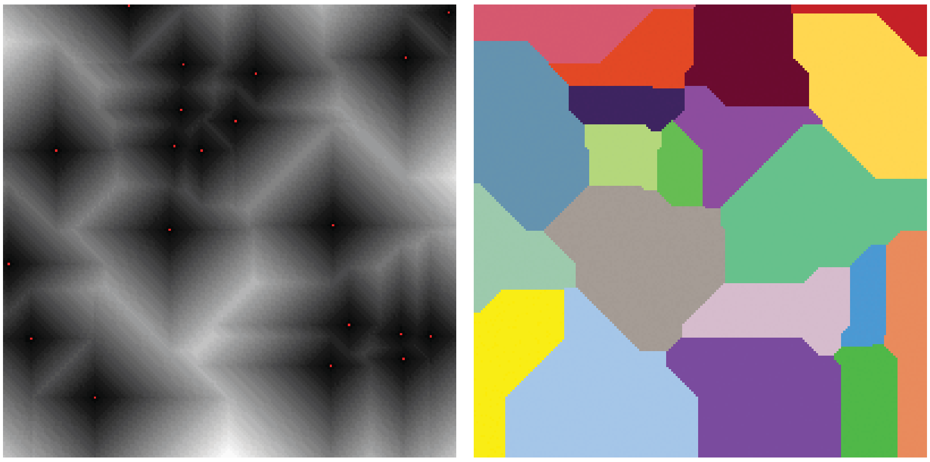

Fig. 20: distance map for a given set of 20 points (Manhattan distance)

Instead of cones, craters or heaps, it forms square based pyramids (Fig. 21):

Fig. 21: interpretation in sand of the distance map of Fig. 20

Minimal triangulation

Another way of using distance (Euclidean distance) was imagined by one of my students, Yann Huet. He explored the connections between nearest points of a set. One of his options was to link each point to the two nearest points, and also to link those three vertices of a triangle to its geometric barycentre.

What is interesting in this very simple algorithm, based only upon distance, is that for a random set of points, we obtain a net that is connected, or not connected. If we add points to the set, sometimes this addition connects parts that were disconnected, in other cases, it disconnects connected parts. Here are an example in 2D (Fig. 22) and an example in 3D (Fig. 23):

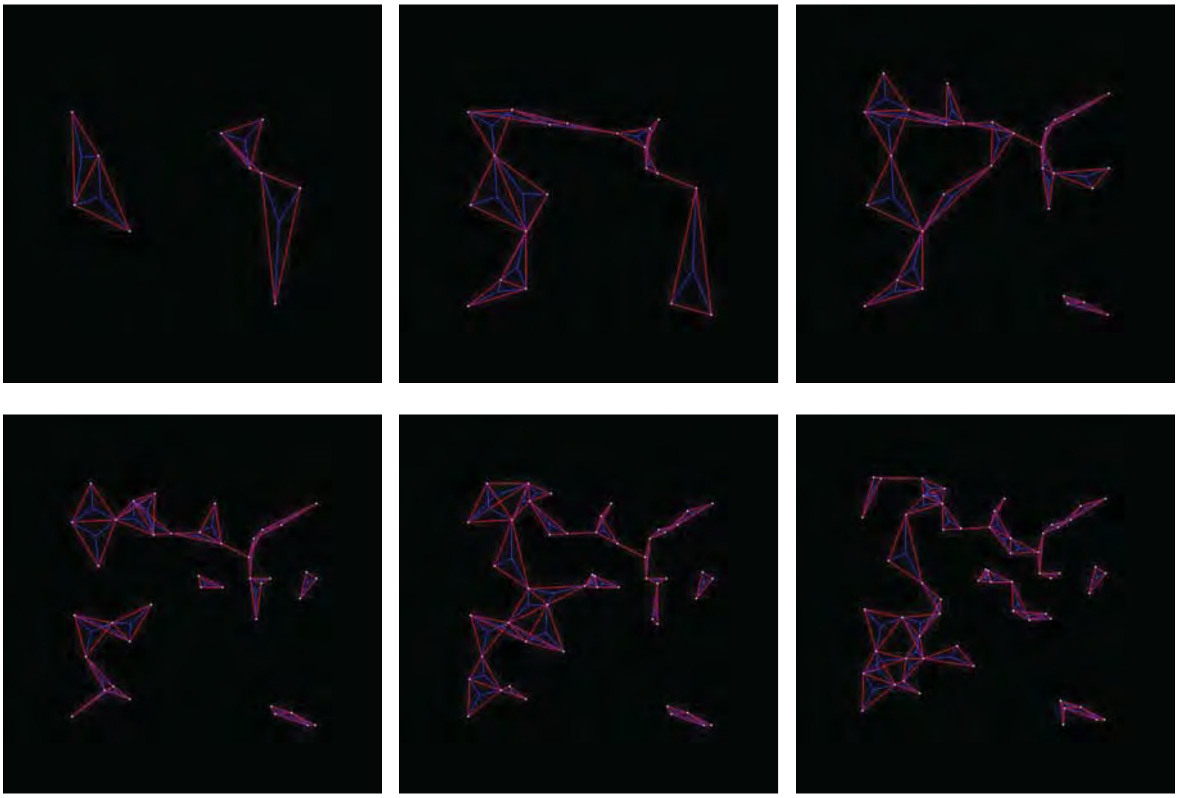

Fig. 22: minimal triangulation of a random set of points (10, 20, 30, 40, 50, 60 points)

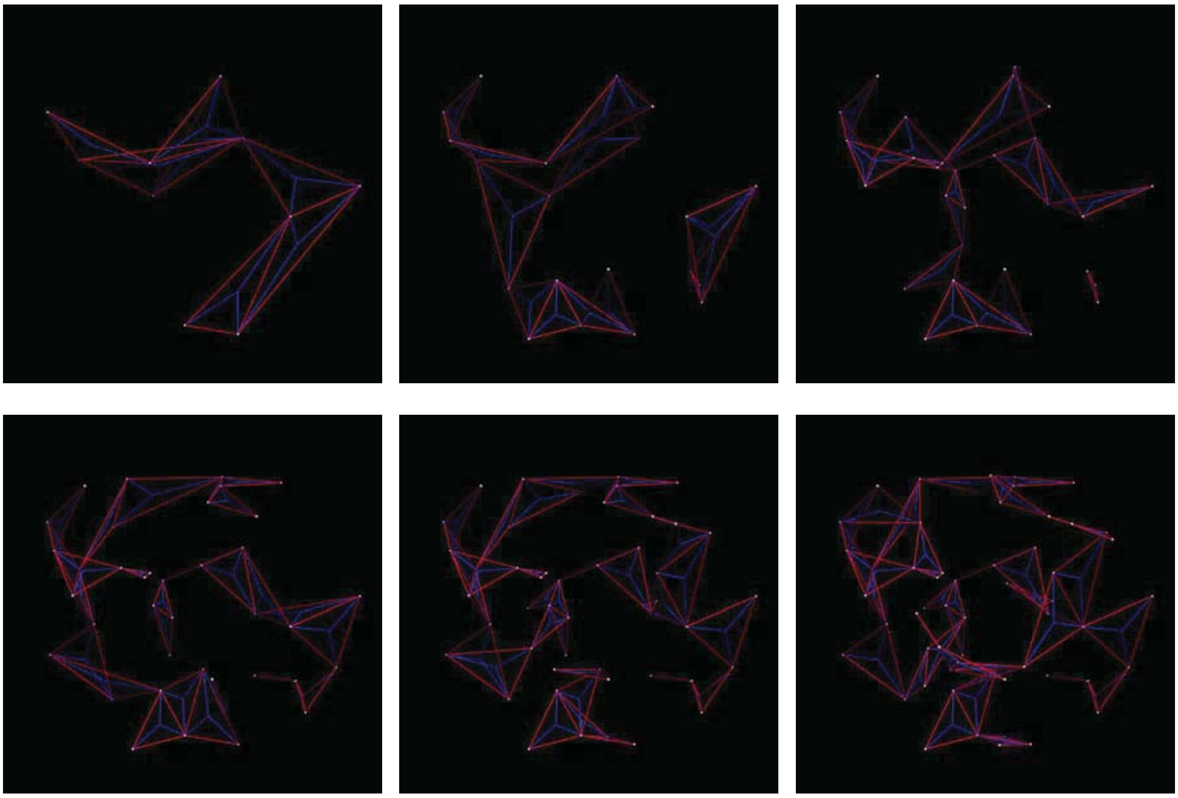

Fig. 23: minimal triangulation of a random set of points in 3D (10, 20, 30, 40, 50, 60 points)

It must be emphasized that this «minimal» triangulation is not the Delaunay triangulation, which is the dual of the Voronoi diagram.

3.2 Discrete spaces

A Voronoi diagram [4] (or Voronoi decomposition, or yet Voronoi tessellation) is a decomposition of any *metric* space (which means that you must have some *distance* to apply) and, given a number of objects («sites», or «generators», or «seeds», or yet «centres»), it is defined as the set of «cells» which are constituted, for each centre, by the points of the space whose distance to this centre is not greater than the distance to the other objects.

Calculating Voronoi diagrams may be difficult. Distance maps are an easy way to obtain a Voronoi diagram in a discrete space. A bitmap is such a space; the same computing may be done in 3D providing one can work in a 3D discrete space, whose elements may be called «voxels» (Fig. 24):

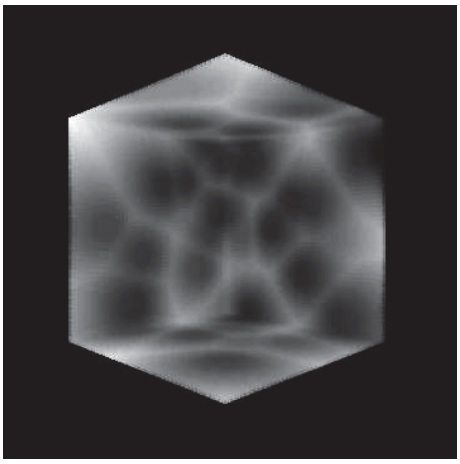

Fig. 24: 3D distance map

3.3 Dimensions

Locations, territories, boundaries, and connections, these topics imply once again the primordial notion of *dimension*. One can say that, in any n-space, a territory is a connected subset of the same dimension, its boundary is a closed manifold of dimension n-1. Locations are points (0-dim), and connections are lines (1-dim). For instance, on a line, territories are segments, their boundaries are points: there is then identity between locations and boundaries; but the idea of connection is not very gratifying, as there is only one way to connect two points, which is by the space itself. On a surface, on the plane for instance, territories are bounded surfaces, their boundaries are closed lines. Those lines may be interpreted as connections. And those lines may have vertices, which are points, and there may be a duality between locations and vertices of the boundaries. In 3D space, territories are volumes, their boundaries are closed surfaces. But those surfaces may have edges, which are lines (and then be interpreted as connections), and themselves have vertices which can be interpreted as locations.

Working in discrete spaces makes things easy, as we saw before, but algorithms that actually calculate Voronoi diagrams in continuous spaces are not so simple. In the Euclidean plane, the boundaries of the cells are defined by bisectors of centres taken two by two, which poses at least two problems: finding the equations of these bisectors is not too difficult, but cutting them to determine into edges of the polygon that encloses a given cell may be tricky; and finding which pairs of centres one must consider is also tedious...

But, if one works with a software that permits to «slice» or «cut» a given object by a plane, or if one implements that function, then one can easily produce the Voronoi diagram for a portion of a plane (or space), for instance a square (or a cube). One determines, for each centre, the planes that are bisectors of all pairs of centres that comport that particular centre, and one cuts the whole square (or cube) by those planes. Some cuts are not necessary, but it does not matter if you are not especially interested in time efficiency. Fig. 25 shows the result of this operation for the same 20 points as before; and Fig. 26 shows the same process in 3D:

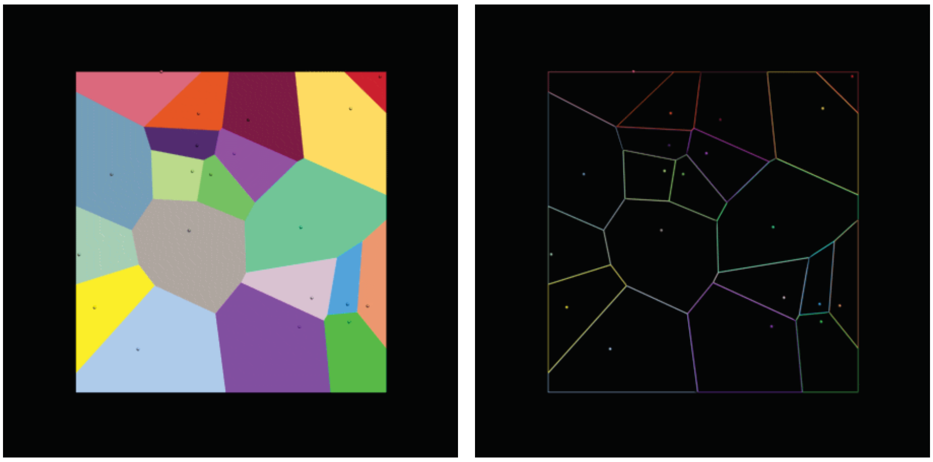

Fig. 25: Voronoi diagram «by cutting» for a given set of 20 points

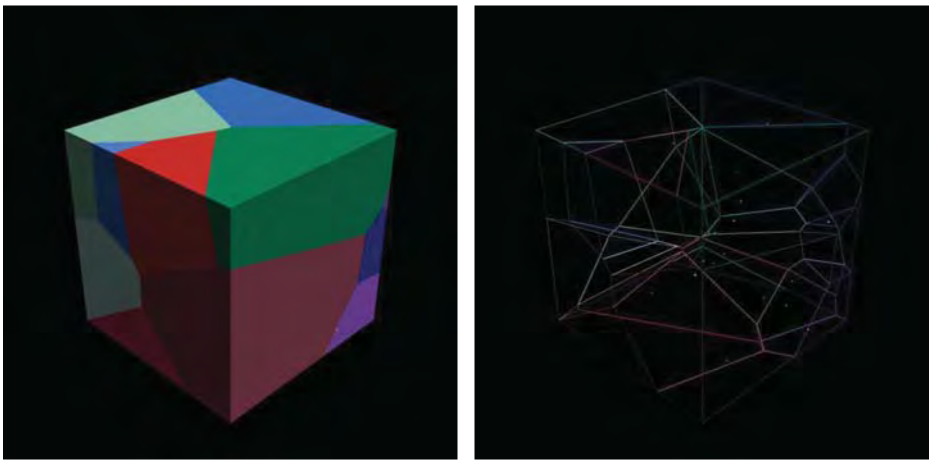

Fig. 26:Voronoi diagram «by cutting» for 20 points in 3D

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MICHAEL BURT

PERIODIC 3-D NETWORKS AND SPONGE SURFACES AND THE ASSOCIATED SPACE PHENOMENOLOGY. MORPHOLOGICAL FUNDAMENTALS OF 3-D SPACE THEORY.

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Abstract:

'Morphologically speaking', at the care of the **creative process of our habitat development and its architectural design and articulation** is the **manipulation of space** and its prime associated 3D space features of **network** structures, space-subdividing **partitions** and **cell-packing** agglomerations.

1. Networks may represent the structure of almost any abstract or physical plurality that may exist, in the world of phenomena of the biological-physical-material-spiritual domains, on every possible scale, from the Nano-molecular to the cosmological..
2. Surfaces-partitions, mostly sponge-like (hyperbolical) space sub-divisions, are probably the most abundant forms in nature, on every possible scale of physical-biological reality.
3. Cellular space close packings, and their polyhedral definitions, represent the morphological essence of the habitat solutions of living multitudinous societies in zoology, botany or the virus domains and the structures of all material crystalline aggregations as well.

   Periodicity of 3-D space forms features the negation of the total formal freedom (arbitrariness), and that by imposing topological parametral similarities and symmetry constraints. The tension between the free form and the topologically-symmetrically constrained periodic configurations are at the heart of the design art.

The 3-D Space Phenomenology – THE QUINTET ENSEMBLE

- Every 3-D network is associated with a dual, its uniquely determined reciprocal network. Networks in general, and periodic networks in particular, come in dual pairs.
- Every 3-D network is genetically associated with a close packing solid (or solids) and therefore, any dual networks pair leads to two modes of close packing cellular-polyhedral solutions.
- Any pair of dual networks is associated with a unique, topologically determined sponge surface, subdividing the space between the two.

If the dual networks are periodic in nature to a point of adhering to a certain specific symmetry group, the two associated cellular packing modes and the subdividing sponge surface relate to same symmetry regime.
The described five features of the 3-D space: the dual networks pair, the two associated packing modes (and their representative packing solids) and the associated space partition, all together, represents the **'Quintet Ensemble'** which encompasses the essence of the 3-D space phenomenology.
The number of 'Quintet Ensembles' in 3-D space is infinite, implying that the number of dual network pairs (and networks in general) and the number of sponge surfaces subdividing 3-D space into two complementary spaces are stretching to infinity as well.

The emergent fundamental morphological principles of 3-D space theory may be formulated as follows:

1. Every four components of the 'Quintet Ensemble' can be accurately defined and derived from the fifth.
2. The connectivity values of the dual networks pair are the same and equal to the genus value of the associated surface partition, subdividing the space between the two. Con. (net) = g (surface).
3. Every continuous 3-D network is embeddable in an unbounded continuous 3-D sponge surface (2d-manifold), thus featuring a specific '**unihedron'**, adhering to specific Val., Σα&g prime parameters, where $\mathbf{\Sigma\alpha_{av.} = 2\pi(Val. - 1).}$

The presentation will be saturated with illustrations and will expand on the above 3-D networks, the related close space packing cellular agglomerations and the associated sponge surface space subdividing partitions which represent the most important morphological features of our architectural design imagery and principal, visually embraced, research tools of 3-D space phenomenology.
The presentation deals with their binding (theoretical) relations which could eventually contribute to the evolution of 3-D networks theory.

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Keywords:
surfaces, morphology

The Morphologically Associated Quintuplet Phenomena of 3D Space

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Abstract

3D space phenomenology of our habitat is mostly concerned with the morphological features of network structures, cellular polyhedral close packing agglomerations and space subdividing partition surfaces.
They form the core of our imagery of the physical and the virtual-imaginary space we live in. Their manipulation determines the structure of our habitat, provides for its architectural design and consequently for its formal evolution and development.
The number of topologically different space networks, sponge surface partitions and cellular space-packings amounts to infinity, even when topologically-symmetrically constrained, as periodic features.
Observing the field of 3D space phenomena it transpires:

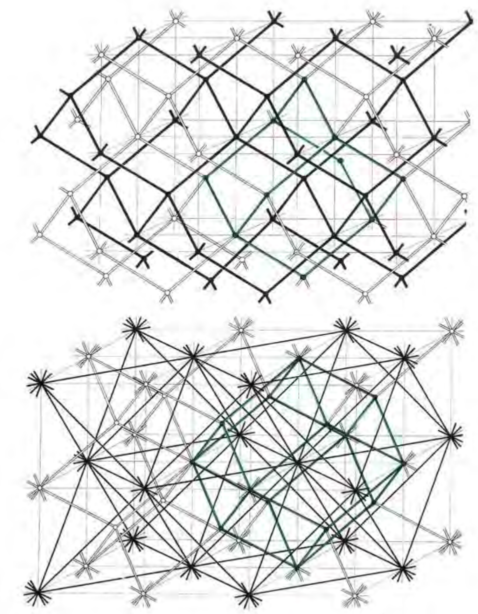
- Networks, in general, come in dual reciprocally related pairs.
- Every 3D network is genetically associated with a cellular close packing of polyhedral (mostly finite) volumetric solids.
- Any pair of dual networks is associated with a unique, topologically and symmetrically determined hyperbolical sponge-surface, subdividing the entire space between the two.

It transpires that every dual networks pair, the associated sponge surface, subdividing between the two and the two associated close-packing modes describe an inter-relating **quintuplet,** in which **every four components can be accurately defined and derived from the fifth.**
The quintuplet phenomena are at the core, and represent the essence of our 3D space phenomenology, and consequently must play a significant role in the evolving networks theory.

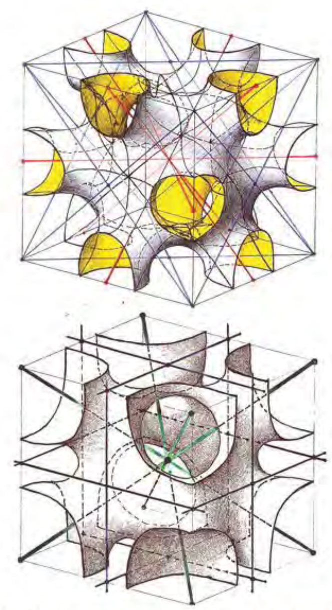
Introduction

The 3D space phenomenology of our habitat is mostly concerned with the morphological features of network structures, cellular polyhedral close packing agglomerations and space subdividing partition surfaces.
They form the core of our imagery of the physical and the virtual-imaginary space we live in. Their manipulation determines the structure of our habitat, provides for its architectural design and consequently for its formal evolution and development.

1. **Networks**, a connected assembly of vertices and edges, may represent the structure of almost any abstract or physical plurality that may exist, in the world of phenomena of the biological-physical-material-spiritual domains, on every possible scale, from the nano-molecular to the cosmological. They are the morphological essence of our built structures of products, buildings, urban sprawls, regional fabric and inter-national boundaries and all the associated transportation-communication interaction systems and installations of our living environment space.

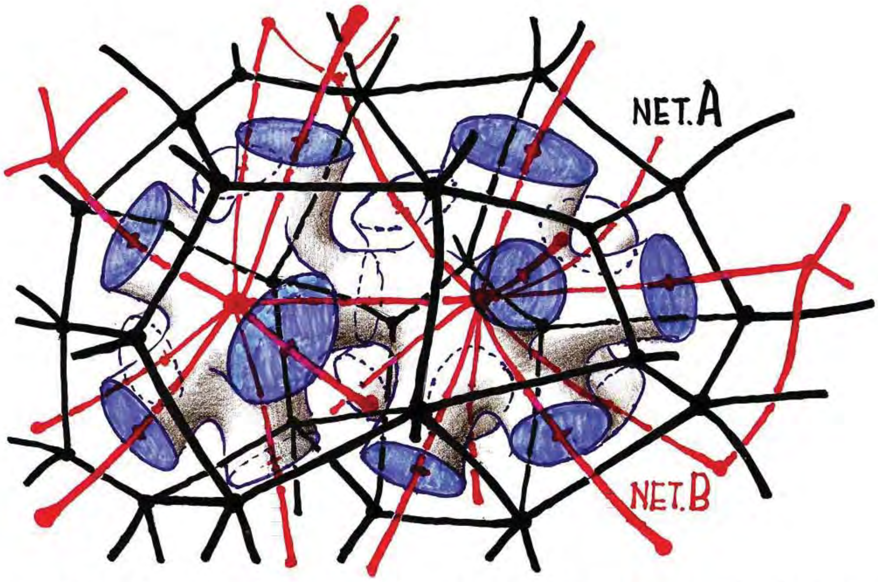


UNIFORM TETRAVALENT 'DIAMOND' LATTICE AND
UNIFORM DODECAVALENT 'OCTET' LATTICE AND DUALS.

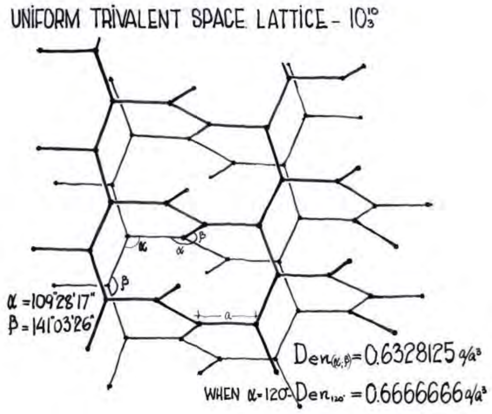


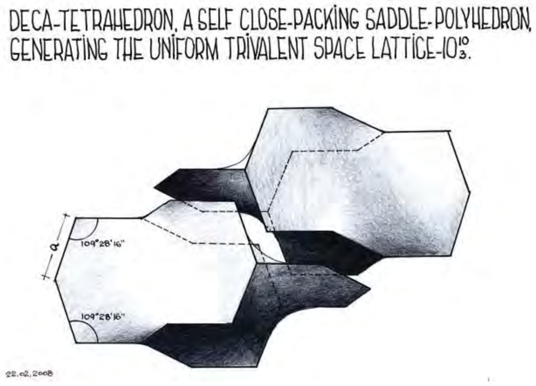
SPONGE SURFACES SUBDIVIDING
SPACE BETWEEN TWO DUAL NETS

2. **Surface-partitions**, plane, spherical but mostly hyperbolical, sponge-like space sub-divisions, are probably the most abundant forms in nature, on every possible scale of the physical-biological reality. Partitions define our personal, family or communal and national territorial-spatial expansion boundaries and the limits of our control, thus defining the boundaries between the **interior** and the **exterior** as predominant features of our environment. [1], [2], [3].

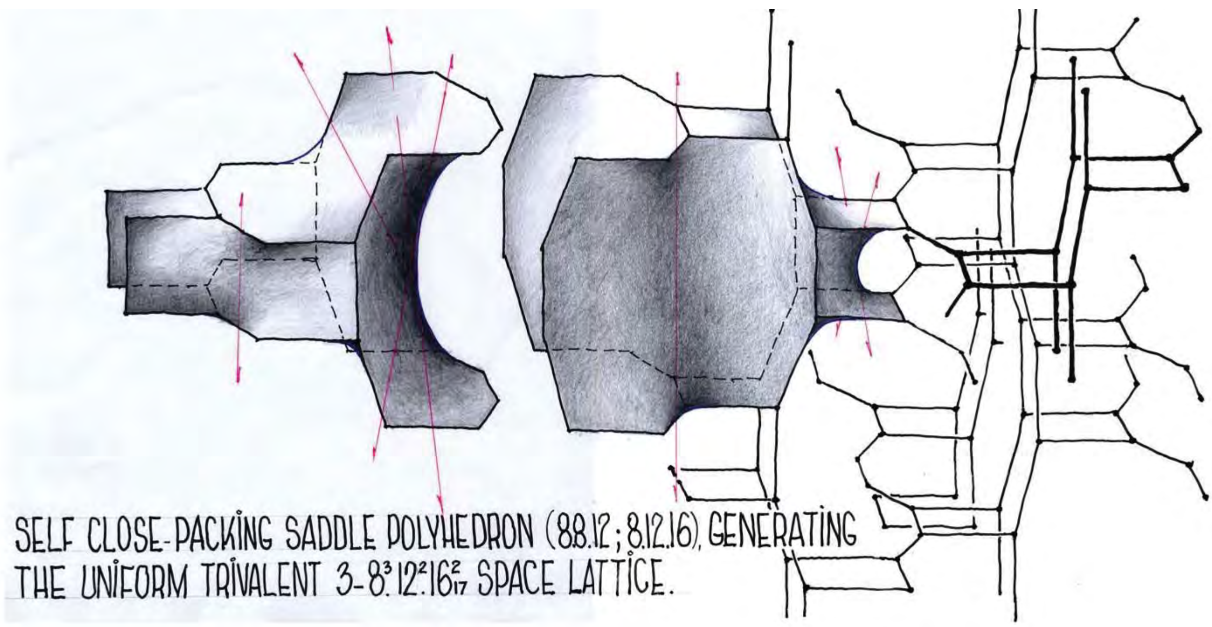


TWO (NON PERIODIC) DUAL NETWORKS, A & B AND THE SPONGE-SURFACE, SUBDIVIDING SPACE BETWEEN THE TWO.





3. **Cellular**, loose or compact close **space-packings** and their polyhedral entities-solids, represent the morphological imagery of the segregated habitat solutions of living multitudinous societies in zoology, botany or the virus domains and the structures of all material crystalline aggregations as well. [4], [5], [6].



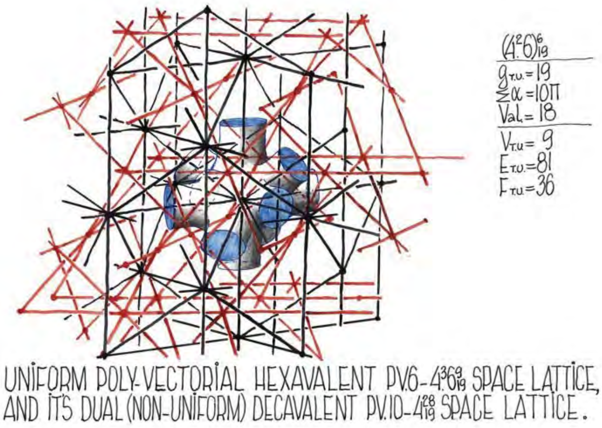
The finite cell units, mostly shaped like "saddle polyhedra", (having hyperbolical curved faces, with

one or two, and no more than two faces, meeting at every edge) conform with the Euler's theorem and formula of V-E+F=2K (where V,E,F&K stand for vertices, Edges, Faces and the Euler characteristic K, respectively). For finite polyhedra K=2.
The number of topologically different space networks, partition-surfaces and cellular space-packings is infinite (for each category), even when periodic in nature, due to topological similarities' or symmetry constraints. [7], [8], [9].
The interplay and the resulting tension between the completely free (arbitrary-chaotic) form and topologically-symmetrically constrained periodic configurations are at the heart of the design art and its phenomenology.

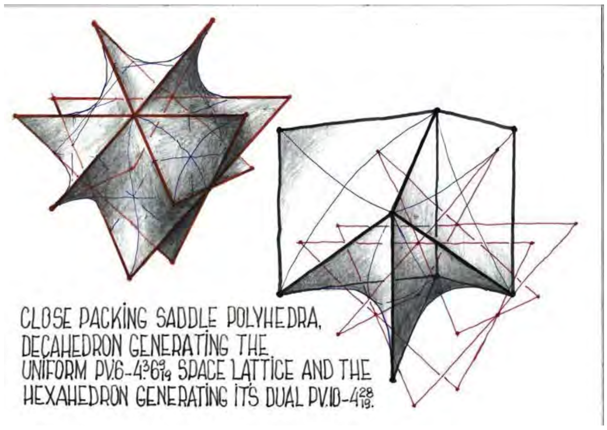
The Primary Infer-Related (reciprocal) 3D Space Quintuplet Phenomena

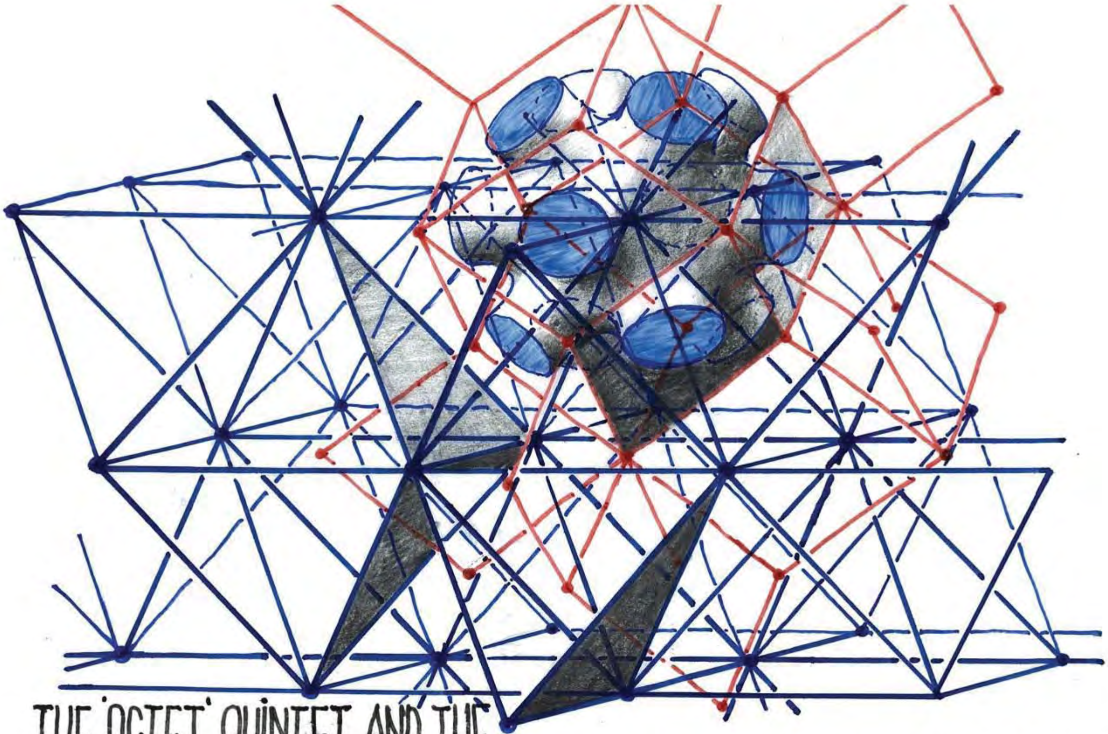
The topological constraints of continuously connected (unbounded) networks in 3D space dictate the following:

- Every 3d network is associated with a dual, its uniquely determined reciprocal network, being uniquely derived from the first.
  Networks in general and periodic networks in particular, **come in dual pairs.**
- Every 3D network is genetically associated with a cellular close-packing of polyhedral (mostly finite) volumetric solids, and therefore, any dual networks pair leads to two modes of polyhedral-cellular close-packing solutions.
- Any pair of dual networks is associated with a unique, topologically determined hyperbolical sponge-surface, subdividing the space between the two. Every such unbounded hyperbolical sponge surface, whether periodic-uniform or hopelessly chaotic, subdivides the entire space between two complementary labyrinthine spaces, with two tunnel systems, the axes of which feature two interwoven dual space networks.
- To construct, from a given network A, its dual network B, the following method should be employed:
  1. Perceiving network A as its associated cellular close-packing agglomeration of polyhedral solid cells (with V_A; E_A & F_A).
  2. Geometrically determining the centroids of all the polyhedral volumes of A.
  3. For network B to emerge, we have to join all the previously determined centroids with edges in such a way that every edge is passing through a polyhedral face of A, with the resulting relations: $E_A \equiv F_B$; $E_B \equiv F_A$; and therefore, the edge valency of any vertex of A equals the number of faces of the corresponding unit cell B and vice versa.
     It transpires that the number of different packing solids of 'A' corresponds to same number of different vertex-figures of 'B', and vice versa. If a network is periodic in nature to a point of adhering to a specific symmetry group, its dual network, the associated cellular packing configurations and the subdividing sponge surface, relate to same symmetry regime.
     The described five features of 3D-Space, namely the **dual networks pair,** the **two associated close-packing modes (**with their respective polyhedral solids and the associated **hyperbolical sponge surface,** all together represent a **'quintuplet assembly'** which encompasses the essence of the 3D space phenomenology. The number of such 'quintuplets' in 3D space is amounting to infinity, implying that the number of dual network pairs (and networks in general), the number of sponge-surfaces subdividing between the two and the number of close packing cellular solutions are stretching to infinity as well.

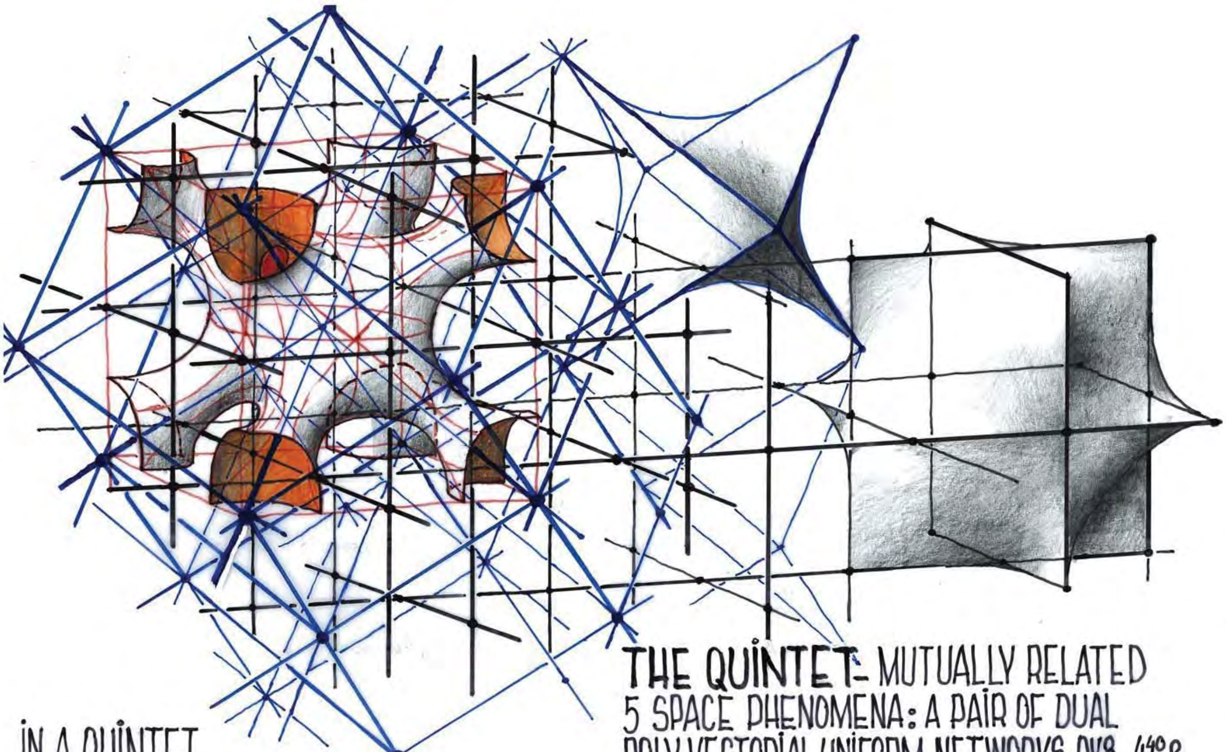


The emergent fundamental morphological principles of 3D-space theory may start with the following formulation:





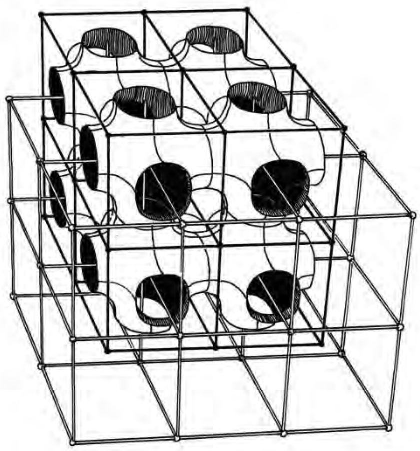
THE 'OCTET' QUINTET AND THE
ASSOCIATED DUAL NETWORK, THE SPONGE PARTITION AND PACKING SOLIDS.

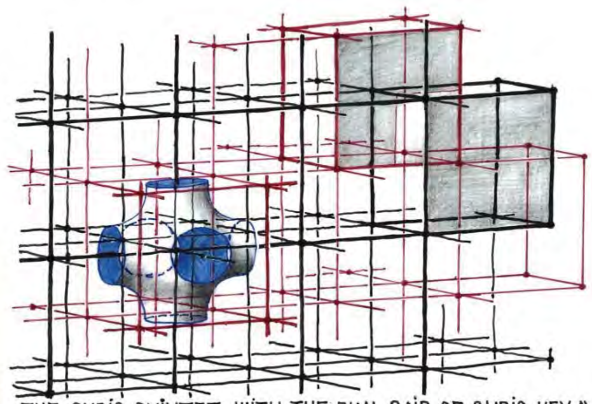


IN A QUINTET,
EVERY FOUR SPACE FEATURES ARE
RECIPROCALLY DERIVED FROM THE FIFTH.

THE QUINTET- MUTUALLY RELATED
5 SPACE PHENOMENA: A PAIR OF DUAL
POLY-VECTORIAL UNIFORM NETWORKS, PV.8-4^{40}_{7}&
PV.4-$6^{8}.8^{6}_{7}$, THE SPONGE SURFACE PARTITION
AND THE TWO CLOSE-PACKING SOLID CELLS.

1. Every dual networks pair, the associated sponge surface subdividing between the two and the two associated close-packing modes describe an inter-relating ‘quintuplet in which **every four components can be accurately defined and derived from the fifth.**
2. The average connectivity values of the dual networks pair are the same and equal to the average genus value of the associated partition surface, subdividing the space between the two.
3. If the ‘quintuplet is periodic-symmetrical in nature, all the five associated components share in the same symmetry regime (adhering to same symmetry group).
4. The particular inter-relations between any two dual networks may be reflected through existing relations between their close-packing modes:
   $V_A \equiv C_B$; $E_A \equiv F_B$; $F_A \equiv E_B$; $C_A \equiv V_B$, with V_A; E_A; F_A&C_A (and same for V_B **;**E_B;F_B;& C_B) corresponding to vertices, Edges, Faces and Cell units of ‘A’, respectively.
5. If the two dual networks are identical (as with the Cubic or the Diamond lattices) the surface partition subdivides the entire space into **two identical complementary sub-spaces**, thus giving rise to a third (highly periodic) lattice, composed entirely of 2-fold rotation axes, each of which is rotating network ‘A’ into its dual ‘B’. All such rotation axes are embedded in the sponge surface partition and represent its tessellation tiling, composed of identical surface unit. [1]





THE CUBIC QUINTET, WITH THE DUAL PAIR OF CUBIC HEXAVALENT PV.6-$4^{12}_{\cdot}6^{8}_{3}$ SPACE LATTICES, SPONGE PARTITION AND THE PACKING CELLS.

6. The number of identical network pairs and the associated sponge surfaces that subdivide 3D space into two identical sub-spaces is amounting to infinity.

In conclusion

In his monumental publication: **"Structural Inorganic Chemistry"** (1962), in a chapter discussing the **'Geometric Basis of Crystal Chemistry',** referring to 3D networks, A.F.Wells makes a startling factual observation: **"The theory of these nets does not appear to be known,** and in fact no attempt to derive them systematically seems to have been made"..(pp. 101). Even his efforts ('Three Dimensional Nets and Polyhedra'-1977) did not help to resolve the issue in a meaningful way. [10], [11], [12].

A comprehensive theory in any research domain may emerge only after the domain's phenomenology is accounted for and comprehended.

It is plausible to hypothesize that if such a theory would have been in existence some decades ago, quasi-crystalinity would have made its appearance much earlier.[13].

Many aspects relating to network's phenomenology are still inviting research. Such a research program, part of the authors agenda through the last years, may include the following.

- Networks topological-symmetrical nature, variability and constraints and the observed impact on their imagery.
- Their exhaustive enumeration, categorization and classification.
- Their primary form-shaping parameters and their mathematical interplay.
- Their inter-relation with space subdividing surfaces and close (compact) packing of space.
- Enquiry into their density properties and evolution, and their stability as physical structures, and many more. Gaining insights into these aspects must be a prelude to a comprehensive theory formulation of networks in 3D space.[14].

The presented **'quintuplet of the associated 3D space phenomena'** are central to our perception and understanding of 3D space in general and that of our habitat environment in particular. 3D networks and the associated hyperbolical partition surfaces and the twin close-packing modes

represent the most important morphological features of our architectural design imagery and primary, visually embraced notions and features of our 3D space phenomenology.
The presentation deals with their binding inter-relations which could eventually contribute to the evolution of 3D networks theory.

Glossary

Polyhedral Envelopes
Polyhedra – **tessellations** of **unbounded (2d) surfaces,** are composed of vertices (V), edges (E) and faces (F), with two faces only meeting in every edge. Polyhedra may be **spherical, toroidal** or **hyperbolic (sponge polyhedra).** Their **primary parameters** are: **Valency (val.)** –number of edges meeting in a vertex; - **Sum of angles** in a vertex, or (when the faces are not planar) the **total surface curvature** of a **vertex region; Genus (g)-** the maximal closed circuit cuts of the surface which leave it un-separated into two (dis-attached) parts.

Space Networks
A network constitutes an array of vertices and inter-connected line segments – edges. Shortest closed circuits of edges may describe **polygons** which in themselves constitute faces of **polyhedral unit cells.** Aggregation of such polyhedral cells, in its totality, describes a close **compact space packing** resulting in the network structure. **Uniform Polyhedra** and **Uniform Networks** result from the imposition of **symmetry constraints,** enforced by a specific **symmetry space group** and are characterized by **identical vertex figures,** meaning that the environment observed from every vertex is one and the same.
The defining symmetry space group implies the existence of repeating **symmetry space units** either as **Elementary Periodic Regions (E.P.R)** or as a **Translation Unit (T.U.)** characteristic of the space network, which include complete representation of the topological-symmetrical features of the configuration.
Network Duality: When the centroids of the close – packed polyhedral cells of a given A network are inter connected, network B, it's dual, is generated, with one edge of B penetrating each of A faces (and vice versa).
Between any pair of dual networks a partition may be drawn in the form of a sponge polyhedron or a curved, mathematically determined sponge surface.
The dual networks and the associated sponge partition share same symmetry characteristics and the **connectivity** of the networks pair and the **genus** of the partition are of the same value.

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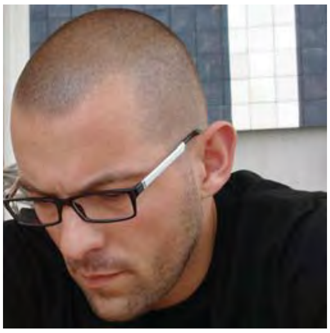
Miguel Carvalhais

Paper: A perspective on Perspective and the genesis of generative narrative



Topic: Art, Artificial Behaviors

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Abstract:
Artificial Aesthetic artifacts produced by computational systems have been in the focus of our previous work, namely in the development of an analytical model [4] that addressed many procedural affinities found in these systems. This model attested to the importance of computational characteristics and of procedurality as conceptual foundations and aesthetic focuses in their own right. By studying sets of inherently multimodal artifacts, we discovered that sensorial modalities were more than aesthetic or communicational resources: they mediated the logical and mathematical structures in the artifacts' processes. The methods through which we, the human counterparts in the cybernetic aesthetic experience, build awareness of the processes that are developed within the artifacts, displace and remold our sensorium [5] and result in what we may call a *procedural* modality. This is dependent on sensorial modalities but unlike those it is for the most part intellectual: reception happens sensorially, while perception is a cognitively developed epiphenomenon [1]. The sensorium mediates the experience of the artifact and the brain fabricates perception, developing simulations of varying accuracy that through processes of patternicity [3] and deduction try to reduce the sensed complexity and to anticipate the outcomes of the witnessed processes.

When experiencing an artificial aesthetic artifact, we watch it perform as we simultaneously perform it, we probe its structure and draw the connections needed to participate in and comprehend it. Most of the times unwillingly, we simulate its processes and create our own parallel sequences of probable events as the artifact unfolds. In these systems, anticipation, the validation of simulations and the eventual violation of expectation therefore play a major role in the creation of narrative. As with other aesthetic constituents of these systems, narrative and drama may either be hard-coded — much as they are in traditional or non-procedural media — or they may emerge from the system. In this paper we propose an approach to how the creation of narrative can be understood in the context of performative or interactive generative systems, in an attempt to integrate in our model [4] the *perspective* variable originally proposed by Aarseth [2] in his study of ergodic texts.

Keywords: Computational media, Generative art, Narrative, Procedurality

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A Perspective on *Perspective* and on the Genesis of Generative Narrative

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Abstract

Aesthetic artifacts produced by computational systems have been the focus of our previous work, namely through the development of an analytical model that addressed the procedural affinities found in these systems. This model attested to the importance of computational characteristics and of procedurality as conceptual foundations and aesthetic focuses on their own right. By studying sets of inherently multimodal artifacts, we discovered that sensorial modalities are more than aesthetic or communicational resources: they also mediate the logical and mathematical structures that are found in the artifacts' processes. The methods through which we – the human counterparts in the cybernetic aesthetic experience – build an awareness of the processes within the artifacts, displace and remold our sensorium and result in what we may call a *procedural* modality. This is dependent on sensorial modalities but unlike those it is for the most part an intellectual process: reception happens sensorially, while perception is a cognitively developed epiphenomenon. The sensorium mediates the experience of the artifact and the brain fabricates perception, developing simulations of varying accuracy that through processes of patternicity and agenticity try to reduce the sensed complexity and to anticipate the outcomes of the witnessed processes.

When experiencing an artificial aesthetic artifact, we watch it perform while we simultaneously perform it, we probe its structure and draw the connections needed to participate in and comprehend it. Even if most of the times unwillingly, we simulate its processes and create our own parallel sequences of probable events as the artifact unfolds. In the interaction with these systems, anticipation, the validation of simulations and the eventual violations of expectations, play a major role in the creation of narratives or narrative-like experiences. As with other aesthetic constituents of these systems, narrative and drama may either be hard-coded — much as they are in traditional or non-procedural media — or they may be emergent. This paper proposes an approach to how the creation of narrative can be understood in the context of performative or interactive generative systems, in an attempt to integrate in our model the *perspective* variable, originally proposed by Espen Aarseth in his study of ergodic texts.

1. Computational Artifacts

Computational artifacts have become nearly ubiquitous in many aspects of contemporary live, including cultural creation and consumption. They are regularly used in the production, presentation and distribution of many arts and media, sometimes replacing previous analog resources, sometimes allowing the discovery or development of whole new niches or specializations and creating entirely new media.

In many technological arts, such as cinema or audiovisual production, not only have computational devices become omnipresent, being found in most areas of production, presentation and distribution, as to some extent they have pervaded the entire creative and commercial cycles of the arts, that can currently be integrally developed without the use of analog means.

When used as tools, computational devices allow the discovery or the invention of whole new processes but also the simulation of previously existing tools. Very often they allow increases in speed, reductions in cost, or both, therefore eventually replacing many of their analog counterparts. Their success in this area is due to their ability to develop highly efficient simulations, as most computational devices are universal machines, able to reproduce and simulate any process that can be reduced to algorithms. They are also able to simulate any medium that can be digitized, which leads to the computerization of the media, and to their ultimate absorption by computational devices. Media become virtual, shedding their materiality and going through a phase transition from matter to bits.

When these devices act as media, their capacity to remediate [7] promises unprecedented fidelity of reproduction, safety in archival and an extreme portability, it may therefore be no exaggeration to claim that very often media benefit from the transition to the digital domain.

However, the shift in distribution technologies is but the first stage in this transition. Computational media must not necessarily abide to the classical traits — or one could say limitations — of analog media, among which we can list linearity, determinability and controlled access. They are perfectly suited to act in such ways, being able to become more thoroughly linear and determinable than analog media, as Aarseth noted [1], by using the laws of code [19] to enforce controlled access in much stricter ways than analog alternatives are able to.

But simultaneously, they ache to be released from the constraints of the classical roles of the media. Computational media permit the departure from some of the attributes of analog media: they allow non-linearity, indeterminacy and random access to be developed in scales that non-computational media are unable to achieve, due to their capacity for various degrees of autonomy [9], both from their creators, contexts of creation or wreaders, as well as from hard-coded information or other external data. Able to develop a plethora of cybernetic communicative acts, they can be manipulatable but also richly interactive. They achieve permanence from transience; they simulate stillness as an outcome of dynamic processes.

As creators, our usage of these devices must be guided by the awareness that even when acting as media, they are capable of simultaneously becoming tools to operate on the media layers they produce. They are capable of reshaping the experience, form, content and expressiveness in runtime. They are able to transform the operational space of the arts, expanding it well beyond the field of possibilities offered by classical media, pushing it further, breaking out and constructing new spaces. They become able to exert some judgment over the products of their operation, to reconsider past choices in deciding where to follow in upcoming steps [5]. They are able to act creatively and to do so in concert with their human cooperators, becoming a new form of artificial aesthetic artifact.

2. From Amodality to the Core of Multimodality

Before being conveyed as sensorial stimuli or aesthetic phenomena, a computational artifact is built from code and software. If we undertake an analysis of the artifacts following Hunicke, LeBlanc and Zubek's MDA formal approach [18], we are able to describe a first set of components, the "rules" of the artifact's mechanics, "the particular components (…) at the level of data representation and algorithms" [18]. Following these, a second level of the system emerges, where we find the dynamics, "the run-time behavior of the mechanics acting on [wreader] inputs and each others' outputs over time." [18] Finally, and from these two, emerges the third level of aesthetics, where we discover the experiences that very often are the goal from the system's designer and that frame the wreader's point of view on the artifact.

We find that at the levels of mechanics and dynamics, artificial aesthetic artifacts most often operate in an amodal space of possibilities, a 'proto-sensory' flux that preconditions the differentiation of the sense modalities [15], and at which the artifacts can take arbitrary forms, because they possess no "natural mapping" and their "critical operations all take place invisibly through internal representations" [25] of a highly abstract nature.

It is only in the verge of aesthetics, when the processes of computational artifacts are transcoded — in the sense proposed by Manovich [21] — that they become modal and multimodal. This is the moment when processes are brought to physical reality and are expressed through concurrent modalities. Most of these are directly linked to the human sensorium [31]: visual, audial and haptic, as well as the perception of motion (that although related to vision can be independently analyzed). Furthermore, we can expand the definition of modality to include, as proposed by Stephanie Strickland [30], the perception of mathematics or mathematical structures, rhythm and harmony. We may therefore propose the description of a 'procedural' modality, that should not be understood in the Pythagorean sense, as a correspondence between art and mathematics in terms of numerical 'harmony', but rather as the intellectual and intuitive understanding of structure and process, and the aesthetic pleasures associated to it. This modality is responsible for the beauty of abstract understanding, not of bodily contact but of cerebral perception. We may also link it to the design stance that humans tend to seek in inanimate objects, or to the intentional stance sought in animate objects [27], the first of these trying to discover a purpose to an object, the later trying to understand motivations and emotions.

The first four modalities are sensorial, directly dependent on vision, audition, touch and proprioception (as the haptic modality frequently involves more than simply the sense of touch, related as it may be to movement through space or other involvements or perceptions of the wreader's body). They are frequently crossed, combined or mutually reinforced, contributing to the communication of the internal processes of the artifact to human wreaders and therefore, to the emergence of the procedural modality. In the process of transcoding, the internal potential translatability guaranteed by code must be relinquished to ensure human readability and, as this happens, a further process of translation must take place. The internal translatability is not only found between modalities, but also between media — images, sounds, films, texts, and so on —, reducing programmed, self-generated and user-generated information to a similar code [16].

Once communicated to humans, stimuli go through reception and perception, two complimentary but nevertheless contrasting processes [17]. Reception gathers inputs that are starting points to perception, where symbols are then selectively triggered and meaning is deduced. The procedural modality is therefore not directly sensorial, as the previous modalities, but rather cognitive and intellectual, and is found at the core of the multimodality of artificial aesthetic artifacts.

3. From Illusion to Simulation, from Patternicity to Agenticity

The human sensorium mediates the experience of the exterior [4] through illusion and simulation. Perception never exists through sensory channels, as the brain uses the body's specialized sensory signals to *fabricate* perception [10]. Objects, artifacts and the whole of the external reality are sensed and recreated in what invariably results in a subjective experience.

Very often this illusion is based on the direct reception of stimuli, however, at times it may be based on a construction of double illusions, as in the case of film — where the real motion between frames remains unseen while it creates the perceived movement-image —, or it may be based on the stacking of multiple illusions, as in video or audiovisuals. Perception is therefore an epiphenomenon, "a collective and unitary-seeming outcome of many small, often invisible or unperceived, quite possibly utterly unsuspected, events" [17], a large-scale illusion. Perception is subjective because it is an illusion and a simulation developed at a higher level than the sensorial creations but also because it is a process where meaning is inferred or created [12]. We distill meaning from the sensed, from reality and media, located in the external world from which the meaning-maker brain is irremediably isolated. The procedural understanding of what is sensed, of its rhythm, structure, order or harmony, contribute to a further, intellectually constructed simulation, that of causal procedurality, of the processes or algorithms that originate the phenomena. Drawing from clues available to the senses, the universal machine of the human brain tries to reconstruct the processes or their best possible approximations, to build internal simulations that predict the external processes and that try to anticipate them. Successful anticipation is then taken as a proof of successful simulation, and a corroboration of the acquired knowledge.

Human brains constantly try to reduce perceived complexity, to make “unfamiliar, complex patterns made of many symbols that have been freshly activated in concert to trigger just one familiar pre-existing symbol (or a very small set of them)”, to “take a complex situation and to put one’s finger on what matters in it, to distill from an initial welter of sensations and ideas what a situation really is about.” [17] The brain tries “to look for and find patterns”, the process that Michael Shermer describes as ‘patternicity’ [28].

If a simulation is not able to ever tell us anything that one does already not know, because it is no better than the assumptions that one builds into it [29], and that are deduced from the received data, there are ways in which a simulation can in fact provide new knowledge, even when one is not in possession of a complete or even a reasonable set of data about the laws that govern a system. Sometimes, by abstracting the details of a set of phenomena, one may find a faster path towards its simulation because “we do not have to know, or guess at, all the internal structure of the system, but only that part of it that is crucial to the abstraction.” [29] Therefore, even incomplete or partially abstracted simulations can provide relevant data to be integrated in new models, contributing to their continued development. If and when partial simulations can be compared between themselves and with the external phenomena, the process can be sped up through a quasi-evolutionary selection of those abstractions that are able to provide more accurate predictions of the external phenomena.

A simulation may produce seemingly accurate results despite being based on false assumptions, developing a process that is dissimilar to the original but happens to produce similar enough patterns of outputs. There is a wealth of examples of such approximations, to be found in natural sciences and their “skyhook-skyscraper construction (...) from the roof down to the yet unconstructed foundations” [29], or in emotional responses, that help “us judge what is good or bad, safe or unsafe, while also providing a powerful communication system for conveying feelings and beliefs, reactions and intentions” [26].

Furthermore, an incomplete understanding of the procedural aspects of a phenomenon may indeed be enough because “what happens on the lower level is responsible for what happens on the higher level, [but] it is nonetheless irrelevant to the higher level”, being therefore possible for the higher level to “blithely ignore the processes on the lower level” [17]. Consequently, if a simulation produces results that are accurate enough with a sufficiently high frequency, it may be judged as correct even if based on otherwise incomplete or erroneous assumptions. This is what we find in the so-called “Eliza effect”, caused by the human susceptibility to read far more understanding than is warranted in the sensorial manifestations of computational devices [17].

The Eliza effect was named after the ELIZA software, written by Joseph Weizenbaum in the mid-1960s, a context in which it was often experienced [14]. It is due to simulations built on erroneous principles that lead to the projection of traits like sentience, intelligence and personality onto machines that were not programmed to develop them and that are absolutely unable to manifest them. This is something we do because these traits are very often the best models readily available to develop a simulation that may produce outputs not dissimilar to those that are witnessed. The Eliza effect can be described as the outcome of three complementary phenomena: 1) the anthropomorphization of technology (with roots in that of animals and inanimate things); 2) the artificial artifact's concealment of processes that are not relevant to the human-side of the interaction or may not be easily or directly understood by the human counterparts; and 3) the strong effect of surprise — or what we can also call of the "violation of expectation" [2] — when interacting with a computational system.

But there is fourth further cause, which we may describe as the natural tendency to develop theories of mind for those processes or phenomena that possess enough complexity to be able to be described as possessing a mind or something akin to one. Because we frequently resort to this strategy when we try to interpret ourselves, other humans or any beings endowed with a mind (regardless of which complexity is perceived in such a mind), we naturally fallback to the same approach when facing complex systems like artificial aesthetic artifacts. After finding patterns, the brain "infuses those patterns with meaning", developing a process of 'agenticity' [28].

We try to understand how a system behaves by using our mind to get "ourselves into [its] mental shoes" [22], trying to 'think' as it does, to operate along the same lines, i.e., to simulate it. In the process of perception our brains do not simply register phenomena but rather affordances in those phenomena, sets of possible behaviors, usages or interactions to be experienced, whether these are actual or virtual. While we see an object, "we are also unconsciously swimming in a sea of possible behaviors. As it turns out, the traditional philosophical distinction between perception and action is an artificial one. In reality, our brains employ a common coding: Everything we perceive is automatically portrayed as a factor in a possible interaction between ourselves and the world." [22]

4. Anticipation and the Violation of Expectation

The operations of a mechanical artifact can often be understood with relative ease, while logical or algorithmic processes developed by artificial aesthetic artifacts are, more often than not, of a higher degree of complexity. Coupled with the very high processing speeds that these devices are capable of achieving, this complexity creates a barrier to their comprehension. During interaction with these artifacts, their aesthetic and expressive behaviors —respectively tied to the sensorial reception and intellectual perception — are simulated and predicted. These behaviors are encoded by prescriptive rules, at the artifact's mechanics level and, as the processes unfold, the human interactant predicts their outcome by elaborating sets of descriptive rules. The interactant builds anticipation as to whether these simulations will be proven correct or if, on the contrary, expectations will not be confirmed. This intellectual tension, coupled with the key-points that allow the evaluation of the simulation, is at the foundation for the emergence of narrative, aesthetics and even drama, as defined by LeBlanc [20]. This is the point where the wreader starts reversing the path outlined by the MDA framework, from a perspective at which “aesthetics set the tone, which is born out in observable dynamics and eventually, operable mechanics.” [18]

As with any media message conveyed by an artificial aesthetic artifact, narrative, drama and tension may be hard-coded and posteriorly reproduced. Acts and multiple arcs, stable situations and the inciting incidents that unbalance them, big events, goals, obstacles, commitments, crisis and showdowns, protagonists and antagonists, accompanied by a host of other characters, may be predefined [3]. When this happens, however, the artificial aesthetic artifacts are used simply as media, not only not taking advantage of their added capabilities but also partially resigning the potential of procedural authorship [24].

Where elements of a more or less classically structured narrative do not exist, when simulations are developed through the procedural modality, a narrative experience may emerge from the tension between simulation and its validation, from the probing and mapping of the logical depth of the artifact [13]. As characters in a script, artificial aesthetic artifacts can be ‘flat’, failing to grow or change, to significantly develop or to violate our expectations during the time of our experience, or they may be ‘round’, reacting to conflict or other stimuli, allowing themselves to be shaped and changed and, in doing so, frequently violating our expectations (although not always positively).

Difficulty of simulation and the consequent violation of the simulator’s expectations are the customary signs of non-mechanical systems. The creation of large patterns as a result of many smaller effects is one of the singular attributes of living systems [24]. Throughout human history complex systems were found in the natural world, not in the realm of the artificial, of the products of man’s labor, for the most part characterized by repetition and predictability, as the epithet ‘mechanic’ so well expresses. We generally do not endow artifacts with a mind, emotions or personality in the same way as we do to humans or in various degrees to animals [17]. What we start experiencing with artificial aesthetic artifacts is not fundamentally different from what we have experienced for millennia with people and animals and classical narratives, and some of the barriers we encounter in the process are effectively the same. It is people — including ourselves — that we most often try to simulate through the development of theories of mind, but it is in successfully simulating people that we most often fail.

The complex patterns that form a person’s ‘I’ cannot be studied at the level of the micromachinery of the mind because we are congenitally unable to focus on it [17], we therefore resort to abstractions and shortcuts, and to channels of communication such as language that, although slow and indirect, allow us to develop minimally effective simulations of other people’s minds. But these will inevitably generate predictions that will most likely fail to be verified because a person’s ‘I’ is a convoluted illusion, as are others to each other and to one self [17].

Furthermore, there is an added difficulty with these complex simulations, one that is found at the level of the referential information, of the hypotexts surrounding a person. As Hofstadter puts it, “We are all curious collages, weird little planetoids that grow by accreting other people's habits and ideas and styles and tics and jokes and phrases and tunes and hopes and fears as if they were meteorites that came soaring out of the blue, collided with us, and stuck. What at first is an artificial, alien mannerism slowly fuses into the stuff of our self, like wax melting in the sun, and gradually becomes as much a part of us as ever it was of someone else (though that person may very well have borrowed it from someone else to begin with)." [17]

We are all simulating and emulating each other to varying degrees, "an inevitable consequence of the power of the representationally universal machines that our brains are." [17]

5. The Procedural Drama

Originating in an amodal space of possibilities, processes are mediated by and through the artifact. After reception and perception, what was communicated modally, once again becomes amodal or metamodal, as Morbey and Steele propose [23]. We find ourselves in a new abstract domain that is similar to what Whitelaw [31] defines as inframedia. Procedural capacities are the key to our identification of amodal characteristics in the perceived phenomena, as they are at a later stage fundamental in the process of simulation.

The understanding of processes and their simulation is not always straightforward, as there is not necessarily a direct mapping between the code and its modal manifestations. There is no blueprint; there are constraints [11]. Furthermore, each modal manifestation may be directed by contrasting processes or be developed at disparate rates. Cross-modal expressions may be created by multiple transcodings in the same system or by multiple systems or threads operating (and transcoding) simultaneously, which they can do independently or in tandem, eventually acting on each other, etc.

The translation processes from code to form, from genotype to phenotype are also not reversible: morphogenesis is generative and therefore it is "impossible to map exactly phenotype in to genotype, since this is the result of epiphenomena, a visible consequence of the overall system organization." [8] On the perceiver's side, we are left with sensations, feelings, perceptions and symbols below which we are unable to peer; we are at a private and incommunicable space.

The outputs of artificial aesthetic artifacts fundamentally differ from what we find in most classical media because, much as nature itself, they weren't necessarily created or shaped by humans. These artifacts are rich with generative potential and they have their own aesthetics, their unique patterns of desire, their ways "of giving pleasure, of creating beauty" [24]. They are inevitably mediated but also hypermediated [6], constantly confronting us with signs of what may be happening behind their modal expressions. It is this layer that truly marvels and that allows the experience of the artifact as a symbolic drama in which we, the wreaders, are inevitable protagonists.

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Paper : **ADVANCED GEOMETRY OF MODULAR TILES**

Topic: Architecture and Mathematics

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Abstract:

The aim of this paper is discussion of symmetry groups of ornaments, function of ornament with regard to the digital fabrication, application of theoretical knowledge in generation of three dimensional parametrical ornamental structures and presentation of achieved results.

Based on the seventeen wall paper groups we try to extend two-dimensional ornament into digital three-dimensional ornamental pattern using appropriate mathematical and geometrical rules. The mathematical basis of our construction is the theory of simple and multiple antisymmetry. A large collection of different ornamental patterns can be obtained by using only six modular prototiles. E.g., beginning from the symmetry group *pmm* and using 2-multiple antisymmetry, we obtain 840 different patterns.

We established the digital flow from design to fabrication using 3d NURBS modeling, visual programming software for code generation and we fabricated our 3D ornamental pattern with robotic arm. This approach enabled huge flexibility in design and real time feedback to the designer concerning: size of robot arm, availability to all desired positions regarding to the chosen tool and robot axes restriction. In the same time our approach enabled to explore how digital prefabrication can contribute to conceptual exploration and how new technology can influence existing design.

The group of the students had a possibility within the course “Design of specialized topics” to use our digital flow and at the end of our work we will present their results.

Images of prefabricated 3d ornamental patterns

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Keywords:
parametric design, symmetry of ornamental group, antisymmetry, modular patterns, robotic arm, digital fabrication

ADVANCED GEOMETRY OF MODULAR TILES

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Abstract:

The aim of this paper is to discuss ornamental symmetry groups, the function of ornaments with regard to digital fabrication, the application of theoretical knowledge in the generation of three-dimensional parametric ornamental structures and the presentation of achieved results.

Based on the seventeen wallpaper groups, we try to extend a two-dimensional ornament into a digital three-dimensional ornamental pattern using appropriate mathematical and geometrical rules. The mathematical basis of our construction is the theory of simple and multiple antisymmetry. A large collection of different ornamental patterns can be obtained by using only six modular prototiles. E.g., beginning with symmetry group *pmm* and using 2-multiple antisymmetry, we may obtain 840 different patterns.

We have established a digital flow from design to fabrication using 3d NURBS modeling and visual programming software for code generation, and we have fabricated our 3D ornamental pattern with the robotic arm. This approach has proved to enable huge flexibility in design and real-time feedback to the designer concerning: size of the robot arm, availability of all desired positions regarding the chosen tool and robot axes restriction. At the same time, our approach has allowed us to explore how digital prefabrication can contribute to conceptual exploration and how new technology can influence existing design.

A group of students had a possibility to use our digital flow within the course “Design of specialized topics” and the results of their work are presented later in this paper.

Keywords: parametric design, symmetry of ornamental group, antisymmetry, modular patterns, robotic arm, digital fabrication

1. Introduction

The possibility to use digital tools to generate 3d models and realize architectural building elements has led, among other things, to the re-establishment of ornaments in architectural practice. The complexity of the subject of ornamentation as it occurs in art, mathematics, geometry, architecture, religion and psychology has inspired architects and designers to reconsider this field again and again and has also represented inexhaustible motivation for new design. The re-establishment of ornaments in architectural practice raises the issue of how ornaments may be given new quality and new use value through the use of contemporary materials and fabrication processes. Is it possible to apply the potential and properties of modularity which the ornament possesses in the age of non-standard architectural design, while avoiding an easily recognizable repetition of basic geometric shapes? In what way is it possible to transform mathematical and geometric laws of 2d ornamental wallpaper elements into parametric 3d ornaments? What constraints must exist in 3d geometry if a specific method is selected for the fabrication of elements using the robotic arm? How may individual digital design be transformed into digital robotic code? What limitations exist in design with respect to the capacities of the robot?

As part of the course “Design of specialized topics” on the subject of Computer Serendipity – The Robot as the Architect’s Best Friend, held during the summer semester 2011 at the Faculty of Architecture in Graz, the students tried to produce design and engineering solutions to solve the above problems.

2. Why ornaments?

Through the history of architecture the role and denotation of ornament was shaped by cultural, intellectual and technical development. The decreasing and increasing use of ornaments in architecture was linked to their use as superficial, mostly two-dimensional and symmetrical elements on the façade. The development from Speiser`s exploration of ornament as a matter of symmetry to Shubnikov`s analysis of the symmetry method for revealing the invariants of transformation to Semper´s theory of ornament and Loos`s opposition to it, to Moussavi`s classification of the ornament based on depth material or effect indicates the complexity of the different approaches to the subject-matter of ornamentation.

The continued use and development of ornaments indicates there is a specific psychological base for using ornamentation. In psychology the aesthetic value of ornaments is related to symmetry. Experimental psychology has proved that people can recognize symmetric forms in less than a twentieth of a second. The eye is very fast in the detection of vertical symmetry. Locher and Nadine have proved that after the recognition of symmetry the eye starts seeking only the superfluous elements of the composition, while the other part of composition is accepted. Symmetry is further related to our perception and perception is related to our sense of beauty. According to Hekkert , design is considered beautiful or pleasing when a great effect is attained with a minimum of means and when our senses perceive this hidden structure.

Cognitive psychology and Gestalt psychology can explain our aesthetic reaction to ornaments. The brain tries to make a group of elements and to find a law of composition. According to Shubnikov , the aesthetic effects resulting from the symmetry (or other laws of composition) of an object lie in the psychic process associated with the discovery of its laws. According to Leder , most people consider aesthetic whatever is plausible.

The beauty of ornamental pattern can be found in the rhythmical repetition of motifs with conspicuous dominants and a distinctively emphasized arsis. Ornaments underlie the architectural effects of buildings and are also vital for effects in the urban landscape . Developed in all historical epochs and in all cultural areas, the ornament was always a unique manifestation of figurative experience in many primitive cultures, performing not only decorative but also a pronounced magic and symbolic function. As the ornament developed, it went from natural motifs to stylization and further to strictly geometric shapes. It is often very hard to trace singular geometric motifs and to decide if we are dealing with an intrinsic stylization of figural motifs or if they are primarily conceived as an abstract form.

The aesthetic effect of ornaments on buildings has been explored in various ways in history. Ornaments on buildings were used in traditional society as an instrument of differentiation. The structural and functional requirements of a building, according to Semper , were subordinated to the semiotic and artistic goals of ornamentation. In the twentieth century with Modernism the ornament lost its social function and became unnecessary. For Loos , the modern society needs not emphasize individuality through buildings but on the contrary suppress it. Modernism tried by means of style to adjust changes in culture. The relationship between the interior and exterior of buildings changed. Modernism used transparency to replace ornament to achieve a conductive representation of architectural elements of space, structure and program. In this “transparent” paradigm the function of architecture was visible and readable in the urban setting.

In the 1970`s, Venturi and Brown formulated the critique of Modernism for the purpose of replacing transparency with décor. For them, décor gives a building a new meaning in the eyes of the public and helps to integrate it in the urban setting. Furthermore, Deconstructivism, as a development in postmodern architecture, uses the geometry of collage as a style instead of transparency and decor. The finished visual appearance of deconstructivist buildings is characterized by a stimulating unpredictability and controlled chaos. Whether an ornament is used as a contingent – matter of décor and communication, or a necessity like an effect or sensation – It is necessary and inseparable from the object.

Particularly new technologies in architecture have a huge influence on the further processing of the ornament as a non-standard element and new systems of production have opened up possibilities for their differentiation and customization. In contemporary architecture we can find examples of contemporary ornaments like laser-cut sheets (Christian Dior Ginza Store, Kumiko Inui), glass tubes (Louis Vuitton Roppongi Hills Store, Jun Aoki), perforated screens (Centre du Monde Arab, Jean Nouvel), color-coding effect (Laban Dance Center, Herzog & de Meuron) or silk screened images (Eberswalde Library, Herzog de Mouron, Thomas Ruff).

3. Geometry of wallpaper symmetry groups

From the aspect of mathematics and geometry, all periodic wallpaper ornaments may be classified in 17 groups . Each wallpaper group is characterized by specific plane transformations, which individual elements – the cells of ornaments – must satisfy to be classified in any specific group. The principal geometric property of a 2d cell is that it may be multiplied to cover a plane completely, through various specific transformations of the plane (translation, reflection, glide reflection and rotation). Namely, two congruent figures may be mirrored, using rotation or translation, whereas two symmetrical figures may be duplicated using reflection and glide reflection (reflection followed by translation along the direction of the reflection axis). When it comes to symmetry groups, there are only three different kinds of regular tessellation to be used to cover a plane completely. This type of tessellation is performed with the shapes of parallelepiped, equilateral triangle and regular hexagon. The unit cells of wallpaper ornaments are obtained when these basic geometric shapes are split into identical secondary elements. Figure 1 shows the plan elevations of basic shapes, cells generated from these basic shapes and the types of wallpaper ornament groups they constitute.

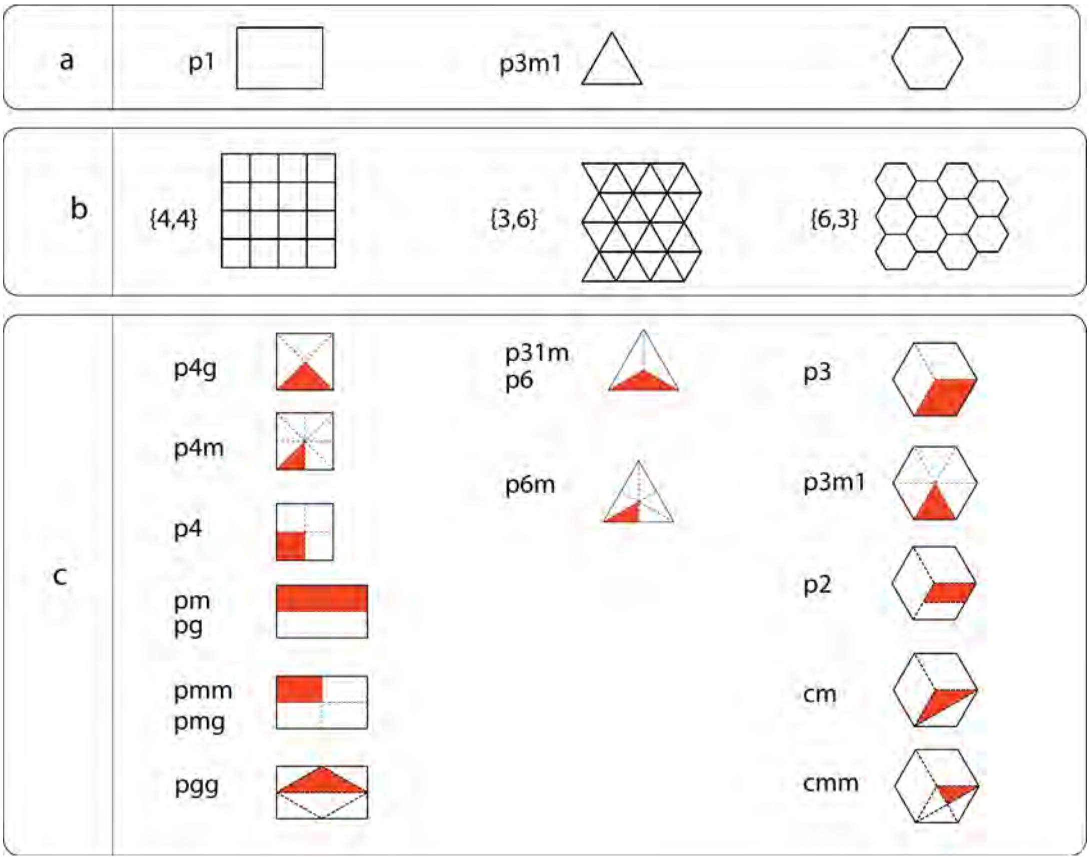

Figure 1: a. Basic shapes that may be used to cover a plane; b. Uniform tiling, plane covered with uniform geometry unit cells; c. Unit cells of specific wallpaper groups

3.1 Modularity

As the modularity will be considered the use of several basic elements (modules) for constructing a large collection of different possible (modular) structures. In science, the modularity principle is represented by search for basic elements (e.g., elementary particles, prototypes for different geometric structures...). In art, different modules (e.g., bricks in architecture or in ornamental brickwork...) occur as the basis of modular structures. In various fields of (discrete) mathematics, the important problem is the recognition of some set of basic elements, construction rules and an (exhaustive) derivation of different generated structures.

In a general sense, the modularity principle is a manifestation of the universal principle of economy in nature: the possibility for diversity and variability of structures, resulting from some (finite and very restricted) set of basic elements by their recombination. In all such cases, the most important step is the first choice (recognition or discovery) of basic elements. This could be shown by examples from ornamental art, where some elements originating from Paleolithic or Neolithic art are present till now, as a kind of “ornamental archetypes”. In many cases, the derivation of discrete modular structures is based on symmetry. Using the theory of symmetry and its generalizations (simple and multiple antisymmetry, colored symmetry...) for certain structures it is possible to define exhaustive derivation algorithms, and even to obtain some combinatorial formula for their enumeration.

3.2 Antisymmetry

Antisymmetry (or „black-white“ symmetry) is the symmetry of positive and negative, light and shadow... Antisymmetry introduced in ornamental art the possibility of expressing, in a symbolical sense, a dynamic conflict, duality, and illustrating alternating natural phenomena (day-night, tides, phases of the Moon, a change of seasons). Its domain can be extended to different geometrical properties, e.g., the relations of „convex-concave“, or „over-under“. Therefore, antisymmetry can be used for so-called *dimensional transition.* Treating the color change "black-white" as a space property, a suggestion of "two-sidedness" (over-under, above-below) antisymmetry introduces a 3*D* space component in ornamental art. If you have an antisymmetrical („black-white“) structure in the plane, e.g., antisymmetric rosettes, friezes, or ornaments, their black parts can be considered to be placed under the plane, and the white parts over the plane. In this way, from the 2-dimensional symmetry patterns of rosettes, friezes, or ornaments, we can obtain 3-dimensional symmetry structures with their invariant planes and their corresponding symmetry groups of tablets, bands, and layers. Using contrast, complementary colors, "black-white", "light-dark", "over-under", "above-below", "positive-negative", "convex-concave", the same object can be turned into its opposite, increasing the rhythm and dynamics.

The idea of dimensional transition was the origin of the mathematical theory of antisymmetry. Visualization of symmetry groups of bands in a 2*D* plane, using black-white diagrams, was proposed by A. Speiser , and presented by L.Weber in 1929. The black-white diagrams of bands from his paper (Figure. 2), where the alternation of colors is used to denote figures above and below the invariant plane of the pattern, suggested the possibility for a more general dimensional transition from the symmetry groups of *n*-dimensional space, using the antisymmetry groups, to the symmetry groups of (*n*+1)-dimensional space. The natural idea of a more sophisticated dimensional transition from 3*D* to 4*D* space resulted in one of the first and the most remarkable early results of Heesch – the approximate number of four-dimensional groups preserving invariant 3*D*-space (less then 2000). The 1651 3*D*-

space antisymmetry groups, modeling the mentioned four-dimensional groups, were derived for the first time more then 30 years later by Zamorzaev in 1953. Unfortunately, the work of H. Heesh , as well as the paper of Woods giving the derivation of the 46 black-white symmetry groups of plane patterns, never attracted the attention of readers they deserved.

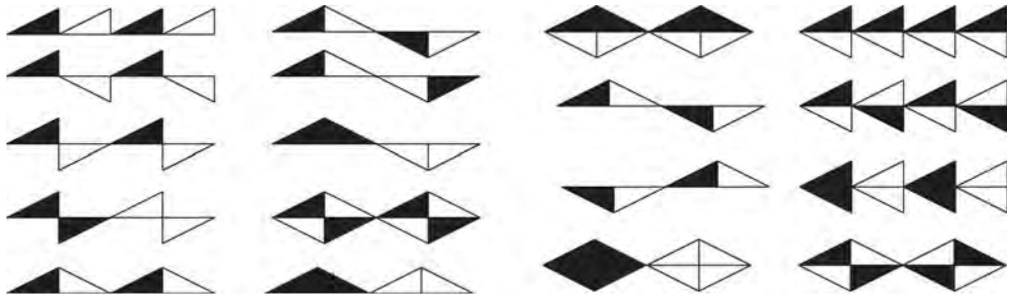

Figure 2: Black-white diagrams

The next generalization, theory of multiple antisymmetry introduced by Zamorzaev , is obtained if instead of only one bivalent property („black-white“, „over-under“...) we consider several bivalent properties commuting between themselve and with symmetries belonging to some symmetry group. As the result, we obtain multiple antisymmetry groups. From the point of view of tilings this means that a basic tile we can divide in *n* regions, and by its multiple antisymmetry coloring obtain 2^n states of the same tile (Figure 3).

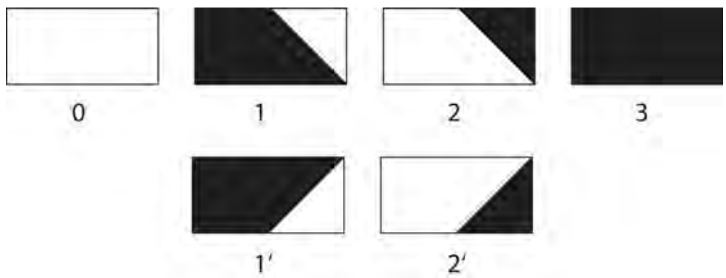

Figure 3: Antisymmetry coloring obtain 2^n states of the same tile

Multiplying such tiles by the multiple antisymmetry transformations, we obtain a very large number of different patterns. E.g. from rectangular tilings corresponding to the symmetry group pmm, by using numerical schemes derived by algorithm based on 2-multiple antisymmetry we obtain 2520 different patterns, and every change of the fundamental region results in a new series of 2520 patterns (Figure. 4). The obtained patterns have the following properties: 1) equal use of all basic tiles; 2) algorithmic creation of modular designs; 3) common visual identity of all designs. The same concept can be directly extended to 3D-structures (Figure 5).

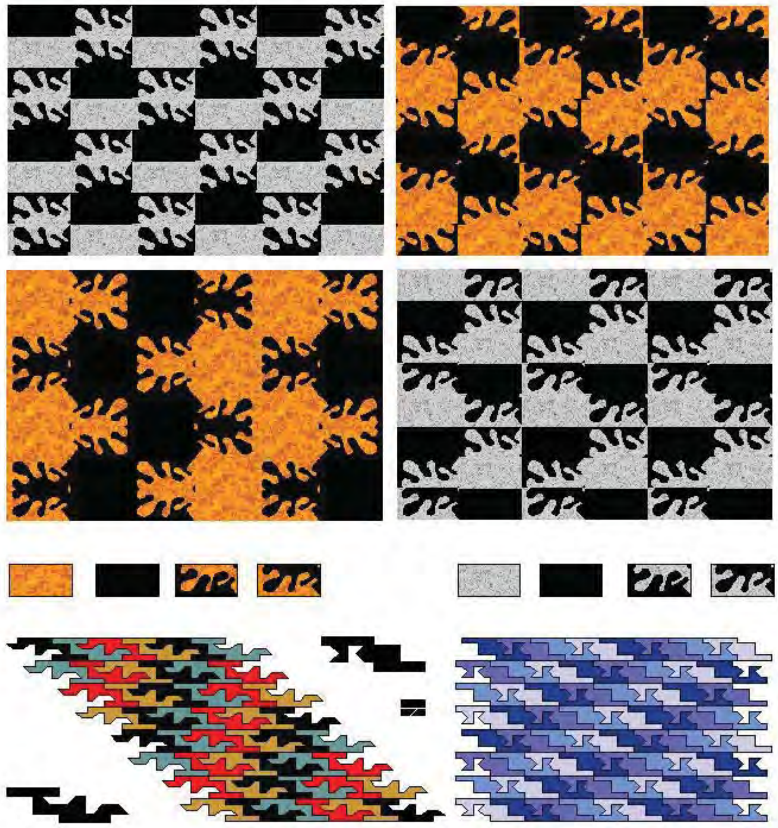

Figure 4: Algorithm based on 2-multiple antisymmetry has 2520 different patterns, and every change of the fundamental region results in a new series of 2520 patterns

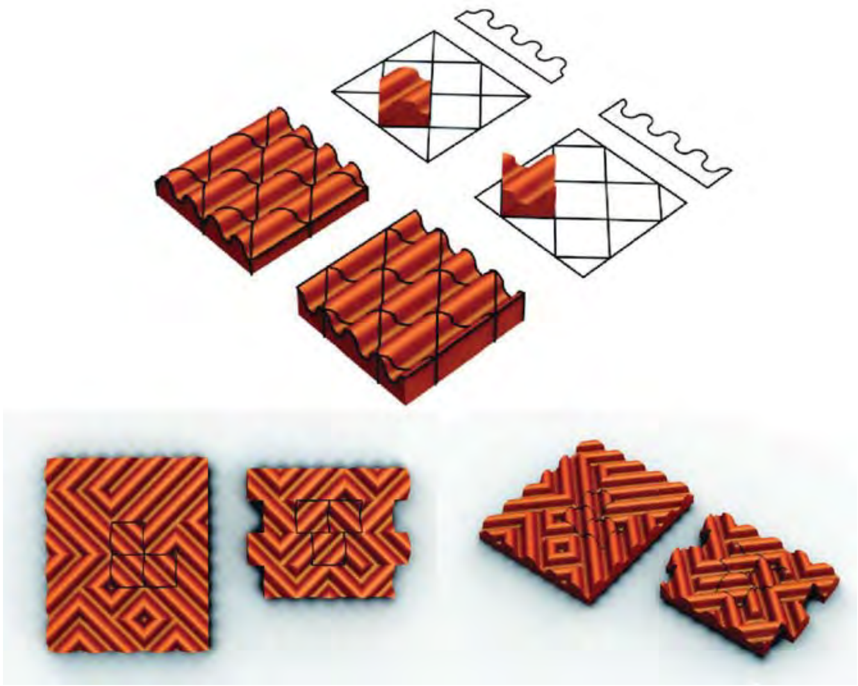

Figure 5: Extended 3-D pattern

4. From 2d to 3d ornaments

In our project, the treatment of wallpaper ornaments will be analyzed from the perspective of geometry. This means 2d ornamental motifs and color will not be the subject of the analysis; instead, they will only be used as the starting point for developing spatial ornaments. Spatial ornaments will be delineated using plane and space curves between which NURBS shapes will be generated. That way, the generated ornaments will represent basic shapes, modules that may be realized using the robotic arm.

The possible shapes of specific cells may be further analyzed based on the geometric structure presented in Figure 1. Symmetry groups *p1*, *p4* and *p3* will be used to analyze some possibilities of generating 3d ornaments.

The unit cell of wallpaper group *p1* may be a rectangle (Figure 6a) or a parallelogram, which is translated to make a group (Figure 6 b). In geometric terms, the cell has two pairs of different sides, which both delineate and separate the cells. That means that one pair (Figure 6c) or both pairs of sides (Figure 6d) may be replaced with arbitrary plane or space shapes.

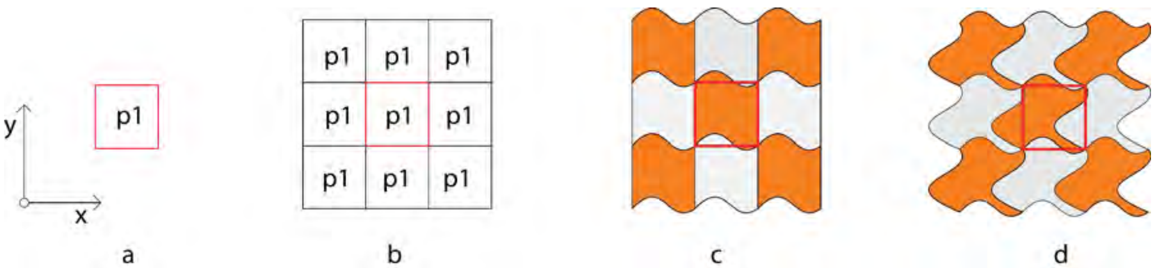

Figure 6: a. Unit cell of group p1; b. Basic structure; c. Change of shape of one pair of sides; d. Change of shape of both pairs of sides

Figure 7 shows one way to generate a 3d ornament. A NURBS surface is generated using plane curves (Figure 7d) and an arbitrary point in space (*x, y, z ≠ 0*). As all curved sides lie in the *xy* plane, it is possible to mirror individual elements across the *xy* plane and thus additionally vary the symmetry group.

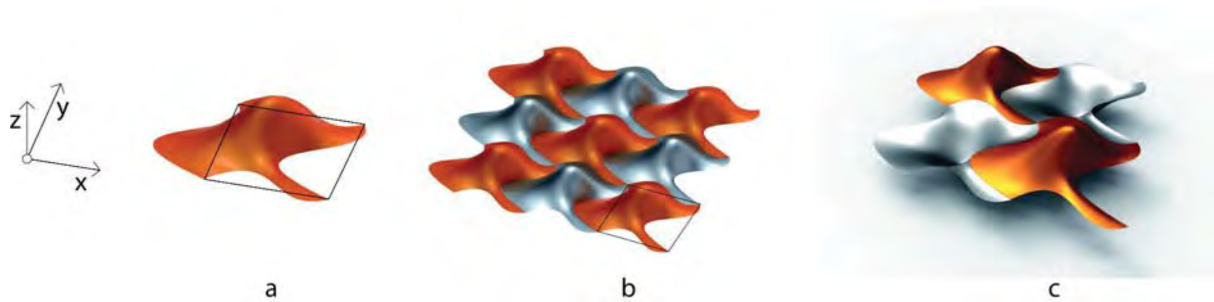

Figure 7: a. Spatial cell of group p1; b. Ornament configuration; c. Ornament variant (some cells mirrored across XY plane)

Figures 8 and 9 show the geometric structure of group *p4*. This group has two fourth-order rotation points and one second-order rotation point. In terms of geometry, the unit cell is lined by pairs of sides. The geometry of one pair is basic (Figure 8c), compounded by the same shape rotated by 90° (with the rotation point at the intersection of two curves).

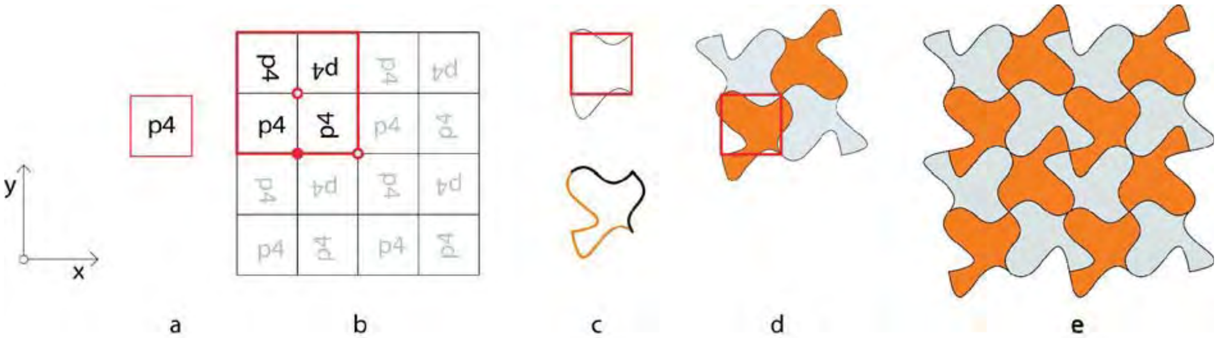

Figure 8: a. Unit cell of group p4; b. Basic structure; c. Changes to shape, with two curved sides rotated by 90 degrees and delineating the other two curved sides; d. Basic module of p4 ornament; e. Newly generated ornament

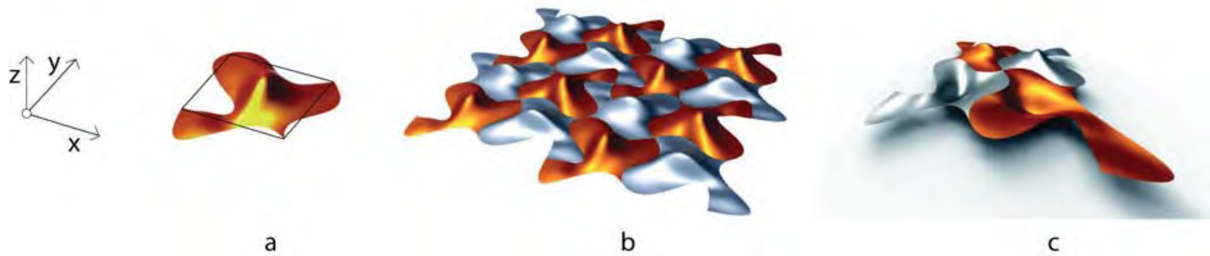

Figure 9: a. Spatial cell of group p4; b. Ornament configuration; c. Ornament variation (with some cells mirrored across XY plane)

Figures 10 and 11 show an example of transformation of a 2d ornament from group *p3* into a 3d ornament. Unlike previous cases, where the geometry of sides changed, the spatial geometry in this case is defined by single cell. Figure 10a shows a cell with spatial geometry/sides given in three different colors. This shape consists of four uniform prototypes whose position in space is special and which allow geometric continuity of adjacent elements.

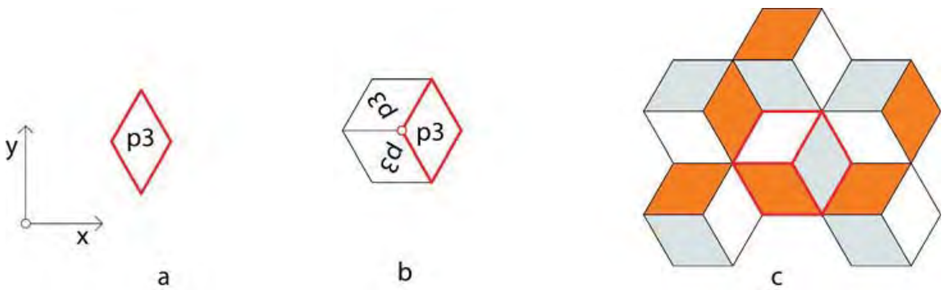

Figure 10: a. Unit cell of group p3; b. Basic structure; c. Ornament p3

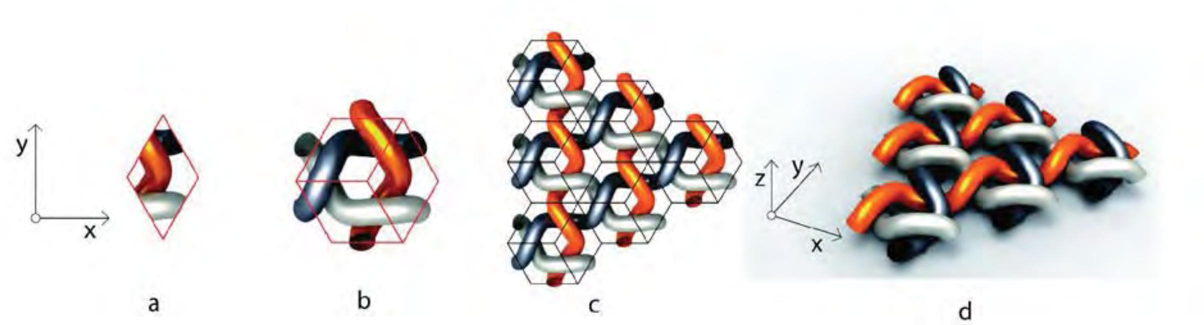

Figure 11: a. Unit cell consisting of four identical elements, of which two are orange, one is white and one gray b. Basic structure of ornament is made up of 3 spatial elements in 3 different directions c. continuity of structure in 2d d. Spatial configuration of ornament p3

The design of 3d ornaments based on mathematical laws of ornamental groups allows for plenty of creativity, despite being highly mathematically structured. The ways in which these ornaments may be transported into a parametric model and modular architectural elements were the topic of the course “Design of specialized topics” at the Faculty of Architecture in Graz.

5. Computer Serendipity – The Robot as the Architect’s Best Friend

The course “Design of specialized topics” held in the summer semester of 2011 featured a project under the name “Computer Serendipity – The Robot as the Architect's Best Friend”. The aim of the project was to investigate the possibility of transformation of 2d ornaments into 3d ornaments, generation of 3d digital models and their fabrication with the robotic arm ABB IRB140. The first objective was the definition of a simple cutting system for XPS/EPS elements that serve as molds for concrete elements, and the second objective was the definition of double curved elements that can be used as outer permanent wall insulation – XPS/EPS permanent concrete shuttering.
A special focus of the project was the efficiency of standard materials in the fabrication of non-standard elements. Namely, it is a well known fact that the fabrication of non-standard elements is connected with inefficient use of standard materials that greatly increases the costs of fabrication . This is why the process of design in this project started with geometry, modularity and ornamental rules. The students were introduced to the technical possibilities and limitations of the robotic arm, constraints when it comes to the cutting tool definition, limitations of materials, and geometric conditions that satisfy the requirement of material cost-effectiveness.

5.1 Design Approach

Since one of the project objectives concerned cost-effective use of materials, in the design phase the students started with modular ornamental parametrical elements. By varying their parameters and position, it was possible for them to get a huge number of variations of the final design. The big challenge for the students in this project was the optimization of the robot data flow from parametric design to a physical model. A basic Grasshopper file was generated within the project that included inverse kinematics with the necessary calculation for direct robot programming with an automatic code generated for the Robot ABB IRB140 (Figure 12).

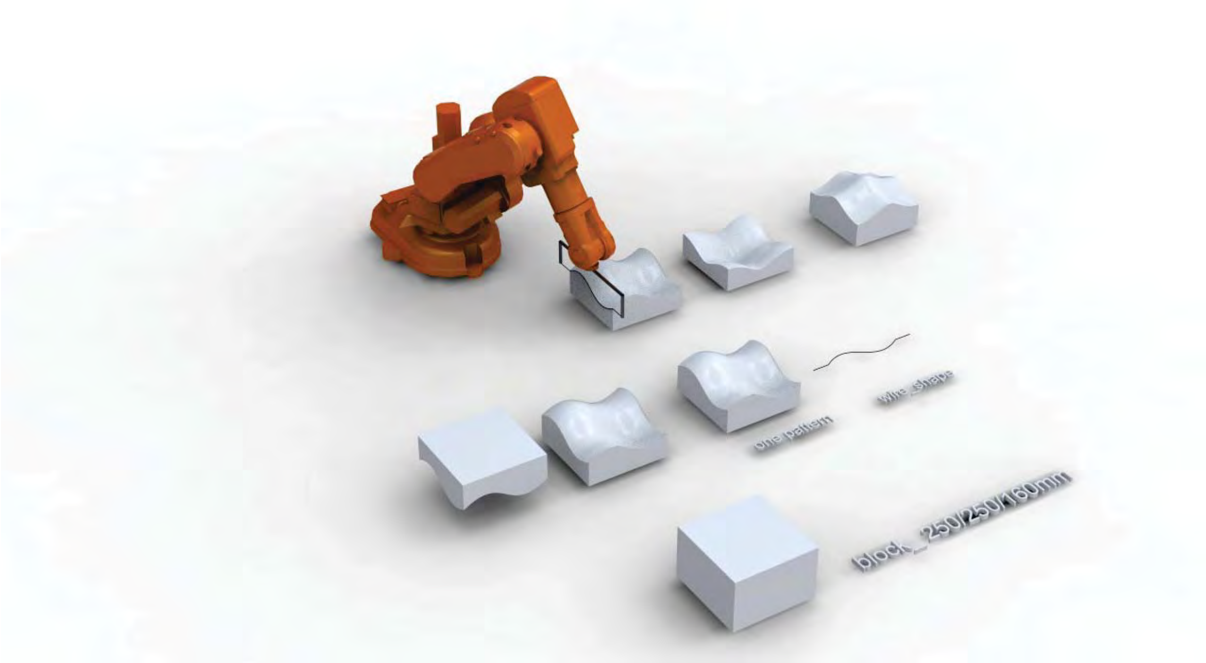

Figure 12: ABB IRB160 robotic arm and one of the tools used in our project for cutting EPS in modular parts

The basic robot code was supplemented with special strategies depending on individual specific design meant to facilitate the transformation of the desired design to the basic robot code. This approach provided great flexibility in design and real time feedback to the designer. The students used differently shaped hotwire and EPS panels (250x250x160mm) to cut into stackable ornamental components, which then composed a negative mold for a concrete wall design. Based on direct feedback, the students had the possibility to understand the robot's constraints, such as: size of the robot arm, availability of all desired positions regarding the chosen tool and robot axes restriction. These constraints necessitated the adaptation of individual designs, starting with changes to the initial design, selected tool or EPS tool cutting strategy.

Conclusion

The digital possibilities of generating 3d models and fabricating architectural building elements have led, among other things, to the re-establishment of ornaments in architectural practice. This paper shows the transformation of a 2d ornament into a parametric 3d ornament. This approach is based on a combination of mathematical algorithms and various linear and spatial shapes, where all geometric properties of mathematically defined ornaments remain invariant in the process of design.
The paper starts with the mathematical model of wallpaper symmetry groups and analyses the geometric invariants of specific ornamental groups and some possibilities of transformation of 2d ornaments into 3d ornaments. The process which starts with a geometric model and leads to design and one way ornaments can be used in architecture is presented using a selected student project, where students used

mathematical algorithms to make their designs and export the desired design directly into the robot code, which was used for realizing individual elements.

Students' works

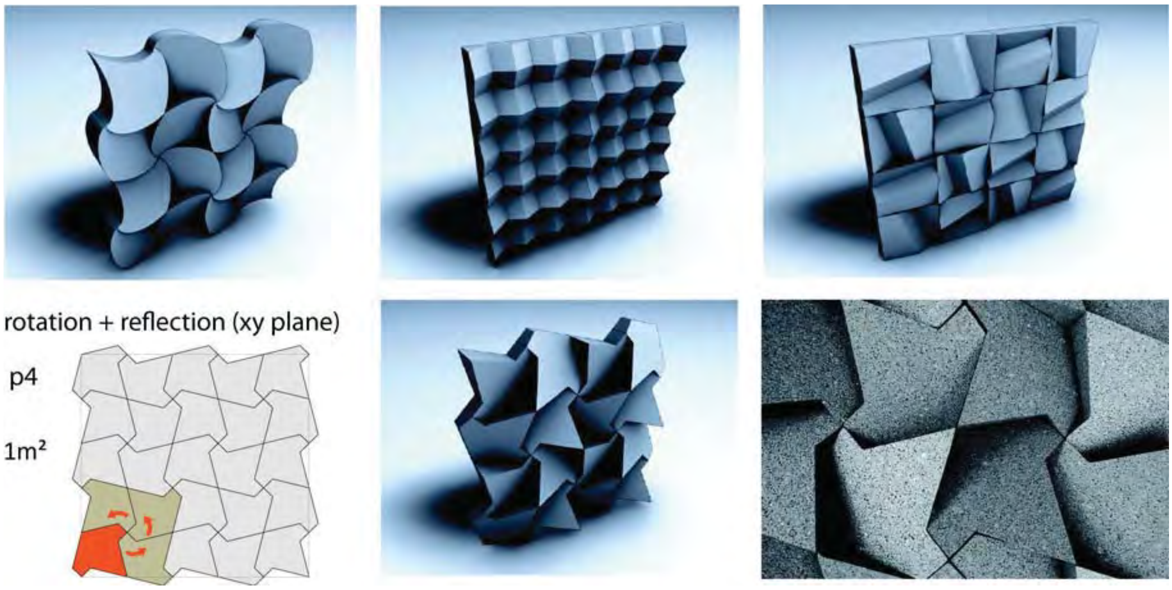

Figure A: Students: Florian Maroschek and Irina Elisabeth Scheucher

- creating an ornament, which can be poured of concrete - form has to be a negative.
- the ornament should slightly fit into the EPS block, which is going to be the form board.
- one piece fills 0,04m², consequential 25 pieces have to be build and joined for 1m^2.

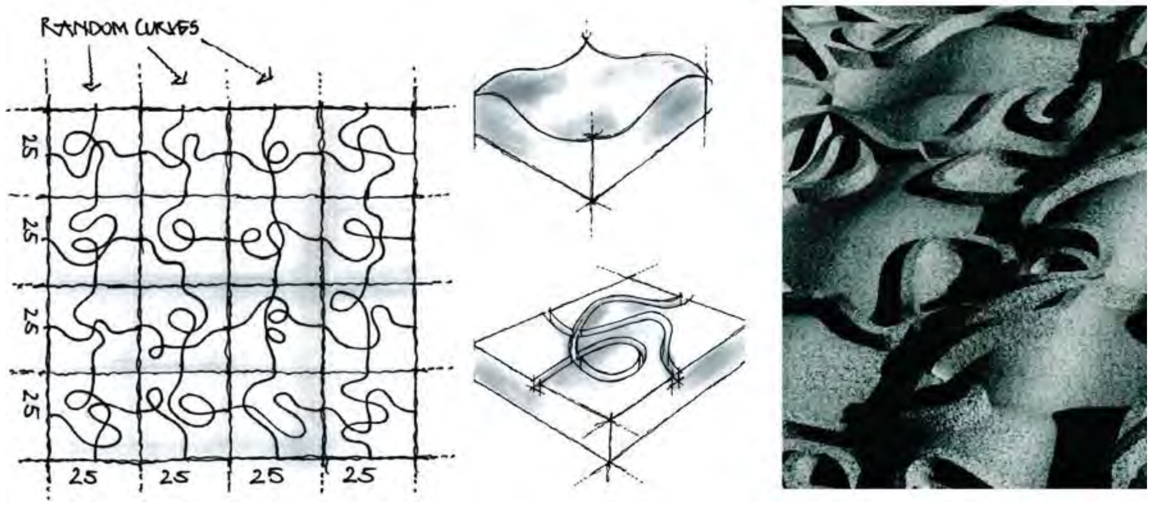

Figure B: Students: Wolfgang Moritzer I David Längle I Klaus Weber

- *surface design: surface was generated by two same curves – on that way each block can be arranged together with any others.*
- *curves: all curves are on the surfaces and each curve is a random curve with first and last points at the middle point on the block boarder*

Figure C: Students: Christopher Leitner and Thomas Hörmann

- *pattern deals with the material specific characteristics - the compactness and hardness of an concrete wall and on the other hand the smoothness and flowing which is always associated with concrete*
- *the design allows a multiplicity of capabilities in an architectural context.*
- *from small scale use like a bar or a dividing wall (interior design) to large scale use like facade elements. The form is capable to absorb vertical forces (statics) as well as it can be used as a sunshield.*
- *translational surfaces with 4 different pattern (but only one cutting wire)*

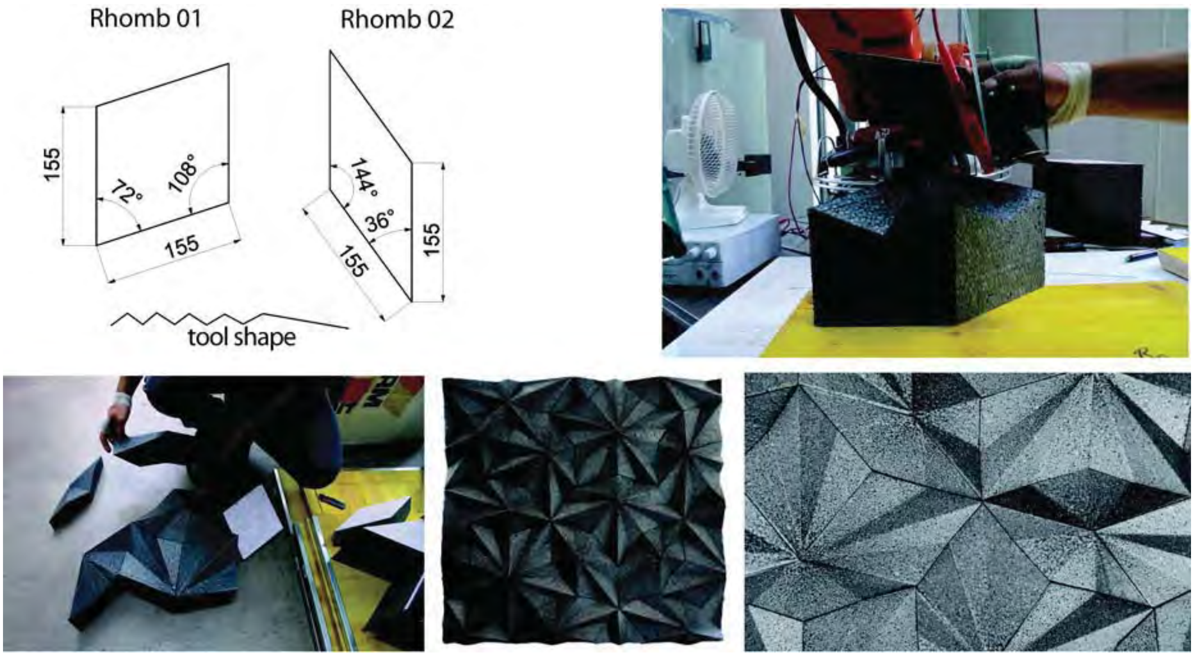

Figure D: Students: Georg Schrutka and Stefan Rasch

- *aperiodical pattern based on the Penrose tilling*
- *two different bricks in the form of rhombuses, one with corner angels of 72° and 108°, second with corner angles of 36° and 144°*
- *The user is able to combine these bricks to get an individual large area pattern.*
- *The shade of the edges is arbitrary. The heights of the corners of the two rhombuses have to be the same.*

Acknowledgements

This work is supported by the Austrian Science Fund (FWF) under the grant T440-N13.

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Paper

Shape Reconstruction
Study of alternative typologies of shaps

Topic: Architecture

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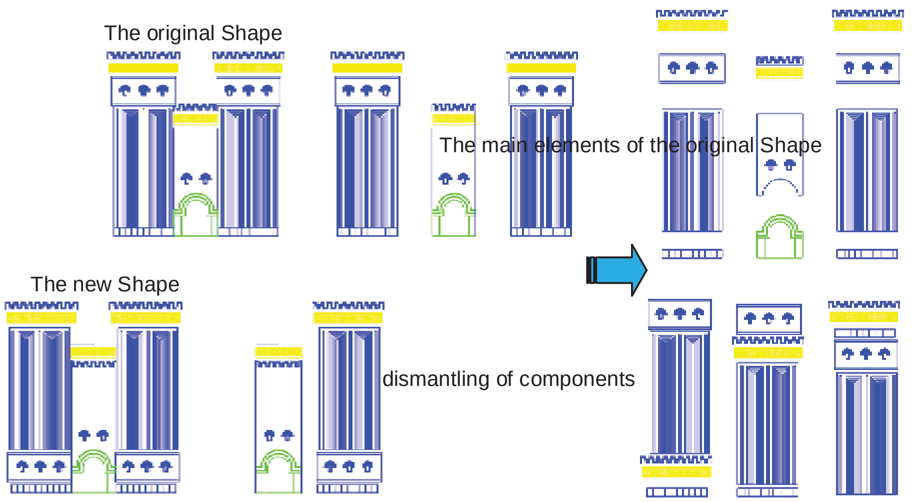
Abstract:

All buildings are characterized by possessing a set of architectural elements and details that are most important in giving the characteristic of the architecture as a style, where these details and architectural elements have configurations structurally different and this difference in structuralism distinguishes the form of another where any architectural configuration is characterized whether to indicate functional aspects or aesthetic formal aspects that has privet and special style which is consistent with the geographical or historical background to this style. This study will focus on one of the architectural configurations of the gates, by testing a sample of these architectural configurations from different time periods such as Assyrian style gate, Romanian style gate and Babylonian style gate ... Etc. as a sample for analyses. This study consist of three stages, the first one is the theoretical framework for analysis and the formation of gates in general, the second stage is a test of the sample of gates by analyzing and dismantling of components to the basic elements of form and then encoded in digital form and make it a matrix , finally the last stage .It is the process of restructuring elements (Re-forming elements) by using the probabilities of the matrix to produce new patterns which has structural properties similar to the original elements.



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Keywords:
gates , matrix , architectural elements, Shape Reconstruction, Topology .

Shape reconstruction

(A structural study of the architectural element as a single entity to find design alternatives)

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Abstract

All buildings are characterized by possessing a set of architectural elements and details that are most important in giving the characteristic of the architecture as a style, where these details and architectural elements have configurations structurally different and this difference in structuralism distinguishes the form of another where any architectural configuration is characterized whether to indicate functional aspects or aesthetic formal aspects that has privet and special style which is consistent with the geographical or historical background to this style. This study will focus on one of the architectural configurations that have a great variety of elements and architectural details like gates as a case study, by testing a sample of these architectural configurations (gates) from different time periods such as Assyrian style gate, Romanian style gate and Babylonian style gate ... Etc. as a sample for analyses. This study consist of three stages, the first one is the theoretical framework for analysis and the formation of gates in general, the second stage is a test of the sample of gates by analyzing and dismantling of components to the basic elements of form and then encoded in digital form and make it a matrix , finally the last stage .It is the process of restructuring elements (Re-forming elements) by using the probabilities of the matrix to produce new patterns which has structural properties similar to the original elements.

1. Introduction

The architectural legacy of the various civilizations is considered an important factor which left its features on the shape of buildings, historical and archaeological cities all over the world. These cities are still examples for the originality and architectural identity of a certain city or region; such as Babylon, Khursibad and Hatra in Iraq and Rome in Italy. So, designers must make use of this heritage in away that fulfill the aesthetic function of the architectural work and achieves a privacy that is connected with the architectural legacy of any area in order to reveal the historical depth of that architectural work.

In this research, focus will be on the simulation of the nature, which is dealing with the geometrical shapes and disassembling them into their primary elements and then reconstructing these elements relying on the same disassembling mechanism for the primary shape in a way which preserves the same spirit and influence of the original shape which is considered a reference for the new shape.

2. Statement of the problem

There are many cities in the world have historically models reflect the architectural authenticity and identity even some city named according to the name of important historical landmark in it, like Mosul city (Alhadba city) in Iraq where the name of the city (Alhadba) come from minaret at important mosque in the same city as well as Hamburg city in Germany where it took its name from the first building was found in that region.

At present, and according to the globalization many architectural design directions appeared which led at times to efface the identity of historical and architectural characteristics of this type of cities therefore we need to find mechanize that help the architects and designer to create new shape compatible with the original shape or style.

From all the above the problem of the research evolves out of:

1. Non-clarity of the mechanism adopted in disassembling and reconstructing the shape to obtain new forms compatible with original shape
2. The limited use of algebraic mathematical formation as a one of shape grammar techniques in the mechanism of the design new shapes.
3. Research about shape reconstruction abounds, but the study algebraic mathematical formation to find design alternatives are scarce.

3. The Purpose of the study

The research aims to find mechanism in disassembling and reconstructing the shape to obtain new forms attuned with the original shape and style , the models which is created can be used as details or part shape to design new buildings.

4. Objective of the research

The objectives of the research are:

1. To understand the mechanism of disassembling and reconstructing the shape
2. To identify the factors which contribute to a create new shape with well-matched with the original shape.
3. To find a matrix of shapes, through which several model that can be designed depending on one shape.

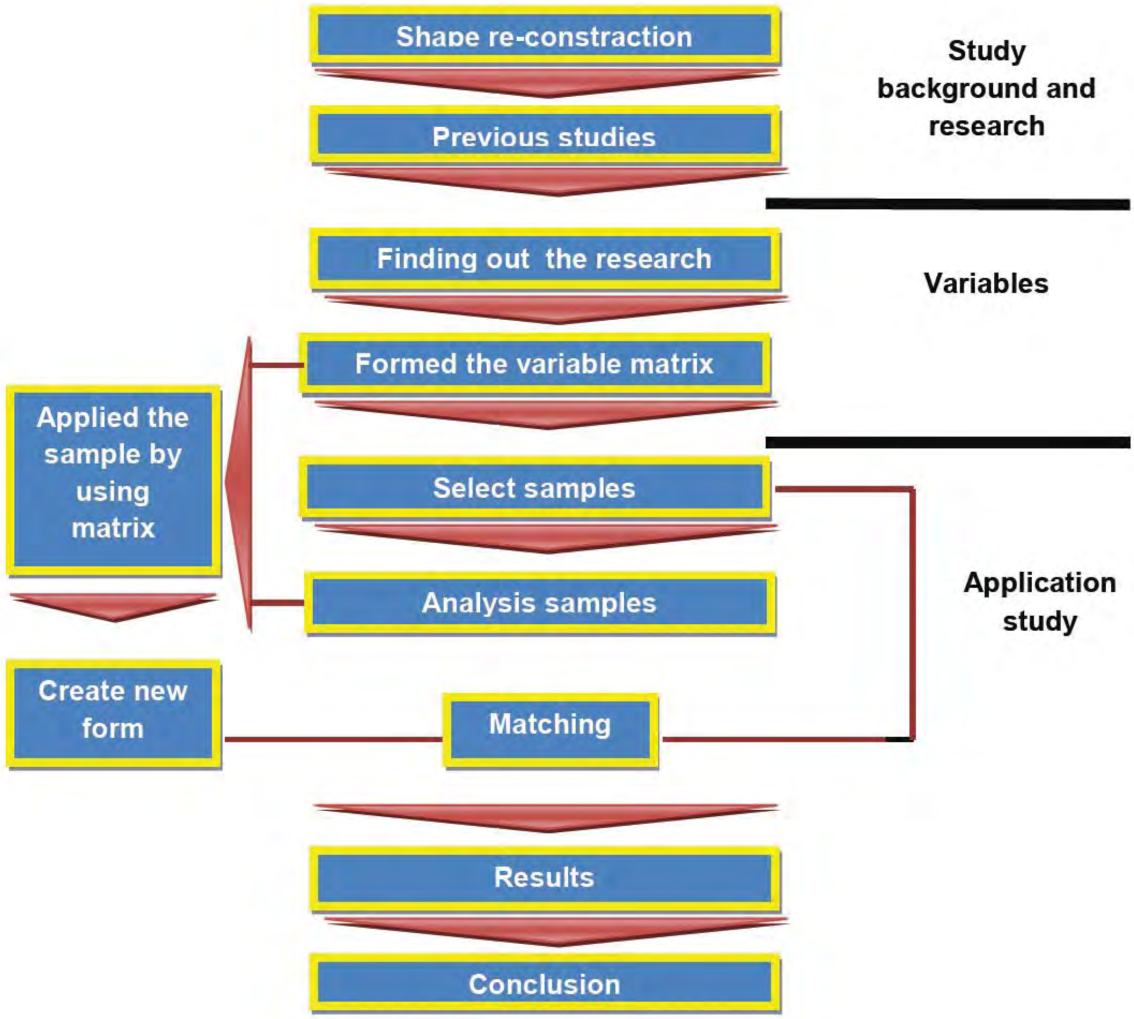
4.To analyse the effects of using matrix to create a new shape compatible with the original shape.

5. Hypothesis of the research

The hypothesis of the research was employed represented by the possibility of design depending on the mechanism of construction and disassembling to find new models and thus reaching the objective of the research.

6. Previous studies

Several studies indicated the importance of studying shape disassembling into its original constructional elements, as it is easy for the designer to use these elements to construct new shapes that belong to the same generation. And this is considered one of the shape construction methods. The work in this research was divided into three parts and as shown in the structure of the research:



Le Corbusier, in his philosophy of design [1], mentioned that there are three techniques for the architectural design process. They are:

1- The technique of utility buildings: The building is considered successful if it performed its function perfectly, just in the case of a machine. So the building is considered successful if it functions well. For example, the house for him was merely a place (machine) for living [1].

2- The common architecture mode: This idea is derived from the duplex idea, which was derived from the Islamic architecture in the middle ages (as Charles Edward says).

3- Contrast with the nature: That is done through the tendency to the human-made geometrical shapes and making use of them in the process of design[1].

Moreover, some studies indicated that the mechanism of the geometrical shape formation is done in accordance with a mathematical equation of formation and that is accomplished through the use of some algebraic methods for analyzing images, as shown by Xiu Wu Huang in his research entitled:[2] where the mechanism of constructing and disassembling the shape is similar to a mathematical equation.

In accordance with the algebraic analysis of images, any shape carries a code or a mathematical equation that stands for it,[2] and when changing the values or the elements of this equation, then we have a different shape.
For example:

5 = 3 + 2 ……………………………….. (1)

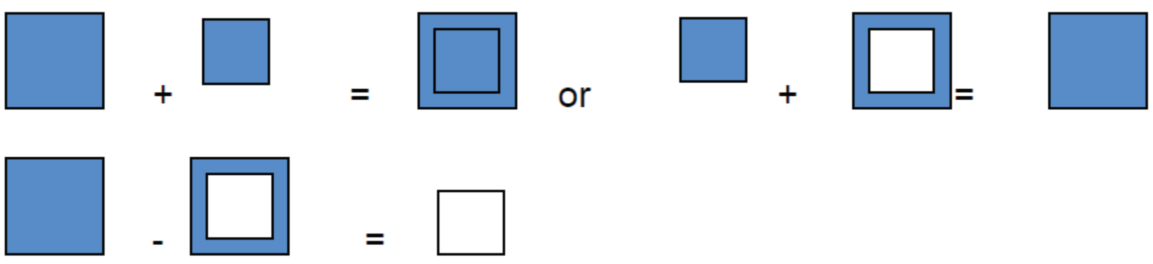
where the reconstruction of several equations from this becomes:

5 = 3 + 2………………….……….. (the original equation)
5 - 2 = 3……………………………….. (1)
3 - 5 = 2……………………............…. (2)

But when using another relationship or other numbers to find the same solution, then this means another design and as the following:

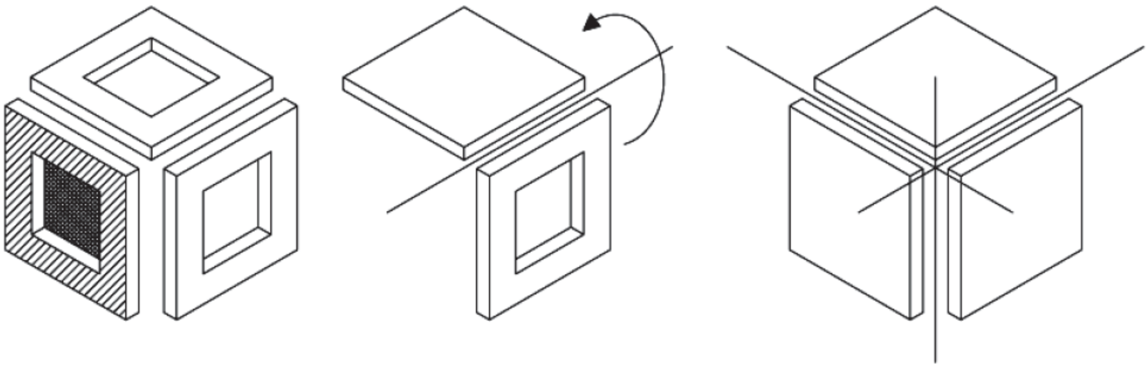
5 = 1 + 1 + 3

An example for that, in terms of formation (Figure-1):[researcher]



(Figure-1) the element of equation shape .[researcher]

But study [3], indicated the formalistic configurations as a relation between one shape with another shape and the relationship of the shape with the whole, and as follows(Figure -2):



(Figure-2) the relation among parts shape to create the compact form.[researcher]

Another study [4] indicated that the architectural formation is similar to the language sentences as there is a relationship between a letter and another to form a word, and a relationship between a word and another to form a term,[5] and several words and terms to form a meaningful sentence and relations can be altered but giving the same meaning.

7. Conclusion from previous studies and discovering the problem

Previous studies focused on the method of disassembling and reconstructing the shape in general. So, some variables – from the previous studies - were identified and a theoretical framework was built up, just as will be shown in the consequent part of the research. After reviewing the previous studies the research problem emerged, which is represented by (the small number of studies which identified the main items of the production process in order to produce design alternative which are related to a formal reference). Based on that, the objective of the study was identified: (finding a mechanism to produce design alternative that depend on a formal reference and the relationships of this reference). For the purpose of making the study more objective the relevant research variables were included in a matrix in order to produce the alternatives, as in the case in the beginning of the research.

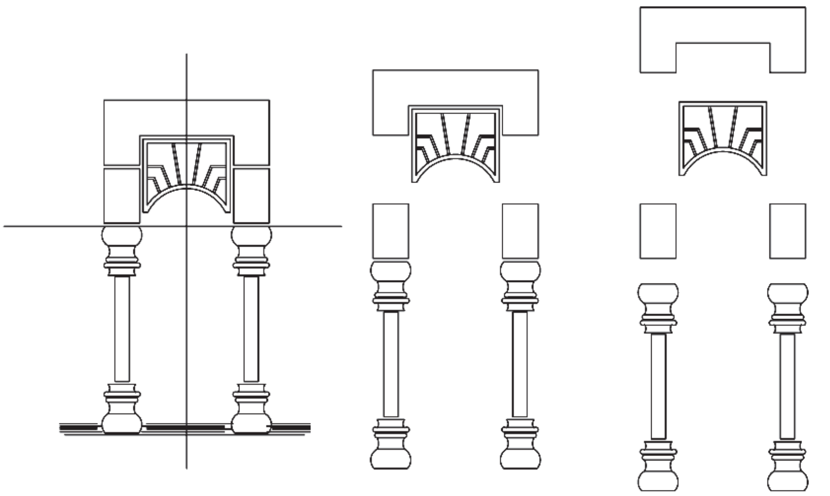
8.The items of the research

After reviewing the previous studies focus will be on several items related to the methodology of the research and that can be made use of in the practical study in order to apply the matrix, and as follows:

8.1 Disassembling the shape

A- Compound shape (main element).
B- Secondary shape (secondary element)
C- Single shape (an element).

Any formation consists of three basic elements (main, secondary and single), where the basic shape represents the original formation[6]



(figure -3) Create form by using object and compact shape [researcher].

Element+element = Secondary shape or Secondary shape + element = main shape

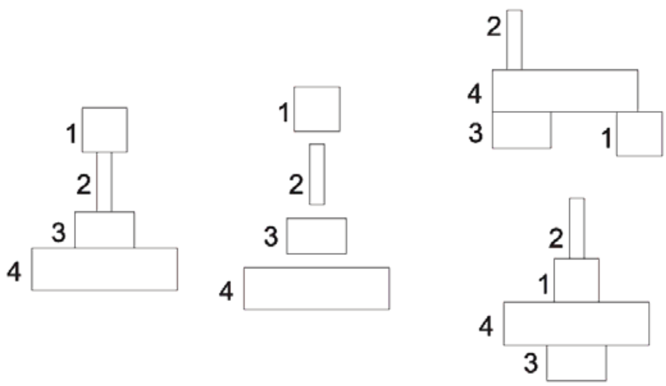
The elements (from 1 to 10) and the secondary shapes (from A to Z) will be coded in order to be used easily in the matrix of shapes that will be designed to explore new alternatives which are identical or not identical to the original shape before analysis in terms of structural and architectural style relationships.
A shape may involve more than 10 elements and it can also include several secondary shapes, as the mechanism of the shape disassembling.

8.2- Relationships between shapes

Each architectural construct includes several geometrical relationships, through which styles and affiliations can be distinguished. And this study deals with shape morphology, correlations and topological sequence[7], as follows:

A- Sequential relationship:

In this case, elements overlap in the form of a connected series and as the following equation. And this series can by in two types[8]; horizontal and the vertical.



(figure -4) Create form by using object and compact shape .

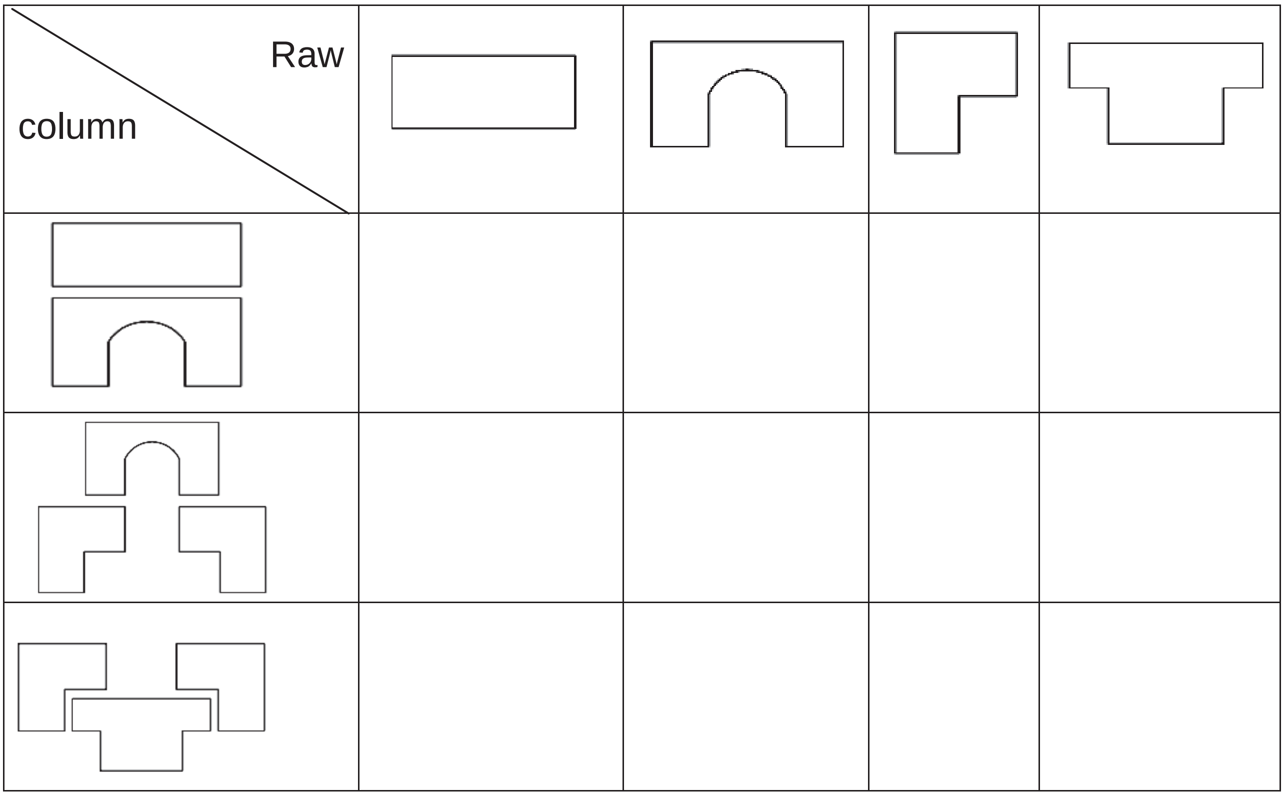
B- Formational relationship:

In this relationship, elements correlate with each other.

9. Making a matrix of the shape

In this phase, a matrix will be designed which includes the shapes potential to form the design alternatives, consisting of elements and secondary shapes which are derived from the original shape. The matrix includes the horizontal row which involves the individual elements of the shape and these can be numbered as shown in the first part of the research in addition to the columns that include the secondary elements .

When we multiply the matrix, we have more than one multiplication process in accordance with the shape we want to find,[6] where the first square of the column can be multiplied by the second square of the row and as follows:
An example for that is the following shape:



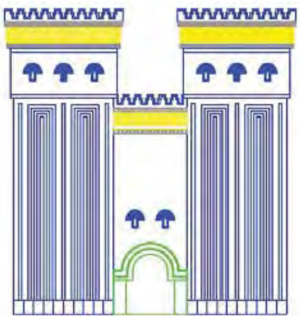
(figure -5) Example of the matrix.

The multiplication process can be identified through the relations that have been mentioned in the first part of the research, so the resultant shape will not be very much different from the original one, because – in this example particularly – there is no rotation of the shape. The resultant shape depends on the determinants of the relationship and the mechanism of multiplication used to find design alternative.

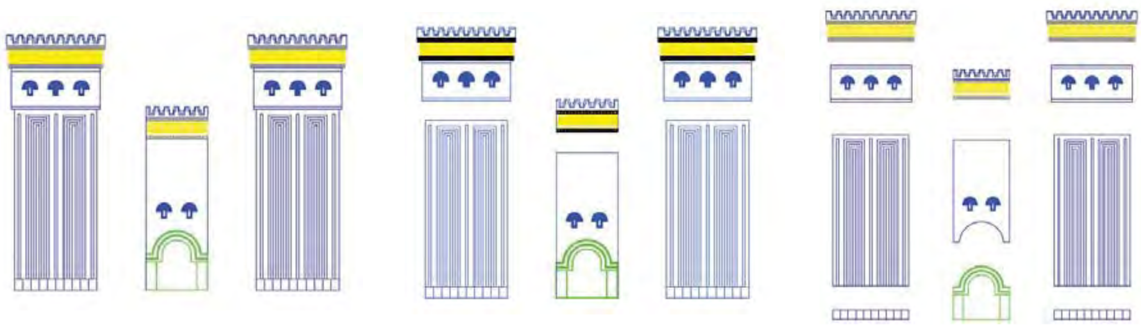
10.The practical study

In this study the practical study consist of the mechanism of disassembling the original shape to three components: compound shape, secondary shape, and single shape as a figure below:

The main shape



Compound shape Secondary shape Single shape



(figure -6) The disassembling of the main shape to three components.

11.Selecting the samples and applying the practical study

Historical gates were chosen and analyzed depending on the items submitted by the theoretical framework in the geometrical method using the computer program Auto Cad and applying the questionnaire form which was designed for the measurement process. These gates are:

1- Ishtar Gate.

(figure-7) Nirgal gate in Mosul City North of Iraq.

2- Khoursibad gate.

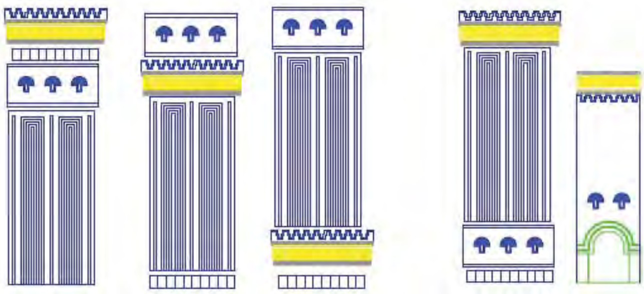
3- Hatr gate. The Sun City , Located to the west of Iraq and to the south-west of the city of Mosul, a distance of 110 km. And away from the ancient city of Ashur 71 km (figure-9).[9]

(figure -8) Hatr city , south Mosul City in Iraq.

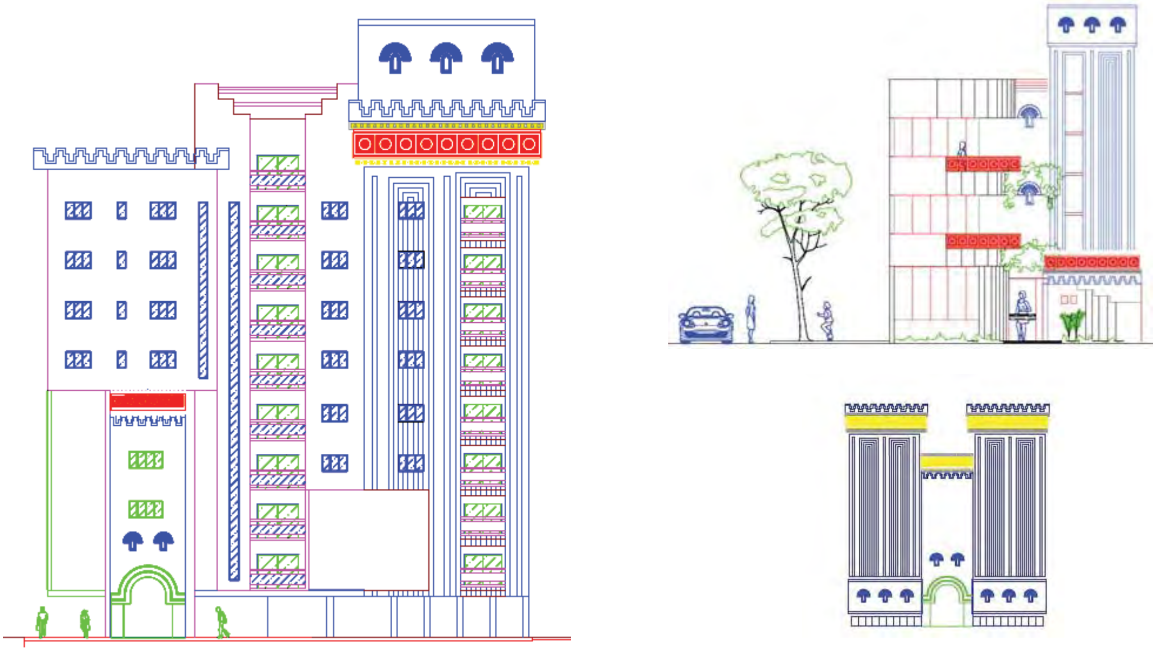
4- Ashurian gate.

(figure-9) Nirgal gate in Mosul City North of Iraq.

Because the results of analysis were tremendous, one sample only was selected (Khoursibad gate) to be included within the research and as in the following shape:



(Figure -10) The design alternatives that resulted from the original shape



(Figure -11) Using of alternatives for design new project

12. Results of the practical study

After analyzing the gates and obtaining the elements and secondary shapes, a matrix was applied in order to find the design alternatives represented by either the design of a new gate with architectural style that is similar to the original shape but with different structural formation or architectural formations that might be used as detailed elements like doors or windows… etc. and as shown in table above.

After comparing the resultant shapes of gates with the original, it was found that the new gate accomplished 20% of structural congruence in terms of the style and 75% in terms of the architectural style, which included a group of secondary shapes included within the original shape. Also the sequential relations have a great importance in the congruence of the new shape with the original matrix and with a percentage of 77% and several statistical percentages concerning this study can be found, but the most important ratios is the congruence in the sequence of the elements.

13.Conclusions:

The type of gates is functional, formal and simple and it has many and diverse architectural elements due to the architectural styles. The results showed that the process of gate parts reconstruction depends on the design purpose of this process (gate, details, mass ….). the small percentage of the congruence is an evidence of using these alternatives was for designing a gate. For the higher ration of alternatives used as a elaborative elements or others due to the desire of the designer. And this way of finding the design alternatives that ensure that the design will be the same as desired.

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Peiman Amini Behbahani

Paper: **DeGRaM: Using chess-like settings as a design space for generative art and design**

Topic:
Art

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References:
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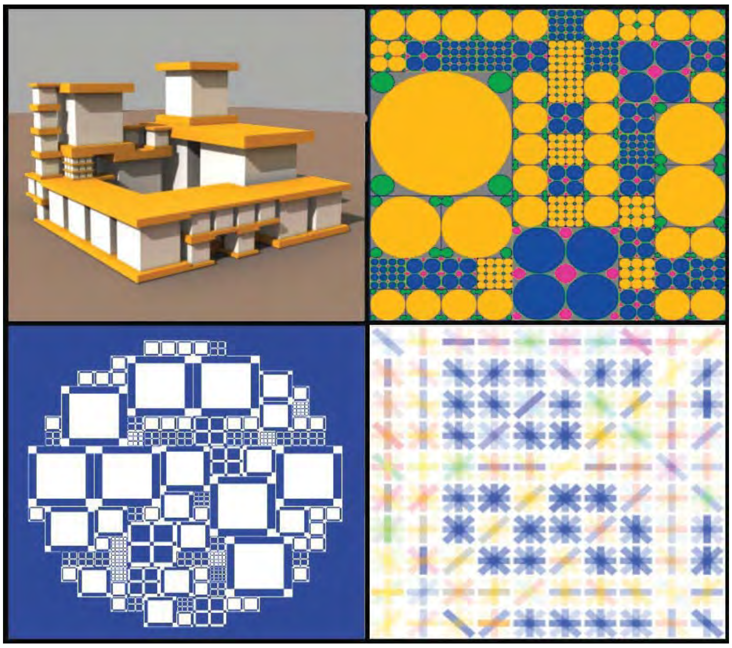
Abstract:

Chess is a complex game with an almost infinite number of piece arrangements and moves. Comparing pieces and their behaviours to automata and rules, respectively, each chess settings can generate its own unique design. It is also possible to extend the chess (both the grid and pieces) to explore different types of generative systems.

For this purpose, a software called DeGRaM (**De**sign by **G**rid **R**elations **a**nd **M**otions) is developed to calculate piece moves and interactions into maps and matrices for modelling them via different kinds of geometrical patterns in both 2D and 3D spaces. In this paper, the software's procedure, concepts and outputs are explained.

This study examines various alterations of chess, ranging from changing the board definition to piece's properties in order to generate initial matrices and how they may influence the software's outputs. To this end, it explores a number of concepts which are involved in producing these matrices. In addition, it applies different patterns and shape grammars suiting different design expectations. Overall, various compositions of piece definition and placements, grid configurations and geometrical patterns are inspected in this research, to explore potentials of this design space.



Samples generated by DeGRaM in 3D and 2D settings

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chess, design space, generative design

DeGRaM: Using chess-like settings as a design space for generative art and design

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Abstract

Complexity is considered a realm for creativity. However, it can be achieved via interaction of simple rules. Chess, and gridded board game in general, are complex situations resulted by simple pieces, rules and motions. The relative infiniteness of chess situations, while each of them being unique, makes it a proper space for generative design. For this purpose, a software called DeGRaM (**De**sign by **G**rid **R**elations **a**nd **M**otions) is developed to calculate piece moves and interactions into maps and matrices for modelling them via different kinds of geometrical patterns in both 2D and 3D spaces. In this paper, the software's procedure, concepts and outputs are explained. In addition, a number of visualisation pattern are introduced in both 2D and 3D outputs.

1. Introduction

Complexity has been considered a playground for creativity, especially when the creative procedure belongs to generative category. However, complexity is sometimes achieved by applying simple criteria. Two early examples of this argument are flocking behaviour of birds by Reynolds and early rules of cellular automata by Wolfram [1]. In a more detailed definition, a complex system is a system composed of interconnected parts that as a whole exhibit one or more properties (behavior among the possible properties) not obvious from the properties of the individual parts [2].

Games are other examples of simple rules which lead to complex situations, called *game complexity*. Chess is one of the most famous and widely played games in this regard. Since hundred years ago, the complexity of chess problems and positions was discussed. Shannon [3] estimated 10^{120} variation of chess situations from the initial position. A brief calculation reveals that there are around 70000 ways to place only two (opponent) pieces on the standard chess board (ignoring the impossibility of king-to-king neighbourhood and pawn on the first row).

$$N = \binom{6}{1} \cdot \binom{6}{1} \cdot \binom{64}{2} = 72576$$

2. Chess

The standard chess is consisted of an 8x8 grid of black and white squares on which 32 pieces of six kinds are placed, equally for each of two sides. Each kind of piece has its own value, moving and capturing style. Ignoring the exclusive rules (like *en passant*, checking or castling), the motion and interaction can be represented via simple 2D vectors (illustrated in **Table 1**).

Piece	**Max Scale**	**Moves**							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Pawn	1	0,1	1,1	-1,1					
Bishop	n	1,1	-1,1	1,-1	-1,-1				
Knight	1	1,2	-1,2	1,-2	-1,-2	2,1	2,-1	-2,1	-2,-1
Rook	n	1,0	0,1	-1,0	0,-1				
Queen	n	1,1	-1,1	1,-1	-1,-1	1,0	0,1	-1,0	0,-1
King	1	1,1	-1,1	1,-1	-1,-1	1,0	0,1	-1,0	0,-1

Table 1. *vectors and scales of pieces' moves in standard chess*

There are different sources for assessing values of chess pieces. A common evaluating [4] for pieces in which they are assigned values based on their moving and capturing capacities (except for the *king* as it is the ultimate goal of chess) is displayed in **Table 2.** The value of *king* in this table is based on its moving and capturing capabilities discarding its importance.

Piece	**Value**
Pawn	1
Bishop	3
Knight	3
Rook	5
Queen	9
King	4

Table 2. *Values of pieces*

Moves in chess are primarily based on how much the possible destination of a piece is exposed to *threat* and gains *support* regarding to the value (or the role) of the piece. However, the best move is generally opted in a more holistic and planned view of the position. In this case, the player considers a map of threat-support-value for possible moves. The map may also be expanded for next step of moves. It will differ for each placement of pieces on the board offering an almost infinite number of maps.

Although the aforementioned maps are generated for individual cells ((in this paper the word “cell” is used instead of traditional “square” as the latter is only applicable for Cartesian 2D boards), we can define zones in chess. Zones are created when a number of adjacent cells have a similar characteristic regarding the chess concepts. For instance, if four adjacent cells are directly accessible for pieces of one side, it can be considered a *threat* zone for the other side.

The ultimate goal in the standard chess is to defeat the opponent by checkmating the king. However, there are different views on how one side may win or a draw is resulted. Capturing the opponent pieces to achieve either qualitative and/or quantitative superiority is a common practice in chess.

3. Chess variants and visualisation

The four main aspects of chess - pieces, moves, board and goal - have been subjects of alterations in order to achieve new, more challenging or more interesting types of chess.

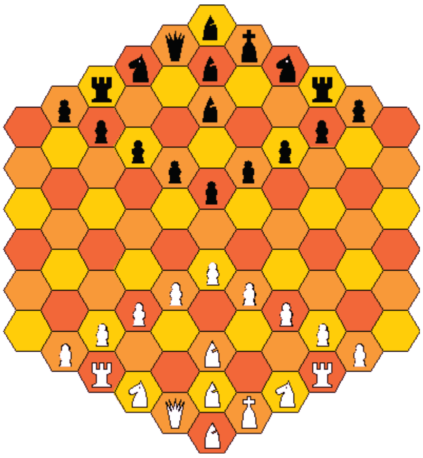

***Fig. 1**: Glinski's hexagonal chess [5]*

An early alteration of board can be found in Glinski's hexagonal (beehive) grid in early 1930s (**Fig. 1**). ChessVariants website [5] enumerates tens of *recognised* chess variants along with hundreds of less considered ones. Besides, there a number of patent registrations of chess. They range from changing the board into an MxN grid like Wildebeest or Tamerlane with 11x10 board with two “camel” pieces, changing or adding pieces like the Anti-king piece or the weird Raumschach complicated 3D five storey chess.

There has been a long time since chess is depicted in visual art. However, almost all objects have focused on static representation of pieces on a dark-light gridded board. In this case, the artistic effects are applied to the figure or pose of various pieces as well as dramatising the board (**Fig. 2**).

***Fig. 2**: A sample chess art [6]*

In this regard, DeGRaM (**De**sign by **G**rid **R**elation **a**nd **M**otion) is developed to capture a dynamic picture of chess, in particular, and other grid and piece games, in general. Therefore, it implements several concepts like moves (including their direction, steps and depth) and relation (such as threat, support or freedom) rather than the direct depicting of pieces and gridded texture.

5. DeGRaM-Chess

DeGRaM is a Windows based software developed in Free Pascal Compiler (fpc) via Lazarus IDE. Its goal is to generate complex visuals by using the simple rules and pieces of grid-and-piece games. Chess as a game with simple and familiar rules was selected as the primary base for DeGRaM pieces and grids.

The software is consisted of three parts that can perform separately. These parts include defining input that contains the grid and pieces rules and arrangement, calculative processing that is the main part of DeGRaM generating matrices and maps of moves and actions, and, finally, the visualisation section that contains geometrical and graphical functions for realising the maps into visible graphics. While the second part has to be done exclusively by DeGRaM, the other parts can be replaced by import or export extensions.

5.1. Defining

The software's input includes a set of piece and grid definition which can be entered either via its own interface or by being imported as text or comma delimited files. A defining file consists of two sections. The first sections includes properties of pieces such as, namely, name, caption, side, moving vectors with their possible depth (how far a piece is allowed to move) and capturing capability (side is only applicable to pieces like pawns, moves of which differ in different sides). **Table 3** shows the definition of bishop. The second section lists the cells by their coordinates and the occupying piece if one is filled. This method allows defining custom shapes of the board by excluding cells in an mxn grid. For example “1,3 B” indicates a bishop (the capital letter shows its side) in A3.

Property	Value(s)				
name	“Bishop”				
captions	“b”	“B”			
value	3				
moves	i	j	k	Depth*	capture or Move
#0	1	1	-	0	Both
#1	1	-1	-	0	Both
#2	-1	-1	-	0	Both
#3	-1	1	-	0	Both
*zero for depth means limitlessness of the move					

Table 3. *Definition of an ordinary bishop*

5.2. Matrix Mapping

This part is the main calculation section of the software. It mostly acts as a cellular automata processing in which cells in the grid behave like automata. Accordingly, for each cell a respective value is assigned for different parameters (threat, support, etc.). Another function of this section is to store paths and movements of pieces. This information is also saved to cells for caps of the path.

Level	Description	Condition
Absolute support	No threat but has support	$Fst(n)=false \wedge \sum_{i=1}^{n} Di=0$
No confronts	No threat, no support	$Fst(n)=false \wedge \sum_{i=1}^{n} Ai=0$
Support	Both, but support is more	$Fst(n)=false \wedge \sum_{i=1}^{n} Ai>0$
Equilibrium	Both and as same	$Fst(n)=false \wedge \sum_{i=1}^{n} Ai=\sum_{i=1}^{n} Di$
Threat	Both, but threat is more	$Fst(n)=true \wedge \sum_{i=1}^{n} Di>0$
Absolute threat	No support but has threat	$Fst(n)=true \wedge \sum_{i=1}^{n} Di=0$

Table 4. *description of support-threat measure*

A measure of six levels is developed to assess threat-support duality for each cell (**Table 4**). This measure is based on the presence and interaction of support and threat. To explain, it is considered that in a situation where a number of pieces are in direct access of each others, they start capturing each other. The capturing is stopped as the one of the opponents has no other involved pieces in the scene. Therefore we have the formula below, where *Fst(0)* is FALSE, *n* is total number of captures, Ai and Di stand for the respective values of attacker's and defender's pieces in the captureing *i.* Therefore, *Fst(i)* is a boolean function which returns TRUE if the cell is in threat.

$$Fst(i) = Fst(i-1) \vee \left(\sum_{i=1}^{n} Ai < \sum_{i=1}^{n} Di\right)$$

If *Fst(n)* becomes true (which means at a capturing sequence the attacker's total loss was lower than the defender's, so he/she stops capturing) this is considered a threat. **Table 4.** displays all possible threat-support measure levels.

The concept of freedom is indirectly significant in piece safety. As a matter of fact, it suggests the number of moves applicable by a piece in its current cell towards the threat free destinations. This is important when a piece is under attack and is seeking for an escape way.

5.3. Visualisation

The third part interprets the matrices into various visuals. Several parameters such as the motion concepts, board settings and zoning are involved in the graphical representation based on which calculation method (cellular or path) is applied. In general, there have been three parameters of presentation:

5.3.1. Dimension

Due to prevalence of 2D board alterations of chess, this software is mostly focused on 2D outputs. However, a 3D geometrical pattern as also programmed to generate design resembling building or furniture outlines.

5.3.2. Matrix

As is mentioned, two matrices - cell's features and moving paths - are generated by DeGRaM. In a presentation method one or both can be shown. However, only one of them is regarded as the main parameter while the other is displayed as texture or colour.

5.3.3. Zoning

Zoning indicated unifying or averaging the values of adjacent cells (single or combined). Functionally, it may be useful to illustrate the dangerous and safe parts of the board. However, its main benefit is aesthetical by variegating the monotonous cells juxtaposition. The current version of DeGRaM uses two scale and percentage parameters to shape the zones. The scale is a number *n* that indicates the maximum *nxn* (or *nxnxn*) block of cells which can be combined as a zone. The value *n* can not be greater than half of the smallest dimension of the grid. Percentage evaluates the proportion of the *n* block that must have the same map value to be considered a zone. It should between 51% and 100%.

5.4. Limits

There are a number of limitations to the efficiency of this software since it is in the initial stages of research. The most important of them is the time consuming process of thousands of recursive motions. This issues reveals itself more in 3D grids. Memory management is also a barrier when the number of steps to predict is high. In addition, as this program primarily aims to generate output on the basis of *simple* rules, the pieces' behaviour is reduced to mere moving vectors. Therefore, it ignores many chess rules like castling, checkmate, pawn's double movement, etc.

6. DeGRaM Output

6.1. 2D Grid

DeGRaM has initially aimed 2D Cartesian grids - *boards.* Boards are defined either as complete *m*x*n* grids or with excluded or missing cells. As is mentioned, pieces are defined by their value, side and moving vectors while being placed on the board in a custom way. Before the calculation starts, the number of steps should entered. This number is often selected as one or two because larger values means more processing time and memory usage. Besides, any number larger than two will not take a great difference in complexity with the two-step calculation. The method of visualisation is input after the calculation with the scale and percentage of zoning. So far, three methods for 2D visualisation are developed in the program. They are named by their appearance: wind-rose, asterisk, articulation.

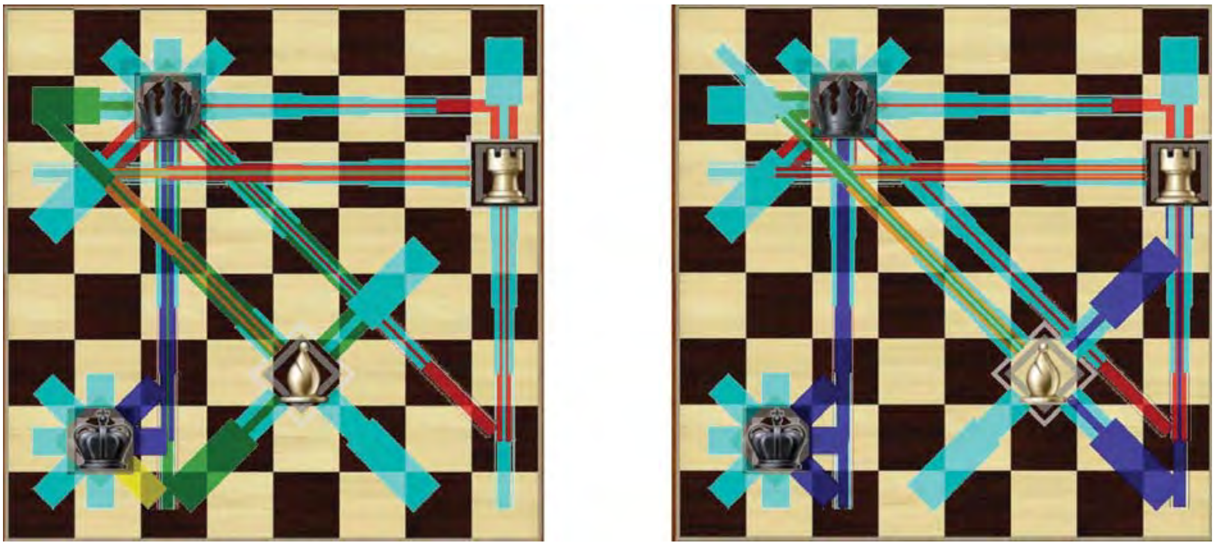

Fig 3. *One-step wind roses by replacing the white bishop from e5 to e6*

6.1.1. Wind-rose

It has been named due to its resemblance to climatic wind roses. It is consisted of bars aligned according to the direction which can also illustrate other properties such as depth of motion and threat-support equilibrium. These data are illustrated through the colour, angle and length and width of the bars. Pieces also are displayed as simple geometrical shapes which is somehow taken from their moving pattern (e.g. squares for rook, 45 degree rotated squares for bishops, eight winged stars for queen, etc). Although these shape patterns are only applicable for standard pieces. **Fig. 3** displays the one-step visualisation for two piece arrangements. The difference between them is in the location of the white bishop. In **Fig. 4**, the change of the output by moving a piece is illustrated in 8x8 grid with two-step visualisation. **Fig. 5** shows the same piece arrangement while the square *d4* is excluded. While the colours indicate the level of threat-support, their opacity represents the step of move (more opaque means earlier steps).

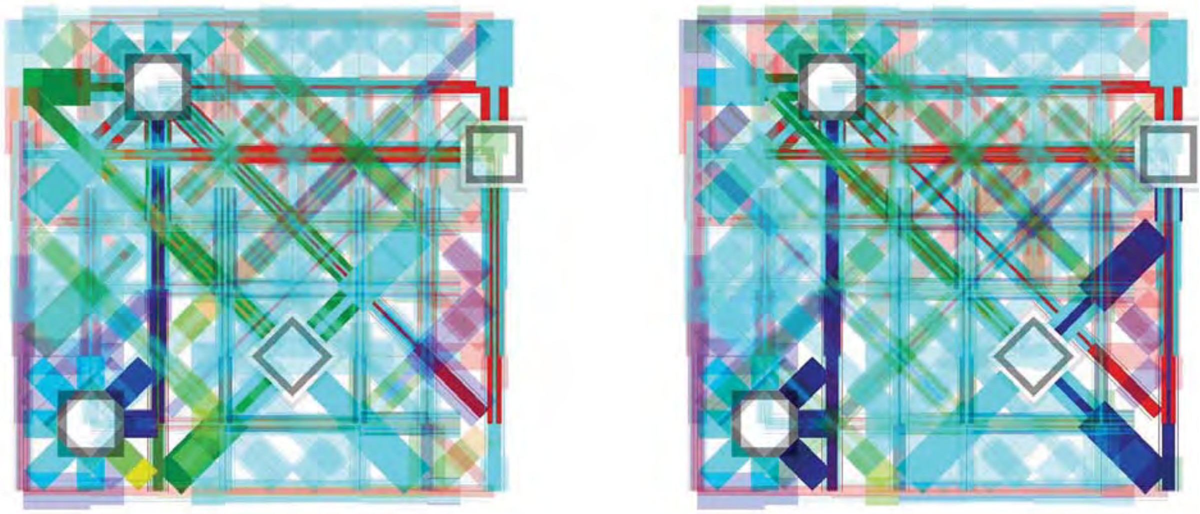

Fig 4. *Two-step wind roses by replacing the white bishop from e5 to e6*

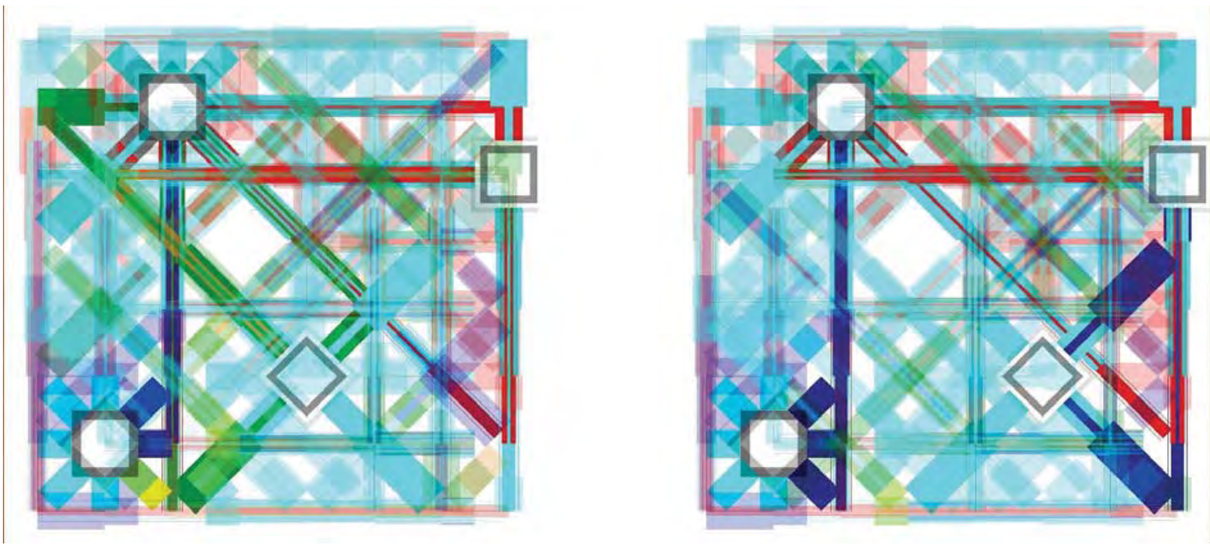

Fig 5. *Two-step wind roses (same as Fig 4.) while the d4 square is excluded*

6.1.2. Asterisk

While in the *wind-rose* the direct path of piece move is illustrated, in the *asterisk* method, only its effect on individual cells is displayed. In this case, the length and width of bars (asterisk wings) are the same, determined by the width of the cell. On the other hand, colours' function and assignment are as same as the wind-rose method. **Fig. 6** show the asterisk visuals for their respective wind rose equivalents (Fig 4).

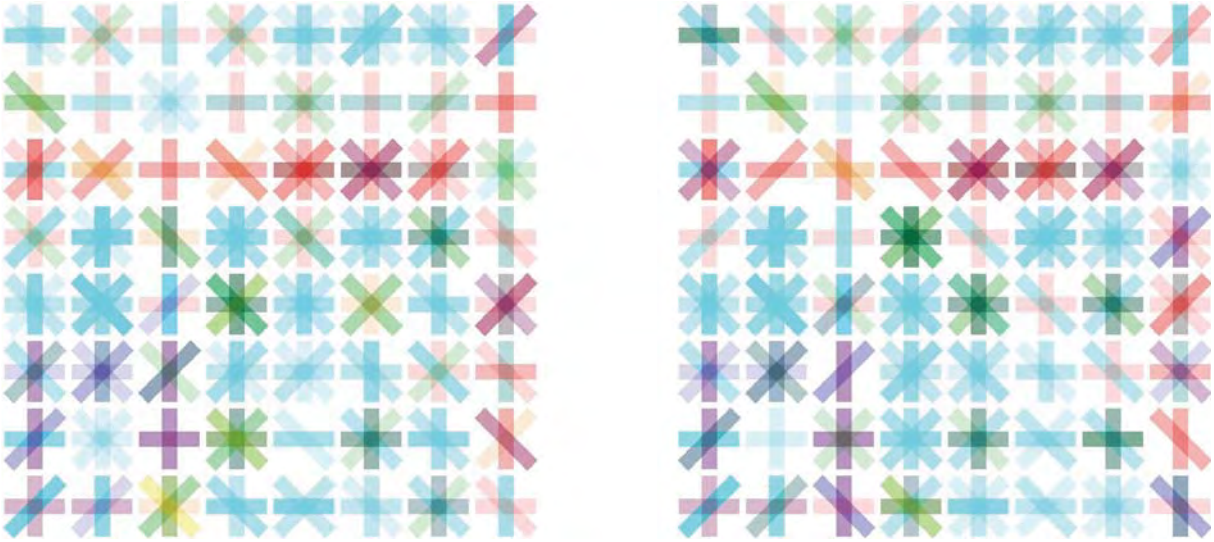

Fig 6. Two-step asterisks (same arrangement as Fig 4.)

6.1.3. Articulation

This type of visualisation focuses only on the value assigned to cells. However, the value is affected by presence of the motion, allowing tracking of the moves. For instance, it will consider threat-support values for either one piece, one side or an average of all sides for each cell. The severity of threats or supports is represented as articulation of cells. Colours are applied to identify sides. So far, two articulation methods are developed: squares and circles. **Fig. 7** shows the square and circles visuals for their respective wind rose equivalents (Fig. 4).

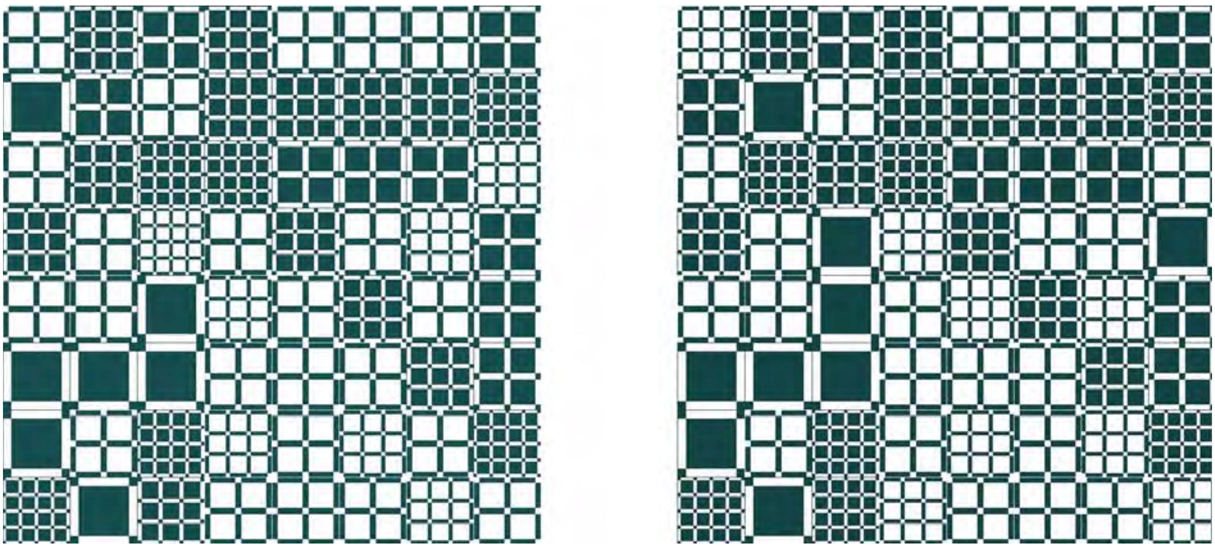

Fig 7. *Two-step square articulation (same arrangement as Fig 4.)*

Since this presentation lacks the direct display of moves, it is more difficult to establish a relation between the output and the original piece arrangement, especially in two-step calculation. The articulation also facilitates zoning as the visualisation is completely modular as well as the board itself. The output-arrangement relation is more undetectable by zoning as several paths are dissolved into zones. **Fig. 8** illustrates zoning for one of the previous settings both in one step and two step configurations.

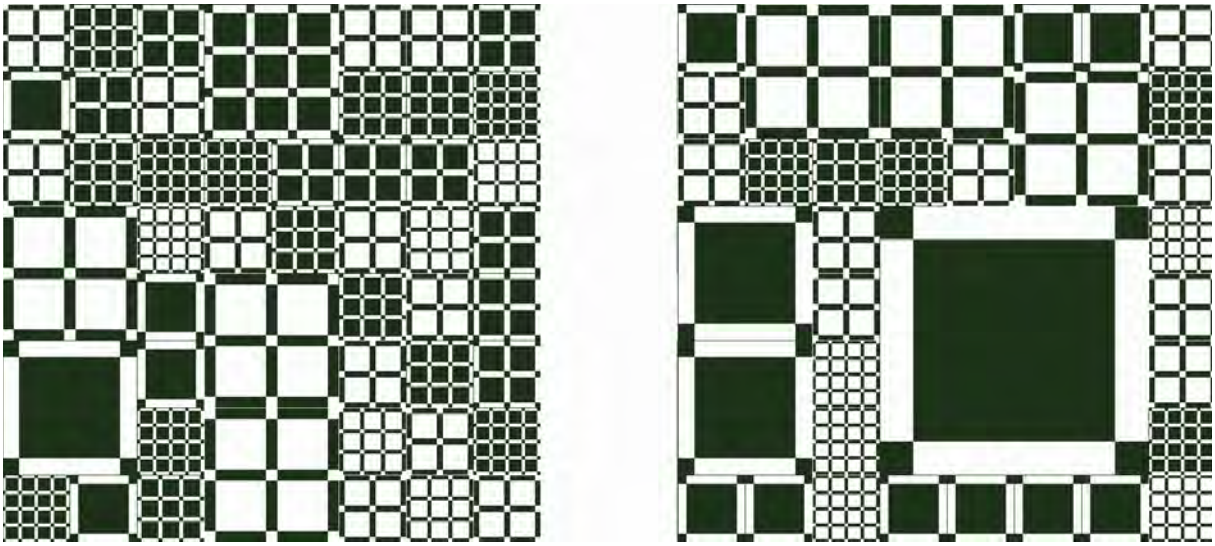

Fig 8. *left:Two-step square zoned articulation (same arrangement as Fig 4.left), right: One-step square zoned articulation for the same settings*

6.2. 3D Grid

3D grids differ from their 2D counterparts in various ways. First, as the 2D pieces are not suitable for this settings, the piece definition is completely different to the standard chess. For instance, the moves for 2D piece does not normally exceed eight vectors, while for a 3D piece, it may be as many as 26 vectors. Second, the visualisation differs as many of the cells are hidden behind other cells. Computationally, 3D grids takes substantially more time and memory.

Grid definition follows the same rules at in 2D type. An initial *a*x*b*x*c* grid is defined by listing its cells coordinates and excluding unwanted cells. Although 2D pieces are possible in 3D grids, they will not gain a satisfactory result as they do not interact in Z-different cells. It is also possible to rotate 2D moves by X or Y axes to see more interactions. However, original 3D pieces are inspired by 2D pieces. For instance, a 3D rook is similar to a 2D one with extra up and down vertical vectors. Detecting the output-arrangement relation is more difficult in 3D grids even in one step results as motion paths are hidden behind cells nearer to the point of view. This is severd in zoned presentation.

Since the DeGRaM was originally developed for 2D boards, there has not been as much diversity for the 3D outputs. The only presentation method is labelled *cubes* which is the 3D counterpart of square articulation in 2D. Like 2D squares, the cubes articulation also may be undergo ne zoning. *Empty zones* are a feature which is given to 3D grids. An empty zone is a zone where most of its cells are neither threatened nor supported by any sides. Please, note that rendering is done by Vray® rendering engine in Autodesk 3DSMax® software.

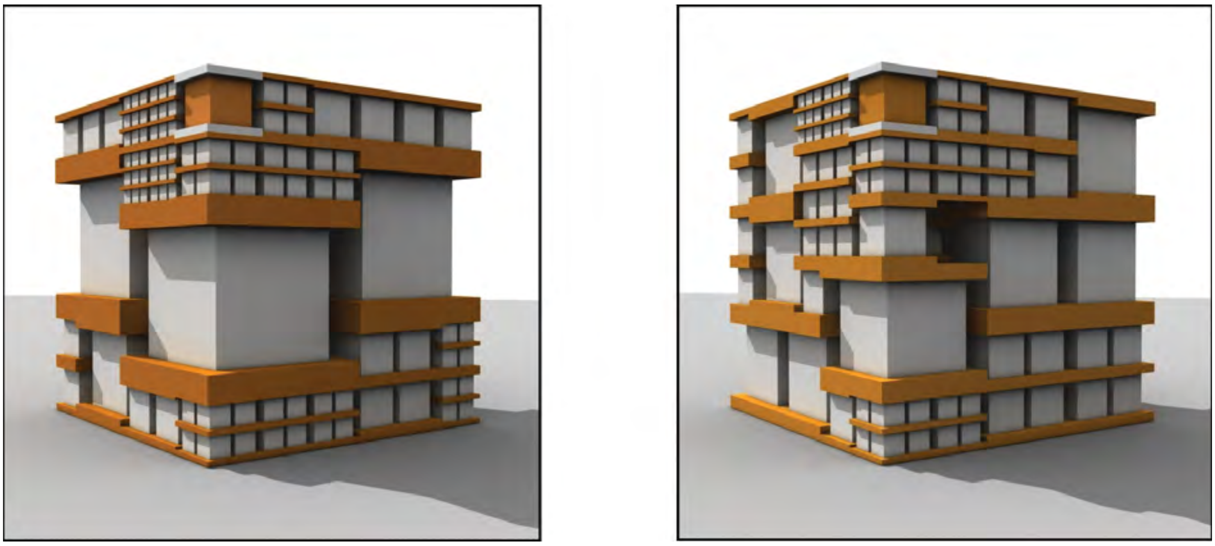

Fig 9. *left:Two-step 3D articulation with 3x zoning (70%). right: Two-step articulation with 2x zoning (70%) for the same settings (R:1,2,1; q:5,1,4; K:2,5,6) in 6x6x6 grid.*

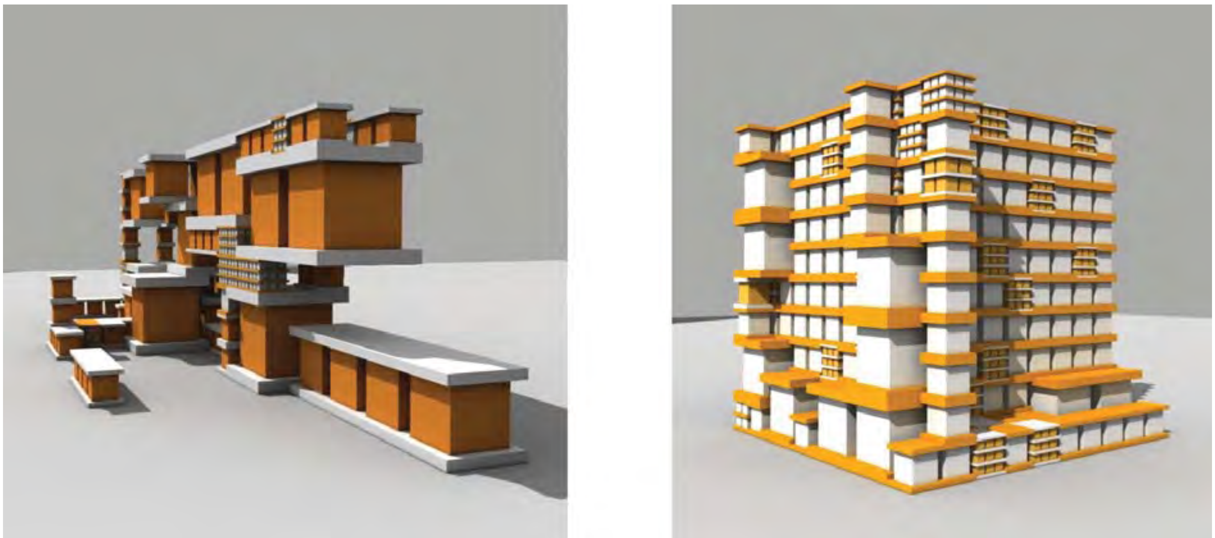

Fig 10. *two different 3D zoned outputs of DeGRaM for larger grids.*

7. Discussion

DeGRaM is a software aimed to illustrate motion and relations in gridded games, especially similar to chess. It uses various concepts in chess such as threatening and supporting to calculate the consequences of the moves for every piece, in order to generate unique maps for each grid configuration. Thereafter, the mapping results are visualised by geometrical patterns.

DeGRaM is still in its early stages of development. It is depended on Cartesian coordinates and simple fixed piece moves. In addition, the software does not regard chess as a win-loss game. Therefore, its calculation and piece motion are based on mere simple one or two move prediction. Besides, the king's role in the game is reduced to a simple piece without being *checked.*

Finally, the software's outputs only have aesthetical purposes. It can be assumed that some of outputs can be planned for specific goals. For example, the 3D outputs may well be used for exploring design space on building architecture.

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Peter Beyls

FOUND SYSTEMS AS GLITCH CULTURE

Abstract:

Most generative art develops imaginary worlds; some form of conceptual machinery, formalized and implemented algorithmically as to manifest itself in a given medium. In contrast, this paper considers the algorithmic potential of found social systems (such as the dynamics of a major city) within the audiovisual medium of film. We contextualize found systems in the light of glitch culture – the deliberate design of imperfection or the exploration of the dysfunctional edges of media – through a significant number of examples. Two projects recently implemented at Interaction Lab of UC Ghent receive detailed analysis in terms of inspiration and performance. The *DataScript* project (based on a film shot in the streets of Paris) suggests a recursive audiovisual generative system; visual features map to audio while audio influences the pictorial development of the film over time.

This kind of projects explores the city as a natural systemic entity; information is extracted, (in real time or non-real time), mapped and used as an information source to influence human-designed cultural systems.

Semantically speaking, the paradigm of film is kept intact though subtle audiovisual manipulations suggest raised awareness in the onlooker while continuously balancing expectations between the obvious and the unpredictable. Finally, our presentation briefly situates the glitch projects within the larger body of work with generative systems developed in our lab.

Topic: Found Systems

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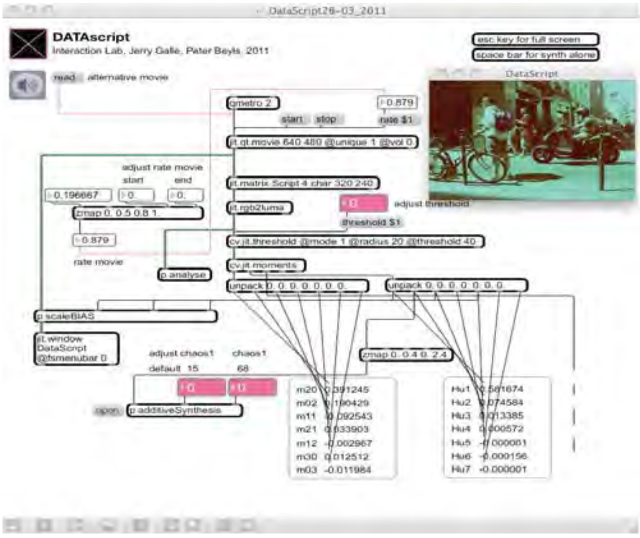

Screenshot of DataScript (Paris project, 2010)

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Found systems, glitch, dynamic mapping, audiovisual systems

Found Systems As Glitch Culture

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Abstract

Most generative art develops imaginary worlds; some form of conceptual machinery, formalized and implemented as to manifest itself in a given medium. In contrast, this paper considers the algorithmic potential of found social systems within the audiovisual medium of film. We contextualize found systems in the light of glitch culture – the deliberate design of imperfection or the exploration of the functional edges of media – through a significant number of examples. Two projects recently implemented at Interaction Lab of UC Gent receive detailed analysis in terms of inspiration and performance. Semantically speaking, the paradigm of film is kept intact though subtle audiovisual manipulations suggest raised awareness in the onlooker while continuously balancing between the obvious and the unpredictable.

1. Definition and history

Astronaut John Glenn first used the term *glitch* in 1962 for describing erroneous and unpredictable behaviour in electronic circuits. Errors often happen spontaneously; therefore they refer to the true nature of things. The genuine character of either tangible or virtual machinery (i.e. hardware or software) gets exposed through non-intentional behaviour. Conversely, glitch aesthetics embraces the unpredictable; it not only accepts irregularities but also suggests active exploration of the potential of accidental performance.

Glitch culture challenges the idea of ‘perfect design’ that is generally believed to be the standard in digital media production. Ironically, most drawing software emulates the inherent physical irregularities of traditional media such as pencils, paint and even the physical characteristics of paper. However, true glitch orientation is much more complex to characterize; the main distinction is between (1) the deliberate creation of accident or (2) expressing blind faith in the accidental discovery of the unforeseen. The first attitude implies an *explicit* orientation towards the design process. The artist creates systems engineered to produce (partially) predictable output confined by (conditioned) randomness. The second attitude acknowledges the *implicit* authority of nature; biological systems develop natural cycles of development and disintegration.

Examples of work incorporating systems aesthetics, a style of procedural thinking related to the practice of conceptual art, are works made using chemical processes (biological or synthetic) such as found in the works of Alan Sonfist or Herman De Vries [5]. Probably the most dramatic example of nature interfering with art is *Spiral Jetty*; a 1500-foot coil of black basalt rocks near Salt Lake City. After 30 years, the landmark sculpture re-emerged from the sea, thus exposing a fresh appearance, because it was completely covered with white salt crystals.

Another materialist precursor of unconventional threshold considerations in the arts is certainly the field of experimental film. As an articulate key figure of underground film, Stan Brakhage describes his technique to Jonas Mekas in 1962: “By deliberately spitting on the lenses or wrecking its focal intention, one can achieve the early stages of impressionism… One may hand hold the camera and inherit worlds of space. One may over- or under-exposure the film. One may use filters of the world, fog, downpours, unbalanced lights, neons with neurotic colour temperatures, glass that was never designed for a camera…” [7]. Early experimental film exemplifies the power of direct physical manipulation and tactile involvement with a creative medium; one may paint the film, scratch and clip holes into it. Brakhage grew mold directly onto film; a significant pioneering instance of (now quite common) Artificial Life oriented thinking in the arts.

Inaccuracies in the human genetic evolutionary process or disease may either trigger uncommon potential or severe inadequacies. Django Reinhardt developed an utterly wonderful personal style of playing the guitar using just three functional fingers. When Joni Mitchell contracted polio, a crippling illness weakening her left hand, she responded by developing highly personal, alternative guitar tuning systems; physical constraints creating a distinct personal system of chordal harmony. Mitchell confirms her quest for novelty while facing constraints; “I called them chords of inquiry, they had a question mark in them.” [8]. Blues legend Hound Dog Taylor was born with six fingers on his left hand, he developed an astounding style of brilliant slide guitar.

Sometimes, virtuoso instrumental performers face physical illness and degradation. When guitarist Derek Bailey was diagnosed with the carpal tunnel syndrome in his left hand, he decided to refrain from surgery and accept the inevitable as a welcome source of novelty. Historically considered a key figure in the British music scene of free improvisation, Bailey developed performance modes by avoiding the constraints imposed by conventional musical perspectives. Paradoxically, the consequences of physical limitations were, however, graciously integrated into his performance practice and cautiously documented in series of chronological recordings spanning 12 weeks [1].

When serious health problems prevented Henri Matisse from painting, he reorganized his artistic method by turning to scissors for ‘cutting directly into colour’.

2. Cultural contextualisation

Let us now focus on the first attitude; the one associated with culture rather than nature, a methodology devised to help design imperfection [9].

Paradoxically, the addition of advanced technology to the artists' palette equally introduced a raised awareness for the functional limits both in terms of hardware and software. By definition, any technology is characterized by promise and failure – and historically speaking – many artists went to great effort to devise methods for exploring the unstable edges of media. Let us first consider three related artists; Tinguely and SRL. Swiss sculptor Jean Tinguely created kinetic machines designed to function on the brink of what is physically achievable; electric motors activate an intricate mechanical construction of interconnected parts giving the impression of functioning on the threshold of collapse. In 1969, a huge self-destructive machine, entitled Homage to New York, was erected and forced to disintegrate at the Museum of Modern Art, NY. The Bay Area collective Survival Research Laboratories (SRL) develops highly advanced machinery often incorporating control systems of military sophistication. Yet typically, many such machines are left to interfere in spectacular inter-machine performances, while pyrotechnics adds another pinch of instability [11]. In conclusion, the ultimate aesthetic in this form of hardware hacking is simply total destruction.

Let us briefly consider the field of interactive composing; a form of human-machine interaction where musical ideas are generated and interchanged by human and synthetic performers. Musical improvisation thrives from a confrontation with musical contexts generated and evaluated by the two improvising parties in real-time. In keeping a conversational attitude, it is mandatory that human and machine somehow connect in the huge space of infinite musical dimensions, yet, a critical amount of surprise is required to guarantee motivated participatory behaviour. Thus, rewarding interaction is believed to be supported only by a critically tuned cognitive platform. Interestingly, randomness has been investigated extensively to generate machine-melodies in response to human input [6]. A deeper form of unpredictable behaviour, while maintaining a coherent connection to a performance context is by way of genetic algorithms. In brief, the idea of a motivated machine is introduced; for instance, is the machine willing to integrate with a human suggested context? If so, genetic algorithms might evolve software modules to both interpret human input and to generate the appropriate machine responses. Genetic fitness is then implicit to the resulting changes in musical distance between human and machine [3]. It is significant to realize that inaccurate reproduction (the combined effects of crossover and mutation) globally provide the intended sustained functionality.

Musical improviser Michel Waisvisz explored quirks in music synthesizer operating systems to spectacular effect. He played synthesizers in ways not intended by their original designers. Waisvisz developed a highly idiosyncratic performance mode still using standard commercial equipment. As a listener, fascination emerges from the integration of two observations: (1) virtuoso instrumental control over musical processes through bodily (physical) effort and (2) the sonorous excellence of the unusual timbres gained from hacking the initial intentions of electronic instrument manufacturers [16].

One might say that the actual practice of improvisation intimately acknowledges the exquisite potential of the accidental; the creative spark in the unintended yet coherent behaviour. Expressed in the words of Steve Lacy; “For me that’s where the music always has to be – on the edge – in between the known and the unknown and you have to keep pushing it towards the unknown otherwise it and you die” [2].

3. Philosophical contextualisation

In the early 1950s, John Cage developed the idea of “indeterminacy” in an attempt to exclude any distinctive form of personal decision-making. Significantly instructed by Eastern philosophical concerns, Cage fully emancipated the accidental as the subject matter of his art which is perhaps best exemplified in his piano piece 4’33”.

In an influential paper entitled Museum of Accidents, Paul Virilio equally calls for the general acceptance of the unknown as vital in any culture. According to Virilio [15], substance and accident are seen as complementary; any creative process should embrace the unpredictable, there are no negative considerations for mistakes, errors are viewed as constructive agents. Virilio’s imaginary museum formulates an activist viewpoint towards imperfection and dysfunction. Catastrophes are the inexorable consequences of the acceleration of socio-cultural phenomena. The museum’s raison d’être is an instinctive reflex to study the unpredictable by “exhibiting the accident”.

Manifestos

It is perhaps striking that many glitch artists turn to manifestos for claiming cultural territory to express radical attitudes and working procedures including controversial methods such as appropriation.
Manifestos include the Manifesto of Futurism of 1909, the Manifesto for the Unstable Media published by the V2 Organization and the Incomplete Manifesto for Growth written in 1998 by Bruce Mau.

Marinetti embraced electric power, movement and speed brought along by the industrial revolution; he acknowledged their potential for changing social structures in radical ways. The seventh statement in the Manifesto of Futurism reads: “Beauty exists only in struggle. There is no masterpiece that has not an aggressive character. Poetry must be a violent assault on the forces of the unknown, to force them to bow before man” [14]. The prospect of instability is fiercely implicit in this statement.

The V2 Organization manifesto, published in 1987, elaborates on the image of instability, as a metaphor of contemporary society, while the most significant feature of the new digital medium, including networking, is the introduction of instability and insecurity in global socio-cultural relationships.
Bruce Mau’s influential manifesto connects strongly with the idea that accidents should be captured as part of any design process: “The wrong answer is the right answer in search of a different question” [10]. Again, the forces of the unknown are considered vital towards the establishment of a creative process driven by changes

rather than outcomes.
Designed unpredictability enjoys a long tradition in software art through the use of random number generators. A concise analysis is beyond the scope of this paper. We shall, however, explain the ideas and implementation of *DataScript*, a recent project in the realm of algorithmic cinema.

4. Project DUSK

Figure 1. Impending fog in Amsterdam harbour.

Figure 2. Electric light about to interfere with daylight.

Project *Dusk* reveals a fascination for 'found systems' in analogy with the idea of found footage in the field of experimental film. *Dusk* is intended as a movie as well as a real-time audiovisual installation. The movie is constructed from consecutive frames taken from a camera overlooking the Amsterdam harbour over an extent of 24 hours. The film features an impressionistic undertone given a low-resolution camera and occasional interference and glitches in the transmission channel. However, the most fascinating images unfold as electric lights illuminate the darker stage of twilight. As a consequence, the movie suggests a developing atmosphere conditioned by human (cultural) as well as ambient (natural) phenomena. The various image transitions evocating variable colour content and fluctuating degrees of abstraction are inherent qualities of the method employed here; the individual frames were not in any way manipulated after being captured. In essence, the project may be thought of as created by a generative system built out of three critically configured components; (1) the harbour as a 'found' system, (2) the environmental conditions and (3) the Internet. Figure 1 shows part of Amsterdam harbour, modulated by a foggy filter provided by temporary atmospheric conditions. Figure 2 captures the point in time where electric light just takes over from natural environmental light. Both images were taken from a webcam on December 22, 2009. *Dusk* was implemented in processing [13].

5. Project DataScript

This section provides a description and analysis of project *DataScript* realized in 2011. A short movie clip shot in Le Marais district of Paris is considered a found system, a micro-universe in itself organized according to the myriad of concealed social forces shaping city life. However, the movie is equally acknowledged to reflect certain aspects of the social affinities being expressed between the agents captured in the movie. The behavioural complexity of the movie is addressed with a systems-aesthetics in mind; is there a way to sensibly interface the implicit activity in the movie with some activity in an explicitly designed algorithm? How could the rhythm of life in the Paris biotope face critical analysis and successfully spawn audiovisual comment in real-time? These thoughts are informative in order to address the medium of film from a novel perspective, though, as we shall see, the general projection format of the movie is preserved.

The project *DataScript* aims to validate the rich yet surprisingly coherent behavioural scope of the movie in terms of new visual and sonic material. To this purpose, consecutive movie frames are analyzed in terms of brightness – colour information is not considered. Being implemented in Max/MSP/Jitter (Cycling74), the functionality of the *cv.jit.moments* external library developed by JM Pelletier [12] serves our application as it computes a wide range of invariant shape descriptors.
The global mapping approach is organized as follows: information is extracted from single frames and from changes between frames. A complex, completely deterministic network of mapping modules interprets this information. The resulting analysis controls various attributes of sound and image in real-time.

First order analysis documents shape descriptors; basically, the moments of inertia relative to several image features. In total, for every single frame, the following data is retrieved: moments, Hu invariants, centroids and momentary mass i.e. the total size of all shapes. A threshold variable constrains the amount of image contents

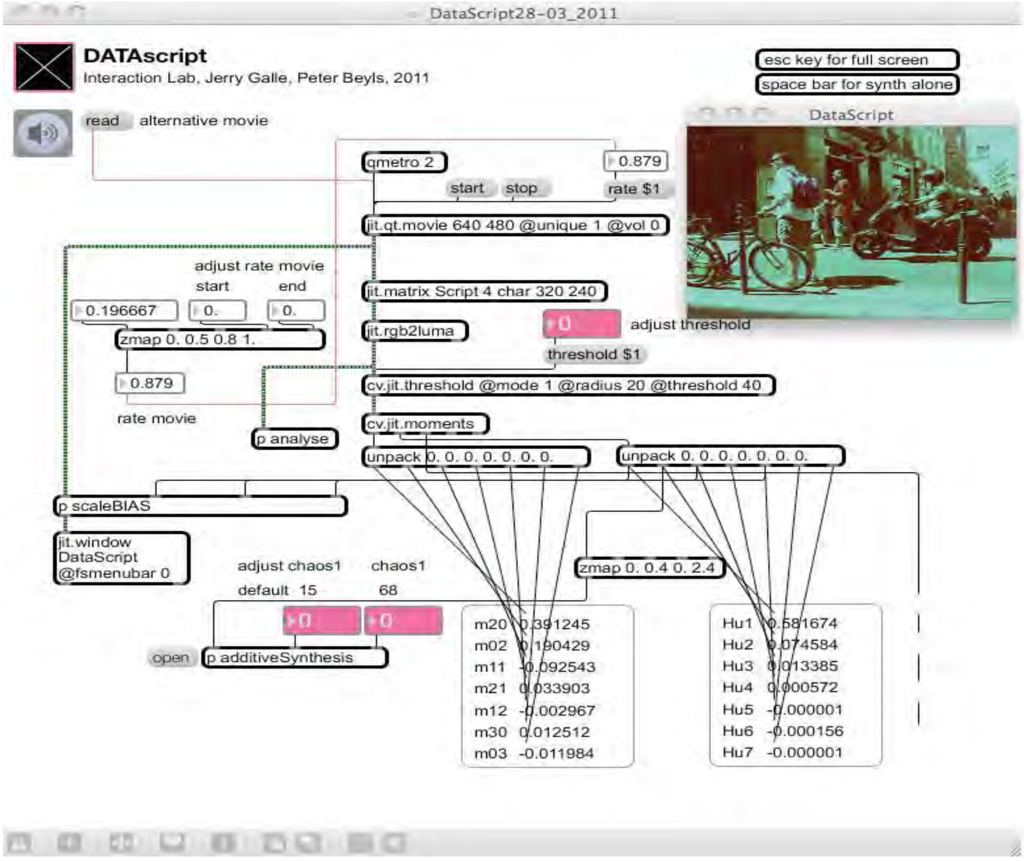

Figure 3. Screenshot of main patch (video) *DataScript*

addressed and is thus to be considered in the mapping process with great care. Second order analysis looks for information *between* consecutive frames: (1) global motion or the amount of difference between frames, (2) the XY-trajectory of the centroid of general motion and (3) the history of the amplitude of general motion. In addition, an adaptive hotspot algorithm is operational; it dynamically follows the centroid of motion with a certain delay. The effect is continuously zooming in on activity as the film develops in time; the mapping algorithm becomes sensitive to visually perceptible regularities expressed between consecutive frames.

Exactly the same type of algorithm is used to map to sound and image. First, analysis data informs the modulation of image colour RGB data and hue – the hue is in fact rotated while luminance data is left unmodified. The outcome is a visual system modifying itself; particular image features will influence the subtle transformation of the same features in the ongoing film.

Both video and audio processing is computed in real-time. We may think of the synthesis section as a blackbox housing a vast network of audio synthesis modules (sine wave oscillators) with variable connectivity. The analysis section creates three data structures for controlling respectively frequency, envelope and amplitude.

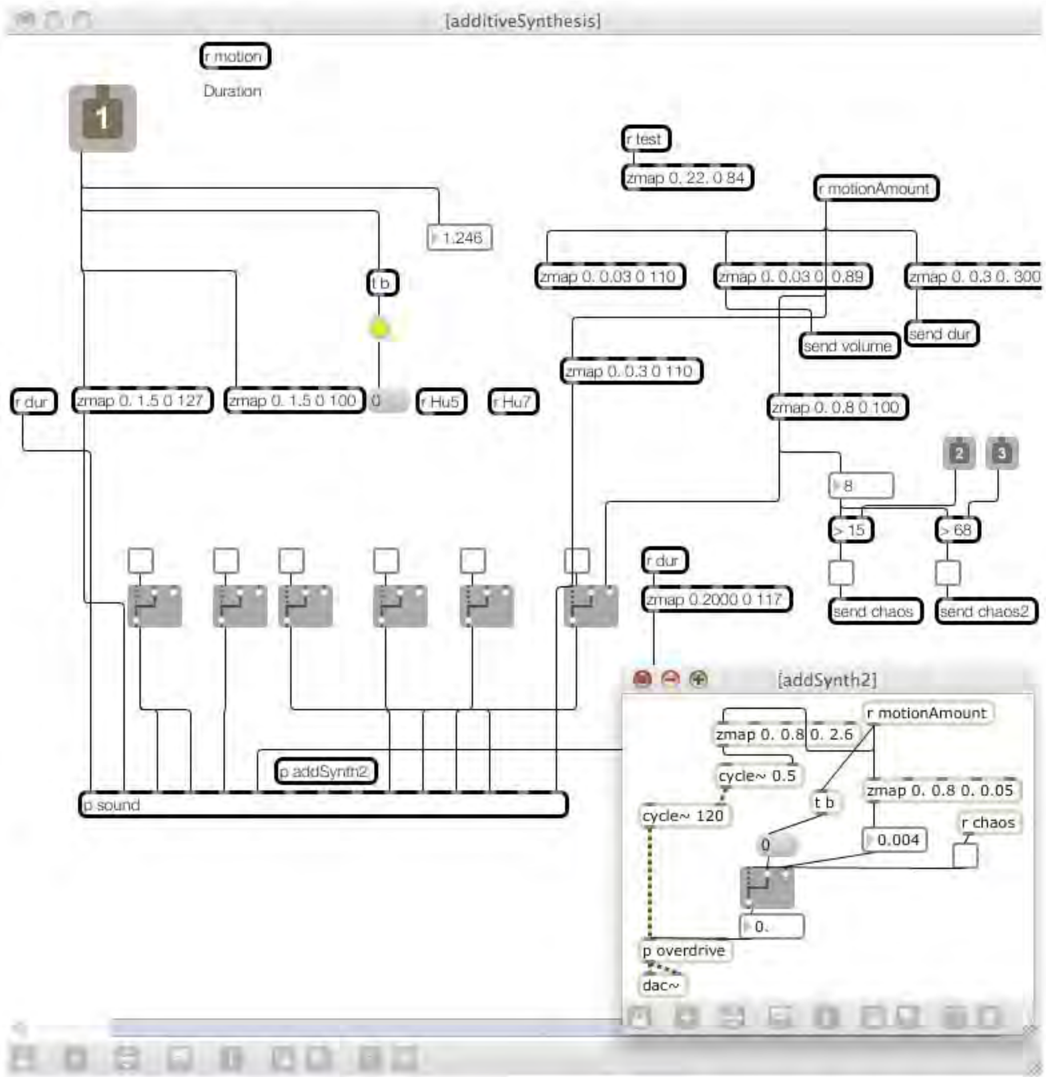

Figure 4. Screenshot of sub-patch (sound) *DataScript*

Although it is beyond the scope of this paper to discuss *DataScript* in detail, let us take a closer look at the two screenshots (depicted in figures 3 and 4) were the main objects are shown that process the outcome. Figure 3 shows a screenshot of the main *DataScript* patch. The ‘jit.qt.movie’ object sends the source video via the ‘jit.rgb2luma’ (this object renders the film black and white) to the external cv.jit objects [12]. ‘cv.jit.moments’ is the main object where the first order analysis is performed on the incoming binary video. Second order analysis, as described above, is performed in the sub-patch ‘p analyse’. The sub-patch called ‘p scaleBIAS’ on the left is where image colour distortion is performed and finally sent to the graphics card. Audio processing takes place in the sub-patch ‘p additiveSynthesis’ (Figure 4). The sub-patch ‘p addSynth’ in the right corner is one of many small sub-patches holding sine wave generators (such as ‘cycle~120’) that compute and synthesize the sound of *DataScript*.

Generally speaking, two practical considerations of critical substance condition the mapping process; (1) the use of a great many variable thresholds spread out throughout the mapping algorithm and (2) the fact that interconnections are explicitly designed as a fixed network of relationships. All decision-making follows this logic without referring to randomness of any sort. This consideration is in line with our wish for preserving the conventional format of film as a linear projected medium.

Also significant; much time was spent to find the proper parameters for guiding the behavioural scope of the mapping algorithm. All threshold values are tuned by hand, using a method of error-and-trial. Networked connections between analysis objects and image modification components were developed on-line; while the system is running, a development scheme that is not possible with compile-and-run systems. All this conforms to a design strategy expressing faith in the power of *intuition*; applications are created from the intimate and continuous consideration of a dynamic range of creative options in permanent flux.

6. Conclusion

In a recent interview in *Oor* Magazine, star photographer Anton Corbijn insists: “an imperfect picture is more perfect than a perfect picture.” Accordingly, the initial incentive for this project was a fascination with found systems; how does one develop an interpretation of a found system – such as a city – as an imaginary generative system expressing its activity in an infinite number of dimensions? This paper detailed the philosophy and operation of an audiovisual rendering of Paris city life. Mapping is conceived as a deterministic yet complex network following an analysis-synthesis approach. Movie footage is manipulated in real-time while certain visual features trigger audio responses. Image manipulations are subtle; they affect the sensual parameters – to paraphrase Derrick De Kerckhove; “the screen as the skin of culture” [4] – of the image and do not obliterate semantics in any way.

Noteworthy, the quality and depth of the aesthetic experience is definitely related to the perception of unexpected artefacts, or more precisely, the incessant development of a looking/listening strategy aiming to balance expectation and surprise. In addition, audiovisual cues manifest themselves in different levels of comprehension, this raises awareness and calls for an active type of involvement of the onlooker and as such defines a novel approach to the audiovisual medium of film.

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Philip Galanter

Paper: **The evolution of style and gigantism in new media art**

Abstract:
In the competition for attention new media artists have increasingly entered the realm of spectacle. If a wall sized projection is good, then a projection on the side of a building is even better. If interactive music using two cell phones is good, using one thousand cell phones is even better. If a small cube made with 27 RGB LED's is good, a garage-sized cube with thousands of LED's is even better.

Is this trend towards gigantism a legitimate strategy for the development of style in new media? This question is explored from the art historical point of view of Heinrich Wölfflin, and the psychological and neuroaesthetic view of Colin Martindale.

Topic: Fine Art

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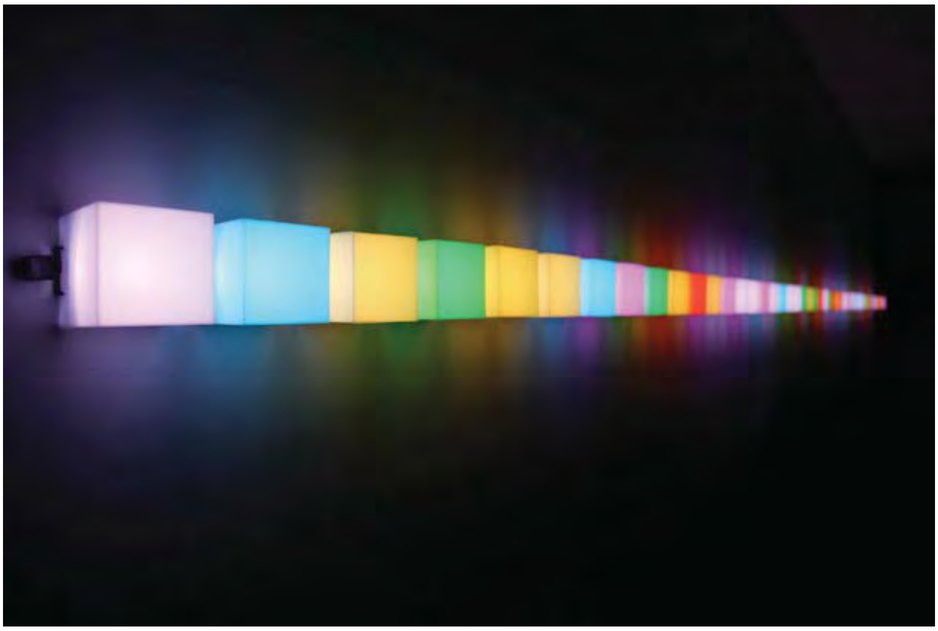

rgbca #2

384" x 3" x 3.5" (2010) - leds, microcontroller, power supply, acrylic plastic, software

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Minimalism, complexity, aesthetics, art theory

The Evolution of Style and Gigantism in New Media Art

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Premise

In the competition for attention new media artists have increasingly entered the realm of spectacle. If a wall sized projection is good, then a projection on the side of a building is even better. If interactive music using two cell phones is good, using one thousand cell phones is even better. If a small cube made with 27 RGB LED's is good, a garage-sized cube with thousands of LED's is even better.

Is this trend towards gigantism a legitimate strategy for the development of style in new media? This question is explored from the art historical point of view of Heinrich Wölfflin, and the psychological and neuroaesthetic view of Colin Martindale.

1. Scale, Style, and New Media Art

Chris Burden is a performance artist perhaps best known for his early 1972 performance peace called *Shoot*. The video and photographic documentation show Burden being shot through the arm by a friend using a rifle from 18 feet away. In his piece *Trans-Fixed* Burden's hands are nailed to the roof of a Volkswagen. With his body stretching across the trunk with his feet on the bumper, he appears to be crucified on the car. Photography documents the stigmata. The performances are conceptual and minimal in form, and yet create a spectacle that is hard to ignore. But where can one go from there?

Burden's solution was to continue making spectacular work, but through the exploration of scale rather than human pain. *What My Dad Gave Me* is a 65-foot, 16,000-pound model skyscraper using approximately 1,000,000 toy Erector Set parts. For *Urban Light* Burden arranged some 200 lampposts creating a forest of lights on the Los Angeles County Museum of Art (LACMA).

Burden's recent piece for LACMA is *Metropolis II.* It is described as follows:

> "Metropolis II is an intense and a complex kinetic sculpture, modelled after a fast paced, frenetic modern city. Steel beams form an eclectic grid interwoven with an elaborate system of 18 roadways, including one 6-lane freeway, and HO scale train tracks. Miniature cars speed through the city at 240 scale miles per hour; every hour, approximately 100,000 cars circulate through the dense network of buildings. According to Burden, 'The noise, the continuous flow of

the trains, and the speeding toy cars, produces in the viewer the stress of living in a dynamic, active and bustling 21st Century city.' " [1]

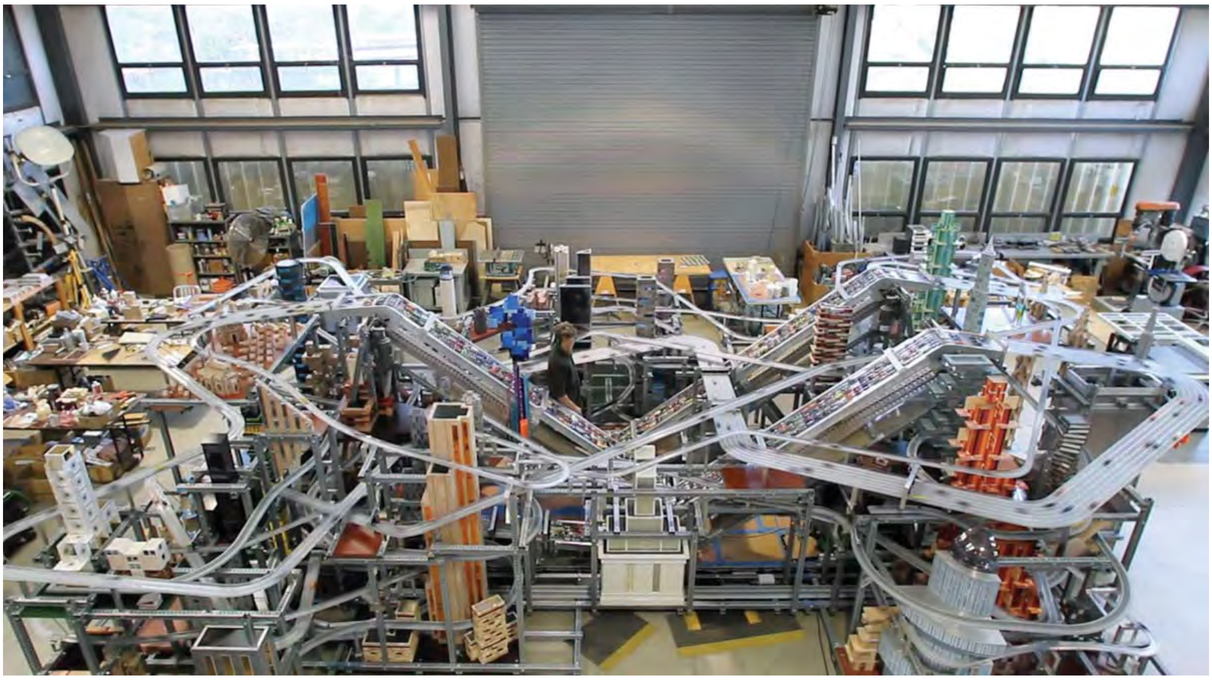

Figure 1 - Chris Burden's "Metropolis II" in his studio

The 100,000 car count is a bit misleading. There are actually 1200 custom made cars that make about 80 laps per hour. Nevertheless the sheer size and sound makes for an impressive experience. But is it art?

Consider the model train systems exhibited at the Museum of Science and Industry in Chicago. The first system opened in 1941 and covered 2340 square feet using 1/48 scale trains and scenery. It included 1000 feet of track and 40 switches running 10 trains. It closed after running 60 years in 2002.

Figure 2 - An early model train installation at Chicago's Museum of Science and Industry

The new exhibit titled "The Great Train Story" took 40 people over 12 months to create. It documents the journey from Seattle to Chicago using 50% more floor space to run 30 trains over 1400 feet of track. The track shape itself took 25 iterations to design. It includes 192 buildings that are exact scale replicas of actual buildings including Chicago's Sears Tower. The Red Line subway station at Chicago and State is recreated brick for brick, and is populated to reflect the individuals who were waiting for the train at 1:56 pm on April 3, 2002. Rather than using a contemporary electronic computer, the control system uses a complex system of relays. This allows the system to be restarted instantly without the need to reboot a computer. [2]

Figure 3 - "The Great Train Story" at Chicago's Museum of Science and Industry

So why is *Metropolis II* considered to be art while *The Great Train Story* is presumably considered to be high craft? If innovation is the key the Museum has Burden beat by several decades. Burden's work is a bit more abstract while *The Great Train Story* strives for mimesis, but both representation and abstraction are found in art. There are many theories of art, but a key notion in contemporary theory is that an object is art when it is presented in an art context. Burden thinks there is a bit more to it than that, but it strikes me as a marginal claim.

> "It's not like a model train set," Burden says as he guides me around the structure—an 18-laned tangle of hills, bridges, tunnels, ramps, overpasses, skyscrapers, spillways, and chutes. "We have suggestions of types of buildings you find in L.A. But they're not models. And we kept the scale vague, making the cars the dominant element." [3]

Ultimately what makes both Metropolis II and The Great Train Story work is the sheer size of the work and the apparent complexity of the multiplicity of moving parts. Like the best contemporary art they challenge the senses without overwhelming them. There's no doubt that *Metropolis II* is art. If *The Great Train Story* was moved to Chicago's Museum of Contemporary Art it would be too.

In the realm of new media art a sort of gigantism has set in. Somehow artistic uses of technology that might seem trivial on a small scale garner headline-like attention when they are simply applied on a large scale. There are many examples; here are but a few:

Chris O'Shea - His installation Audience uses actuator-fitted mirrors and sensors such that as people pass by the mirror tracks their motion and always faces them. A single mirror would be an amusing piece. By installing dozens of mirrors it becomes notable art. [4]

Mark Lottor / 3waylabs - The RGB physical pixel, sometimes in the form of a single LED, has become a staple of physical computing. Relatively simple to control, countless hobbyists have created RGB pixel cubes with LEDs in a matrix configuration. What Lottor has done is build large versions with thousands of lights measured in yards rather than inches. His work is popular at Burning Man and similar festivals. [5]

Philip Beesley - His Hylozoic Ground series of installations presents dense arrangements of biomorphic plastic constructions that integrate sensors and actuators to slowly respond to visitors. The behavior and supporting technology of a given segment is within reach of most advanced physical computing students. His taste and style is finely tuned. Again what makes the work so compelling is its sheer mass. [6]

Leo Villareal - Working with light sources of various kinds Villareal's work has grown over time to works of architectural proportion. Unlike the other artists noted here Villareal's pieces exhibit complex behaviors based on simple rules and emergence. Before he became an international figure I was pleased to include his first light piece

Red Life in the exhibit COMPLEXITY. (I curated this travelling show with Ellen Levy in 2002.) *Red Life* is only 30 by 36 inches in size. [7]

These few pieces are not enough to make the global case. Nevertheless, if the reader will allow that the trend towards gigantism is present in at least some new media, then we can explore whether some broader principle of stylistic evolution is at play.

2. Heinrich Wölfflin and the Development of Style

Heinrich Wölfflin is a foundational art historian and theorist on the development of style. In Principles of Art History he presents a framework for the analysis of art in the 15th and 16th century *classic* style as compared to the 17th century *baroque* style. He breaks down the transition using five pairs of polar concepts.[8] These are:

Linear versus *Painterly* - The classic style emphasizes the edges of objects where the baroque emphasizes areas in terms of shade and texture without hard edges.

Plane versus *Recession* - Depth in the classic style is established by assigning objects to planes parallel to the picture plane. In the baroque objects can continuously recede into the picture without a sense of layered planes.

Closed Form versus *Open Form* - Also called tectonic form, classic works tend to be self-contained with predominately horizontal and vertical relationships. In a-tectonic baroque works lines of action can point beyond the image fully exploiting diagonal relationships.

Multiplicity versus *Unity* - Both the classic and baroque styles achieve unified compositions, but they do so by treating collections of parts differently. In the classic style parts are detailed coordinated accents. In baroque work parts are subordinated to the whole and lose their sharp individuality.

Absolute Clarity versus *Relative Clarity* - Classic art strives to present a view that is complete and lends itself to analytical viewing. In the baroque the view is not as obvious in service to a painterly presentation that invites contemplation without exhaustion.

While Wölfflin addresses a specific period in art history he implies that this framework can be applied to other times. More generally his use of dualities in stylistic analysis has been quite influential. However, the issue of what happens after the baroque has been maximized is not adequately addressed. With regard to the concerns here, he doesn't address the issue of scale as an aspect of style. And most importantly Wölfflin describes the development of style but he doesn't explain the underlying reasons *why* it happens as described.

3. Colin Martindale's Clockwork Muse

Psychologist Colin Martindale spent a lifetime applying the empirical methods of experimental psychology to the arts. Building upon and correcting previous art related psychological work, particularly that of Daniel Berlyne, Martindale has attempted to give a scientific account of the evolution of style in the arts. [9] The first principle he builds upon is the *peak shift phenomenon*.

3.1 Peak Shift

Hanson first documented peak shift response in an experiment with pigeons trained using operant conditioning. The pigeons were taught to discriminate between color stimuli, learning to peck on a key when shown one color and to ignore a second color. The pigeons were then shown color-shifted variations of the positive stimulus. One might expect the pigeon's response to fall off symmetrically with greater color-shifts in either direction. Surprisingly the pigeons showed an exaggerated response to color-shifts away from the original negative response. [10]

It is hypothesized, for example, that the evolution of the peacock's display began with a mutation that created a crude eye-like mark here or there on the male's plumage. The stimulus elicited a response from females resulting in a higher probability of mating. Given the peak shift phenomenon males with more numerous and distinct markings would fare even better in the mating game. Over a number of generations this resulted in the elaborate markings we see today.

It's possible that the gigantism we see today in new media is simply the result of the peak shift phenomenon. If a small cube made of RGB LED's is stimulating, perhaps doubling the size and number of light sources is more stimulating yet. And so we see light cubes growing from palm sized, to tabletops, to free standing sculptures, to assemblages of nearly architectural size.

3.2 Arousal Potential and Habituation

Daniel Berlyne defined *arousal potential* as a property of stimulus patterns and a measure of the capability of that stimulus to arouse the nervous system. Arousal potential has three sources; psychophysical properties such as very bright light; ecological stimuli such as survival threats like pain; and especially what Berlyne called collative effects. Collative effects are combined, comparative, context sensitive experiences such as "novelty, surprisingness, complexity, ambiguity, and puzzlingness." Numerous studies have established that observers prefer a medium degree of arousal potential avoiding over- or under-stimulation. [11, 12]

In dynamic tension with arousal potential is the phenomenon of *habituation*. Whether considered at the low level or neurology or the high level of audience response, the repetition of a stimulus results in decreasing psychological reactivity to it.

The combination of peak shift and habituation creates a dynamic such that artists will seek novelty, and over a period of years the arousal potential of works within a given style will increase monotonically. According to Martindale this is the engine that drives the evolution of style.

3.3 Martindale's Model of Stylistic Evolution

Martindale's model for the evolution of style turns on the interaction of two cognitive modes.

Secondary-process cognition is the mode of everyday waking reality. It is used for problem solving, logical deduction and induction, and deals with abstractions and analysis. Martindale calls this the *conceptual*.

Primary-process cognition is the mode of fantasy, dreams, and reverie. It is irrational, free-associative, and concrete as opposed to abstract. In its extreme forms it becomes psychosis and delirium. Martindale calls this the *primordial*.

The conceptual and primordial, however, exist on a continuum, and our moment-by-moment thoughts can modulate on this axis. For example, making mental distinctions is more conceptual, and finding similarities is more primordial.

When a new style is invented, that alone is a source of novelty. Conceptual content can be used to populate analytical elaborations of the initial style. Over time, however, the search for novelty requires what Martindale calls *regression into the primordial*. The primordial is the source of truly novel ideas and unexpected associations. As obvious associations are "used up" the primordial must be mined to new depths in the search for novelty. Once the primordial content is maximized only the invention of a new style can introduce novelty and further increases in arousal potential.

It is beyond the scope of this article to describe them in any detail, but Martindale has conducted a wide range of experiments that analyze style in the arts. Typically these studies use large bodies of historical art over long periods of time. Functional definitions of primordial and conceptual content are used to create quantitative measures of both. In addition measures for arousal potential are made. In a broad range of art forms from across the centuries these studies confirm Martindale's model.

For example, Martindale studied British poetry from 1550 to 1949. By applying textual analysis software he was able to extract time-series data as to mean word length, word frequency variation, semantic intensity, and so on. From there he was able to create a composite index that more or less reflected unpredictability or entropy. He was able to show that 71% of the variance from one 20 year period to the next was due to increasing arousal potential.

Primordial content was also found to rise over time, but the data also contained a cyclical or oscillatory signal.

> "70% of the variation is due to a monotonic uptrend. This trend is purely linear: it does not accelerate or decelerate across time. However…the means do not all fall on a straight line; the other 30% of variation is due to the quasiperiodic oscillations around the trend line. Presumably, the linear uptrend has occurred because poets needed more and more primordial cognition to think of useful word combinations. Theoretically, the oscillations indicate stylistic changes. Thus, in British poetry, primordial content does tend to decline during periods commonly seen as involving initiation of new styles - Chaucerian, Skeltonic, Tudor, Jacobean, neoclassic, preromantic, romantic, postromantic, and modern - and to rise once a new style is established." [9]

Martindale confirmed this pattern of rising arousal potential and rising yet oscillating primordial content across a number of art forms and periods including French, British, and American poetry; European and American painting; Gothic architecture; ancient art; Japanese prints; and music.

There are understandable criticisms of Martindale's approach to evolution in art style. Some complain that the theory says nothing about individual artists or works of art. Others argue that while retrospective studies can show a pattern of increasing arousal potential and increasing while oscillating primordial content, Martindale's model has no real predictive power as to where style will go in the future.

Martindale points out that just because the law of gravity says nothing about whether a falling apple is sweet or sour, that doesn't mean it's a useless law. Whatever one thinks of Martindale's model his broad range of empirical evidence cannot be ignored or easily explained away.

4. Conclusions

In Wölfflin we see what may be a single cycle contained in Martindale's model. Wölfflin begins with the classic style as a fresh presentation that can be exercised based on abstract rational principles such as linearity, stacked planes, and closed forms. Over time the style regresses into the irrational primordial baroque of painterly areas, continuous recession in depth, and open forms.

As for the gigantism now exhibited in new media, it is hard to justify as an evolution of style within Martindale's model. His evolution of style involves regression deeper and deeper into the primordial. The scaling up of new media is merely a brute-force method of increasing arousal potential. It ignores the deeper exploration of primordial content required to further develop a style and set the stage for the invention of new styles in the future.

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Philipp Röhe Hansen Schlichting

Artwork(painting-object) + paper: *“**"About a special relationship: abstract art - aesthetics - mathematics** ”*

Topic:
-abstract painting
-colour studies
-aesthetics

Author:

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References:
www.prhs2011.blogspot.com

“1to2to3” 2011 [MDF and acrylic colour, size: 1,3m x 0,8m x 0,3m]

Eye generated art:
This is a constructive art object, which is based on the aesthetic measures of human perception. In true renaissance tradition, the only phase in history that united art and science, this work of art combines empirical studies on “colour aesthetics” with form-based logical developments towards abstract painting. The result is a highly emancipated artwork, which allows the colour itself to generates form, akin to the principles of human perception.

About art and science:
Today mathematics is the language of science. The principles of nature have been non-visible since Maxwell´s research on electro-magnetics (1860). Current to this loss of visual contact to nature, art too seized being solely object-based. With the onset of these developments, art was no longer born entirely out of the visual. Rather, it took on the tendency to be born out of very essence of art as well as out of creative processes of the artist´s subconscious. This is where art and science part ways. The challenge for abstract art today lies in how to translate the “what” so into the “how” that processes and principles of painting itself became relevance.

Aesthetic and colour studies:
The relationship between colours has two important aspects. Firstly the empirical study of the physical characteristics (subtractive mixture) of colour and secondly the “aesthetic field”, i.e. the psychology of cognitive human perception. The artwork is generated from the results of these studies.

Contact: forphilipp@ googlemail.com

Keywords:
Abstract painting, aesthetic

About a special relationship:
Abstract painting – Aesthetics – Mathematics

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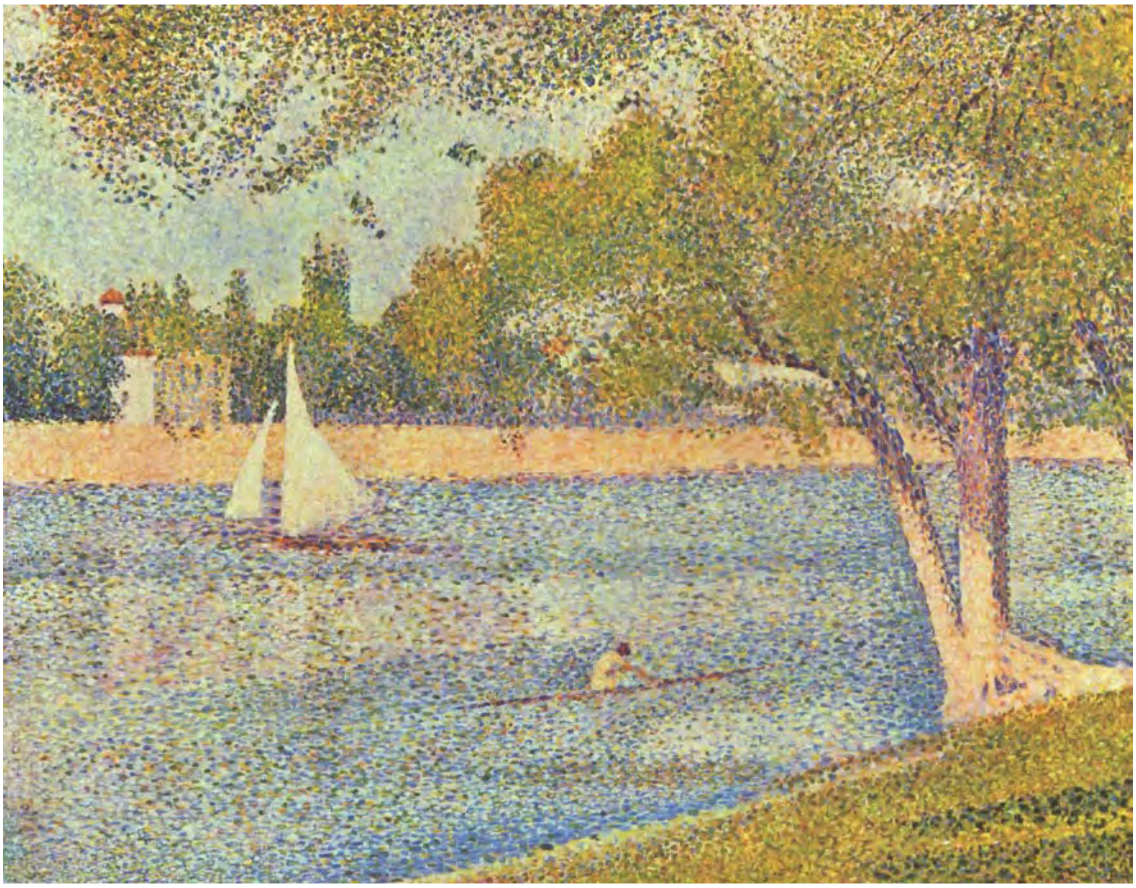
[1]

Abstract:
While Renaissance art was still in a position to unite science and art, this is no longer possible. Today, science and art are united in their search for principles in Nature. This search is taking place on a level that is no longer accessible through the human senses, on a level that represents the invisible sphere of Nature. In doing so, the search has overcome a rather naïve perception of reality. But the evolution of the process into this deeper level of perception has not been easy and called for countless new methodologies and models. It also resulted in extensive consequences for art. I will outline the consequences for abstract and conceptual painting and elucidate their specific conditions and meanings. For example, how and why does art become abstract and enter a sphere which is neither grounded in the visible material world nor is immediately tangible? And what about the "question of principle"? This discussion will be followed by a closer look at perception itself, specifically whether a form of inner "sensual regulation" makes it questionable that an abstract work of art is concurrently regarded as a mathematical formula.

Part I: A short story “peinture conceptuelle”
Nature moves out of sight – The development from the “what” to the “how” of representation – an elementary sign language – the comment next to the artwork – the principles of perception – seeing in and of itself becomes objectified.

Part II: Aesthetic views
Art as reflection – the laws of visual perception – the mindset of viewing art – geometric forms as signs – abstract art and mathematical formulas


„The Seine at Le Grande Jatte“ by George Seurat [3]

Part I :A short story of “peinture conceptuelle”
This section draws on the main ideas of Arnold Gehlens book “Period-Pictures” [2]

The first conceptual artist was Georges Seurat (1859–1891), who was one of the key representatives of pointillism. His work and thinking represent an excellent example of how an artist becomes interested in the “question of principle”, as well as the mental reasons and historical conditions that lead up to that point. In other words, his story best represents what drives an artist towards “peinture conceptuelle”.

The question first and foremost on any artist’s mind is that of motif, i.e. what should be represented in the picture?

Seurat´s pictures build an important key position between a last throes of realism and abstraction. His pointillism is still object based on the one hand (you see a landscape), but the essential element is the very way the landscape is represented. It catches everybody´s eye that the picture is built up with dots. This in turn directs the observer's attention away from the motif and towards the surface of the canvas and the method in which the paint was applied. In this way, the act of painting itself and the specific way of representation become important. In terms of definition, a painting becomes abstract as soon as natural objects make way for increasingly spiritual "objects".

This shift in observation and interest is linked to a broader cultural change, which also became palpable in science. Some marked scientific findings include:

1857 kinetic theory of gases
1858 cathode rays
1864 Maxwell – electro-magnetic theory

These breakthrough scientific events nonetheless also meant that even science lost visual contact with Nature. At the height of the Renaissance, the only phase in history that successfully united science and arts, science was still conducted on the visual level. The anatomic studies of Leonardo and Duerer's studies on proportions of the human body had been scientific studies conducted with the naked eye. With the historic events around Maxwell, the relationship between visual perception and the object that is being scientifically investigated changed fundamentally. The language of mathematics became a basic necessity while its theoretical models became non-visible.

Thus both in art, as well as in science, and almost at the same time, the natural object disappeared from immediate visibility. Concurrently, the increasing urbanisation brought about by the industrial revolution ended what had hitherto been a daily occurrence: seeing Nature.

Consequences of the natural object's disappearance

The visual loss of contact with the natural object led to a deep insecurity. While realist art was still able to claim some measure of scientific identity, this had now changed. Suddenly the eye as organ of reflection had become doubtful. Instead, optical illusion (trompe l´oil) became important and artists began contemplating the relationship between the eye and the surface of the canvas. Seurat was one of the first artists to shift perception away from the natural object and towards the surface of the canvas. From this point onwards, the focus increasingly moved towards the "how" of the painting rather than the "what", as well as the rather subjective manner of interpreting this.

What does an artwork depict when it no longer depicts natural objects?

For Seurat, the process of perception itself became an object of study. It is well known that he first studied the then current theories of perception (Helmholtz) before applying the model of the retina's receptors to the canvas by means of pointillism. A dot symbolises a receptor. The dots are thus to be understood as symbolising the scientific model of visual perception. As a result, the act of perceiving - seeing itself - becomes an integral part of the painting. As a consequence, artists now needed recognisable symbols to translate the imagined relationship towards the external world into a visually understandable language. In other words, from now on, the challenge was to find the right symbols.

In 1952, Herbert Read remarked: “Plastic art suffers from its basic illiteracy” [4] This quote highlights another problem in abstract art. The fundamental correlation for language is about the word and its subject matter. Yet if the natural object disappears from art, then art itself becomes speechless. This development began to necessitate explanations of what was depicted. It was clear that a theoretical foundation was needed. This need introduced resorting to explanatory commentary next to artwork. Manifesto, critiques and books were made public by artists from now on. A historic example is Kandinsky´s book “Über das Geistige in der Kunst”.

“*The meaning and legitimacy of the motif on the canvas were no longer discernable, but rather withdrew into the experiences, reflections and theories of the artist through the process of creating.” [5]*

The increasing focus on the surface of the canvas as opposed to the motif ascribed the surface a new individual quality. The surface itself became a stimulus. From now on, image area, colour and form had their own individual value and worth..
This opened the door for geometrical elements to enter into the works of abstract artists (Kandinsky, Malewitsch and Mondrian). But this development can also be dangerous because of its closeness to banality and decoration, from which artists needs to clearly distance themselves..

“This whole venture of a “peinture conceptuelle” is parallel to science in that the centuries-old scientific search for principles, the drive to systems and the fallback onto the elements created a scientific state of awareness which now also co-determines, developments in the arts.” [6]

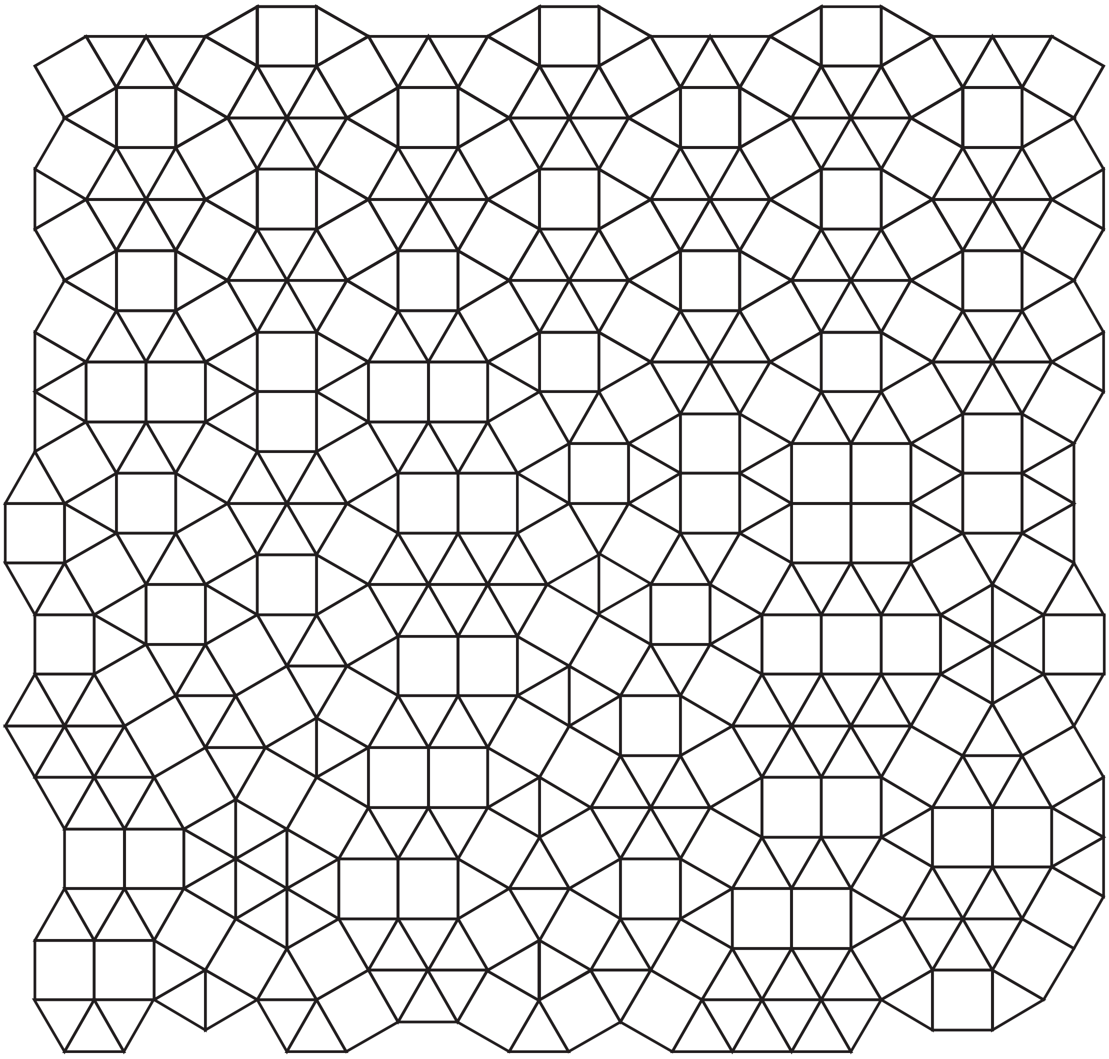
Part II: Aesthetic perspectives

The main question in the second part centres on the different levels of impact of a single work of art. Where exactly do these levels of impact lie if the work of art takes us into a speechless and wordless world, composed only of reduced symbols like colour and form? What can the spectator still identify with?

To find answers to these questions, different aspects of aesthetics need to be considered. Specifically, what type of impact does the work of art have on the spectator with respect to mental processes? This will be augmented by examining the process of perception through the lens of psychology before turning to formal aesthetics, which compares the work of art to a mathematical formula.

The shift in perception towards the surface of the canvas represents a specific challenge to the spectator. When looking at an abstract work of art, the spectator observes a visually appealing object without that object depicting anything known. The spectator at once experiences a heightened sense of visual appeal and pleasure as well as a clear sense of deceleration given that the observed image remains hinged in the mute, unseizable world of abstraction. This inner contradiction leads to a heightened state of oscillating attention, which Arnold Gehlen refers to as “perpelexion” [7] . Konrad Fiedler even goes as far as referring to artistic activity as a *“self-contained operation of the* *cognitive faculty*" [8]. The cognitive achievement of an abstract work of art lies precisely within that latent area of visibility, in which language - or any other medium - can no longer be meaningfully used. The artist's creative hand picks up where the function of the eye, i.e. seeing, ends. In this way, the artist demonstrates the principle of seeing in the painting.

The following section examines this principle. For this purpose, please have a look at the following pattern. You will see something happens automatically during the act of observation. .



[9]

"It is a basic knowledge of the classical "gestalt theory" that perception itself is a dynamic process of generating order" [10]

Wolfgang Metzler refers to the "laws of perception" [11]. These laws relate to the fact that incoming visual impulses are reduced and transformed into electric signals (bits) on retina. From the perspective of cognitive psychology, perception in and of itself is declared as a valued activity. In general, four distinct value-oriented levels can be distinguished within the process of perception:

“1.the basal-sensorial physiological level, which is also found in many animal species; 2. the species-specific genetic human hominid level; 3. the culture-specific and ethnic-oriented semantic level. The fourth level will be discussed later on. .” [12]

According to the theory of evolution, the human organs of perception developed to enable orientation in a greater environment. This means that every organ of perception (1.level) can be regarded as a developed hypothesis about the environment. Countless external data have to be selected and processed in a system-sustaining way by the senses. In this context, the human system of perception constructs the world around it while adhering to the internal laws of data selection and processing.

The term “principle of prägnanz” refers to the fact that the system of human perception resorts to its own type of orderliness. This orderliness is constitutive for the system of perception (2.level). The most important laws in regulating perception are similarity and closeness of form. In addition, the perception of colours is also guided by internal regulations, which assesses the colours, their contrasts, constancy and so on. This links to prejudices within the perceptive system, which occur on a subconscious level. In other words, independent of any cultural pre-determination, the human system of perception includes visual prejudices, and thus welcomes the use of simplified geometrical forms and pithy colouring.

The very act of perception is judgemental and accompanied by a need to identify function. It is as a result of this that all cultures across the globe exhibit a need to use culturally coded symbols as a type of formal language. The cultural-specific meaning of such symbols is generated on the 3.level of the process of perception. At this level, symbols and signs are valued arbitrarily by cultural processes. A drastic example of this is the swastika. In its pre cultural meaning the swastika conjures up a positive connotation (2.level). Yet through its use as a symbol of the Third Reich, its positive connotation was entirely destroyed.

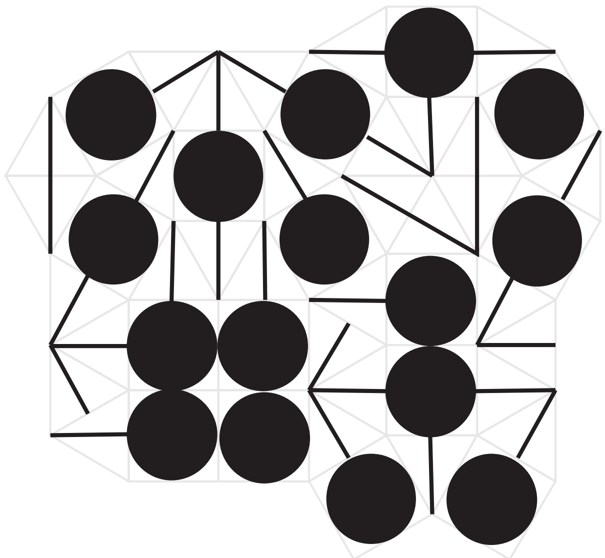
Within increasingly sophisticated societies, there is the additional level of the individual coding of symbols. Yet the more sophisticated a society is, the more the communication-related value of a symbol decreases. This is a fundamental problem in the use of symbols and signs.
As the above discussion shows, the cultural context is necessary to understand symbols. In this context, the western art-system needs to be viewed as a specific space within which specific symbols and signs are used.

In the western culture, museums are regarded as special protected areas with their own histories of significance. How do we enter a museum? What kind of mindset do we have? A text about “evolutionary aesthetics” by Karl Eibel generally points out two different mindsets of the human being.

“During the functional mode all conduct is rendered in real-time: the functional mode is essential for both survival and reproduction. The organisational mode by contrast is like an idle state of our adaptation. During the organisational mode the organism is learning and exercising.” [13]

That means information processing and inner impulses for action are decoupled. The organisational mode seems to be the biological foundation for the enjoyment of art and the artists' work. Because of this many people speak about a mode of "play", whereby the laws of gestalt and principles of perception in the world of art can be enjoyed freely and light-heartedly. Kant refers to this as "uninterested pleasure".

"Mathematics is merely one specific way of world-creation, which starts with the counting of objects and the isolating of geometrical forms and which ends with modern physical theories (quantum physics, cosmology)." Yet mathematics in combination with arts lends "structure and form to the experienced reality notwithstanding the fact that these aspects cannot be experienced by the human senses. Rather, they are models that are injected into the experience. . In short: the descriptions or models are transformed into a reality that can be experienced." [14]



[15]

Triangle (line) = 1 = white = (day) light = electricity
Square (circle) = 0 = black = (night) darkness = non electricity

Geometrical forms as symbols

Fundamentally, geometric, constructive and elementary symbol or sign languages lean towards scientific models and principles. A mathematical vocabulary of forms and signs continues in this tradition and thus seems to be an ideal tool for planning the composition of a painting.

Nearing the end, there is a need to return to the question of what exactly an abstract work of art is able to represent. The previous section highlighted a specific identification with the internal processing of data, and an anthropogenic disposition towards the enjoyment of art. . This section aims to shed light on the types of symbols that an abstract work of art depicts.

For this purpose, "formal aesthetics" by Lambert Wiesing will be used together with a phenomenological perspective towards abstract art. Such a perspective emphasizes the artwork’s character value, as well as its referential character.

The particularities of elementary symbol or sign language lie in the fact that it is both non-verbal and non-cultural. As a result, a certain “openness” exists towards the symbol itself. In other words, the classical phenomenological assignment of two possibilities of reference to a symbol is not enough to make up an abstract work of art. In the classical phenomenological tradition, the artwork would have to clearly reference another object or another sign. Yet this is not the case. There is no object anymore because of the represented principles of perception and there is no distinct reference to another symbol. To overcome this dilemma, Charles William Morris (1901-1979) developed his theory of sings. He compares an abstract artwork to a mathematical formula as a special character due to its self-referential character.

“The formula itself is part of that which it symbolises as a whole.” [16]

This represents a status of semantic uncertainty, given that there is neither no reference nor is there a distinct one. A mathematical formula works with variables and its essential aspect centres on the relationship between the mathematical elements. It functions by placing a priority upon the variable and their relationship to each other and emphasize the relationship rather than the individual variables.

“The human eye owns a large treasure of formulas, which are used to process information it receives. In this way, it generates perception which is pleasing as long as the input has been processed in its entirety by any of the formulas. ” [17]

In conclusion, an abstract painting works like a mathematical formula. It refers to an imaginary and a relational space. It acts as concretely sensuous embodiment of a difficult-to-imagine principle. The invisible levels of seeing become visible in this way. The work of art becomes a visual depiction of sensual logic.
As artist I am interested in researching, working and understanding this “sensual logic”. At the end it becomes a question of attitude towards yourself.

To keep in touch and updated on this work in progress, visit by blog at www.prhs2011.blogspot.com I look forward to hearing from you.

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Robert Spahr

Paper: **Toward a Pedagogy of Generative Art**

Abstract:
In the Spring of 2011, I developed and taught a course in generative art within the New Media track of the Cinema curriculum at my university. The students ranged from junior and senior undergraduates in cinema, as well as interdisciplinary MFA and PHD graduate students.

Because of the range of students, this course introduced concepts of generative and algorithmic art through historical examples such as Dada, Happenings, Fluxus, Systems Esthetics, and Conceptual art. Students were encouraged to investigate art created by simple sets of rules, chance operations, genetic algorithms, cellular automata and generative processes found in nature.

Students with no previous programming experience were exposed to the creative possibilities of computational art using HTML, Javascript, Processing and Arduino hardware. The class explored issues of new media, such as modularity, automation, and variability, as well as the creative possibilities of the computer interface, computer operations, and the database.

Through creating generative art, students began to question previous assumptions about originality, creativity, and craft, as well as the role of the artist within the creative process. This course helped students expand their current art practice to include generative processes while further exploring and developing their personal artistic voice.

Topic: Pedagogy of Generative Art

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Cory Fehrenbacher interacting with sound and image glitch, made by Nichole Nicholson and Sam Sloan, in the class Generative Art, 2011

References:
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Keywords:
Generative Art, Algorithmic art, process, teaching, student work

Toward a Pedagogy of Generative Art

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1. Abstract

Abstract:
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2. Background: Developing My Own Generative Art Processes

“I can't understand why people are frightened of new ideas. I'm frightened of the old ones.” [1] - John Cage

In this paper I will briefly outline my own development as an artist and the current generative art I produce, followed by a description of the cinema curriculum at the university where I teach, and how I then developed a course in generative art.

My evolution as an artist followed a path that began in a visual art tradition of post-minimalist sculpture. At this time I was making objects out of wood, plaster, tar and wax that embraced random occurances from the materials themselves. Soon after I read the essay *The Work of Art in the Age of Mechanical Reproduction*, by Walter Benjamin [2], my work opened up to installation and performance that contained objects, images, smells and processes that I set into motion, yet had an autonomy independent of me as the artist. I felt it was now possible for me to create work from potentially any materials, with an emphasis on duration and random processes.

Fluids, Feb 26, 1994

2.1 Technical Skills, Computational Art and Generative Processes

In the late 1990's in New York City, I participated in the dot com bubble as a web developer and designer. My technical skills included basic computer programming that I then began to include in my art practice. Two almost simultaneous events were the catalyst for my current series of generative art works. The dot com bubble burst, quickly followed by the attacks on the World Trade Center on September 11th, 2001.

I became frustrated with the way the main stream media was presenting ideas and images that affected our world view. The ever present cable news cycle pushes a daily message of fear, filled with political polarization; domestic and foreign terrorism; recent kidnapped white girls; celebrity scandals; and the imminent threat of hurricane, earthquake or flood. I began to think about how these digital images and text operated, one day influencing our daily discourse, the next day vanishing without a trace. Digital leftovers reminded me of redundant computer programming. Code that was once useful, but later forgotten and obsolete.

Since 2003, I have borrowed the computer hacker term 'Cruft', defined as an unpleasant substance; excess; superfluous junk; and redundant or superseded computer code. [3] To create this work I call CRUFT, I write simple algorithms that an automated computer system follows. The instructions outline what websites to target, and the stystem then downloads selected images and text which are then used as source material, and remixed to create new artwork on a schedule that imitates the 24 hour cable news cycle.

2.2 Recent Cruft Images

Hourly Cruft (2003-present) http://www.robertspahr.com/work/hourly/

This cruft algorithm extracts images from the NYtimes home page once every hour. The images from this page are then manipulated to generate the three panel overlapping "cruft." Over time the changes or lack of change seen in the crufts reflect the news cycle of the NYtimes.com site.

Load (Limbaugh) Cruft (2010-present) http://www.robertspahr.com/work/load/

This Load Cruft is the result of my consuming and digesting the words of Rush Limbaugh as well as the associated images offered up by the Internet. This algorithm begins by downloading daily quotes from Limbaugh's talk radio show, and passing his individual words as search terms into Altavista Image Search. The results are processed using a genetic algorithm, creating a daily cruft of incendiary text and image. downloading digital leftovers as source material to then be remixed into a collaged composite.

3. Challenges: Generative Art & New Media in a Cinema Curriculum

One of the challenges I first had when I was hired to teach new media at Southern Illinois University Carbondale, was to figure out how new media would work within a tradtional cinema curriculum. The students learned basic narrative, documentary and experimental filmmaking using 8mm and 16mm film stock, as well as digital video and HD video. The Cinema and Photography department has an equal amount of faculty teaching studies courses and production courses. I looked to the writings of Lev Manovich, and specifically his book *The Language of New Media*, [4] as a guide in thinking about new media as an extension of the language of cinema.

I quickly developed a course called *New Media Production* [5] and a companion studies course called *History of New Media*. [6] These two newly created courses followed the curriculum structure of tracks of study consisting of a studies course and a production course. Now students could choose several tracks either in narrative, documentary, experimental and new media. The curriculum also had a more general course listing called 'Experimental Strategies.' Each time this course was offered, the specific topic would change depending on the faculty member teaching it. This is where my generative art course fit within the cinema curriculum. In that gap between experimental filmmaking, and the study of new media.

3.1 Generative Art Course

My course called *Generative Art* [7] needed to serve a large and varied population of students within our college of Mass Communication and Media Arts. In the spring of 2011, I developed and taught a course in generative art. The students ranged from junior and senior undergraduates in cinema and photography, as well as interdisciplinary MFA and PHD graduate students.

Each student was coming to the class with a variety of technical skills. Many of the graduate students were well on their way in developing their own artistic voice, compared to some of the undergraduate students who had only just begun the journey. So I created a course introducing generative art in a way that would appeal to this broad range of students. As a group we discussed generative art, and for the purposes of the course, accepted the following definition:

“Generative Art can be defined as any analog or digital art practice, that incorporates instruction-based, mechanical, organic, computer-controlled, and/or other external, random, or semi-random processes and/or apparatuses directly into the creative process, which is then set to motion with some degree of autonomy contributing to or resulting in a work of art.”

Most of my students came to the class thinking of themselves as either filmmakers or photographers. I worked to create a culture where they could safely experiment, explore, and develop as artists. The course was arranged for them to make two individual projects, and one collaborative exhibition. In fact what happened was that I had the student create weekly experiments. I described them as sketches. Creating the quantity of work; weekly explorations, greatly increased the quality of work. It became a matter of discussion as to where does a weekly exploration end, and where does a 'finished' piece begin.

3.2 Course Topics and Objectives

Topics

- Chance / Randomness / Systems
- Computational Art (Processing and Arduino)
- Dada, Happenings, Conceptual Art, Minimalism, and Fluxus Art
- Art Practices / Open vs Closed / Centralized vs. Decentralized Networks
- Cellular Automata / Conway's Life
- Genetic Algorithms

Objectives

- Develop an understanding of algorithmic art
- Explore and develop their own artistic voice
- Identify historical precedents and artists using generative processes
- Understand the role of simple recipes and computer code, as well as random processes to discover new artistic form and expression

Students were exposed to the history and current practice of generative art, and to consider the use of chance and automation, which brings into question assumptions about originality, creativity and craft, as well as the role of the artist within the creative process. The students explored issues of new media, such as modularity, automation, and variability, as well as the creative possiblities of the computer interface, computer operations, and the database. This course was taught as a production/studio class, but was combined with critical readings and discussion.

4. Examples: Selected Student Work of the Generative Art Class

Cory Fehrenbacher interacting with sound and image glitch, made by Nichole Nicholson and Sam Sloan, in the class Generative Art, 2011

Exhibit of Generative Net.Art, in the class Generative Art, 2011

Exhibit of Generative Documentation, in the class Generative Art, 2011

Work by Patrick Mulcrone, Ana Paula, Adrienne Foster and Danielle Williamson, in the class Generative Art, 2011

Cory Fehrenbacher and Deron Williams, in the class Generative Art, 2011

5. Conclusion: The Role of Generative Art in a Cinema Curriculum

Generative Art allowed the students to explore new techniques and media such as installation, performance, and computer code. This freedom and exploration, as well as forcing them to work quickly with very little self-consciousness; to consider their role as the artist and the context of interactivity, the viewer and where the work will be seen; allowed them to develop a body of work that has since influenced their other media-making. Many of these students are cinema and photography majors, and the ideas in this course have since influenced them as artists, becoming a permanent part of their creative vocabulary and process.

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Ryuji Takaki

Paper: **EDUCATIONAL SYSTEM OF SCIENCE ART FOR STUDENTS OF ART AND DESIGN**

Topic: Teaching Theory of Science Art

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Abstract:
The science art is defined here as a kind of art created with strong scientific mind. There are two kinds of science art; one is an art created with a scientific method which is being developed, and the other is an art expressing a scientific concept. The generative art occupies the major part of the first kind.
The present author, after the career of many years as a physicist, began in 2004 to establish an educational system of science art for graduate students of art and design at Kobe Design University, Japan.
In my course of the University students observe natural (physical, chemical and biological) phenomena or their simulations with brief introductions of their mechanisms. After that they are encouraged to create artworks based on their impressions which they have had during the observation. Although they have no training of scientific activity, they are eager to observe real phenomena, and try to create artworks based on what they have felt in the observation. The important point in developing this educational system is to choose suitable natural phenomena.
In the presentation of this paper total system of the education is introduced, and some examples of artworks created with definite algorithms are shown (see figures below). Although students follow processes of the algorithms, they prefer deforming their results or combining them with other images by arbitrary manipulations.
The present author believes that the artworks created by algorithms, which simulate natural phenomena, should be attractive in principle, because we have grown up while observing natural phenomena around us. Therefore, it is a good strategy to apply such algorithms to production of art and design.



Left: Relief of snow crystal by N. Nagahama (2007), created by following an algorithm of crystal growth mechanism.
Middle: Rheo-art by S. Tomioka (1998), which shows deformation of a spherical dyed part in a viscous fluid owing to two rotating cylinders. The deformed part is expressed as a transparent material with ray-tracing.
Right: River branching system by T. Yamashita (2007), created by die throwing and merging principle of streams.

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Keywords: science art, simulation of nature, educational system

Educational System of Science Art for Students of Art and Design

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Abstract

The author's trial to establish an educational system of art and design based on scientific experiences of students is introduced. The basic concept of this system is that our senses of beauty and preference are constructed through observing the nature from childhood, hence a good strategy for creative activities will be developed by applying mechanisms of natural phenomena. In this paper the framework of this educational system is explained briefly, and some examples of particular topics are illustrated with students' works as outcomes of this system. In addition a recent trial of creating animation movie is introduced, which is created by the use of natural signals extracted from video image of natural scene. A question is put in the last section on what an attractive art is.

1. Introduction

The term "science art" is defined in this paper as an art which is created with a scientific mind. It is realized in the two cases, first when an art is produced with a method which is newly developed by the artist, secondly when the art expresses a scientific concept clearly. It is noted here that development of a new method necessarily stimulates a scientific mind and affects the content of the art.

Fig.1 Garden design by N.Nagahama (2007), and "The Persistence of Memory"

An example of the first category is shown in Fig.1 left, which is a model of garden by a teacher of garden design at Kobe Design University. He drew a set of sunflower spirals exactly according to a certain algorithm and applied it to this design. A good example of the second category would be the painting by Salvador Dali, “The Persistence of Memory” (Fig. 1 right, sketch by Takaki). It is believed that Dali expressed his idea about the relativity theory.

The present author, after a long career as a physicist, began in 2004 to establish an educational method of the science art for students of art and design. Although the students are not familiar to mathematics or scientific thinking, they are eager to observe natural phenomena and to express their impressions as art and design works. Based on this experience the present author began to have an idea about the relation between the science and the art, as explained below.

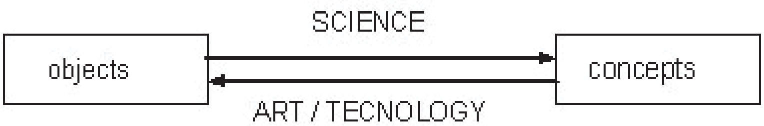

Fig. 2 Relation between the science and the art/technology.

Both science and art (including design) are products of human activity, and make a bridge between real objects and concepts. Here, the concepts mean what appear in human brain, such as natural laws, social needs and personal desires. The role of science is to make up concepts about nature, while the role of art and design is to produce real objects based on the concepts. Technologies belong to the side of art, because their roles are to produce useful objects based on scientific concepts. Thus, the major difference between science and art is that of the directions of creation processes, as shown in Fig. 2.

In the course of education students have experiences of both these directions. They observe natural objects and phenomena and study basic mechanisms of those phenomena, so that they can have some concepts about the nature, then they are encouraged to create artworks as home works according to these concepts. The topics treated in this course are classified into five groups arranged as a hierarchy shown in Fig. 3. Each topic is associated with a lecture, workshops of observation of phenomena or hand works to understand mechanisms of phenomena within three hours.

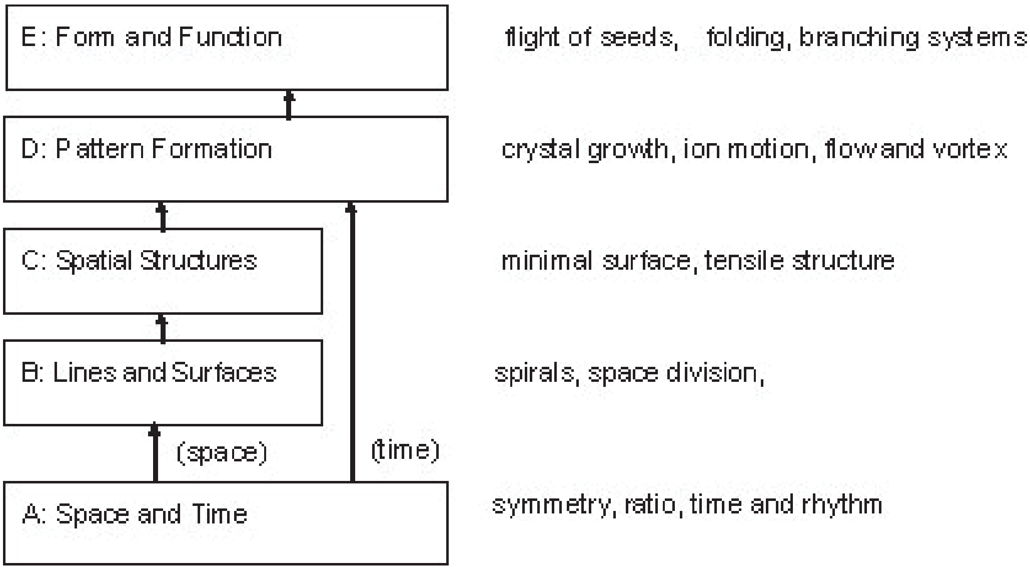

Fig. 3 Framework of the educational system of science art with topics

Results of this activity were reported in an international meeting called ISIS Symmetry [1], and also introduced in a monograph published in Ukraine [2]. An English report of the course was issued from Kobe Design University in 2006 [3]. In the following sections three examples of topics are explained, and some results of students' activities are shown.

2. Topic: Growth of snow crystal

The snow crystals grow slowly from small seeds. The variety of their shapes is understood by the so-called Kobayashi diagram (Fig. 4), which determines one growth mode according to the climate condition, i.e. the temperature and the humidity (degree of over-saturation of vapour). This diagram is an improved version of the Nakaya diagram, and Dr. U. Nakaya was a Japanese scientist who produced a snow crystal in the laboratory first in the world. While a snow flake falls down, it encounters variety of the climates, hence the flake grows at each stage with respective growth mode.

In the class, after introduction of the mechanism of crystal growth, students have a workshop to draw a snow crystal by pencil on a sheet of section paper with oblique grid lines. They make snow crystals grow on the section paper according to a fixed rule, which is a simplification of the real growth mechanism.

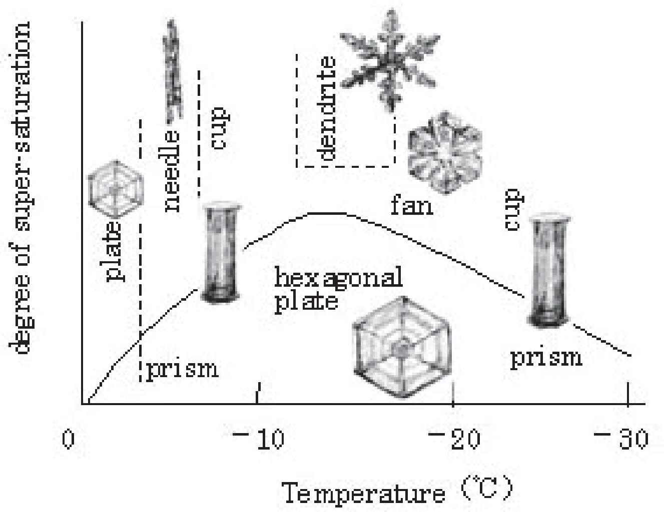

Fig. 4 Kobayashi diagram for growth of snow crystal. The growth mode depends on the temperature and the degree of super-saturation (sketches by Takaki)

This rule is composed of the three types of growth modes, the hexagonal growth and two kinds of dendrite growth. At each time step students throw a dye and choose one of the three growth modes, which is a modelling of the situation that a falling snow flake meets various climates randomly. According to the dice they add small growing parts in the following way:

(1) Hexagonal plate mode: add a layer of outer envelope around the crystal. Note that the crystal shape asymptotes to a hexagon If this process is repeated.
(2) Simple dendrite mode: the ends of all branches are extended by a certain length.
(3) Complex dendrite mode: the ends of all branches are extended by a certain length and new side branches are added.

An example of resulting crystal shapes is shown in Fig. 5(a). This crystal began with a hexagonal plate, then made a simple dendrite growth and finally made a complex dendrite growth. Owing to the simplified rule this crystal shape is not very realistic, but students can understand how various shapes appear in the nature. An exhibition is made at the end of each semester, where group works including those of crystal growth are exhibited. Two of such works are shown in Fig. 5(b), (c).

The mechanism of crystal growth is a good topic for students to become familiar to natural phenomena, because the mechanism of crystal formation is understood easily through the growth algorithm given above. Moreover, they can enjoy producing crystal shapes not arbitrary way but with a fixed algorithm.

(a) (b) (c)

Fig. 5 Examples of produced snow crystals. (a) Pencil drawing by K. Ishida (2005), (b) oil painting by H. Wang and C.-N. Chang (2005), (c) crystals pasted on a plastic plate by J. Xu. et al (2006)

3. Topic: Rheo-art - chaotic pattern in viscous flow

The chaotic behaviour of viscous fluid under a shearing motion is discussed by many scientists in physics and fluid dynamics. It is a deterministic flow showing chaotic nature and is different from the turbulence containing randomness. Good introductions of this phenomenon are given by a monograph and a review by Ottino [4, 5]. The present author has been interested in this phenomenon because he considers that it might be a powerful method for creation of artworks. Based on this idea he made some researches and published a few papers [6, 7]. The following example illustrates the process of chaos formation in a viscous fluid.

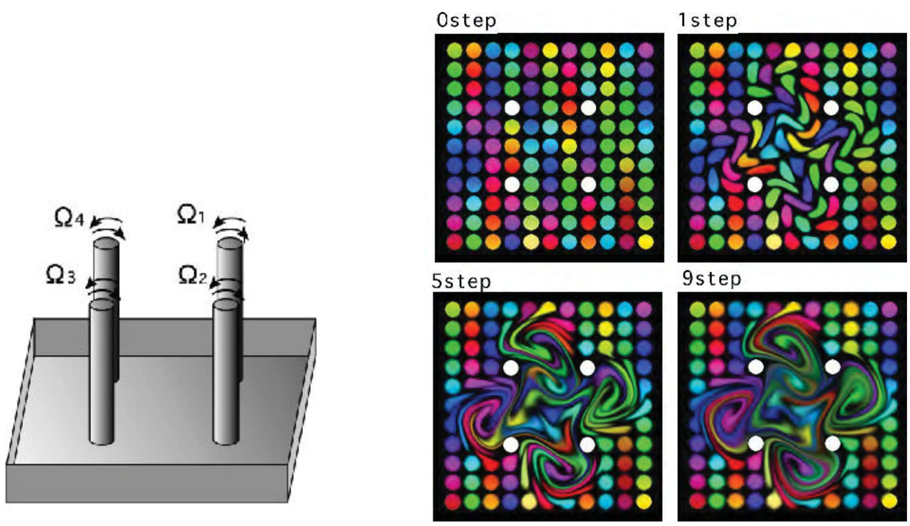

Fig. 6 Mixing chaos in the two-dimensional case. Right: Rotations of four cylinders, left: deformations of dyed parts after several steps of cylinder rotations.

Suppose four cylinders are inserted vertically and given rotations with angles Ω_1-Ω_4, not simultaneously but in turn as shown in Fig. 6(a). The rotation of cylinder produces a fluid motion around the cylinder with speed inversely proportional to the distance from the cylinder. After rotations of four cylinders, they are given rotations in turn in the opposite directions with the same angles as before. These processes as a whole result in mixing the fluid, which is called 1 step of mixing. In order to visualize this mixing, many parts of the viscous fluid have been dyed beforehand with various colours, as shown in Fig. 6(b) upper-left (0-step), where the four white circles are not dyed parts but the cylinders. Deformations of the dyed parts were obtained by computer for the case $\Omega_1=\Omega_2=\Omega_3=\Omega_4=180°$ as shown in Fig. 6(b). Since these deformations are not random but deterministic, this phenomenon is called a mixing chaos. Repetition of this mixing process produces more complicated patterns. Note that arbitrary paintings by artists can not create this kind of patterns.

This process is possible also in the three-dimensional configuration of cylinders. Let two cylinders be placed in a twisted configuration as shown in Fig. 7(a). They were rotated with the same angle 180° (opposite rotations are not given). Then, a spherical part of the fluid between the two cylinders deforms at each step, as shown in Fig. 7(b). A solid model of the three-dimensional shape at 9-step was produced by a sculptor, as shown in the left of Fig. 7(c). At that time he did not like this model. Therefore, the author asked him to produce one more model by deforming the shape at 9-step arbitrarily, which is shown in the right of Fig. 7(c).

(a) (b) (c)

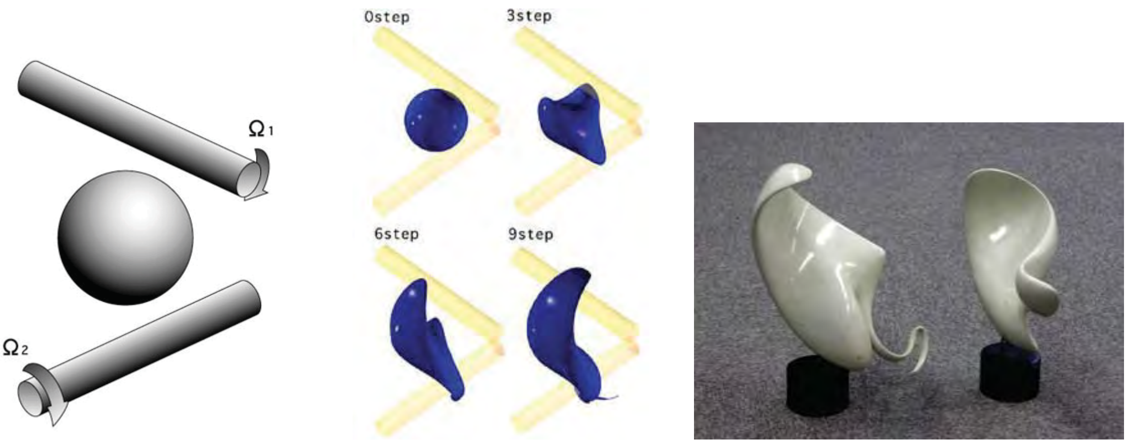

Fig. 7 Mixing chaos in the three-dimensional case. (a) Configuration of two cylinders, (b) deformations of dyed part at the 0, 3, 6, and 9-steps, (c) left: solid model of the 9-step, right: solid model by a sculptor with arbitrary deformation of the 9-step.

It is interesting to compare these two solid models. The left is a shape faithful to calculation (i.e. a generative art), while the right includes arbitrariness just as in traditional arts. The present author often showed both of these to students in the university class and audiences in conferences, and asked them which they liked better. In most cases they liked the right one. However, the fraction of those supporting the left is recently increasing.

One can point out two fundamental differences between these models. First, the left one has a shape of developable surface, while the right one has a shape like a spherical surface. Secondly, the thickness of the surface of the left one decreases monotonically as approaching to the edge, while the right one has swelling parts near the edge. These properties in the right one are seen at many parts in human body, which might be a reason why people like the right one. At the same time the recent tendency towards the left one might show an interest in non-humanistic objects.

Recently, a group including the present author produced a simple computer program to create arts of chaotic mixing in two-dimensional space and used it in the workshop for students of Kobe design University. Students prepare images and operate the program by arranging cylinders and giving angles of their rotations. Some examples of students' works are shown in Fig. 8.

Fig. 8 Rheo-arts by cylinder rotations inserted into a viscous fluid. Left: by T. Zhou (2006), middle: by N. Endo (2007), right: M Liu (2006). The program is developed by S. Sasada, K. Ishigaki and R. Takaki in 2004.

4. Topic: Computer animations by the use of natural signals

The natural signals, such as sounds from water waves coming to the coast, often have the so-called 1/f spectrum, i.e. the intensity is inversely proportional to the frequency f. This type of spectrum is considered to have a healing effect. Then, there is a possibility that computer animations become more attractive, if the objects in the animation are given motions which are determined by the use of natural signals. This idea was pursued by the present author and his collaborators, and some results were presented at an international meeting in 2010 [8].

In the university course, however, the creation of animation is not made, because it takes much time and needs a special technique. Instead of that students are asked to obtain spectra of images, such as natural sceneries and human bodies, which students choose arbitrarily. The images are scanned in the horizontal direction and changed to one-dimensional signals, from which spectra are obtained by a computer program. This program is produced by an author's colleague, K. Ouchi. This activity belongs to the topic "rhythm" in the framework shown in Fig. 3. Two examples of images and spectra are shown in Fig. 9.

(a)

(b)

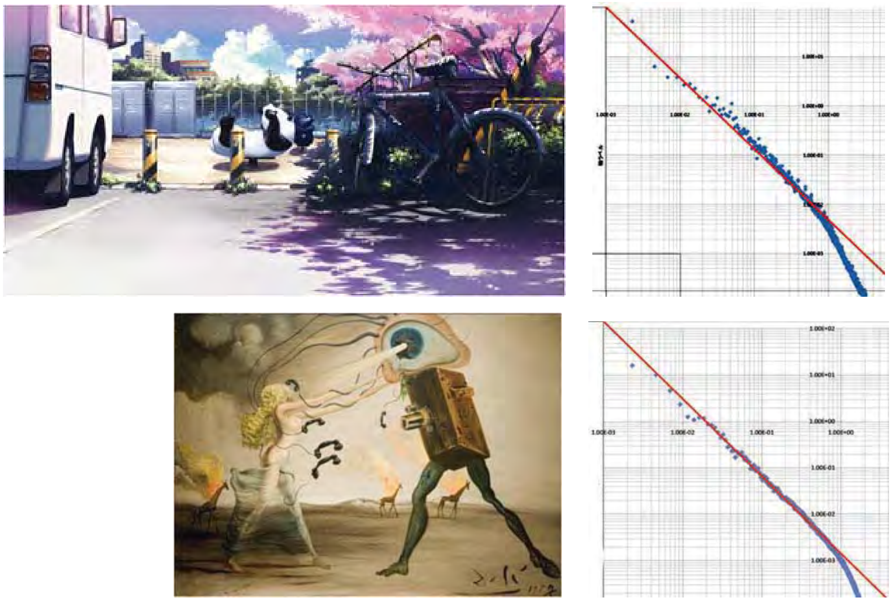

Fig. 9 Images and spectra (plotted in logarithmic scales) obtained by students. (a) A scene in the town and its spectrum ($1/f^{1.43}$) by M. Urbanowicz (2011), (b) a graphic of two characters and its spectrum ($1/f^{1.59}$) by Soraya (2011)

Both of these examples have spectra of $1/f^{n}$. This type of spectra means that the images contain high frequency noise, but it intensity decreases rapidly with frequency. Through this workshop students are expected to understand the meaning of spectra obtained from images. After that we show them the animations created by the use of natural signals.

The method to produce the animation is shown in Fig. 10. Before producing an animation, a video movie of natural scene are obtained, such as the waves near coast or the shaking of branches in the wind. It is also possible to catch a natural scene while producing the animation. Next, characters or objects to appear in the animation are produced by hand or CG, and are input into computer. Their initial positions in the 3D space are given randomly.

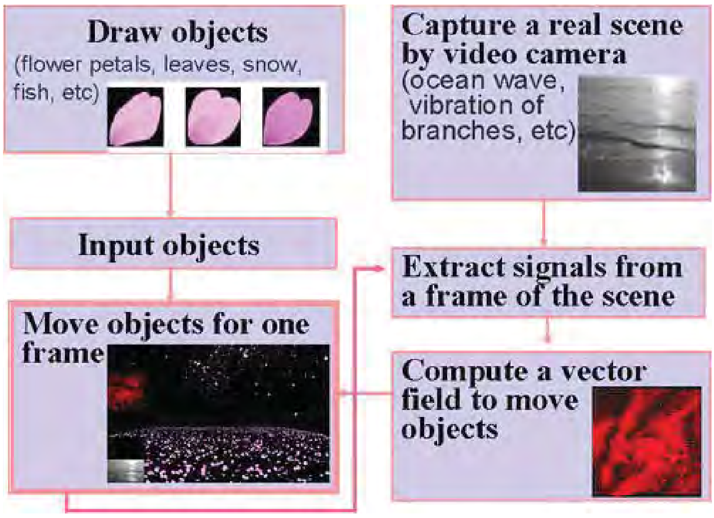

Fig. 10 Flowchart of production of animation. A vector field to drive objects is constructed based on one frame of a movie of natural scene within 1/30 second.

In creating animation the motions of objects in each frame are determined by a 3D vector field, which is constructed from each frame of a movie of natural scene. The 3D vector field is constructed in a clever way from 2D movie frame in real time, i.e. within 1/30 second.

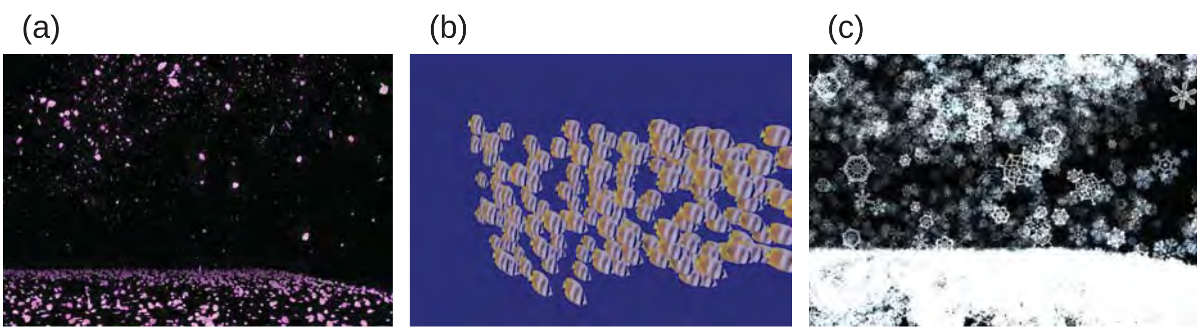

Fig. 11 Shots from computer animations of (from left to right) fall of cherry petals, swimming of fish and snow fall.

Some shots of produced animations are shown in Fig. 11. Figure 11(a) shows a scene of fall of cherry petals, where each petal has fluctuations of speed and direction in 3D space. These fluctuations are controlled by a video movie of waves at a sea shore. Figure 11(b) is a scene of swimming of fish, where their directions and speeds of swimming are uniform but they fluctuate with time. These fluctuations are controlled by a video movie of shaking tree branches in the wind. Figure 11(c) is a scene of falling snow flakes, whose motions are controlled by a video movie of water waves. In this animation, the falling objects can be chosen from two options, realistic snow flakes and hexagonal crystals (the latter is shown in Fig. 11(c)), by pushing the space bar of computer while producing the animation.

The present author had several chances to show these animations in the university classes and conferences. People seemed to be impressed by the animations. The reason is considered to exist in the process of producing animations, i.e. to use natural signals in controlling motions of objects.

(a)

(b)

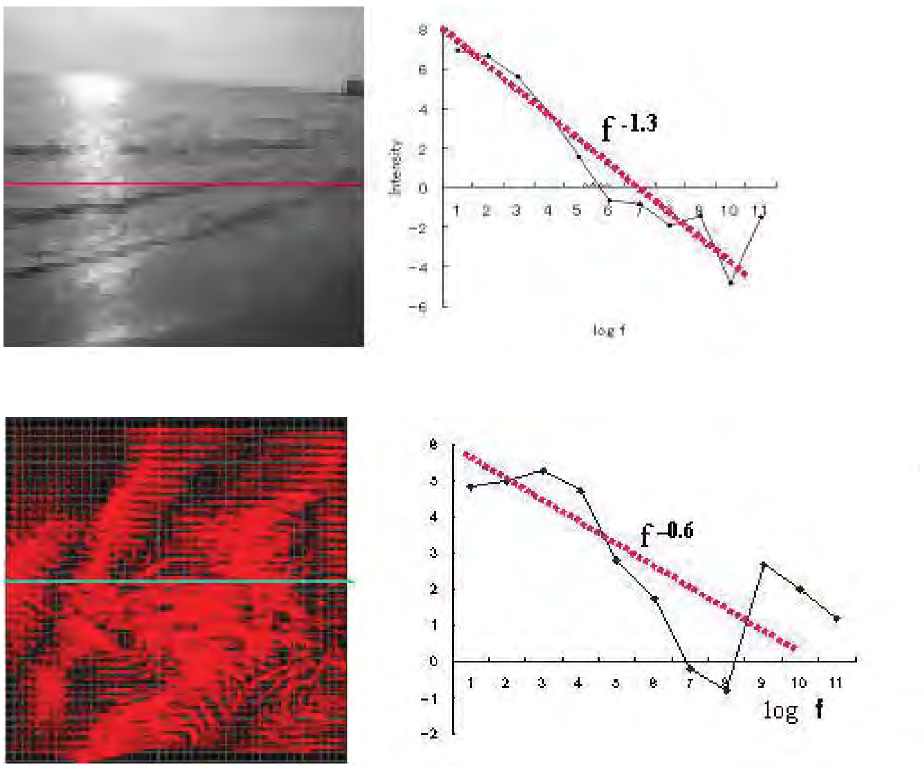

Fig. 12 (a) Image of natural scene (water waves) and its spectrum of signal on a horizontal line, (b) a vector field obtained from the natural signal and its spectrum.

Fig. 12(a) shows one shot of water waves and a spectrum (shown in logarithmic scales) of the brightness signal on a horizontal line at the central level (a line in the image). It has a spectrum type of $1/f^n$. Fig. 12(b) shows one shot of vector field constituted from an image of water waves, whose spectrum of horizontal components of vectors on a horizontal line seems to have also the type of $1/f^n$. Although these spectrum curves deviate from the simple $1/f^n$ type, it will converge to this type if spectra along many horizontal lines in these images are averaged.

In conclusion, the use of natural signals to control motions of characters or objects is considered to be a powerful method in order to produce animations which look quite natural and give strong impression to observers. However, this method is yet not developed enough, and the present author welcomes the offers of cooperative work.

5. Concluding remarks

In this paper some results of the trial to construct an educational system are reported, along with works of students and the present author. Here, a comment is given on the problem of “What is art?” In section 1 it is claimed that the art is an expression of a concept as a real object. Hence, everything produced by humans can be an art, if it is an outcome of some concept. Then, a meaningful question for fruitful discussion is not “What is art?”, but is “How an attractive art is created?” This question is almost equivalent to “What kind of objects or phenomena is attractive for humans?”

Most of humans have grown up while absorbing much from natural and social environments. Experiences in these environments should have affected in forming their senses of beauty. Then, the arts created by methods or algorithms which match to these experiences should be attractive. It was a motivation of the present author to produce an animation movie based on natural signals. However, there will be many other ways to create attractive arts. It seems to be the most important question for the present author what kinds of methods or algorithms match to experiences in our lives. The present author would like to hear opinions from others who are conscious of this kind of problem.

The present author would like to express his thanks to the organizer of GA2011 for inviting him to this meeting, and to the collaborators, especially Mr. S. Sasada, Mr. K. Ishigaki and Dr. K. Ouchi. He also thanks to students in my course for their cooperation with establishing this educational system.

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Tatsuo Unemi

Paper: **SBArt4 as Automatic Art and Live Performance Tool**

Topic: Visual art

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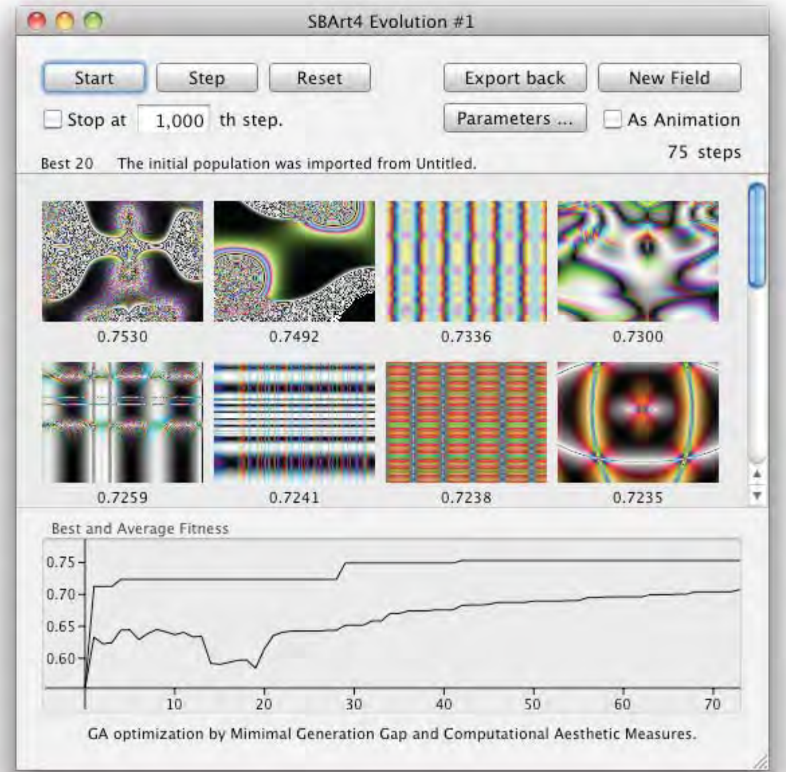
Abstract:
SBArt4 is originally a breeding tool to produce abstract images and animations [1]. This paper describes a newly implemented functionality of automated evolution using some types of computational aesthetic measures as fitness criteria. Measures include information complexity, global contrast factor, histogram of color distribution, and so on. In addition to these measures for a still image, a method to evaluate the motion was introduced. They are useful to discard boring pieces but do not always fit with human user's preference.
I introduced graphical user interface to allow the user to adjust the balance among different measures, and provided methods to let individuals migrate between a field for breeding and a population for evolution. It realized a wide range of intermediate production style between pure breeding and fully automated evolution.
Utilizing parallel processing, efficient algorithms, and synchronized sound effects, a new generative style of both live performance and fully automatic art became possible to be realized.



A sample shot of monitor window of evolutionary process.

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Keywords:
Evolutionary art, abstract animation, aesthetic measures

SBArt4 as Automatic Art and Live Performance Tool

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Premise

SBART [1] is originally a tool to produce abstract images and animations by means of interactive evolutionary computation [2]. Through a number of revisions since 1993 following the innovations of both hardware and software, it was equipped with capability for real-time breeding of animations [3]. This paper describes a newly implemented functionality of automated evolution using some types of computational aesthetic measures [4] as fitness criteria. Measures include information complexity, global contrast factor, histogram of colour distribution, and so on. In addition to these measures for a still image, a method to evaluate the motion was introduced. They are useful to discard boring pieces but do not always fit with human user’s preference.

A graphical user interface was designed to allow the user to adjust the balance among different measures, and provided methods to let individuals migrate between a field for breeding and a population for evolution. It realized a wide range of intermediate production style between pure breeding and fully automated evolution. Utilizing parallel processing, efficient algorithms, and synchronized sound effects, a new generative style of both live performance and fully automatic art became possible to be realized.

1. Breeding Real-time Animations – Overview

SBART is one of derivative systems from K. Sims’s Artificial Evolution in 1991 [5] that uses functional expression as a genotype to determine the colour of each pixel in a rectangular area. The phenotype is the image constructed by these pixels that the user evaluates and selects as a parent to produce individuals for the next generation.

The first release of SBART was in 1994 on UNIX workstations utilizing Motif GUI gadgets and X window system, and has been extended and migrated to MacOS 8, MacOS X on Power PC, and then MacOS X on Intel CPU. A number of features have been examined and added through these 17 years. One of the unique features in SBART is that it uses a vector of three elements as a value in any point in calculation. Some of the non-terminal symbols for functional expression on genotype calculate the value of each element in vectors independently, but the others mix the values to reconstruct the result value. The terminal symbols are also vectors. A variable is a permutation of three scalar variables, x, y and t, that express the coordinate of the pixel in 2D space and time. The other unique features include multi-field user interface, some alternative drawing modes of deformation and discoloration for external image data, synchronized sound effects for animation, and so on.

The most recent innovation is automated evolution combined with real time breeding of animations. Thanks to the recent progress of GPU technology, it became possible to draw 15-30 images within one second. To draw an image in a rectangular area, it requires computational time proportional to the number of pixels in the image and the number of elemental functions in the genotype. Because the genotype is the object for mutation and crossover, it is represented in a data structure in the memory. It is not technically impossible but difficult to develop a mechanism of so called on-line compiler for each functional expression in genotype under ordinary programming environment of C, C++, and Objective-C languages.

To take an advantage of GPU that originally developed to accelerate calculation for 3D polygon graphics, the shading language is suitable for our purpose. A graphics library OpenGL accompanying with a GPU vender's extension includes the compiler of a programming language GLSL that has similar syntax of C language, and it compiles the program text in the memory into the machine code for GPU. This means that any application software can utilize the power of GPU by only prepare its aiming procedure in GLSL to rely on the compiler. The newest version of SBART compiles the genotype into Core Image Kernel Language, a subset of GLSL provided by Apple as a part of Core Image framework. Program fragments run on the processing elements in GPU in parallel for each pixel. The number of pixels it calculates at same time is depends on the capacity of GPU, but all of Apple's personal computers released in these three years have capability to draw smooth animations in real time.

2. Automated Evolution

The criteria for artistic production should fundamentally be under subjective judgement of each individual person, but it's also the fact that there are sharable measures among people for interestingness of any pieces. Some of the challenges of computational aesthetic measures are to find such criteria to evaluate and select better images from digitized pictures and paintings.

The aesthetic evaluation done by human is fundamentally driven by the cognitive system of individual person, of which functionality is strongly depending on the personal experiences under the cultural background. To implement such type of functions in the computer, it is necessary to use a type of learning mechanisms to adapt to a variation among persons and changes through the time in an individual person. Some researchers are trying to embed such adaptability utilizing algorithms of artificial neural networks, for example in [5]. However, we avoid such an adaptive mechanism but consider only common criteria that a majority of people will agree to use to omit some types of uninteresting images as an assistant mechanism for efficient breeding. Therefore, a style of paintings of abstract art, such as a painting with a single colour in the whole area of the canvas, is out of scope from this approach, because it usually requires knowledge of the historical and cultural context to interpret the piece appropriately.

The following subsections describe three types of measures for spatial arrangement and two types for colour variation. To unify these measures in different dimensions for a final fitness value, a normalization method is introduced as described in the following subsection. After description of the measure for motion in animation, the method to alternate generations in evolutionary computation is described in the final subsection.

2.1 Information theoretic complexity

Commonly used measure is information theoretic complexity. Intuitively saying, simple uniform pattern, such as a solid colour, should be eliminated from the candidates for interesting images. Theoretically, Kolmogorov complexity in information theory is the ideal concept to measure how meaningful information the data contain. However, the computation of this measure cannot always correctly be completed in a feasible time and space. For example, a pattern of pseudo random dots is usually describable by a simple algorithm and a few parameters, but it is difficult to find the parameter values from the data even if the algorithm is given. The alternative method to approximate this measure is to employ an algorithm of data compression, such as JPEG compression for two-dimensional image. P. Machado *et al* examined some different types of methods for aesthetic measure from the complexity [6], and J. Rigau *et al* made deeper consideration on the complexity as aesthetic measures [7]. In this system, only one simple method has been implemented, that is, to measure a distance between the compression ratio of the given ideal value and the real value measured from the object image, as same as E. den Heijer *et al* examined [8]. It was implemented utilizing an API of JPEG compression embedded in MacOS X Cocoa framework with the image quality parameter as 0.67. Because the ideal value of compression ratio should be a subject to alternate due to the user's preference, this system allows the user to adjust it using a graphical user interface (GUI) described later.

2.2 Global contrast factor

E. den Heijer *et al* employed Global Contrast Factor (GCF) [9] as an alternative measure for interesting pattern [8], of which algorithm was originally designed to evaluate *contrast* as nearer with human's intuitive measure as possible. Contrast means the difference among brightness in a single image, but it is more than a simple statistical measure of variance among brightness values over the pixels. It should be called high contrast if the image is organized only black and white pixels without any intermediate gray ones, but it should be called low contrast if the allocation of black and white for each pixel was randomly determined. K. Matkovic *et al* proposed the algorithm to calculate a weighted summation among average differences over all of pairs of neighbouring pixels for different resolutions of a single image [9]. Their original method uses a greyscale image of 1024 × 768 pixels as the original one, and reduces the resolution in half by half in seven steps until it reaches the smallest size of 4 × 3 pixels. The weight values were statistically induced through the psychological experiments with human subjects.

To expand it to be applicable to a colour image, the difference between brightness is changed into the Euclidean distance between colour values in RGB colour space. Three component values are scaled in 2:3:1 for red, green and blue to adapt to the characteristics of human eyes.

In the current implementation in SBART, it starts the calculation from the half size of the original one, that is, 512 × 384, because it needs to keep the computation time short enough for interactive use combining with simulated breeding. This point will be revised by developing more efficient algorithm using GPU and improvement of hardware performance.

2.3 One-dimensional brightness distributions

The above two measures are concerning the placement of colours in an image, but they do not include any consideration on two dimensional distribution, that is, one dimensional patterns, an image of parallel stripes, are also given a chance to gain high aesthetic score. Two dimensional Fourier analysis should be useful to evaluate such a pattern expansion over the image, but it consumes long computing time of O(*N* log *N*) for each frequency. Another easy method to detect a pattern of parallel stripes is to compare the variances of brightness distribution among rows and columns. If the pattern is horizontal stripes, the variance among rows is large, but the variance among columns is zero.

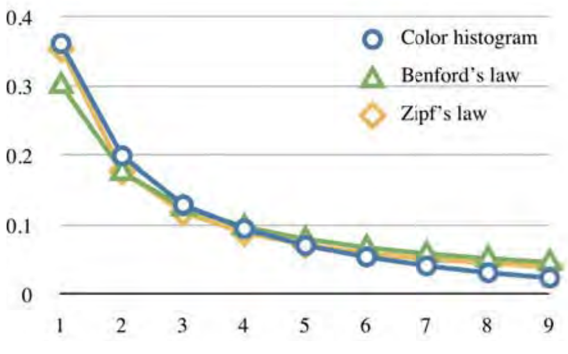
The algorithm implemented here is constructed by following three steps.

1. It calculates the distances between distributions of brightness in the ideal one and measured one for each angle from 0 to 90 degrees stepping by 15.
2. It transforms each result value to adjust zero to 1 and furthest to 0.
3. Then, it takes a geometric mean among the values.

Measurement for a variation of different angles is helpful to detect the orthogonal parallel stripes. The ideal distribution is extracted based on a statistical analysis over 500 snapshot photos similarly to the case of colour histogram described in the next subsection.

2.4 Color histogram

In addition to the shape, some statistics on colours is also important to index the characteristics of an image. The frequency distribution of brightness was examined in a previous work by E. den Heijer *et al* using the distance between the ordered frequency distribution and an ideal distribution based on Benford's law [8].Benford's law is that the appearance frequency of digit d at the highest column in prime numbers follows the value of $\log_{10}(1+1/d)$ [10]. The algorithm E. den Heijer *et al* developed counts pixels for each span of nine grades of greyscale from black to white over all of pixels in a single image, sorts the frequencies calculated from the counted numbers in descending order, then measures the distance from the distribution of Benford's law. Another distribution found from frequency of occurrence for each word in texts is Zipf's law that the frequency is proportional to the inverse number of the rank in descending order, that is, the second frequent word appears a half times of the first one, the third frequent word appears one third of the first one, and so on [11]. Both of these distributions can be found in a number of natural phenomena.



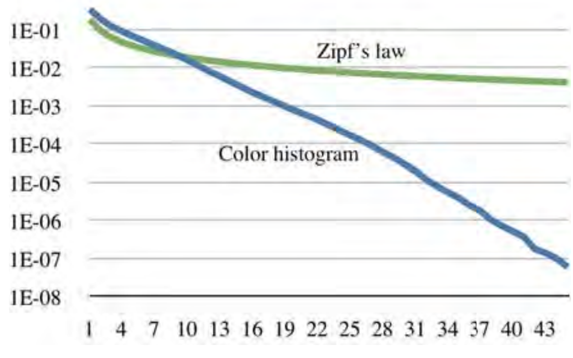


Figure 1. Comparison among distributions of average colour histogram extracted from 500 snap photos, Benford's law, and Zipf's law.

To extend the method applicable to colours, we divide the colour space into 6 × 9 × 3 for each component of red, green and blue, 162 clusters in total. Instead of using the above two well-known distributions, we investigated the average distribution among snapshot photos of nature, urban sceneries and portraits. The result using 500 photos showed almost following Zipf's law in the top nine colours, but the rest of low frequencies figured an exponential distribution as shown in Figure 1.

Therefore, as the ideal distribution, we embedded a sequence of frequencies in top 45 colours revealed from this investigation. The distance is calculated by taking the summation of the absolute differences between the ideal frequency and the calculated frequency for each rank in the same way of [8].

2.5 Favorable distribution of saturation

There is no universal aesthetic criterion on the tone of colours. However, the user, an image breeder, sometimes has preference of monotone or colourful. Here we introduce a user interface that allows the user to indicate the ideal values of average and standard deviation on saturation values over all pixels. A gray image becomes preferable if both the average and the standard deviation are indicated low, and a colourful image becomes preferable if the average is high.

When we define the range of saturation values within a fixed span, such as [0,1], the possible value of standard deviation is limited within a range depending on the average value. The standard deviation takes the maximum value when the sample values are restricted in the edge values of the range, that is, 0 and 1. In this case, the average μ and the maximum standard deviation σ_{max} are:

$$\mu = P_1 \tag{1}$$

$$\sigma_{\max} = \sqrt{P_0 P_1} \tag{2}$$

where P_0 and P_1 are frequencies of saturation values of 0 and 1 respectively, that is $P_0 + P_1 = 1$. The detail derivation of equation 2 is in Appendix. For the user's convenience, the user is allowed to input the value within [0, 1] as the standard deviation, and the system multiplies it by σ_{max} of equation 2 for actual ideal value. The measure is the two dimensional Euclidean distance between the ideal values and the actual values extracted from the image.

2.6 Normalization and unified measure

It is necessary to develop a kind of normalization for the five measures described in the above subsections, because they are in different dimensions for each that should not be compared as they are. We transform each measure in the range of [0, 1] so that 0 indicates the worst and 1 indicates the best, and map it to the normalized measure by two stages so that all of processed values form distributions of similar shapes. The first stage is a gamma correction $f_1(x) = x^\gamma$ so that the average value is equal to the median value, that is, $\gamma = \log_m \bar{x}$ where m is the median and $\bar{x}$ is the average value of x. The second stage is a linear transformation so that the average and the standard deviation are adjusted to 0.5 and 0.2 respectively. The equation is $f_2(x) = (0.2/\sigma_2)(x - m) + 0.5$ where σ_2 is the standard deviation among the transformed values by f_1. Combining these two stages, the transformation function f is defined as:

$$f(x) = f_2(f_1(x)) = (0.2/\sigma_2)(x^{\log_m \bar{x}} - m) + 0.5 \tag{3}$$

If the final value is out of the range [0,1], it is revised to the nearest boundary 0 or 1. To determine the coefficients in the transforming functions, we examined 1,000 images drawn with randomly generated genotypes. Figure 2 shows the distribution of each measure and its normalized version.

The final aesthetic measure for a still image is calculated as the weighted geometric mean among these measures, where the weights are adjustable by the user using a GUI in figure 3. It includes sliders for each measure to allow the user to operate any of them in anytime. Once one of these values is manually changed, the others are automatically adjusted to keep the summation of the weights to be 1 and to keep the ratio among the weights being adjusted if possible.

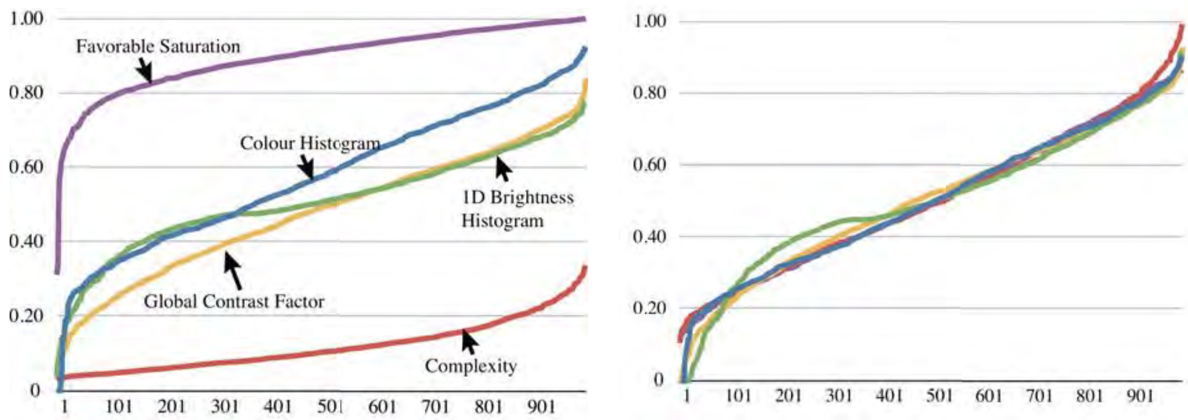


Figure 2. Distributions of aesthetic measures for 1,000 images produced from random genotypes. Each measure is sorted in ascending order.

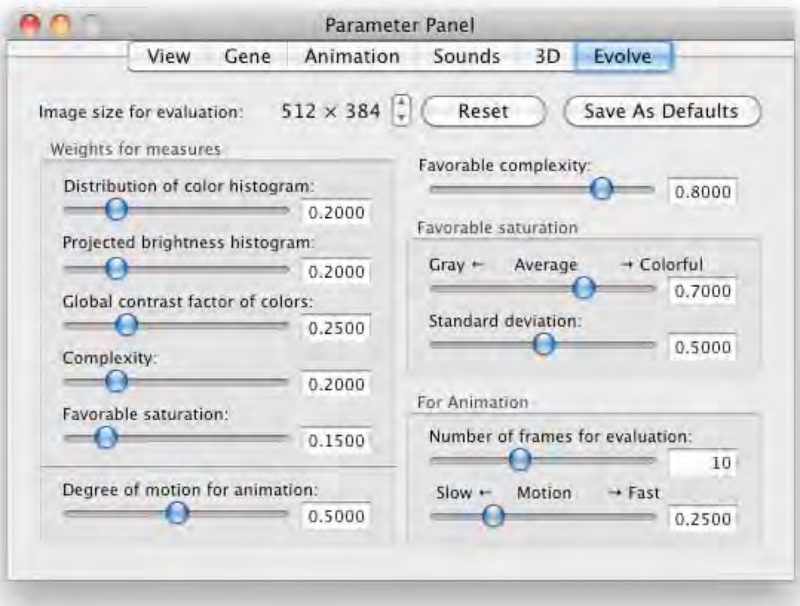


Figure 3. GUI for parameter settings of automated evolution.

2.7 Aesthetic measure for animation

One of the unique features of SBArt4 released in 2010 is that the user is allowed to breed not only still images but also animations in real time [3]. It used be difficult because the required computation time to draw one frame was much longer than the usual frame rate for smooth animation, but the recent improvement of GPU made it possible to realize it. We tried to implement a measure of favourable degree of movement in animation to be combined with the measures for still image. Ideally saying, this type of measure should be constructed with total evaluation over whole duration of the animation, but it seems very difficult because of too much computation power needed. As the first step of minimal functionality for this measure, we implemented the algorithm to calculate the average difference between consecutive frames among samples picked up from the whole sequence of frame images. It is theoretically possible to breed an animation of arbitrary duration, but to keep the evaluation by the user easy, SBArt4 treats relatively short animation, four seconds in default. It is a usual dilemma between a quick response and precision. To keep a smooth interaction between automated evolution and breeding, the current implementation uses ten samples in default to estimate the average motion by calculating the distance between colour values in pixels of same position in a sampled frame and the next frame. Because the degree of motion should be a subject to be adjusted according to the preference of the user, the system is providing a slider to allow the user to set up the value in anytime, that is located at bottom right in GUI shown in Figure 3.

The measure for still image is also applied to each frame image of ten samples. The total evaluation is calculated as the weighted geometric mean between the average measure of still images and the average degree of motion in sampled frames. The weight is also adjustable by the user using a slider at left bottom of the GUI.

2.8 Method of generation alternation

From the view point of the main objective of this system, the fitness value based on the measures described above is just a hint for users expected helpful for the user to find better candidates efficiently. We designed it not as an automatic (or artificial) artist but as a support system (or assistant) for human artists and designers. During the usage along with this principal, the system should allow the user to interrupt the evolutionary process to revise the parameters and the population in anytime. In a case with such a requirement of interruption, the generational change should be designed in a style of small-grained alternation to keep the computation time between generations short enough for human-machine interaction. Among the several methods available for this style of genetic algorithms, we chose Minimal Generation Gap (MGG) model [12] because of the smallest grain size and the most effective exploration in a large search space. In each step of generation alternation, the algorithm randomly chooses two individuals from the population as parents to organize a family by producing two children by crossover and mutation. Then it evaluates each members of the family if necessary. It selects the best individual among the family and randomly selects another individual from the family to restore the selected two individuals into the population. The other two individuals in the family are discarded. Random selections of parents and the second survivor are effective to keep wide diversity in the population, and the best selection has the same effect of the elitist strategy that guarantees the best individual discovered in the process always remains in the population.

We designed a GUI shown in Figure 4 to make it easy for the user to monitor the evolutionary process. The middle part of the window displays the best 20 individuals discovered in the process. The fitness value for each individual is also shown under the image. The bottom part shows a live animation of the trend graph on fitness values of both the best one and the average among the best 20. Each measure of both still image and animation is observable by a tooltip balloon attached to each view of the best 20 individuals that pops up when the mouse cursor stays some seconds on the view.

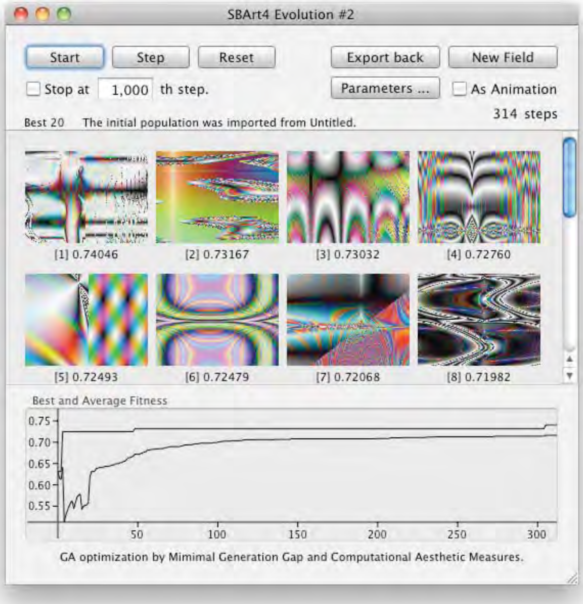


Figure 4. GUI for automated evolution.

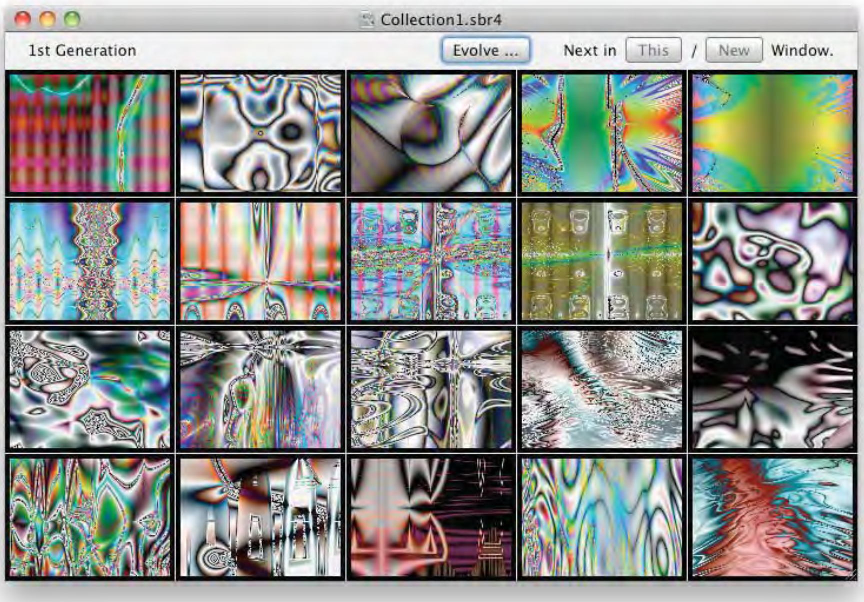


Figure 5. GUI for simulated breeding.

3. Combination of breeding and evolution

We designed a GUI for easy operation by the user to exchange the individual genotypes between the population in automated evolution and the field for simulated breeding. Figure 5 shows a sample field window of simulated breeding in SBArt4. New 20 individuals are organized as children, when the user selects his/her favorite phenotypes displayed in the window as the parents and clicks one of the buttons at top right corner of the window. A new button labeled “Evolve . . . ” was added by which the user open a new evolution window to start a new process of automated evolution as shown in Figure 4. Because the population size for evolution is 80 in the current implementation, the initial population is organized with 20 individuals imported from the field window and the other 60 are generated via crossover and mutation from these 20 individuals by random selection. It is also possible to start an automated evolution from a pure random population from a menu item in the menu bar of the application independently from a field window.

Two buttons at top right of the evolution window are to export the best 20 individuals to a field window of the original field by the left button and a new field by the right button. In the same style implemented in SBART for multi-field user interface [13], any individual displayed as one of best 20 can migrate to arbitrary position of a field window by copy & paste and drag & drop operations. By these functions, the user can progress breeding from his/her favorite individuals produced though an automated evolution when he/she found them in the best 20 views.

The individuals in a field window are also able to migrate to a population of automated evolution already running by copy & paste and drag & drop. In this case, the destination place of migration is not in the best 20 individuals, but another individual in the population of which fitness value is not calculated yet or less than the migrant. When there is no appropriate place found in the population, the individual of the least fitness is replaced.

4. Breeder/Evolver and Displayer

It became possible to produce interesting abstract animations in real-time by the automated evolutionary process described above. This means it is theoretically possible to set up an installation of never-ending series of animations by showing sample individual in the population in turn. It must be a new style of automatic art, but we need to solve the following two issues to realize it.

The one is on a computing performance of the hardware. Because the processes both of evolution and of animation require much of computational power, a single portable computer is not powerful enough. It is feasible if a hi-end personal computer with eight cores and hi-performance GPU board is available, but portable ones are preferable to keep the installation easy in any place.

The other problem is to keep the animation played back smoothly even when the evolutionary process requests GPU resource to draw an image to evaluate its fitness value. In the case of breeding, this point is also a problem when the breeder wants to keep a bred animation played back during he/she is searching a next candidate for playback by breeding. The process of playback must have higher priority than both evolution and breeding if they share any of computing resources such as CPU, GPU, and memory.

To solve these issues, we employ two computers connected by a local area network, and developed two new application software. The one named *controller* runs on the same machine that SBArt4 is running, and the other one named *player* runs on the other. The main role of *player* is to receive a text of code written in shading language to draw the animation on the hi-resolution screen. *Controller* is a type of communication-bridge between SBArt4 and *player*. It receives a code through the general pasteboard usually used for copy & paste between independent applications, and passes it to *player* by TCP/IP connection through the network. It has a GUI to control player remotely to change parameters for timing and sound effects.

For the performance of real time breeding, the human player breeds his/her favourite animation on SBArt4 and send the code by copy & paste operation to *controller*. The pasted code is automatically sent to player running on another machine. If we used a single machine to run both SBArt4 and player, an extra equipment of audio I/O is required because a personal computer usually has only one pair of stereo audio channels for both input and output though we need two separated audio output for breeding and playback.

For the automatic art, we developed software in AppleScript that supervise both SBArt4 and *controller*. It initiates an evolutionary process in SBArt4 starting with random parameter settings and picks up 10 individuals after 50 steps to copy their codes into *controller* in turn. Then, it demands SBArt4 to reconstruct the population by genetic combination among the individuals in the current population. Some of the individuals are replaced with new random genotype to keep diversity in the population. Evolutionary process restarts again and continues until playbacks for all of previous 10 individuals are completed. These processes are iterated arbitrary times to produce ever-changing stream of abstract animations. The duration of an animation for each individual is 20 seconds in a typical setting, in which the evolutionary process is allowed to continue 3 minute 20 seconds to produce the next 10 individuals for playback. It is long enough for small computer to execute more than 50 steps of generational changes in MGG model described in section 2.8.

5. Conclusion

New mechanism of automated evolution of abstract animations is introduced to SBART. Each of the produced pieces is not perfect for human critics but it is useful to find interesting animations. This functionality enabled to implement a new style of installation of automatic art that shows visitors ever-changing abstract animations for long time. To run this installation smoothly in portable machines, two new applications were developed to use two computers. These new development also enabled a live performance of real time breeding of animations on stage.

The automatic art have been exhibited twice in the Open Campus in Soka University. We received positive comments from visitors at both occasions. For the breeding performance, GA 2011 is the first occasion to perform in public. The author hopes the audience enjoy it and having another chance to exhibit the installation.

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Appendix: Derivation of equation 2

From the definition of standard deviation,

$$\sigma_{\max}^2 = \frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2 = \overline{x^2} - \bar{x}^2 .$$

Because x_i = 1 or 0 and the expected number of x_i of value 1 is $P_1 N$,

$$\overline{x^2} = P_1 \text{ and } \bar{x}^2 = P_1^2 .$$

Therefore,

$$\sigma_{\max}^2 = P_1 - P_1^2 = (1 - P_1)P_1 = P_0 P_1 .$$

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Paper : **Application of the art and architecture principles in the design of spatial models**

Topic: Architecture

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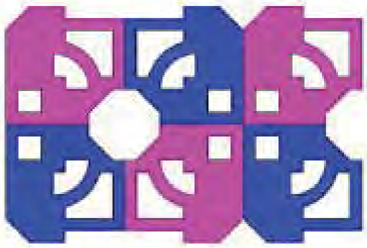
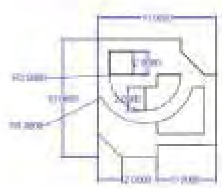
Abstract

In the field of architecture and art the design of any spatial models should adopt important principles in the creation of an integrated model: one or more principles can used to generate the same shape or an object , and many objects can be created employing architecture and arts principles. The color and texture give a model a sense of form and the possibility of recognizing it from the more scientific perspective: as an example, students from the first year of the College of Engineering have used several different models of art and architecture; these models have been analyzed using geometrical methods to find the strategies for creating those models. After geometrical analysis had been completed, the results showed that models used more than one principle to generate them. The principles have been used on two levels: at the first level the macro composition was created; the second level included a micro composition to create one unit. This unit has formal relationships that linked to the other unit. In addition to using a selection of color (homogeneity and contrast) , this paper provides an insight into the principles of installation form such as adjacency and proportionality at the first level, and at the second level, the principles of private relations as well as structural design have been used, such as the gradient balance. The focus has been on exploring shape and design alternatives, where producing many shapes from different colors and different relations depends on the principles of art and architecture, which, in turn, provide the basis for the formation of design models.





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spatial models, geometrical analysis, art and architecture principles

Application of the art and architecture principles in the design of spatial models

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Abstract

In the field of architecture and art the design of any spatial models should adopt important principles in the creation of an integrated model: one or more principles can used to generate the same shape or an object, and many objects can be created employing architecture and arts principles. The color and texture give a model a sense of form and a possibility of studying it from a more scientific perspective: as an example, students from the first year of the College of Engineering have used several different models of art and architecture that they have analyzed using geometrical methods to explore the strategies for creating those models. After geometrical analysis had been completed, the results showed that models used more than one principle to generate them. The principles have been used on two levels: at the first level the macro composition was created; the second level included a micro composition to create one unit. This unit has formal relationships that linked it to the other unit. In addition to using a selection of color (homogeneity and contrast) , this paper provides an insight into the principles employed to create forms such as adjacency and proportionality at the first level, and at the second level, the principles of private relations, as well as structural design have been used, such as the gradient balance. The focus has been on exploring shape and design alternatives, where producing many shapes from different colors and different relations depends on the principles of art and architecture, which, in turn, provide the basis for the formation of design models.

1. Introduction

The principles of arts and architecture are considered to be of scientific basis, on which the students of arts, architecture and the artistic-architectural design rely at the first stages of learning design as well as the geometrical and spatial formations. Students focus on one or more than one principles related to color, shape and the formal relations according to the instructions of their professors. A sample of students' designs was studied: they designed spatial shapes using the shape unit and finding the most frequently-used principle in designing them. The structure of the research was adopted to accomplish the objective of the research as in (fig. 1).

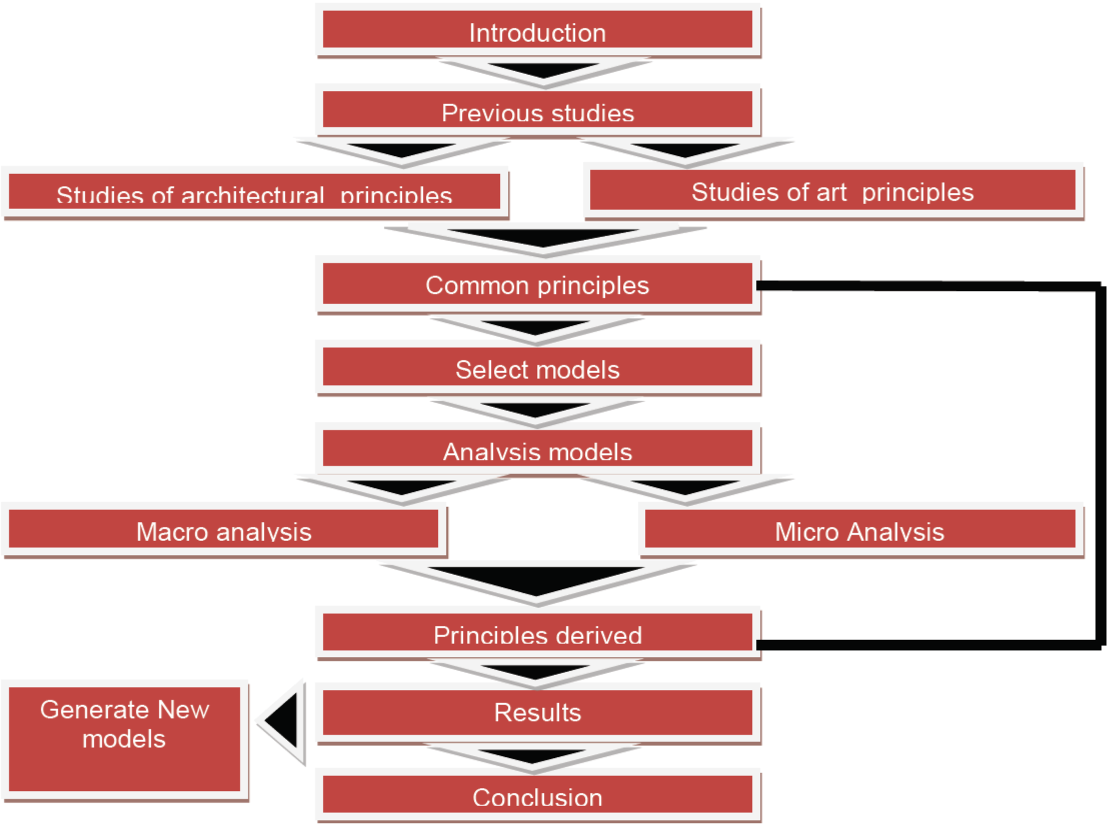


Figure (1) the structure study.

2. Previous Studies

There are many studies that deal with the principle of arts and architecture and their applications. Some of these studies separate the principles used in the architectural design and the principles used in the artistic design[6]. The following are the studies that analyze the principles of arts and architecture not based entirely on science, or on one of the disciplines, but rather as two integrated parts:

Study [1] focused on the principles which apply to a shape and its construction. The study indicates that three basic stages were used in this process. The first stage is an abstract proposed shape, i.e. any basic shape or basic unit. The second stage connects this basic unit with another unit to form the part which, in turn, forms the final design or the resulting shape. More than one basic unit or one basic shape can be used in order to construct the spatial models, [1] and the difference of the relations strategy in these three stages is what produces different and various alternatives for the same basic units. (fig. 2).

(figure -2) three stage to create the compact shapes.[1]

From this study, it can be concluded that there are three stages which determine the kind and the value of the product. In addition to the repetition, the principle of a copy of the unit or the basic shape was also noted. Furthermore, copy and repetition taking a certain direction is connected to the mirror principle to formulate the main parts of the whole shape.

Study [2] emphasized the part and the whole principle in arts and architecture. The part cannot represent the whole in most of the cases because a part or any artistic work can be formed from a part or an element, but the product is something else which diverged from the basic element [2]. An example for that is using a cube for a pyramid formation. And through this study we can conclude that there is one main element that is a part of the whole in the design process (fig. 3).

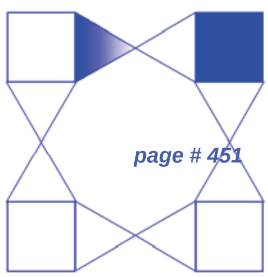
(figure-3) the partial object and the concept.[2]

Study [3] discusses the formation of a shape using multiple shapes or elements and these elements can be have different dimensions and colors in accordance with the designer view [3]. And from this study we can conclude that shape can be formed in two ways, as follows:

a. Single shapes.

(figure-4) Using single shape to design compact shape.[3]

b. Multiple shapes. (fig. 5).



(Figure-5) using many shapes to create multi-compact shape.[3]

Study [4] is part of the studies which investigate the main shape or the basic element. This study relies on the subtraction and addition principles to formulate the shape in arts and architecture and this process should be planned well, i. e. cannot be random. There are many kinds of subtraction and addition for the shape including the following:

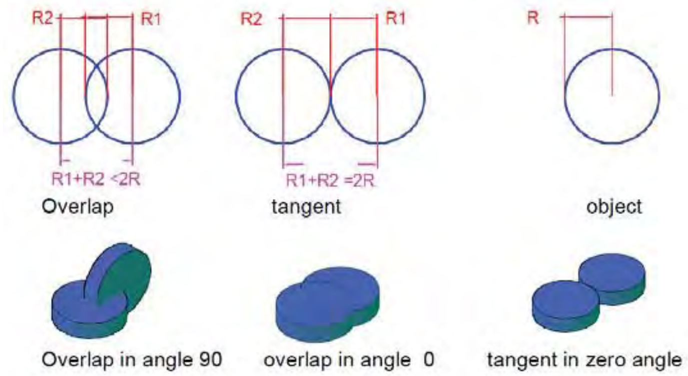
a- Subtraction or addition of a part with the same shape of the original part and with different proportion.

b- Subtraction or addition of a part which is different from the original shape part and with a scale that is connected to the original part.

c- Subtraction or addition of different parts; some of which are similar to the part and some are different and with a scale and a proportion that is connected with the original part [4].

d- Random addition and subtraction.

Study [5] focuses on the importance of the formal relations amongst the elements and parts. There are several relations that we can make use of in this study, and the focus is on the overlapping relations horizontally and vertically (angle = 0) for the horizontal and (angle > 0) for the vertical (fig. 6)



(Figure-6-) variable of overlapping [5].

3. Conclusion from the previous studies

The previous studies indicated the importance of the basic shape and the three stages of designing in addition to the formal relations and the mechanism of copy and repetition. Moreover, focus was on the part and the whole as well as on the principles of subtraction and addition. The studies have not shown the mechanism of using these principles in the formation of several models out of one or more than one basic element that a student can count on to form the spatial shapes or to accomplish any other design which involves an artistic aspect. Therefore, the problem of the research was identified based on the level of clarity of the adopted mechanism for designing the spatial or the imaginary models which are dependent of the principles of arts and architecture. To solve this problem the following hypothesis was adopted: there are design strategies for using the principles of arts and architecture the students and the instructor can implement to complete the design of the product. Also, the objective of the study was established, which is to identify the strategies to use the principles of arts and architecture in the artistic and architectural design for the first year students. To accomplish the objective of the research certain spatial models will be selected and analyzed relying on the items that will be extracted from the previous studies.

4. The items of the theoretical framework

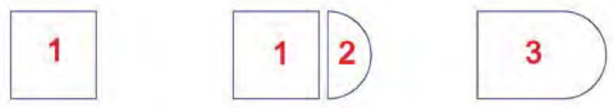
Through reviewing the previous studies, it became clear that there are two fundamental points in the process of forming the imaginary spatial shapes as follows:

4-1 The level of individual parts:

It stands for the principles used in forming the part (the basic units), and this variable involves secondary variables such as:

4-1-1 The shape of the part: The formation might involve one or more than one shape and as follows:

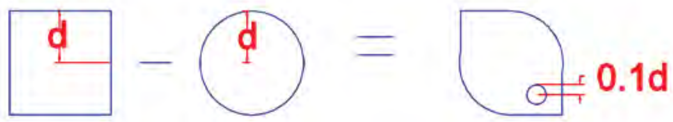
A- One shape . B- Several shapes (fig. 7).



(figure-7) one shape with another shape to create multi-shape .

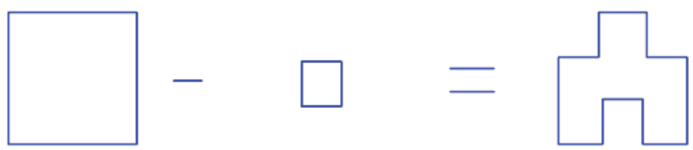
4-1-2 Subtraction: This includes three items, as illustrated below:

A- Subtraction of a new shape with proportions that are related to the proportions of the basic shape. (fig. 8)



(figure-8) using new shape to subtract from main shape

B- Subtraction of a shape with the same shape of the basic part with proportions that are related to the proportions of the basic shape (fig.9)



(Figure-9)using same shape in deferent scale in subtraction process

C- Subtraction of several shapes (includes the two above cases) (fig. 10)

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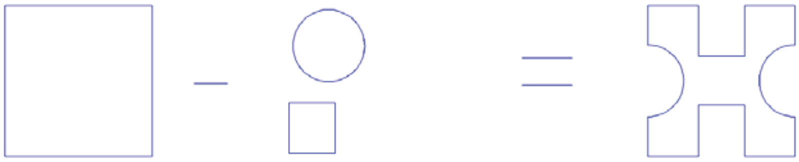


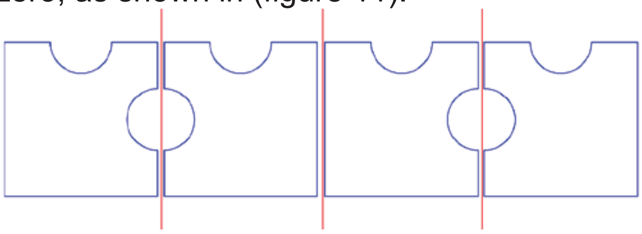
(figure-10) deferent shape are used subtraction process

4-2 The level of the whole:

The changes related to this level are centered around the relation between the parts and the whole, and this relation can be found through studying the following variables and measuring them in accordance with the models, as follows:

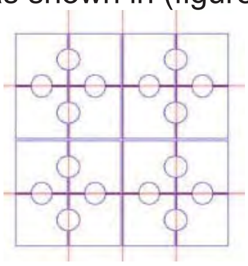
4-2-1 Mirror: It is the process of the repetition and copy in a certain way and in a certain direction:

A- One directional: The axis of the repeated shapes is in a parallel direction and the angle equals zero, as shown in (figure 11).



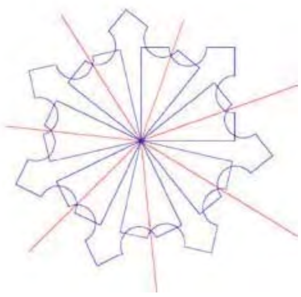
(figure-11) parallel Axis .

B- Vertical or in two directions and the angle between the axes of the repeated shapes is bigger than a zero, as shown in (figure 12).



(figure-12) the angle between the axes of the repeated shapes is bigger than a zero

C- Radial: When the axes of the repeated shapes meet in one point, as shown in (figure 13).



(figure-13) radian axes with overlapping objects.

4-2-2 Overlapping relations: These involve two axes which are:

A- Contact: It includes two variables:

- Horizontal, where the angle between the front faces of the two shapes equals zero, as shown in (fig. 6).
- Vertical: where the angle between the front faces of the two shapes is bigger than zero, as shown in (fig. 6).

B- Overlapping: in this variable, the shape should be restored to its original shape before addition or subtraction and then measuring it , (fig. 6).

- Horizontal, where the angle between the front faces of the two shapes equals zero, as shown in (fig. 6).
- Vertical: where the angle between the front faces of the two shapes is bigger than zero, as shown in (fig. 6).

4-2-3 Color relations: The colors are measured depending on the lever of colors and it involves three variables and as follows[6][7]: (fig. 14).

(Figure-14) color variables (harmony , tone ,contrast).

After identifying the main components of this study a measuring model was formulated to measure the study cases as shown in table (1).

(Table -1) variables to measure the samples.

<table>
<tr><td colspan="3">Sample No.1</td><td colspan="3"></td></tr>
<tr><td rowspan="5">Micro level</td><td colspan="2" rowspan="2">Basic shape</td><td>clear</td><td></td><td></td></tr>
<tr><td>Not clear</td><td></td><td></td></tr>
<tr><td colspan="2" rowspan="3">Subtract</td><td>New shape in different proportion</td><td></td><td></td></tr>
<tr><td>Same shape in different proportion</td><td></td><td></td></tr>
<tr><td>New and same shape in different proportion</td><td></td><td></td></tr>
<tr><td rowspan="12">Macro level</td><td colspan="2" rowspan="3">Mirror</td><td>one direction</td><td></td><td></td></tr>
<tr><td>Multi- direction</td><td></td><td></td></tr>
<tr><td>Radial</td><td></td><td></td></tr>
<tr><td rowspan="6">Overlapping relations</td><td rowspan="3">Face to face</td><td>vertically</td><td></td><td></td></tr>
<tr><td>Horizontally</td><td></td><td></td></tr>
<tr><td>both</td><td></td><td></td></tr>
<tr><td rowspan="3">Intersect</td><td>vertically</td><td></td><td></td></tr>
<tr><td>Horizontally</td><td></td><td></td></tr>
<tr><td>both</td><td></td><td></td></tr>
<tr><td colspan="2" rowspan="3">Colour relation</td><td>Contrast</td><td></td><td></td></tr>
<tr><td>Tone</td><td></td><td></td></tr>
<tr><td>Harmony</td><td></td><td></td></tr>
</table>

5. The empirical study

In this part of the research models of the Department of Architecture first year students' works were selected; they were supervised by the subject matter experts, professors well-experienced in dealing with the students at this level. The focus was on developing the process of thinking in forming the shapes by adopting the determinants for the design process. The basic shape (the unit) for all students was selected, which serves the purpose of a unified shape. Then the subtraction, addition and shapes correlations were implemented to formulate spatial shapes that, at the same time, have the artistic and the geometrical characteristics. 20 models (with artistic and the geometrical aspects) were selected to be analyzed using the geometrical method and some geometrical programs available, to measure the items and the variables of the theoretical framework as shown in table (1).

(Note: the measure of one model was chosen due to the great number of the analysis results; for further information please contact the researchers for providing the rest of the models).

<table>
<tr><td colspan="3">Sample No.1</td><td colspan="3"></td></tr>
<tr><td rowspan="5">Micro level</td><td colspan="2" rowspan="2">Basic shape</td><td>clear</td><td>*</td><td></td></tr>
<tr><td>Not clear</td><td></td><td></td></tr>
<tr><td colspan="2" rowspan="3">Subtract</td><td>New shape in different proportion</td><td></td><td></td></tr>
<tr><td>Same shape in different proportion</td><td></td><td></td></tr>
<tr><td>New and same shape in different proportion</td><td>*</td><td></td></tr>
<tr><td rowspan="12">Macro level</td><td colspan="2" rowspan="3">Mirror</td><td>one direction</td><td></td><td></td></tr>
<tr><td>Multi- direction</td><td>*</td><td></td></tr>
<tr><td>Radial</td><td></td><td></td></tr>
<tr><td rowspan="6">Overlapping relations</td><td rowspan="3">Face to face</td><td>vertically</td><td>*</td><td></td></tr>
<tr><td>Horizontally</td><td></td><td></td></tr>
<tr><td>both</td><td></td><td></td></tr>
<tr><td rowspan="3">Intersect</td><td>vertically</td><td>*</td><td></td></tr>
<tr><td>Horizontally</td><td></td><td></td></tr>
<tr><td>both</td><td></td><td></td></tr>
<tr><td colspan="2" rowspan="3">Color relation</td><td>Contrast</td><td>*</td><td></td></tr>
<tr><td>Tone</td><td></td><td></td></tr>
<tr><td>Harmony</td><td></td><td></td></tr>
</table>

(figure-15) image for one real modes which is measured in table above.

6. Results of the practical study:

Through the application of the practical study to the models, it was shown that 100% of the results used the principle of subtraction from the basic shape. Furthermore, the principle of subtraction from the main element and with different shapes from the original shape represented 50%, 40% for the subtraction as original same shape and 10% for the subtraction of a new shape. Therefore, the ratio on a clarity scale for the main shape was 65% not clear and 35% clear. For the principle of mirror repetition and the directional copy, the greater percentage was in the variable with multiple directions (horizontal and vertical) and that percentage was 70%. The percentage of the radial repetition was 25%, while for a single direction was 5%. For the variable of overlapping, the results were close to each other somehow because most of the models have correlation and contact face to face. The difference was in the secondary variables; the variable of the face-to-face horizontal direction and with zero angle was 50% and for the vertical (angle bigger than zero) 10% and 40% for both variables.

For the principle of overlapping, the ratios were close to each other between the horizontal and vertical overlapping. Results concerning the colors relations showed that 60% represented the contrast in colors, 15% the tone and 20% the harmony. Moreover, the results showed that the models with high percentage were with normal shapes which lacked the artistic and geometrical innovation when evaluated against the models that used the principles with less percentage.

7. Conclusion:

The design process depends greatly on several geometrical, artistic and aesthetical principles and norms, but in this research, principles were relied upon as they are the basis of the design success. The results of the practical study indicate that changing the original shape by means of subtraction or addition is an important principle that is more frequently used in the first phase of the design process. The clarity of the original shape is vital therefore, the designs in which the original shape is changed lose the original form and this will make the design less valuable artistically and architecturally. The comparison between the designs showed that implementing the most commonly used principles to show the design creates a good configuration, however, it may be better to use the less common principles. For instance, the employment of subtraction principle, adjacency relations, color relations and the way in which we repeat and copy is a simple fraction of architecture principles. If these principles were employed with a planned mechanism, then the design will have more value and will be more efficient. Three methods were established for the use of these principles that the professor and the students of art and architecture can rely on with the potentiality of selecting other principles such as balance, hierarchy among many others. These methods are illustrated in the following table:

Line one

Contrast	Horizontal correlation	Horizontal face-to-face overlapping.	Two-directional repetition	Different kinds of subtraction	Clear

Line two

Harmony	Horizontal and vertical correlation	Horizontal face-to-face overlapping.	Radial repetition	Subtraction in the same shape	Clear

Line two

Tone	Horizontal and vertical correlation	vertical face-to-face overlapping.	Radial repetition	Subtraction in the same shape	Clear

8.Refrences :

[1] Nikos Salingaros," ***A Scientific Basis for Creating Architecture Forms, Journal of Architectural and Planning Research*** , Vol(15) , Locke Science publish ,1998.P2-6

[2] M. Graves , "***The Art of colour and Design***" 2nd edition , USA,1951.

[3] Stout,Gane Ann, "***design exploring the elements and principles***" Iowa State University of science and technology , Ames, Iowa.

[4] Francis D.K. Ching, "***Architecture Form, Space , and Order***", John Wiley & Sons, INC 2nd edition, America, 1996.

[5] March, L.and Steadman, P., (**The Geometry of Environment, An introduction to spatial organization in design**), RIBA Publications limited, Great Britain, England, 1971.

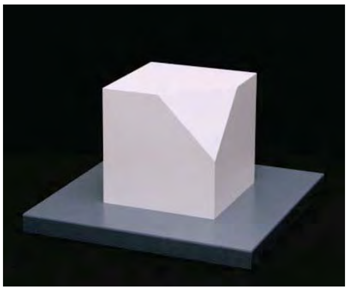
[6]Aldwri, Ayath abdalruhman, " ***the Semantic of colour in the Islamic and Arabic ART***" first edition , Baghdad, 2003.

[7] Gloag , H.Gold & J.Mary , 1978 **, " *color co-ordination hand book* "** , HMSO , London .

ART PERSPECTIVE:

Following the adopted structure of the research which analyzes architecture principles of color, repetition, and different transformations of a single shape (on a micro level) to create a complex shape or spatial forms (on a macro level), it is instructive to note that the architecture principles applied in this study are equally relevant for the design of art, process-based art that relies on sets of precise instructions explaining how to do something. They can generate infinitely original outcomes. A good example of this is the work by the artist, Sol LeWitt, who has worked both with 2D shapes and spatial forms, writing instructions for his artwork, sets of rules, which, when applied, can generate many results, and thus open up the doors to interpretation, ambiguity and contradictions. The following illustrations do not necessarily follow the same rules, however, they provide good examples of what can be done with the introductions of the variables: here he explores geometry and repetition:

Sol LeWitt:



Cube Without A Corner, 2005

Octagon on a Cube, 2005

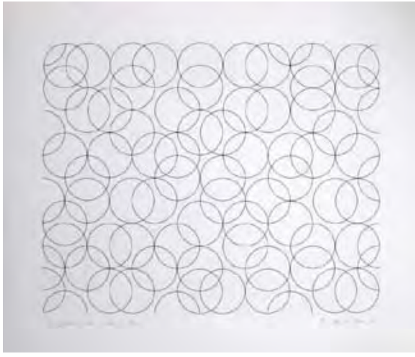
Progression #2, 2005

Similarly, Manfred Mohr, an algorithmic artist, creates simple shapes based on his sets of rules to create interesting variations which, when compared, have relationships to other versions, but they are also different, depending on the number of parameters used and the range of values; in this case, the work is based on the 11-d hyper-cube; the algorithm the artist wrote selects a subset of cubes from 42240 cubes inherent to the 11-d hyper-cube and decides which sides shall be black or white; the whole structure rotates in front of the green background:

Manfred Mohr: Subset Series

Common Principles in details:

Repetition:
In previous studies in architecture principles, the principle of repetition proved to be a simple, yet powerful principle to create a variety of complex shapes using simple shapes, as illustrated in Figure 2. It is simple and at the same time complex as it opens up an incredibly rich space for experimentation in both architecture and art. With the power of computers it continues to be a field of limitless variations. From weaving patterns that offer orderly outcomes, carefully planned and executed, to generative art forms employing variables with infinitely varied results, repetition has a powerful effect on human psyche. Dynamic visual patterns (such as in the work of op art movement artists from the 1960s– Bridget Riley) can appear to “vibrate physically” (1); they can ‘encourage our eyes to dance’ (2) as they have a very strong sense of depth and motion, as illustrated below:



Bridget Riley: Composition with Circles

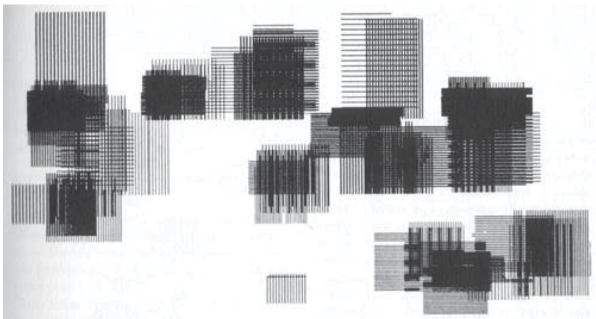
Similarly, the work of Elena Manferdini and her “Ricami Stool” , 2008, with its intricate pattern cut in metal plays with our perception as it appears to be very delicate compared to its actual strength as a piece of furniture.
By using the process of recursion as part of the orderly and planned repetition principles, similar to repetitive patterns described above, shapes become repeated in a self-similar way. A good example of that would be a fern leaf that contains a series of smaller and smaller leaves. The patterns found in nature provide a rich field of study as in exploring fractals by Mandelbrot, which is a good example of recursive patterns; the following is an example from the work of University of Advancing Technology student, Garrett Savo, where he uses a simple fractals program to generate his fractal artwork.

Garrett Savo: Arts and Technology class; University of Advancing Technology, 2011

In the world of architectural design, the Japanese architect, Toyo Ito, has designed a pavilion in Serpentine Gallery. London, where he uses a recursive repetition principle of rotated concentric squares to create a complex structure that is simple in its implementation of a simple process of repetition using simple elemental shapes to create a building that occupies the space of controlled chaos, architecturally innovative and sound:

Toyo Ito, Serpentine Gallery, London

Implementing repetition principle by varying values creates limitless possibilities: Frieder Nake modulates random values by applying space-division algorithms, as in his work, Rectangular Hatchings (1965):



Frieder Nake: Rectangular Hatchings (1965):

The random elements employed here are total number of rectangles, position of rectangles, size of rectangles, direction of lines and selection of drawing pen.

Modularity, as part of the repetition principle, uses one or more shapes to produce a complex form. However, here the elements of the shape are not transformed, they are only repositioned.
The product, Coat Hook, by MOS Architects that is created using the modularity principle explores a design space to place simple shapes as being repositioned to create a new product:

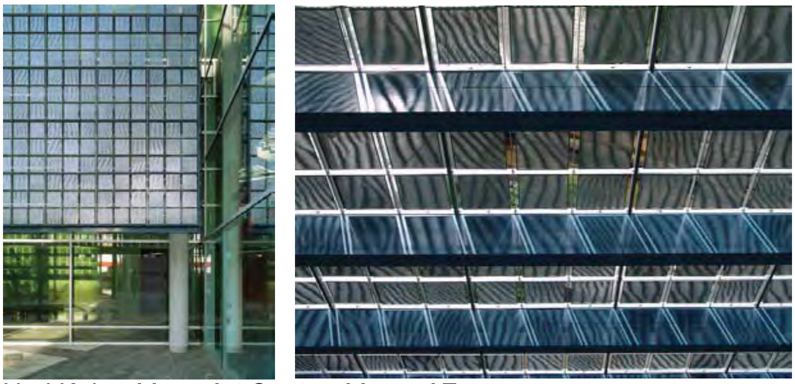
MOS Architects: Coat Hook

In this research I am particularly interested, as an artist, in the process of **parameterization,** which indentifies and describes the variable elements, and discussed in the book, Form+Code by Casey Reas. Parameters in this context are defined as values (for instance, color and size, and proportions, which have been heavily explored in the architecture part of this paper) which have an effect on the output of a process. This process opens up a space for further research in the field of both art and its implications on the architectural forms.
It also ties in the two principles that provide the foundation of this study, that of repetition and transformation (in this case here, subtraction, addition and overlapping). Repetition, as already explained, provides outcomes of some possible

designs which are also valuable with good configuration. The transformation principles explore the effect of the parameters on the whole, on the outcome of the complex shape. “Fractal Dice” by the artist, Keith Tyson, uses a very simple set of rules, “a dice-based system, to achieve complex results. The initial state of each piece originates from a cube, and the method by which the piece evolves to its final state is by a cube, or more specifically, the roll of a die. Fourteen aluminum and plastic works will be on view in Fractal Dice. “(3):

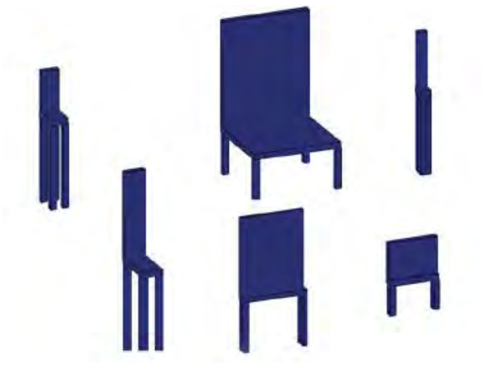
Keith Tyson: Fractal Dice

In a parameterized system, where there are constants and variables, random values are used to evoke unpredictable results of the physical qualities.
In the public art work by the artist, Ned Kahn, in any set of rules there is always room for variations. For Mesa Arts Center in Mesa, AZ, he created a wall of simple, identical moving squares which are repeated in a patterned way. However, with the introduction of unpredictable interaction from nature, such as wind, in this case, the outcome of this complex spatial shape becomes randomized and always original, based on the forces of the wind:



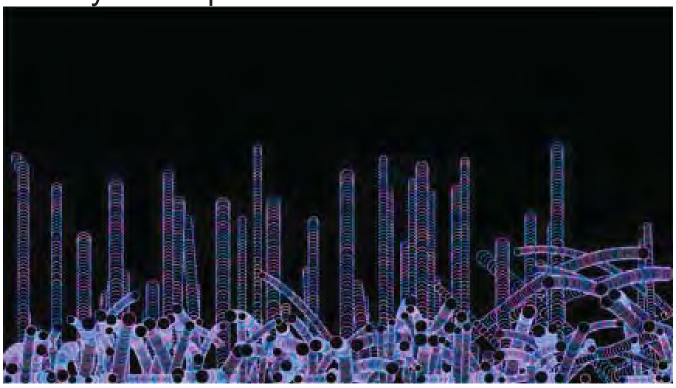
Ned Kahn: Mesa Art Center, Mesa, AZ

Using simple geometric programs, such as open source Processing, parameterized design becomes an open-ended, exploratory field.
A good example is the code that Casey Reas wrote for the parameterizing the chair, where he decomposes the object into its simple parts: seat, back, legs and applies variables to each simple component, choosing values at random, to generate always unique designs of the chair when the code runs:



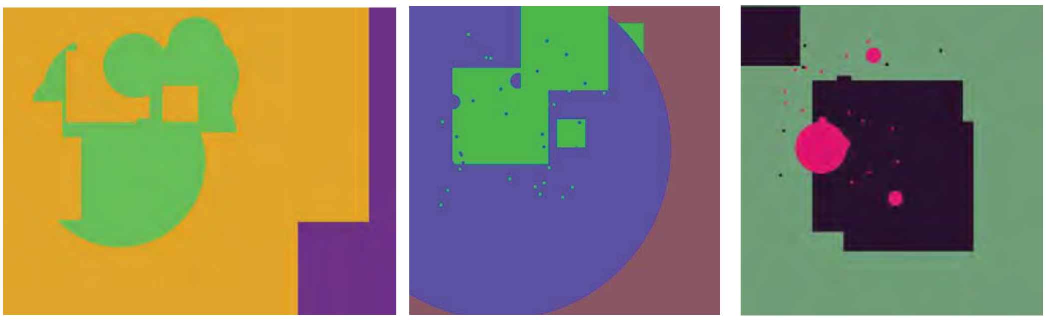
The following are some examples of the work of University of Advancing Technology students that employ simple set of rules with constants and parameters, using Processing, to create original, chance based outcomes:

Tommy Buonopane:



using the sample parameter of limited color scheme and one simple shape (circle);

Dan Parish:

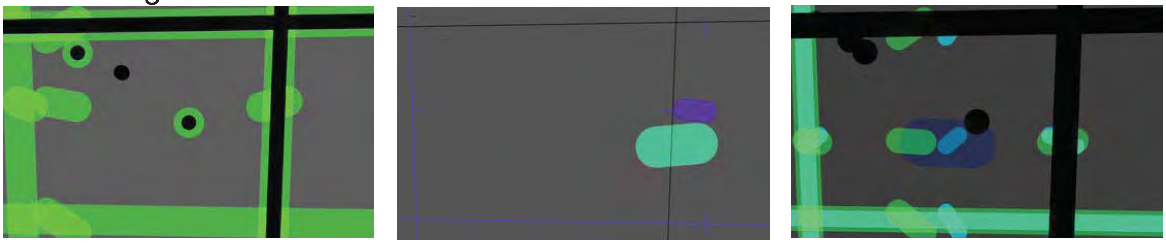


Using only two shapes: circle and square as constants to create original art implementing variables for color and the scale of the shapes

Dennis Pishik:

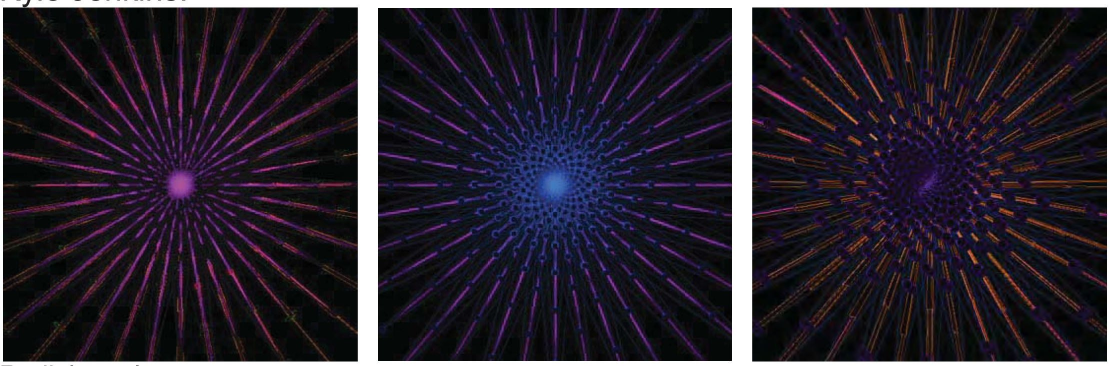
Using one constant and constrained space to create original outcomes with variables of color and velocity.

Ian Furlong:



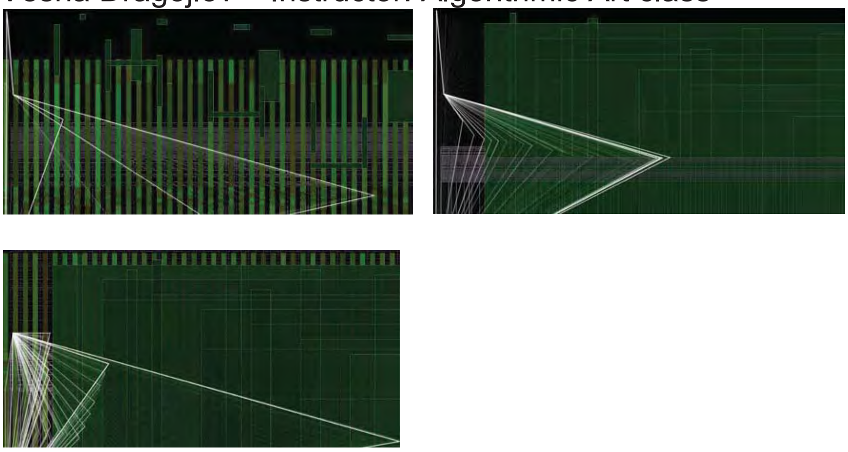
Using only stroke weight and limited color scheme to create infinitely redesigned space.

Kyle Jenkins:



Radial overlaps

Vesna Dragojlov – Instructor: Algorithmic Art class



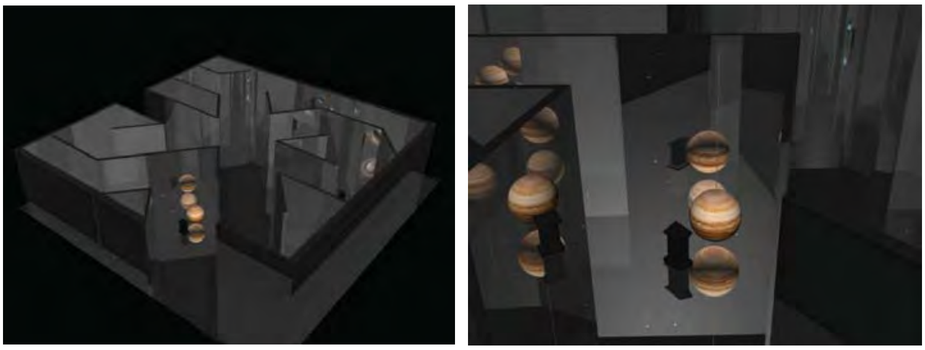
Using simple shapes, line and squares, with limited color scheme.

CONCLUSION:

From the art perspective it is valuable to look into the main principles discussed here and the multitude of the possibilities for generating complex forms using very simple geometric elements. The limitations are necessary to identify for sound architectural structures, however, looking more deeply into the various techniques of repetition, as an example, may result in the creation of quite innovative spatial shapes. The quality of controlled chaos that can be created using variables with constraints may lead to further exploration of the redesign of the space.
As the French architect, Francois Blanciak asks himself,
“What would happen, if architects liberated their minds from the constraints of site, program and budget”? (4)

The answer is his book, “Siteless”, 1001 building forms

For further research into the design of the space, it is recommended that the element of light as an interesting design element is explored as it can lead to the creation of dynamic, constantly redefined spaces based on the interaction of light source and the spatial shapes within it, and the projection of light as an immaterial element onto the physical spaces, creating an interplay of augmented and physical environment, as in the example of the work by University of Advancing Technology student, Josh Hemmy. He places spatial forms in a maze of mirrored rooms that, by projecting them onto the mirrored walls, infinitely redesigns that space:



Josh Hemmy, student at the University of Advancing Technology, 2011

Footnotes:
(1) Casey Reas: Code+Form, pp.49
(2) Casey Reas: Code+Form, pp.49
(3) http://oneartworld.com/The+Pace+Gallery/Fractal+Dice.html
(4) Francois Blanchiak, Siteless, MIT, 2001

References:

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3. Francois Blanchiak, Siteless, MIT, 2001
4. Design Basics, David A. Lauer and Stephen Pentak, Thompson, 2007
5. http://oneartworld.com/The+Pace+Gallery/Fractal+Dice.html
6. http://www.beflix.com/reichardt.php
7. http://formandcode.com/code-examples/parameterize-chair
8. http://www.bonluxat.com/a/elena-manferdini-ricami-stool.html
9. http://www.barbarakrakowgallery.com/sol-lewitt
10. http://www.emohr.com/

Yeeun Yang,
Boram Park,
Moonryul Jung

Paper :
Artificial Creatures from Biological Development


Topic: Generative Robots

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[2] Karl Sims,” Evolving Virtual Creatures”, Siggraph '94, Computer Graphics1994, pp.15-22

Abstract:

This paper investigates a method of building artificial creatures in virtual environments by means of **artificial development and evolution**. Building blocks of a real creature are cells. The “cells” that our system uses are called “macrocells. They are much bigger than real cells, but much smaller than usual segments or modules used to build robots. Macrocells are simple but embody mechanisms **analogical** to those of real cells. The development procedure generates a creature body out of a single macrocell; Macrocells [simply “cells” hereafter] divide, grow, and connect to other cells to build a whole body. Cells have joints such as rigid, prismatic, rotational joints, and can connect to other cells that have matching joints. The development mechanism is specified by the genome in each cell. Each gene in the genome is designed to have specific attributes which define the behaviors of the gene products. Some gene products are control signals, which play the role of catalyst protein, and the other gene products are used to differentiate the cell into a specific cell, e.g. a neural cell and a structural cell with a rotational joint. Control signals are used to express specific genes that match them. The initial cell has predefined control signals corresponding to the maternal factors in a real fertilized cell. Neural cells, which include sensor and motor cells, connect to each other to form a neural net, which in turn connects to structural cells to move them. The physics of the environment and the creatures is simulated by means of the ODE (Open Dynamics Engine) library. Initially, genomes are generated randomly, though their attribute structure is designed. The generated creatures will be also fabricated into real robots, by using small hardware modules and electrical circuits corresponding to the structural and neural cells. Our method embodies mechanisms of reall cells quite faithfully in that **the phenotype do not correspond to the genotype one to one**, in contrast to most artificial creatures generated by genetic algorithm. Through this study, we can learn some organizing principles of life, though quite abstract from and only analogical to real life.

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Keywords: Artificial creature, Macrocells, Genomes, Development, Evolution , Mechanism of Life, Genetic Algorithm

Artificial Creatures By Biological Development

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Abstract

This paper investigates a method of building artificial creatures in three dimentional virtual environments by means of artificial development. Building blocks of a real creature are cells. The “cells” that our system uses are called “macrocells”. They are much bigger than real cells, but embody mechanisms analogical to those of real cells . Cells have joints such as rigid, ball, rotational joints, and can connect to other cells. The development mechanism is specified by the genome in each cell. Each gene is activated when a particular set of gene products are in the cell. When activated, each gene creates particular gene products. Some of them are used to trigger cell actions, e.g. cell division, creation of joints, necessary for the development of the creature.
The creatures are simulated by ODE (Open Dynamics Engine) library. In the future, the generated creatures will be also fabricated as real robots by small hardware modules and electrical circuits.

1. Introduction

In this work, we apply biological concepts of development to simulate artificial creatures. There are some researches that use biological concept to create artificial life. We design our algorithm within the framework of artificial development proposed by Bongard and Pfeifer [2]. This approach tries to model a gene regulatory network based on a set of genes in the genome [6,7].
The gene regulatory network is used to implement the developmental process. That is analogous to biological development. This approach contrasts to more traditional approaches to the simulation of artificial creatures, where the phenotype corresponds to the genotype almost one-to-one [1,3,4].
Section 2 describes the morphology of artificial creatures and fundamental principles

of development, e.g. gene expression, diffusion of gene products, and neural network. Section 3 discusses the implementation of these concepts. Final section provides conclusion and future work.

2. The Model

2-1. Creature Morphology and Development Mechanism

Building blocks of a real creature are cells. In this work, spheres are used to represent cells. Agents begin its development as a single cell. Each cell has sensors such as touch sensor and distance sensor. The cell can contain joints and internal neurons. The cell may grow until the radius is double. Then the cell splits into two cells, each of which has default radius and inherits the genome from the parent cell.

The development is driven by the actions of each cell at each time step. The action of the cell is divided into two kinds: gene regulatory action and structure building action. The action of the cell at each time step is determined by the current state of the cell. The state of the cell is defined by the gene products in the cell and their concentrations. The gene products that trigger structure building actions are called structural genes. The gene products that trigger gene expression to produce gene products are called regulatory genes.

When genes are expressed, the gene products are generated at specific diffusion sites. They are diffused to nearby diffusion sites as time passes by. Six peripheral sites are defined midway along the six line segments originating at the center of the sphere. We also set up the “central site” at the center of the cell.

The cell division action is triggered when the growth enhancing gene product is greater than a threshold and the difference between the growth enhancing gene product and the repression gene product is greater than a threshold at any peripheral site. The new daughter cell is attached to the parent cell at that site.

If the concentration of the joint creation gene product is greater than a threshold at the site where the cell division has occurred, a joint is created. When the joint is not created, the parent cell and the daughter cell are connected rigidly.
The joint receives a signal from the motor neuron, which receives signals from various sensors via internal neurons (Fig1). During development, at each time step, gene products get diffused to the neighbour sites in the same cell and to the neighbour site in the neighbour cell at certain rates (See Fig 2). Gene products also decay at the sites where they are created at a certain rate each time step.

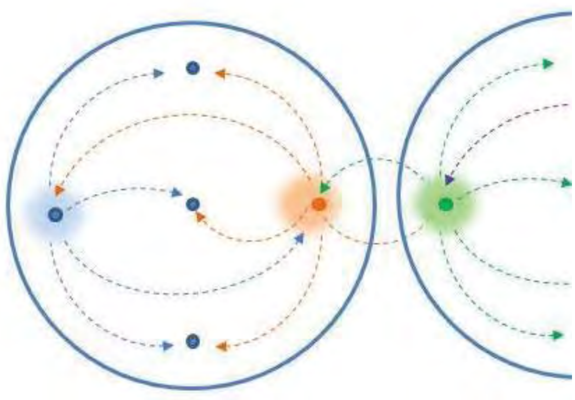

Figure 1.Diffusion of gene products

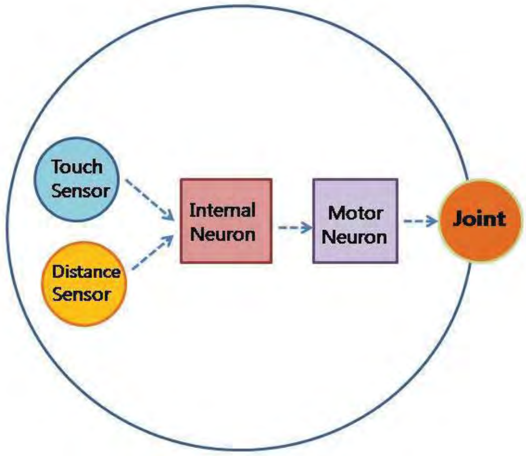

Figure2. The flow of signal transmission in the single cell

2-2. Sensors and Neurons

Sensors /Neurons	Abbreviations
Touch sensor	TS
Angle sensor	AS
Distance sensor	DS
Motor neuron	MN
Bias neuron	BN
Oscillatory neuron	OS
Internal neuron	IN

< Table 1. Sensors and Neurons>

Sensors detect signals of the environment (See Table1). Each diffusion site in the cell can contain neurons, sensors and motors. Internal neurons receive signals from sensors and other internal neurons (Fig 3).

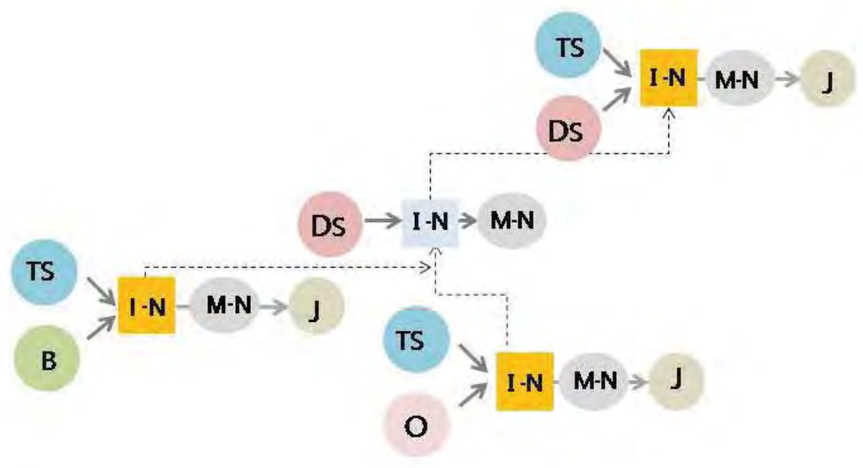

Figure3. Internal neuron nodes

The touch sensor of a cell is activated when the cell contacts either the target object or the ground. The angle sensor returns the angles of the connected joint. The distance sensor returns the distance of the cell to the target object.
The oscillatory neuron generates a sinusoidal signal and the bias sensor generates a specific constant signal. The signals from sensors propagate the motor neuron via the internal neurons. The motor neuron controls a degree of freedom of the joint.

Neurons and sensors are created in a similar manner as cells themselves. The creation of neurons and sensors are triggered by the states of the cell, which are specified by neuron creation gene products and their concentrations.
A touch sensor is created at a site when the touch sensor creation gene product has concentration greater than a threshold at that site.
Similarly for angle sensors, distance sensors, bias neurons, motor neurons and oscillatory neurons. When a motor neuron is created at a given site, it is connected to the joint at that site, if it is already there.

When the internal neuron creation gene product is available at sufficient concentration, an internal neuron is created. It is connected to the motor neuron at th e site, if it is already there. Each sensor is connected to the most recently created internal neuron that is not yet connected to any sensors.
If such internal neuron is not available, the most recently created internal neuron is used, even if it is connected to another sensor. An internal neuron can be divided when it is not connected to any sensor.
It can be divided in serial connection or in parallel connection depending on the regulatory gene product triggering the operation.

Only the non parent internal neurons can be divided. In the case of serial division, the two neurons are connected. In the case of parallel division, the two neurons are connected to their parent neuron (See Fig4).

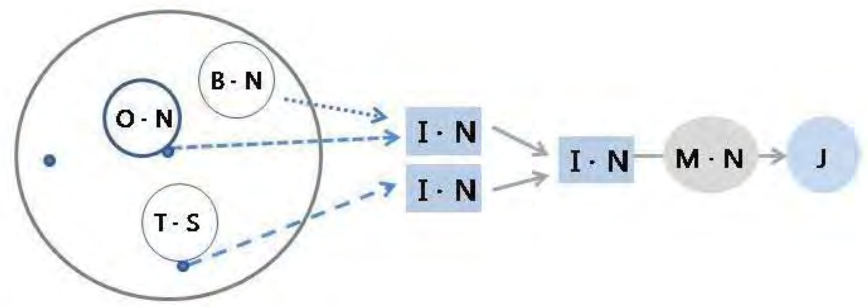

Figure 4. The parallel division of an internal neuron.

The internal neuron sums the input signals from the connected sensors or other inter nal neurons. The output signal of an internal neuron is scaled into range of (-1, 1).

The agent's motion is accomplished by the joint angles generated by the motor neurons. The above rules of neural network development does not ensure that the developed neuron network is well connected and works. It depends on the sequence of structural gene products. In turn, it depends on how the genome is defined. Since in our approach, the genome is generated randomly, only a few creatures will have working genomes and develop successfully.

2-3. Design of the Genome

The development mechanism is driven by the sets of structural gene products and their concentrations. The structural gene products are created by the genes in the genome. A gene is designed to create a regulatory gene product or a structural gene product depending on regulatory gene products currently available in the cell. We use 13 structure gene products, and 10 regulatory gene products (see Table 2, 3).

A gene has the header field and 9 parameter fields (Fig 2). The header field is the promoter. The promoter indicates the starting position of the gene along the genome.

The 9 parameters are used to regulate the gene expression. The parameter P1 (See Fig2) is the enhancer. If its value is greater than 0.5, the gene expression is enhanced by the presence of the regulatory gene products mentioned in the fields P2 and P5. Otherwise, the gene expression is repressed. Parameter P2 indicates on e of13 structure gene products. Parameter P3 and P4 define the range of P2's concentrate on in which the gene expression is enhanced or repressed. Parameter P5 indicates one of 10 regulatory gene products. Parameters P6 and P7 define the range of P5's concentration.

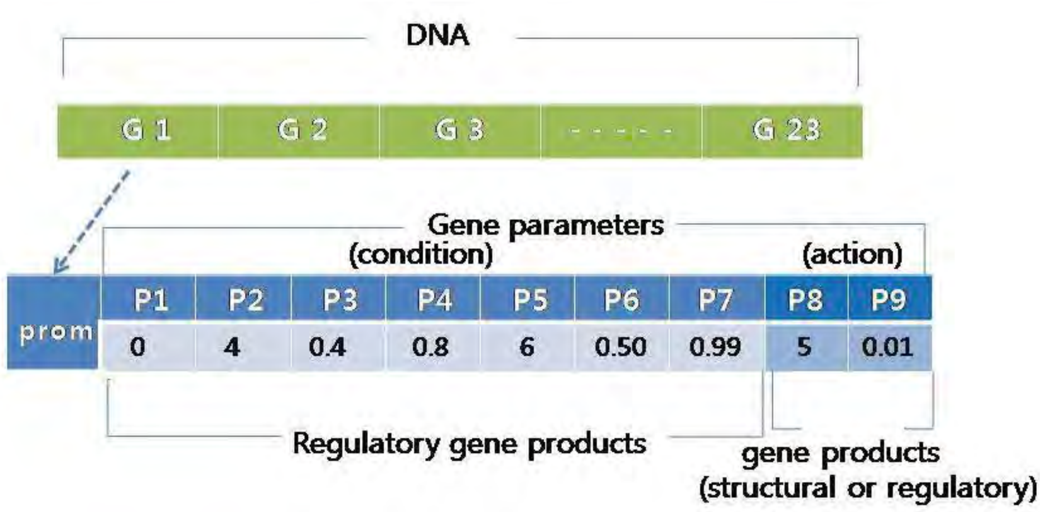

Figure5. The structure of genes

The gene expression is triggered when both regulatory gene products denoted by P2 and P5 are available in the cell and their concentrations are within the given ranges. Parameter P8 indicates one of 16 gene products which include both regulatory gene products and structural gene products. Parameter 9 defines the concentration of the generated gene product each time the gene is activated. The generated gene product is assumed to be injected at the central site of the cell.

To generate the genome the parameters of the genes are set randomly. To start development, some regulatory gene products should be injected into the initial cell. For example, the growth enhancer gene product and the growth repression gene product can be injected to opposite diffusing sites of the cell.

3. Development of Agents and their Simulation

Gene product	Description	Gene product	Description
GP1	Growth enhancer	GP 8	Create internal neuron
GP2	Growth repressor	GP 9	Create Angle Sensor
GP3	Create motor	GP10	Create joint
GP4	Create touch sensor	GP11	neuron serial division
GP5	Create distance sensor	GP12	neuron parallel division
GP6	Create oscillatory neuron	GP13	neuron division repressor
GP7	Create bias neuron		

<Table 2. Actions of the structural gene products>

Gene products	Description
RP1~RP10	Any two of the regulatory gene products are used as the triggering condition for gene activation

<Table 3. Regulatory gene products>

The development process is implemented by the following algorithm:

1) Generate a set of 23 genes by generating the values of the fields randomly. The structural gene products can range from 1 to 13 and the regulatory gene products can range from 14 to 23.
The values of the other fields can be set randomly up to reasonable constraints. For example, in the case of range values, the lower limit cannot be greater than the up-per limit.

2) Inject the created genome into the initial cell, and inject the initial regulatory gene products into the cell.

3) For each time step until the specified steps N, do:

3-1) Grow each cell.
3-2) Decay and diffuse the gene products of each site by the specified rates for all cells.
For each cell, do:
3-3) Visit each gene.
3-4) Check if the conditions of each gene are satisfied.
That is, if regulatory gene products of the gene and their ranges are satis-fyied by the current state of the cell.
3-5) If so, generate the gene product of the gene by the specified amount.
3-6) For each structural gene product, perform the action associated with it If the conditions for the action are satisfied by the current state of the cell, that is by the structural gene products and their concentrations.

Once the creature is generated by the developmental process, its behaviour is simulated by the ODE engine [8]. Since during the developmental process, the creature is created according to the creature data structure used by ODE, the creature can be directly simulated by implementing the simulation function so that it can access the creature data structure.
Figure 6 shows the result of artificial development of creatures which are composed of spheres.
At the present moment, the developmental process proposed by the paper is not sufficiently tested, and a full implication of this approach is not available. Also, the developed agents are supposed to be selected by testing their performances. It is because the genome used for development is created randomly, and most of them do not produce viable agents. This evolution step is not yet implemented at the moment.

4. Conclusions and Future Work

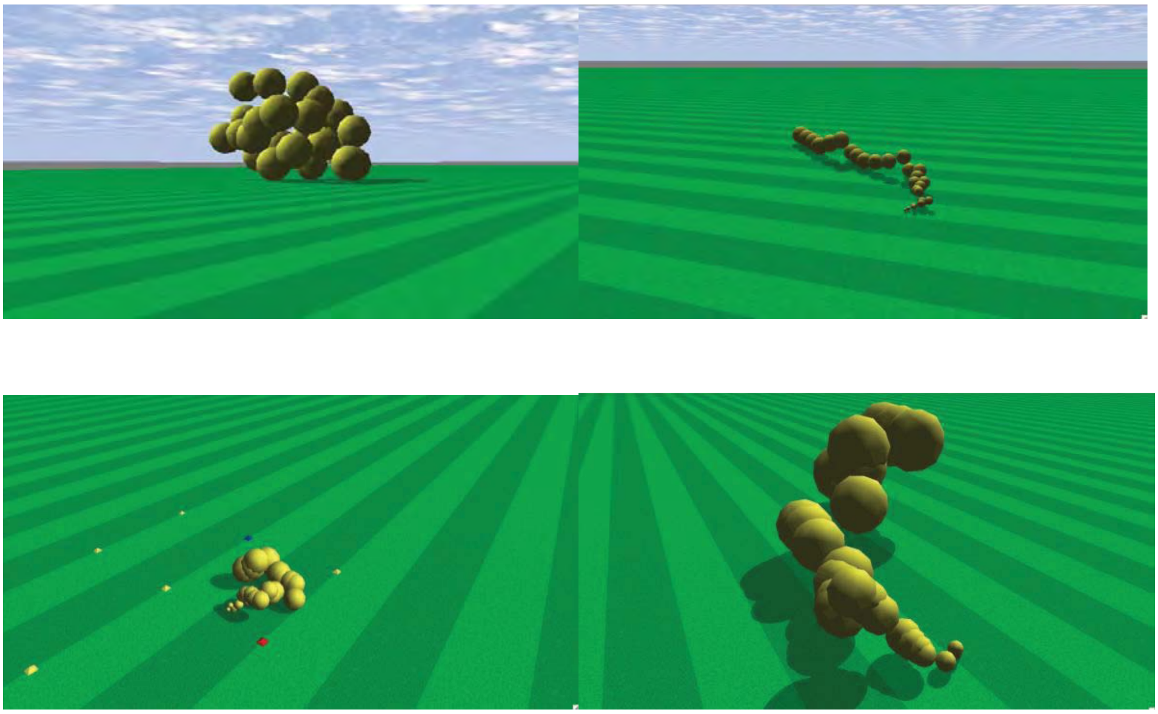

Figure 6. Developed agents

In this work we proposed a gene driven mechanism of the development as a new way of designing and simulating artificial creatures. The strong point of the approach is that the phenotype is developed via a mechanism hidden in the genome as in real creatures. Though the proposed mechanism is extremely simple compared to that of real creatures, the basic architecture of the mechanism is analogous to that of real creatures.

This approach is expected to give us some hint to the mystery and beauty of biologic al development by means of constructing artificial creatures by using biological principles.

In the future we plan to fabricate the generated creatures as real robots by small hard-ware modules and electrical circuits.

5. References

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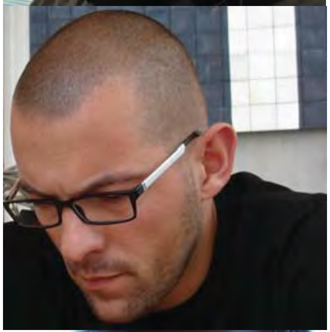
POSTERS, SHORT PAPERS
INSTALLATIONS, ARTWORKS
LIVE-PERFORMANCES

André Rangel

Live Performance: **OAV, Multimodal Object**

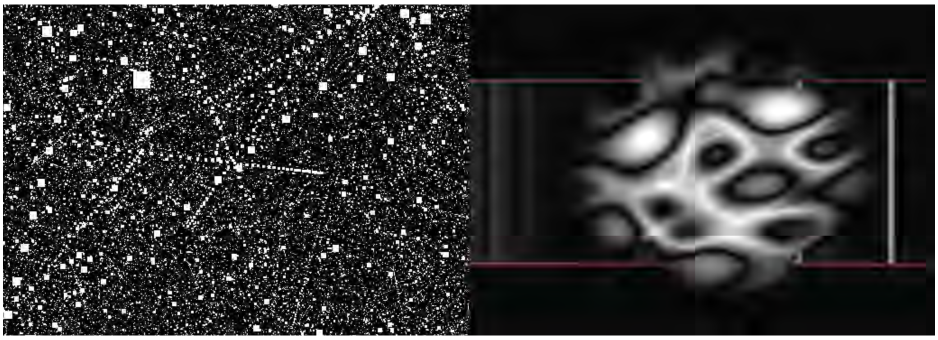


Abstract:
OAV is a multimodal performance system, programmed and operated by A. Rangel, actuating in the visual domain, and M. Carvalhais and P. Tudela in the audio domain. OAV is not designed as a self-running autonomous installation, rather as a performance tool to be deployed in coprocessing with human operators. OAV's structure is generative, with varying outputs ranging from minimal to extremely noisy, progressing from a high level of abstraction and a slow tempo to near figuration and an increasingly accelerated rhythm.

The object simultaneously uses real time generative and processing methods: 1) a noise generator based on matrices of pseudo-random values; 2) procedural models generating visuals and audio of arbitrary resolution and open-ended variation; 3) incorporation and reprocessing of inputs from the physical world. The audial layer is created from the integration of algorithmic processes, synthesis and field recordings, partly auto-actuating, partly performed live with computational tools.

The visual procedural technique is based on algorithms that generate coordinates along a Cartesian grid, transformed by offset and rotation. The algorithm accesses a pseudo-random coherent noise mathematical function, inspired in Voronoi tessellations, to create texture and modify geometry. The visual outputs are reminiscent of imagery of the nanoscopic world, this was not the result of a conscientious decision or of an aesthetic influence, but rather a resemblance discovered after the image generating processes were programmed. Beyond plastic and structural similarities, the processes use high levels of codifying, meta-codifying and trans-codifying techniques that cause totally synthetic systems to resemble chemical and biological entities.

OAV was premiered at "Granular at Ar.Co", May 2011, Lisbon. http://www.granular.pt/granular_arco.html Duration: approx. 30 min.



Topic: Art, Music, Performances

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Keywords: Audiovisual, performance, generative, computational

Angela Ferraiolo

SUBWAY

Topic:
Generative Video

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SUBWAY was shot in New York during the fall of 2010. The footage was then color graded, converted to single frames, and reassembled dynamically by a computer. After a series of experiments with computational text, there seemed to be some similarities between the deep grammar of language and the somewhat intuitive decisions involved in sequencing montage. For instance, while watching a heavily edited film sequence, or some kinds experimental video, one might feel a kind of linguistic architecture guiding certain motifs, one that seems similar to certain kinds of computationally generated text. The idea behind Subway was to take a long sequence of still frames and arrange these according to a linguistic architecture. The movie has relations to traditional film grammar, but it's also related to language itself, so that in some ways it feels new, but in its deep logic there is also something familiar.

SUBWAY Film Still

Screenings:
AIEFF/Australian International Experimental Film Festival
http://www.aieff.org/2011programme.html

NYFF/New York Film Festival: Views From the Avant Garde
http://www.filmlinc.com/pages/subway

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Keywords:
context free grammar, video, generative

Asghar Fahimi-Far

Painted tile work in the Tekkiyeh Muaven ul- Mulk in Kermanshah

Topic: Architecture

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References:
Painted tile work, Tekkiyeh Muaven ul-Mulk in Kermanshah city, Iranian and European patterns.Amanat, A. (1999) Qajar Iran, an article from Royal Persian Painting, ed, Diba, L. Tauris Publishers in association with Brooklyn Museum of Art.

Fahimi-Far, A (1997) Eshq-e sharqi, (Oriental Love- The Role of Religion in The Development of The Ancient Arts), Tehran, Qader

Abstract:

This paper examines the influence of both European and Iranian patterns on the painted tile works in the Tekkiyeh Muaven ul- Mulk in Kermanshah city in Iran. These art works based on a new artistic movement which called folk art in the 19th century in Iran.

Popular or folk-art developed intensively during the late Qajarid period (1785-1925) primarily deriving from popular Shi'ah beliefs and rituals. This artistic movement gave rise to some specific architectural forms in the urban landscape of Persian cities- in particular the Husayniyye or Tekkiye, where the popular Shi'ah rituals and practices were performed. These Tekkiyes were decorated with murals, painted tiles, and canvases showing the major personalities of the Shi'ah pantheon and their exploits. The building of religious edifices for theatrical performances and the decoration of these Tekkiyes and other structures with figurative representations of the holiest and most revered personalities, displayed for the public at large, was a startling new development in the history of Persian Islamic art (Chelkowski, 1999). The improvement of folk mural decoration and wall painting was, paralleled with the growth of the religious architectural spaces such as the Takkiye at the same time. For all social classes the artistic movement associated with the Takkiye was triggered and inspired by the annual commemoration in Persia of the Karbala tragedy (Chelkowski, 1986 & 1999). In the nineteenth century the Takkiye became a major feature of Persian urban life..

The building of Takkiyes reached its zenith during the late Qajarid period. According to Salari (1992) there were many Takkiyes in Iranian cites such as Kirmanshah. The Tekkiye Mu'aven ul-Mulk in Kermanshah is generally held to be among the best of the survivors. The construction of Tekkiyes in Persia was largely based on the popular artistic movement which grew during the late Qajarid period. It is ornamented with many painted tiles whose subject matter is largely religious.

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Keywords:
Painted tile work, Tekkiyeh Muaven ul- Mulk in Kermanshah city, Iranian and European patterns

Painted tile work in the *Tekkiyeh* Muaven ul- Mulk in Kermanshah

A study on the influence of the both Iranian and European patterns on the painted tile works this place

(1785-1925)

Dr Asghar Fahimi-Far
University of IRIB (University of Islamic of Republic of Iranian Broadcasting)

Popular or folk-art developed intensively during the late Qajarid period **(1785-1925)** primarily deriving from popular Shi'ah beliefs and rituals. This artistic movement gave rise to some specific architectural forms in the urban landscape of Persian cities- in particular the *Husayniyye* or Tekkiye, where the popular Shi'ah rituals and practices were performed. These Tekkiyes and subsequently other architectural forms such as *saqqakhanehs* (wayside shrines providing water for wayfarers) were decorated with murals, painted tiles, and canvases showing the major personalities of the Shi'ah pantheon and their exploits. The building of religious edifices for theatrical performances and the decoration of these Tekkiyes and other structures with figurative representations of the holiest and most revered personalities, displayed for the public at large, was a startling new development in the history of Persian Islamic art (Chelkowski, 1999). In fact traditional royal art now ended gradually with the Nasirid court (Nasir-al-Din shah, 1843-1852, was one of the most famous Iranian kings. Nasirid court or Nasirid period were derived from Nasir-al-Din shah). It was succeeded by popular art with the same patterns and techniques. New patrons, such as urban merchants contributed to its growth. The improvement of folk mural decoration and wall painting was, paralleled with the growth of the religious architectural spaces such as the Takkiye at the same time. For all social classes the artistic movement associated with the Takkiye was triggered and inspired by the annual commemoration in Persia of the Karbala tragedy (Chelkowski, 1986 & 1999). In the nineteenth century the Takkiye became a major feature of Persian urban life. In fact during Nasir-ed-Din Shah's reign the pride of any Persian community was its Tekkiye. In this form may be a uniquely Persian feature and certainly characteristic of 19th century.

The building of Takkiyes reached its zenith during the late Qajarid period. According to Salari (1992) there were forty-five Tekkiyes in Tehran in 1870. There were also many in other provinces such as Kirmanshah, Isfahan, Kashan, Kerman, Shiraz, Yazd and Mashad. The Tekkiye Mu'aven ul-Mulk in Kermanshah is generally held to be among the best of the survivors. The construction of Tekkiyes in Persia was largely based on the popular artistic movement which grew during the late Qajarid period. The Tekkiye of Muaven ul- Mulk was built in 1890 (A.H. 1315) by Muhammad Hasan Khan Muien ul-Ru'aya (Muaven ul-Mulk). It is ornamented with many painted tiles whose subject matter is largely religious.

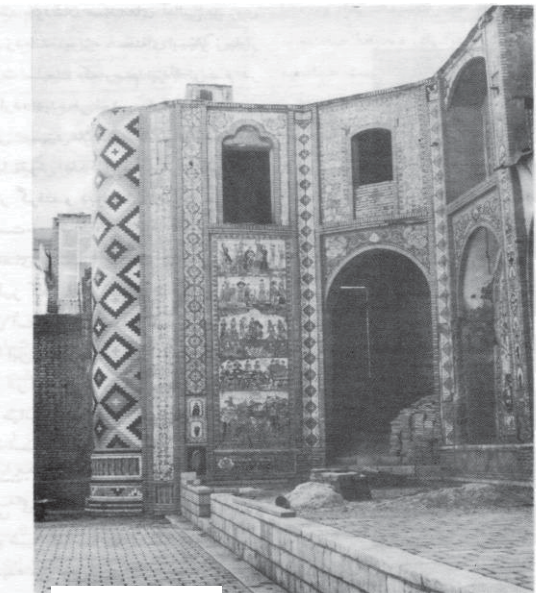


Fig. 1a

Fig. 1b

Fig. 1c

1a. A view of the Tekkiyeh Mu'aven ul-Mulk from its northeastern side

1 b. A general view of the dome of the Tekkiyeh Mu'aven ul-Mulk from the section which is called Zaynabiyeh.

3 c. An interval view of the Abbasiyeh of the Tekkiyeh Mu'aven ul-Mulk. After Salari (1992).

Note: as the superintendent explains, different parts of this place were named for Imam Husayn and his family. For example the Zaynabiyeh derived from the name of the sister of Imam Husayn and the Abbasiyeh referred to his brothers. Both of them were with the Imam at Karbala. The name of Imam Husayn was given to all the Tekkyie (*Husayniyye)*. For this reason such places are known alternatively as Husayniyye in Persia and other Shi'ah strongholds such as Bahrein.

In terms of painted tile work, the Tekkiye Mu'aven ul-Mulk in Kermanshah is one of the finest in Persia**.**

Religious identity and the function of the Tekkiyeh Mu'aven ul-Mulk has controlled the subject matter of the majority of tile works of the building which have focused on religious events, often in the form of Qur'anic stories and also in particular the events of the martyrdoms at Karbala. Moreover some tiles portray national stories, which, for the most part, originated in the *Shahnameh* of Ferdawsi. The depiction of the tragedy at Karbala and the martyrdom of Imam Hussain with the epic national stories provide common motifs for the tile work of this type of building. In contrast to the polarization of politics and religion by intellectuals during the late Qajarid period however the national and religious concepts were integrated and correlated as different aspects of common beliefs. Consequently a single group of folk artists seen to have used both nationalistic and religious material as subjects in these places.

To illustrate both traditional and European influenced, I have selected some of the most important and relevant works in the Tekkiye Mu'aven ul-Mulk.

Fig. 2. Detail of a panel of painted tiles dated to the later 19th or early 20th centuries showing the battle of *imamzade* Qasim, Imam Husain's nephew, with the enemy. Photograph by the author.

Note: this work shows continuity of the Iranian traditional artistic patterns in both theme and style. The title written at the top is 'the battle of Qasim'. Artists for the most part use similar patterns to depict different stages in the Karbala story. The Imam's family are very similar. Therefore the painter tries to distinguish such scenes by their title. This pattern is regarded as a very old tradition in Persian art (**see fig. 2. a**).

Fig. 2.a. Two harem girls dating to 1811- 14. attributed to Mirza Baba. Oil on canvas. Collection of the Royal Asiatic Society, London.

Note: The artist depicted two harem girls in archetypical form and in identical pose. The painter displayed his personages and other natural objects in an absolutely typical way which pointed to celestial and divine rather than material beauty. Artists tried to discover and display archetypal forms and turned the objects in a typical way. This tradition penetrated into early Qajarid art. The early Qajarid artist recovers this traditional pattern and discarded the European element which was promoted in the Safavid period. In the early Qajarid period artists tried to idealize the subject. The static quality as well as the striking resemblance between many figures (men with men and women with women) suggests that the early Qajarid artists were not interested in portraying the personages as individuals, but as stock types to blend into the painting's decorative setting. (See detail of fig. 2.a).

Detail of fig. 2.a

The Persian artist always tried to present heroes in a typical way. Here Qasim is presented in his youth, very beautifully, with strong eyebrows recalling the common type of miniature. Good people were always represented beautifully and their enemies were portrayed with ugly faces.

Detail of fig. 2

Fig. 3. Detail from a coffee house painting by Qullar Aqasi, dating from the first 20th century showing Ali Akbar (the son of Imam Husain) in battle at Karbala. The out-stretched hoorses neck and the position of its rider compares directly with the portrayal in the Tekkiye.

There are essential similarities between this paintings and fig. 2. Only title distinguishes them.
The artist would enlarge Qasim and his enemy to emphasize their significance in the narrative. In order to show the mass of the enemy the artist followed tradition by crowding the canvas.

Basically the religious and social role of these stories is to arouse the emotion of the Shi'ah against their historical enemies. This was the purpose of the painted tiles. These pictures combined to lead the Shi'ah to a proper understanding of events, particularly at Karbala and so to justify the separation of their sect from Sunni Islam. That is why painted tile work with a religious theme was associated with the Taziyeh (passion play) as another aspect of religious art in the period. In fact both of them had similar religious and social objectives and were part of the same phenomenon.

Fig.4.1.

Fig.4.2.

Fig.4. 3.

Fig.4. 4.

Fig.4.1. Ali Akbar, Imam Hussein’s son. Unknown artist. Dated to the first half of the 20th century. 170 x 110 cm..

Fig.4. 2. Qamare-e Bani Hashem, anonymous. Dated first half of the 20th century. 170 x 110 cm. Photograph by the author

Fig.4. 3, Qasim Ibn Hasan, anonymous. Dated first half of the 20th century. 170 x 110 cm. Photograph by the author

Fig.4.4. Imam Hussein, the victim of injustice, anonymous. Dated first half of the 20th century. 170 x 110 cm.
Photograph by the author

Note: These works in the Tekkiye Mu’aven ul-Mulk express the different stages of the tragedy of Karbala. Shi’ah followers know such stories very well because the Ulama (the Shi’ah priests) recite them endlessly. Their verbal presentation is echoed in the pictorial presentation. All the iconography of the events at Karbala followed distinguishable archetypes. For this reason the personality and character of the artists was not allowed to impinge on the works. Individuality was sublimated to the dominance of the theme.

The similarities between figures in terms of technique and composition, demonstrate that they have been created by one specific artist.

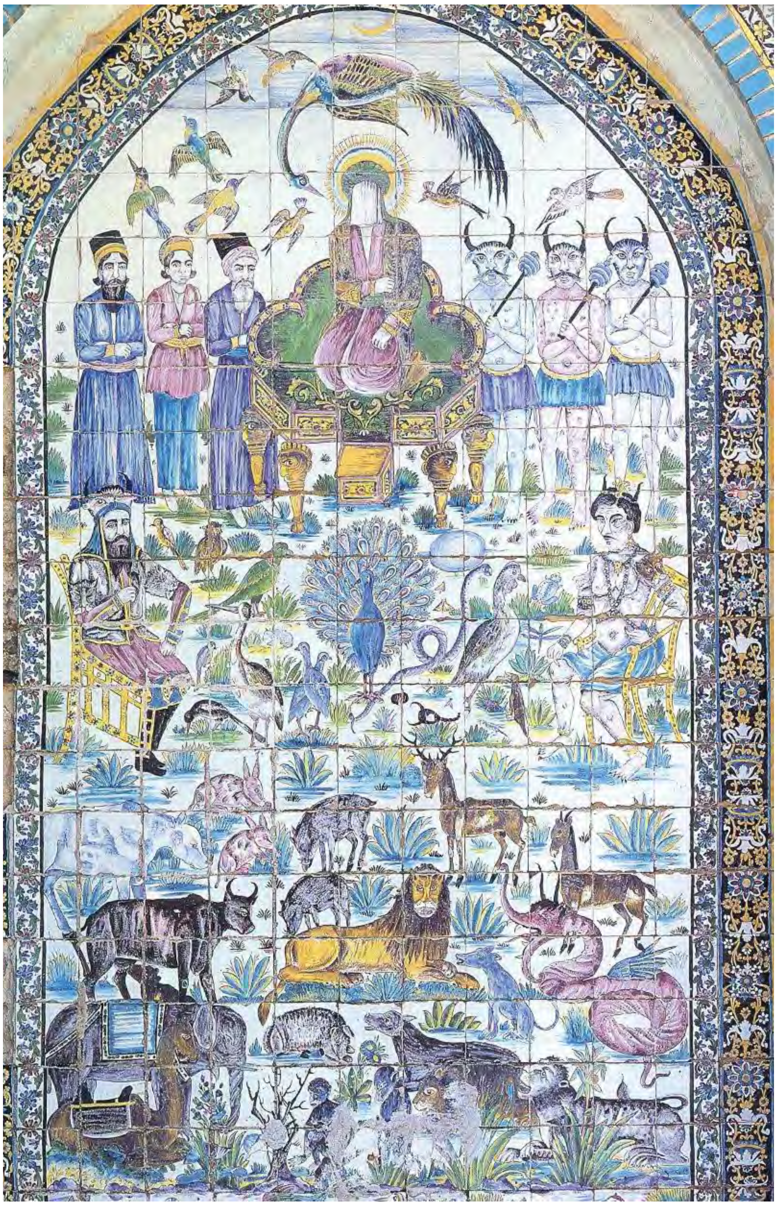
Fig 4.1 portrays the martyrdom of Imam Hussin’s son Ali Akbar. It is one of the most tragic and important elements of the Karbala stories in which Ali Akbar as teenager embraces his father after a major battle. According to the history of Karbala Imam Hussain embraced all his companions in his last moments.

At first glance the type of framing commands attention. The cartouche dividing the literal subject from its surroundings was introduced to Persia through postcards and picturesand became significant during the Qajarid period, together with, it seems, the attaching iris flowers. These are of European derivation.

The three quarter viewpoint and similarities are evident in all them. The stance derives from European religious iconography in subjects such as the Madonna and child. Persian patterning around the frames is intended to beautify the composition; but otherwise, caries no symbolic meaning.

In such tiles the face of Imam Hussain was covered by a veil because according to the Shi’ah beliefs the painters are not allowed to show the face of the Holy prophet and the innocent Imams. Despite this some painters did.

The halo beyond the head of Imam Hussain emphasizing his sacred position probably cames from the Christian iconography of Persia during the Safavid period (1502-1722) A.D.) . It should not forgotten that the halo appears in Sasanid (642 AD-224 BC) relief depicting Mithra, the God of Light.

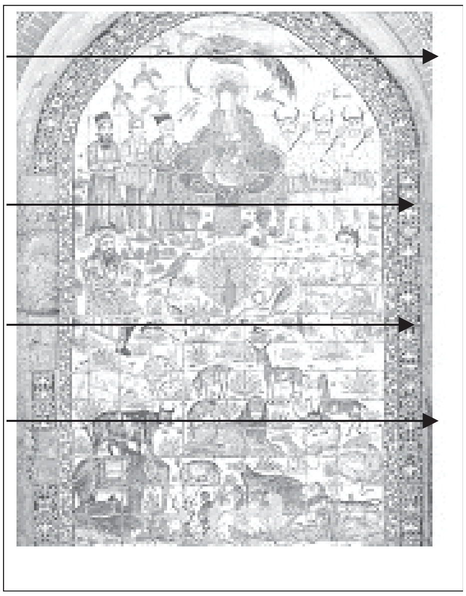


5. The panel of the prophet Solomon Tekkiyeh Mu'aven ul-Mulk in Kermanshah, artist unknown. First half of the 20th century, 400x 2660 cm,

Note: The panel is based on a Qur'anic story. According to the Qur'an and other religious sources the prophet Solomon had a splendid court. He governed people, animals and divine beings (*Jen)*. All are depicted in this panel. Birds shade his head to protect him from the sun and he is able to converse with the creatures around him.

The conception of space in this work is totally derived from tradition and is essentially two-dimensional. There is no sign of perspective so the artist employed traditional devices to show the various several depths within the viewing plane.

Fig. 5a. Shows different layers of the composition.



Solomon seated on the throne is placed at the top of the composition, surrounded by courtiers. His superiority is shown by his position; this pattern, derived from the Achaemenid phase (550B.C.-330B.C.)

, has been constant throughout Persian history. The face of Solomon is covered by a veil out of respect for religious bans which ban the artist from showing the countenance of the sacred person. Birds fly around Solomon in profusion. According to the Holy Qur'an (a flock of birds was commanded to fly above Solomon's head, to shade him. The *Symurgh* (a fabulous bird) as a symbol of *Ensan-e Kamel* (the noblest of men) flys around the head of Solomon identifying him as perfection among human kind. According to the Holy Quran all the animals and Divines were within Solomon's dominion and obeyed him. Consequently animals occur throughout the composition.

In the second layer, Rustam, the national Iranian hero, is seen seated on the left faced by the *Dive-e Sefid* (white devil). According to the Shahname,(book of king) Rustam killed the *Div-e Sefid*, in order to rescue the king. The question arises as to why Rustam was added to the composition. While Rustam was considered a national hero who served the Persian kings before the coming of Islam it seems that here the artist deliberately tried to integrate religious and national myths. As Meskoob (1998) claims it was in order to integrate national beliefs and Islamic ideas that Persian artists tried to redefine and revaluate their ideas. For instance they made *Kiumarth*, the first Persian man, into Adam and Jamshid one of the greatest mythological kings into Solomon. In this way, Persian cultural history became more intimately associated with Islamic culture.

The courtiers on the right side of Solomon, are wearing Qajarid clothes. Qajarid kings took on the inheritance of the prophets.[1] The Shah is also metaphorically seen as Solomon, in Persian poetry. Therefore the artist also tries by this association to link his work with the Qajarid rulers.

The composition is based on a symmetrical balance. This is clear at the top. At the bottom the lion, symbolic of the monarchy, is placed on the centre line and is surrounded by animals. The lion may here symbolized Solomon, or the king, reflecting mythological beliefs, which is why the artist has used a warm colour (yellow) to make a connection between them.

This analytical image illustrates the composition based on a symmetrical sub division. Despite the continuity of Persian tradition some European elements such as anatomy, shading and lighting enhance the detail of his composition.

[1] As is evident in the letter of Fath Ali Shah to the king of Afghanistan (Haeri, 1999).

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Anna URSYN

Artwork

TITLE: Programmed Artwork - Computer Art – Nano Art

Abstract:

Generative art results in precise images with perfect lines that follow premeditated transformations Through the use of software I can recycle drawings along with generative shapes and patterns. In my works, natural order infuses several levels of both worlds: some determined by man and some determined by nature. It guides our understanding of big data sets related to network analysis, whether we employ physical analogies of the data, render the data graphically, or interact in real time. I examine what technological and human worlds have in common. My task is to juxtapose the regularity of nature with man's constructions, both physical and intellectual.

Topic:
Programmed Art

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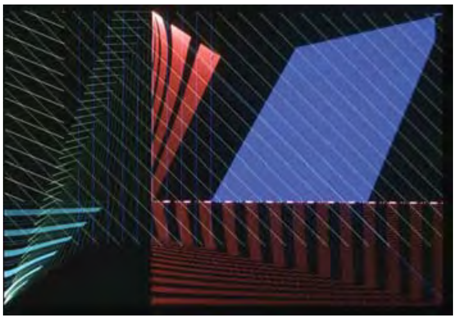
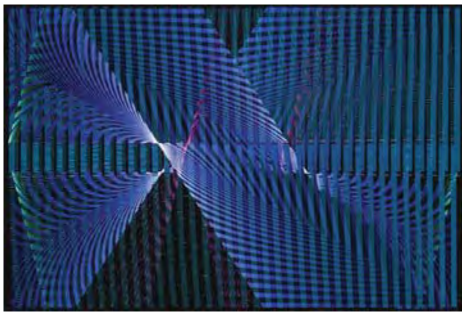
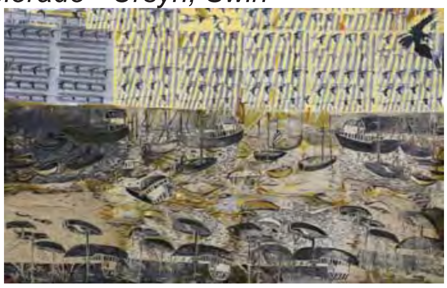
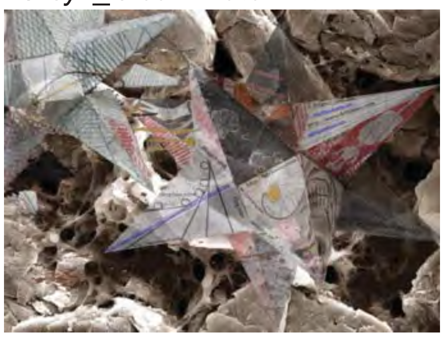




Ursyn, Report from Colorado - Ursyn, Swirl



Ursyn, Green Architecture - Ursyn_Clean Water Art



Ursyn, Nested Watch - Ursyn, Draco

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Keywords:
Programmed art, Computer art

Brian Evans

music/animation:

cartographs: Coding Metaphor in Visual Music

Topic: *visual art, music, metaphor, data mapping, computation*

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Abstract:
The visual music composition *cartographs*, is a audio-visual work in three short movements. Each movement is an abstract animation—a visualization of a numeric process—that then is also mapped into sound. Through the process of data mapping we hear and see a process unfold, each sense simultaneously experiencing a map (a metaphor) of what the other sense is experiencing.

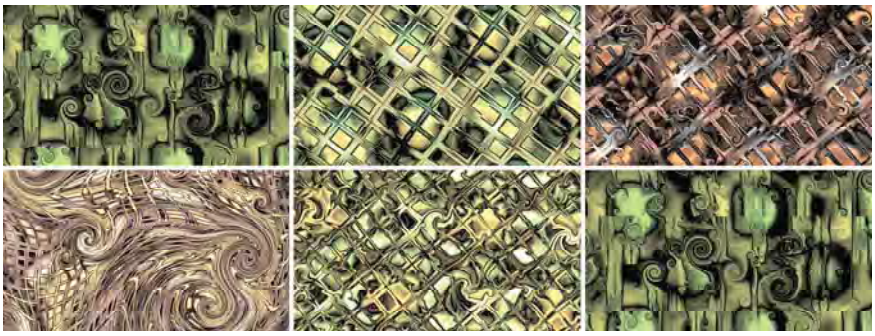
Artist statement:
Maps are metaphors. Through metaphors we connect what we experience to what we remember. We create knowledge by connecting the new (the present) to what we know (the past) and so maybe predict what happens next (the future).

Our desire to predict is fueled by our desire to live, to survive. Desire is the foundation of narrative. Narrative reduces to desire, action and result—the structure of story. We exist in endless loops of desire—layer upon layer of stories of varying temporalities and shifting priorities—all synchronized to rhythms of breath and heart. [1]

I make maps, in and out of time. I start with raw digital code—simple numeric models. As all is number in the computer I can map the numbers to the senses—turn numbers into tangible experience? [2] The maps might loop in time. There is synchrony in the sensory vertical and the temporal horizontal as image and audio derive from the same numeric source. Each maps the other in the moment and through time. It's a visual music in a synæsthetic counterpoint.

Musical narrative developed over centuries, moving the listener through time with the Pythagorean struggle of harmonic conflict—dissonance seeking consonance, number seeking a simpler and simpler ratio. My little loops and images engage that struggle at various levels. Color shifts. Composition flows. Image and sound agree, complement, disagree and resolve.

Perhaps it's abstract expressionism, true to its digital materials, founded in musical traditions and Modernist formalism. But it's loosened a bit. It's jazz in color, shape, sound and computation. Relax. Hear the colors. Listen with your eyes.



This strroryboard of "calidri" (first movement of "cartographs") shows a loop, with the last frame of the animation the same as the first frame.

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[2] Evans, B., Simple Mapping and the Aesthetic Dimension, *Matematica e Cultura 2007*, ed. Michele Emmer, Italian trans, Winter 2007 Springer-Verlag Italia: Milan..

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Keywords:
visual music, art, metaphor, data maps, computation

Brigid Burke

Performance: **A Snapper is a Feast, Hats and Blooms and Death**

Topic: Performance/ Music/Visuals

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References:
[1 Goldstein, Malcolm. Sounding the Full Circle (1988) The Gesture of Sounding 8/26/1986
[2 Russolo, Luigi The Art of Noises(extracts)1913 Published as a leflet by Direzione del Movimento Futurista, Milan 11 January
[3 Colour and sound by Maura McDonnell
mmcd@soundingvisual.co mAcknowledhements

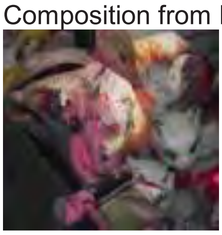
Peformance Notes: *clarinet, Live Audio Mulching (laptop) & video projections*

Blooms and Death (2011)
This short Interlude brings new life to the image of the red stationary rose and blowing images in the fan to create a fast and racy visually, accompanied by a beautiful soundscape. There are occasional raw utterances from the clarinet but this only adds to the freshness and sense of surprise created in the tapestry of the work. The visuals are forever moving, creating their own pulse and energy to the point where the rose fades to become unrecognizable.

A Snapper is a Feast (2011)
This composition is inspired by the joy of food, eating and the transformation from the live product to the finished banquet. The visuals have incorporated layers of video footage of plated food, coloured pencil drawings of chefs, fish and marzipan figures and these have been combined with computer transparencies of images. The opening audio takes you from hearing the fish swimming in the sea to the clattering of plates, saucepans, knives slashing and sizzles from the stove in the kitchen, through to the intimate sounds of people eating at the Feast and finally the laughter of the party. These familiar sounds are transformed into an abstract world where they are recognisable only as glimmers while the visuals essentially provide a narrative of the journey. The Bb clarinet and voice are processed live with audio mulching enriching the sonic world of layering throughout the composition.

HATS (2010)
Hats was inspired by a dancer wearing a hat moving through a large space. The multimedia composition is comprised of acoustic and electronic sound integrated with the visual palettes resulting in a timbral, dynamic and spatial composition. A layering of pitches is obtained from the whole range of the Bass and Bb clarinets through a multiple sound approach focusing on a central pitch. A continuous pulse is created with clarinets through sub-tones and overtones using quarter notes, monophonics and multiphonics. Real-time Audio Mulching, enabled by the computer interface, contributes further to the possibilities of a sonic world of layered clarinet, subtones and pulse fragmented overtones throughout the composition.

Brigid Burke
Brigid is an Australian clarinetist, composer, video and visual artist. She has had works performed extensively both nationally and internationally, Her involvement in many audiovisual performances has led her to integrate real time sound, visuals and theatre in her performances to create innovative use of sonic objects, speakers, video cameras, computers, clarinet animations, original prints, drawings, digital animation and free improvisation.
She has received commissions and fellowships from many Australian organisations for her performances, compositions and artwork. She is currently c enrolled as a PhD in composition supported by a Graduate Research Scholarship from the University of Tasmania. She also has a Master of Music in Composition from Melbourne University, Australia.

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Keywords: music, composer, multi media artist, clarinet soloist, visual artist, film maker, peformance artist, installation artist, printmaker

Clice Mazzilli

Poster

POETICS OF GENERATIVE CARTOGRAPHY

Topic: Architecture

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References:

[1] Gilles Deleuze, "*Pintura. El concepto de diagrama*", Cactus, Buenos Aires, 2007.
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[3] Joan Fontcuberta, *Googlegrames*. Revista Fisuras. N.14, P 37, Madrid, 2007.

Abstract:
This article presents some partial discussions of the research "Image and representation: maps from urban daily life", which deals with the city as a space of experience, enabling critical and poetic reflections to architects and urban planners. In the contemporary metropolis, spaces formed by flows of images, people and information live side by side with places connected to the history, permanence, imaginary and limits. Recognizing its visuality, its conflicts and tensions can lead to sensitive ways of urban interventions. Considering the complexity of the stimuli generated by these environments, as well as the new information and communication technologies, this research aims to discuss the image and the poetics of great metropolis. We are studying the existence of conceptual matrices in the contemporary city in order to unravel the implicit diagrams in its structure. This proposition is based on the Situationists writings about "drift" (*derivè*) and "psychogeography", and on Deleuze's [1] diagram concepts. This first moment involves breaking with the automated look, according to the urban drift procedures - "a technique of the transient passage through varied ambiences" [2]. The possibilities of urban image mapping are investigated from the grouping of photographic images (people, cars, architecture, places, paths, memories, colours, graphisms). The images are deconstructed and reconstructed in order to clarify, at each time, the generative principles as: simultaneousness, superimposition, excess, mobility, permanence. Joan Fontcuberta's [3] work is the reference used for the photograph map construction. These studies took place at Madrid, Spain.

Image created from 900 photographs, using a free software and an image captureted by satellite (Google Maps, district of Madrid).
Map of the routes traversed.

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Keywords:
urban drift, carthography, poetics, generative, image, diagram

Poetics of Generative Cartography

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Abstract

Contemporary metropolis challenges us to frequent exercises of reflection, discussion and criticism. Spaces formed by flows of images, people and information live side by side with places connected to the history, permanence, imaginary and limits. Considering the complex stimuli generated by these environments as well as the new information and communication technologies the research "*Image and representation: maps from urban daily life"* aims to discuss the image and the poetics of great metropolis. We believe that recognizing its visuality, its conflicts and tensions can lead to sensitive ways of urban interventions. This paper presents some partial discussions of this research. We are studying the existence of conceptual matrices in the contemporary city in order to unravel the implicit diagrams in its structure. This proposition is based on the Situationists writings about "drift" and "psychogeography" and on Deleuze's diagram concepts. This first moment involves breaking with the automated look, according to the urban drift procedures – "a technique of the transient passage through varied ambiences". The possibilities of urban image mapping are investigated from the grouping of photographic images (people, cars, architecture, places, paths, memories, colours, graphisms). The images are deconstructed and reconstructed in order to clarify, at each time, the generative principles as: simultaneousness, superimposition, excess, mobility, permanence. Joan Fontcuberta's work is the reference used for the photograph map construction.

1. Reading the City

Lynch was one of the first authors to approach the image of the city, introducing the idea of "imageability" and "legibility". He investigated the mental image of American cities from the point of view of its inhabitants, and discussed the importance of perception of physical elements to construct the legibility, that is, the ease with which the parts of urban environment can be recognized and organized into a coherent structure [1]. His study emphasizes formal and visual aspects of the built environment, expressed in concepts of visibility and imageability, that superimpose to legibility. He presents the following elements of urban image as a fruit of overlapping descriptions and images (mental maps) of many individuals: paths, edges, districts, nodes, and landmarks. Further, he notes the change of images constructed by people according to the place and the urban elements. Lynch believes it is possible to create clear and harmonics urban images – a highly imaginable city (apparent, visible or readable) with an aesthetic domain that simplifies the environment. He also understands the city as a continuity, with numerous distinct but identifiable parts, where the user could easily orient and move himself.

Amos Rapoport [2] considers mental images as specific arrangements that go beyond consciousness, synthesizing abstract or concrete information. They are mental representations of parts of the reality, known through direct or indirect experience, and group environmental characteristics organized according to certain rules. Thus, this image includes the idea of structure or schemas and incorporates a certain type of ideal and functioning of the world. He defines the components of the image as: 1) ideals and preferences, affective ordering of values; 2) knowledge of reality and ordering of its elements; 3) similarity and grouping in terms of structure, properties and components.

With a broader approach, Rapoport makes some criticisms about Lynch's understanding of image saying that his studies are not reflected in the design process of the built environment. Besides eliminating the "meaning" in the image studies, Rapoport points the super valuing of "legibility" in relation to "complexity" of the image. The perception of social and physical aspects of a city converts it into informational flow. Between deprivation and super stimulation there are desired levels of information. These are the components of environmental complexity. The perception through the senses enriches experience. The memory is always a reflection of the perception richness. The cognition purpose is to clarify the means and simplify them, by focusing on some limited parts.

The city is rich of stimuli and the perceptive experiences are desirable. People desire to know the means cognitively, but also perceive its sensorial richness. The complexity is constituted by the game between the cognitive and its overcome. Then, there is no contradiction between legibility and complexity in the urban environment. They not only are not exclusive but complementary: one depends on the cognition and the other depends on the perception. Where there is excess of clarity, there is not any interest; the complexity is in the small scale of clarity. The perception partially depends on the orientation in space and time. Even if people desire guidance capacity, they also want the complexity and richness. An urban place is not considered attractive if it does not offer possibilities of new information and certain hazards of disorientation (thus avoiding full adaptation, homeostasis and total subliminal perception). Therefore, the complexity not only relates the cognition to perception but suggests levels and "steps for change", i.e. challenges that avoid changes [3].

Contemporary studies in the anthropology field introduce new paths for understanding the image of the "supermodern" city. Marc Augé explores the concept of "non-place" – public spaces of rapid movement as airports, bus stations, subway stations, means of transport, or also hotel chains and supermarkets. Diametrically opposed to the idea of identitary place, readable, relational and historic, non-places are ephemeral, provisional, crossing spaces. However, he clarifies that the place and the non-place have transitory polarities: the first is never completely erased and the second is never fully performed – like palimpsests in which re-register without ceasing the scrambled game of identity and relationship. [4]

In "*The Polyphonic City*", Massimo Canevacci [5] makes an essay about his personal experience in São Paulo city, Brazil, enabling new forms of complex societies interpretation. Featuring São Paulo as “patchwork city”, he presents a methodology of “give voice to many voices”, trying a polyphonic approach to the mult-vocal city. For him, there is no possibility to represent São Paulo objectively. The city shows itself in different facets, that allows one, at any time, a new survey of concepts. To capture the local reality he uses the "drift", characterized as "abandonment to the emotions flow" and defends the attentive look for the signs interpretation.

2. Poetics of Drift

The drift (dérive) – “*a technique of the transient passage through varied ambiences*” [6], created by the Situationists – is characterized by a kind of experimental behavior connected with the urban society condition. The walking aimlessly, the chance, conduct to everyday re-interpretations, to the automated look breakup, leads to an appropriation of urban space by pedestrian. "*The dérive entails playful-constructive behavior and an awareness of psycho-geography effects* (…)" [7,8]. The psycho-geography studied the urban environment, especially the public spaces, through the "drift" and tried to make the map of various affective behaviors on this basic action of walking in the city [9]. The Situationist thought continues current by the critical strength of their ideas, by the announcement of the spectacle-city, the media-city, "whose control of flows is increasingly determined by electronic networks and the urban territory turns into pure virtuality" [10]

2.1 Walking through Madrid

The city was speculated by walking, by drift. Attention and observation were used as opportunities to discover and associate ideas by an unforeseen way. The photograph was the medium used to register this experience. Starting the knowledge of the city by its Centre was a natural impulse (as any visitor). On the other hand, it was necessary to overcome the initial moment of "traveller" in order to achieve the concentration needed for the research work and critical reading.

There was no concern with historic journeys initially, the city was revealing itself naturally. In the exploratory phase, the routes were often fragmented, disconnected. Using the subway, it was common to leave a place and get out on another without knowing the transition between the points. Not all places were photographed. This was a preliminary recognition and had a certain fear. I had a rough idea of the areas that I wished to go: the Centre, the North-South axis of *La Castellana* (crossing several neighborhoods), East and West boundaries. I noted the complexity of the proposed study, once Madrid had extensive approaches possibilities. This phase lasted three weeks. The next step was the preliminary analysis of the first records in order to select the most interesting cases. The first impressions were more sensorial: materials, shapes, colors, textures, rhythms, sensations of amplitude and stricture, monumentality, commanded, many

Descrição dos Percursos

- **Percurso 1.** 02/01: manhã, sem documentação, à pé e de carro. Proximidades da residência: Calle de la Rábida, Calle de Numancia, Calle Alejandro Rodriguez, Calle de Francos Rodriguez, Calle de La Dirección, Av Del Doctor Federico Rubio y Galí, Av de Pablo Iglesias, Av de La Reina Victoria.
- **Percurso 2.** 02 a 05/01: manhã, tarde e noite. Centro da cidade: Gran Via, Plaza de España, Plaza Callao, Plaza Puerta del Sol, Calle Preciados, Calle Alcalá, Plaza de Cibeles, Paseo del Prado, Paseo Recoletos, Plaza Collon, Calle Serrano.
- **Percurso 3.** 06/01: Gran Via, Calle Alcalá, Puerta de Alcalá, Parque del Retiro, Av Menendez.
- **Percurso 4.** 08/01: manhã. Sem documentação: Puerta de Toledo, Ronda de Toledo
- **Percurso 5.** 10/01: Paseo del Prado / Estacion Atocha / Plaza del Emperador Carlos V / Calle de Atocha / Calle del Doctor Drumen / Calle de Santa Isabel / Centro de Arte Reina Sofia.
- **Percurso 6.** 12/11: manhã e Tarde neve em Madrid. Entorno c/ de La Rábida, Cidade Universitária,
- **Percurso 7.** 14/01: Av de La Reina Victoria, c/ Calle del General Rodrigo, C/ Julián Romea, Paseo de San Francisco, c/ de Guzmán el Bueno, Av de Filipinas, c/ Cea Bermudez / Teatros del Canal. 2a parte Barrio del Pilar, c/ de Ginzo de Limia / Calle 30 (M30) / Av de la Ilustración, Paseo de La Vaguada, Teatro de Madrid.
- **Percurso 8.** 16/01, 11:00 a 17:00h: trajeto a pé: Estación Chamartin, Calle del Padre Francisco Pallau, Cuatro Torres Business Area (CTBA), Paseo de La Castellana, Plaza Castilla, Edificio Realia / Caja Madrid / INE / Plaza de Cuzco (metrô) / Gran Via, Plaza de España, Calle de Ferraz, Calle de Bailén, Plaza de Oriente, Teatro Real, Calle de Lepanto, Calle de Vergara, Plaza de Isabel II, Plaza de Ramalles, Calle de San Nicolas, Calle Mayor, Catedral de La Almudena, Muralla Islâmica de Madrid, Cuesta de La Vega, Cuesta de Ramon, Jardines Del Emir Mohamed I, Calle de Segovia, Costanilla de San Andre, Calle Del Alamillo, Calle de Alfonso VI, Calle de la Moreria, Plaza de Alamillo, Calle de Segovia, Ronda Segovia, Catedral de La Almudena, Calle Baillen, Palácio Real.
- **Percurso 9.** 18/01, 11:00 a 17:00h, trajeto a pé: Puerta de Toledo, Calle de Toledo, La Latina, Plaza de La Cebada, Calle San Millan, Plaza Cascorro, Calle Ribera de Curtidores, Calle Ruda, Plaza Puerta de Moros, Plaza San Andres, Costanilha de San Andres
- **Percurso 10.** 21/01. Plaza Puerta del Sol, Calle Mayor, Calle Cava de San Miguel, Calle del Sacramento, Plaza Mayor, Mercado,
- **Percurso 11.** 08/02: (ônibus). Calle Alberto Aguillera, Calle de Génova, Calle de Goya, Calle Alcalá, (a pé) Plaza de Manuel Becerra, Plaza de Toros / (metro) Calle de O'Donnell / Torrespaña
- **Percurso 12.** 07/02. Plaza de Chueca, Calle de Gravina, Calle Hortaleza, Calle de la Farmácia, Calle Fuencarral, Gran Via
- **Percurso 13.** 11/02: Plaza de España – Calle de los Reys, Calle Del Pez, Calle San Bernardo, Noviciados
- **Percurso 14.** 19/02: Paseo de La Castellana, Nuevos Ministérios, Estádio Santiago Bernabeu, Torre Picasso, BBVA / Paseo de la Chopera - Matadero
- **Percurso 15.** 24/02 – Manhã: Puerta de Angel, Paseo de Estremadura, Mercado Tirso de Molina, Calle de La Ribera del Manzanares, Glorietta de San Antonio de la Florida, Calle de Anicero Marinas, Glorieta de San Vicente, Príncipe Pio, Paseo de la Florida, Paseo la Virgem del Puerto, Campo del Moro, Parque de Atenas, Calle de Segovia, Calle de Juan Duque, Calle de Manzanares, Cuesta de Javaquiño, Jardines de las Vistillas, Plaza de Grabriel Miró, Calle de La Moreria, Calle de Bailen, Calle Mayor, Calle del Rollo, Calle del Sacramento, Marcedo de San Miguel, Plaza Mayor, Calle de Postas, Calle de San Cristóbal, Calle Mayor, Plaza Puerta del Sol
- **Percurso 16.** 26/02: Centro / Templo de Debot / Gran Via / Plaza Callao
- **Percurso 17.** 27/02: Bilbao, Calle de Fuencarral, Museu de História (fechado)

1. Madrid Map. Routes.

Traçado hipotético das muralhas islâmica e cristiana sobre o mapa atual de ruas
Fotografia Instituto de Estadística de la Comunidad de Madrid

2. Hypothetical Islamic and Christian Wall

times, the look. As well as formal and structural: serial vision, the main paths, buildings and striking elements, the squares, urban equipment, boundaries, neighborhoods. The meanings was also incorporated: the old town, the baroque city, industrial and post-industrial city, cultural city; the power of capital (trade, advertising, tourism), workflows, history, leisure, fun, live meeting, including, art, culture, society. I felt the need to return to some places, and complete some paths. The initially imagined homogeneity was undoing itself and the singularities were revealed. Little by little, breaking with the automated look, I experimented the daily life and the unusual. This step lasted one month and enabled me to have a clearer idea about cases of interest: the area between the *Rio Manzanares* and *Calle de Toledo*, taking as the axis to *Calle de Segovia*, because that represent the city generator principle and also by *the recent reintegration project of Rio Manzanares at the city. 2. Paseo* de La Castellana – because it represents the transition from the historic city to the hypermodern town.

2.2 Generative Cartography

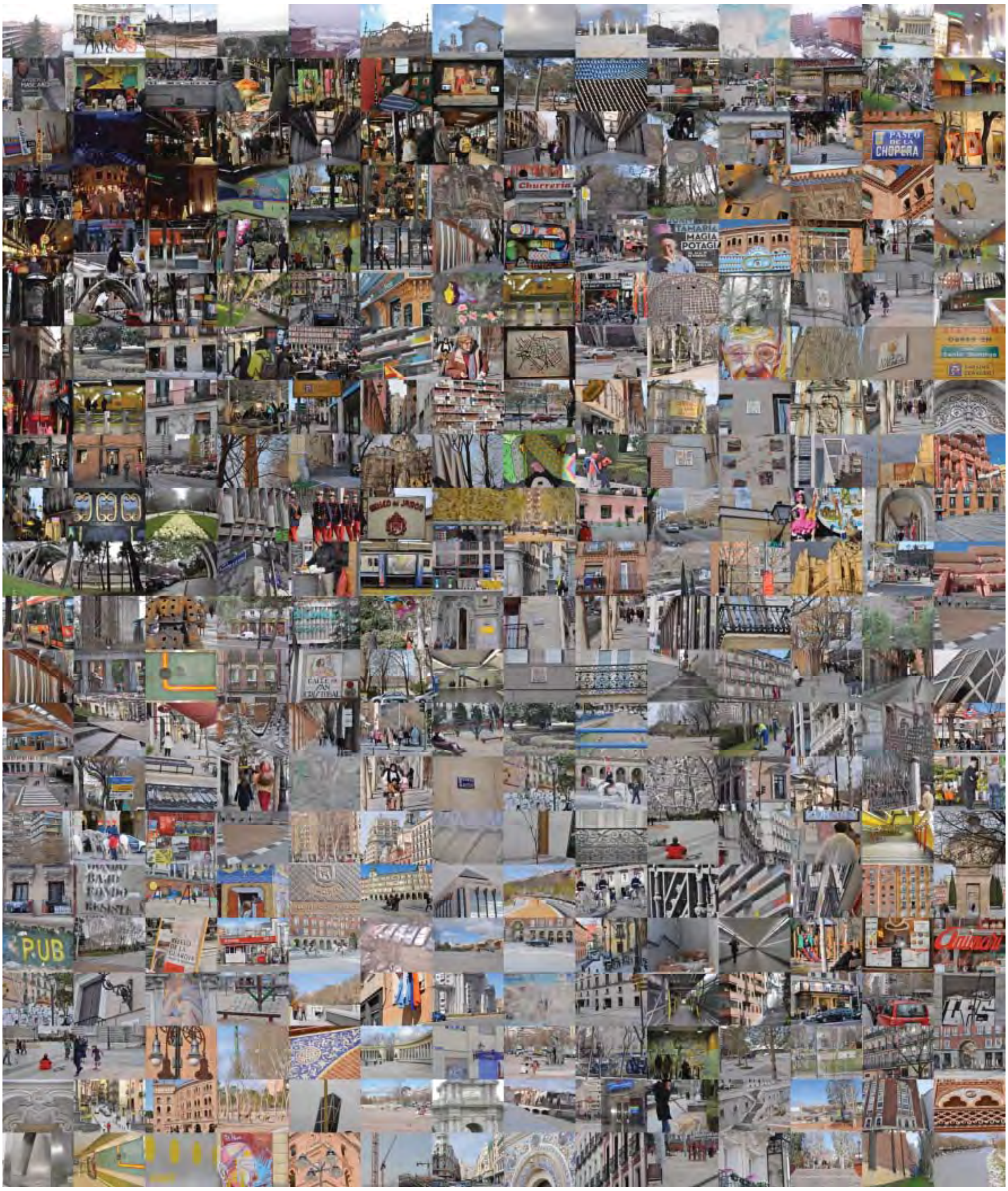
Whole systematization and data analysis was developed in Brazil. Several joints of photographs, maps and mosaics were tested to discover the creative research sense. Finally, I reached the proposition of conceptual matrices in the city in order to unveil the implicit diagrams in its rhizomatic structure.

I sought to deconstruct and reconstruct the image to make clearer the array generator: groupings by colors and textures, people, graphics were some tests. I intend to perform work on video so that I can add sound and moving images. I believe the studies about Deleuze's [11] diagram concept will enable advances at theoretical formulations and practices, to fetch graphical synthesis representing the embryo of new ideas of city. What I present in this article, therefore, is a partial result of what I desire developing. On the other hand, the photograph synthesis exposed is not restricted to the two reported regions of Madrid, being this one choice for other trials in video. This work is only a part of a larger study to be developed in São Paulo city.

Following are exposed some tests using a freeware photo mosaic programme. They were constructed under a Madrid's cartographic base, from Google Maps, and with 900 photographic images taken from that city in the beginning of 2010. This technique is referenced to the Joan Fontcuberta work, presented in the magazine "Fisuras" belonging to "Googlegrames" series which "*are made by using a freeware computer programme of photomosaic connected on line to a searcher in Internet, using as search base, words related to the topic of photography*" [12].

Acknowledgments

This pilot study took place at Madrid, Spain, in Visiting Professor Program, held at the Universidad Politecnica de Madrid, granted by Fundación Carolina.



3. General cartography. Image created from database of 900 photographs, using a freeware computer programme and image captured by satellite (Google Maps, district of Madrid).

4. Sign cartography

5. People cartography

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Celestino Soddu

Paper (or Poster, Artworks, Installation, Live Performance): **TITLE**

Abstract:

The teaching activity on the 5th year of Engineering-Architecture School was focused on setting up the students ideas by designing generative scrips directly focused on the peculiar design character of each student. Design themes were different, from architectures to Imaginary garden.
In the images the posters of some students explaining these experimental design activities.

Topic: Architecture

Authors:
Celestino Soddu
Politecnico di Milano
School of Engineering-Architecture, Lecco

In the Images
the abstract presentations of:
Ferenc Scura
Stefano Amedeo Banaiti
Federico Albonico

all design experiments are in www.generativism.com

References (books):

[1]
C.Soddu, “Citta' Aleatorie“, (random cities), Masson Publisher. 1989

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[3]C. Soddu, “Milan, Visionary Variations”, Gangemi publisher, Rome 2005

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www.generativism.com

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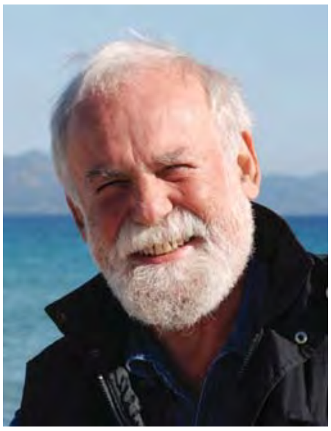
soddu@polimi.it

Keywords:
generative scripts, identity

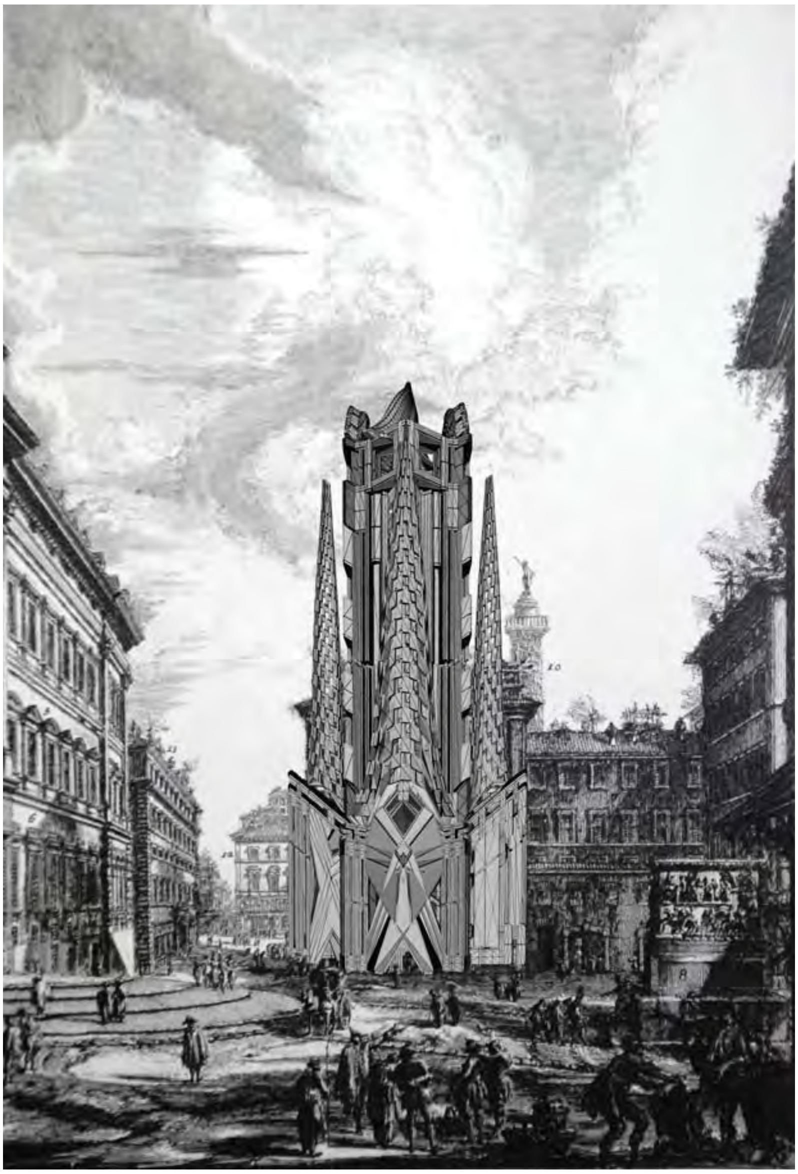
Celestino Soddu

Artworks: **Generative Baroque Architectures "d'apres Borromini in the Rome of Piranesi"**



Abstract:
Using the generative baroque Algoritms I generated a sequence of baroque Architectures that try to interpret the main reference of Francesco Borromini. I inserted them in the representation of Historical Rome made by G.B.Piranesi.
The aim was to identify if the character and the complexity of these architecture can fit the historical image of Rome and if they can work together with the complex architectures existing in this wonderful city.

Image of generated Baroc inside Piranesi engraves. C.Soddu 2011



Topic: Architecture

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References:
[1] C.Soddu, "Citta' Aleatorie",
Masson Publisher. 1989
[2]
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Keywords: Baroc, Identity, Rome, Borromini, Piranesi, Generative

Enrica Colabella
Celestino Soddu

Generative Architecture Student's Posters

Topic: Architecture

Authors:
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Celestino Soddu
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Abstract:
"Geometry is the language of mind"
Main aim of teaching is to perform conscience in each student of their ability to read the reality for discovering a possible creative interpretation of it for a possible transformation.
The generative design process starts from the rediscovering the first remember of mind in infancy. The aim of this opening exercise is to define a possible direction and a first point of view for the design process of a Kindergarten. Catalyze is "*Hard Times*" by Charles Dickens .
Lectures ex cathedra on Chirality – The dynamic point of view, i.e. Psycho by Hitchcock, the shower sequence.
Organicity, i.e. 1 - a transforming drawing by Michelangelo at the exhibition in Castello Sforzesco. 2 - the antropomorphism by Bernini for St. Pietro square. 3 – Gaudì, La Predera.
Extempore on the progressive logic of design.
Exercise on the common question; on a transformation of a sphere, from axonometry to perspective.
Matrices and generative scripts using Rhino.
Design of a Cultural Center at Manatthan and of a residential house with pathio. Poster of synthesis of the design iter.

References:
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[2] www.generativism.com

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Keywords: Generative Scripts, Drawings of Mind, Organic Design

Gabriel Maldonado

Live music performance with video: **“Flight”**

Topic: Music

Authors:
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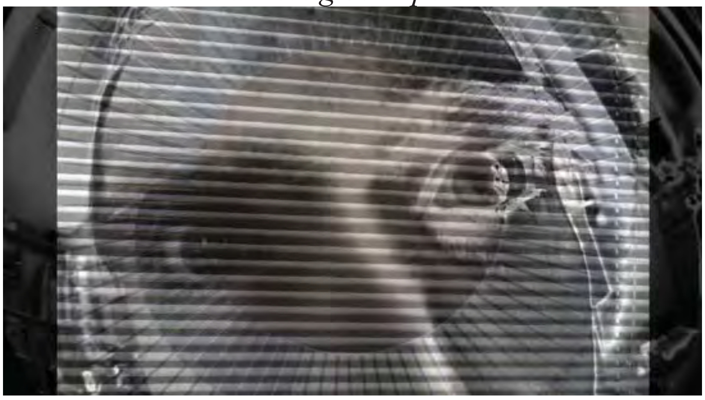
http://www.fundacionestuardomaldonado.org/

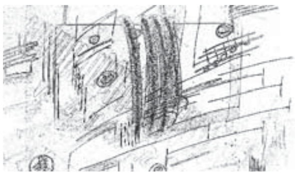
www.generativeart.com

Abstract: “Flight” *(for computer, guitars and video)*

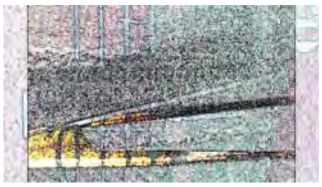
"Flight" *(2011 version) is the Pindaric flight of an hypothetical insect or a very small bird that approaches disproportionately close to very small objects casually occuring everyday in front of our eyes. Normally we do not notice them and do not give importance.*



This flyby induces the entrance to a parallel world where a heavy distortion of reality reigns (either in the images and sounds), an unconscious self-produced "lysergic trip". The total lack of logical thinking is intended to lead beholder to a nonlinear perceptual catharsis.





Contact:
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Keywords:
Pindar, Flight, Fly, hummingbird, live electro-acustic music, video

Davide Madeddu

Interactive facade optimized for daylighting and pedestrian response using a genetic algorithm.

Topic: Architecture

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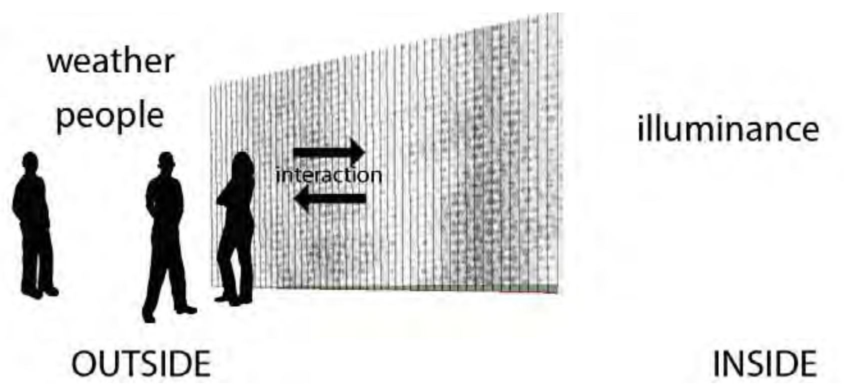
Abstract:
There are well documented studies that show the potential of the use of genetic algorithm (GA) in architecture and engineering. Numerous studies focuses on the application of the GA in the exploration of performance based façade design with single or multi-objective optimization to satisfy the illuminance and glare requirements. As part of an ongoing research on the use of the GAs in the built environment, this paper investigates on the potential of their application in an interactive façade design with a multi-objective optimization.
The objective was to develop an adaptive building façade to provide the optimum light conditions in the interior and to perform as interactive device for the exterior reacting to weather conditions and pedestrian activity. The façade act as a sort of medium to play and communicate with outside while maintain the privacy for the activities inside the building.
The façade is based on a series of shading device modules that can change aperture and tilting angles to allow to capture more or less light and to create a pattern that could change when pedestrian passed behind it to block the view through to increase the privacy in interior spaces. The façade works as interface between interior and exterior continuously reconfiguring its envelope to optimize the luminance requirements inside and the scenographic effects outside as emergent pattern and interaction with the audience.
The interaction between interior and exterior is controlled with a multi-objective GA that evaluate the different solution configuration optimizing the natural lightning inside and in the same time the pattern construction on the external side of the envelope with the interaction of the pedestrians.
The façade was designed and digitally simulated and finally was made a small scale prototype model using devices as Arduino connected with camera and sensors (Microsoft Kinect ®) to recognize gestures and interaction with users.



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[2] Glynn R., "*Conversational environment revisited*", 19th Meeting of Cybernetics & System research, Graz (Austria), 2008

davide.madeddu@gmail.com

Keywords:
Interactive, adaptive, facade, genetic algorithm

Interactive facade optimized for daylighting and pedestrian response using a genetic algorithm

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Premise

There are well documented studies that show the potential of the use of genetic algorithm (GA) in architecture and engineering. Numerous studies focuses on the application of the GA in the exploration of performance based façade design with single or multi-objective optimization to satisfy the illuminance and glare requirements.
As part of an ongoing research on the use of the GAs in the built environment, this paper investigates on the potential of their application in an interactive façade design with a multi-objective optimization.
The objective was to develop an adaptive building façade to provide the optimum light conditions in the interior and to perform as interactive device for the exterior reacting to weather conditions and pedestrian activity. The façade act as a sort of medium to play and communicate with outside while maintain the privacy for the activities inside the building.
The façade is based on a series of shading device modules that can change aperture and tilting angles to allow to capture more or less light and to create a pattern that could change when pedestrian passed behind it to block the view through to increase the privacy in interior spaces. The façade works as interface between interior and exterior continuously reconfiguring its envelope to optimize the luminance requirements inside and the scenographic effects outside as emergent pattern and interaction with the audience.
The interaction between interior and exterior is controlled with a multi-objective GA that evaluate the different solution configuration optimizing the natural lightning inside and in the same time the pattern construction on the external side of the envelope with the interaction of the pedestrians.
The façade was designed and digitally simulated and finally was made a small scale prototype model using devices as Arduino connected with camera and sensors (Microsoft Kinect ®) to recognize gestures and interaction with users.

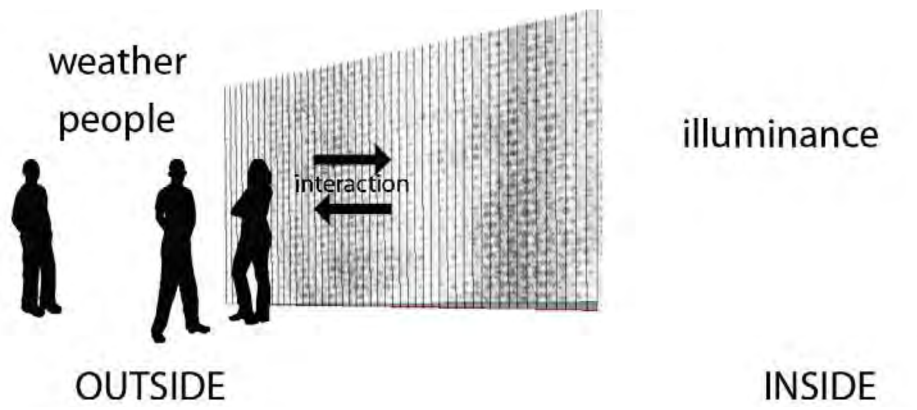
1. Introduction

The facade is often considered the most important part of a building. The designers should take into account shape, size and materials, but at the same time aesthetic and meaning as stand out features of the building. From a technical point of view the design is more focused in the control of the comfort inside the building through the correct sizing of the openings, their orientation and the use of the proper shading system to maximize the daylighting and the energy saving.
Moreover, especially in the commercial and administrative buildings, the facade has

an important role and is important the beauty, the meaning and the potential engagement with the public, as communication device for marketing purposes of the brand.
The design complexity generated by a large variety of architectural and technical objectives, can limit the research of design solutions that properly fulfill to a wide spectrum of requirements. In the analysis of such design constraints, where interact many performance variables, the genetic algorithms can be a good computation technique to explore different design solutions.
The application of this type of algorithms can explore different optimal configurations very quickly and is recognized the validity of their application in the early design stages [1-4]. Recently, the construction industry, is spreading devices that allow the automation of buildings can respond in real time to environmental data (temperature, humidity, pressure) controlling the louvers and windows configuration (aperture, tilting angles, ect).
Furthermore, the designer not only can use data from sensors inside the building, but also weather data coming directly from the Internet and coded messages through Twitter/Facebook networks according to the new vision of the Web of Things.
The market availability of several high-tech electronic devices such as smartphones, pads, sensors, actuators and the open source software and communities had generated a great interest to the design community. Designer, artists and architects can incorporate in their design small electronic devices that allows the development of interactive installations for commercial and exhibition purposes [5].
As part of an ongoing research on the use of the GAs in the built environment, this paper investigates on the potential of their application in an interactive façade design using a multi-objective optimization.

2. Method

This paper proposes a design of a prototype of an adaptive building façade to provide the optimum light conditions in the interior and to perform as interactive device for the exterior, reacting to weather conditions and pedestrian activity. The façade act as a sort of medium to play and communicate with outside while maintain the privacy for the activities inside the building.



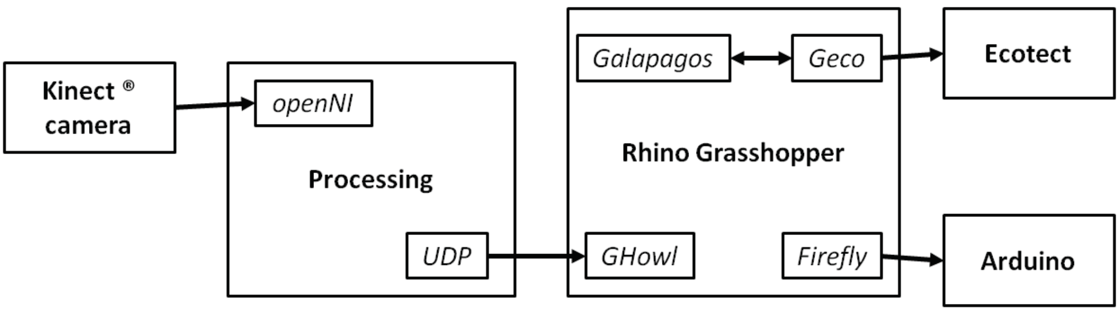
The façade works as interface between interior and exterior continuously reconfiguring its envelope to optimize the luminance requirements inside, and the scenographic effects outside as emergent pattern and interaction with the audience.
The facade may be represented as a grid, consisting of modules that are free to rotate to change the opening and allow the passage of light. As described above, the opening of several modules, and then the transparency of the facade, is influenced by environmental conditions and the presence or absence of people and their activities that they perform in front of it.
We can distinguish some main operating conditions of the facade:

a) In the absence of people:
   a.1. The facade responds only to external environmental conditions to obtain the optimal natural lighting;
   a.2. The facade displays graphic patterns and images. The modules act as pixels of a display panel;

b) In the presence of people:
   b.1. The facade responds to the passage of people and change the graphic pattern depending on the particular motion detected by the sensors;
   b.2. The facade responds to shield the view of the interior of the building ensuring the privacy of the activities that take place inside.

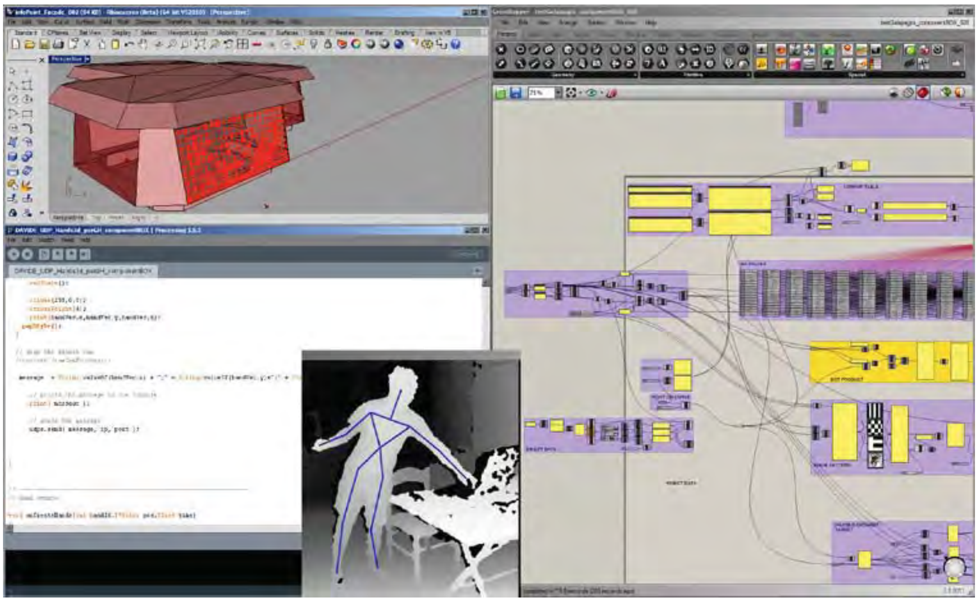
The initial conditions are defined by well-defined initial vocabulary in order to develop more complex conditions such as in relation to the number of people detected by the sensor and their behavior, as individuals or groups who walk fast, slow or stop in front of the facade. Each condition produces a particular behavior of the facade as a result of recombination and evaluation performed by the genetic algorithm. It generated over time an intelligent interactivity of the façade able to anticipate or to engage the audience in an action-reaction exchange.

The diagram show how the façade works, describing the hardware and software configuration, and the data flow through the entire process.

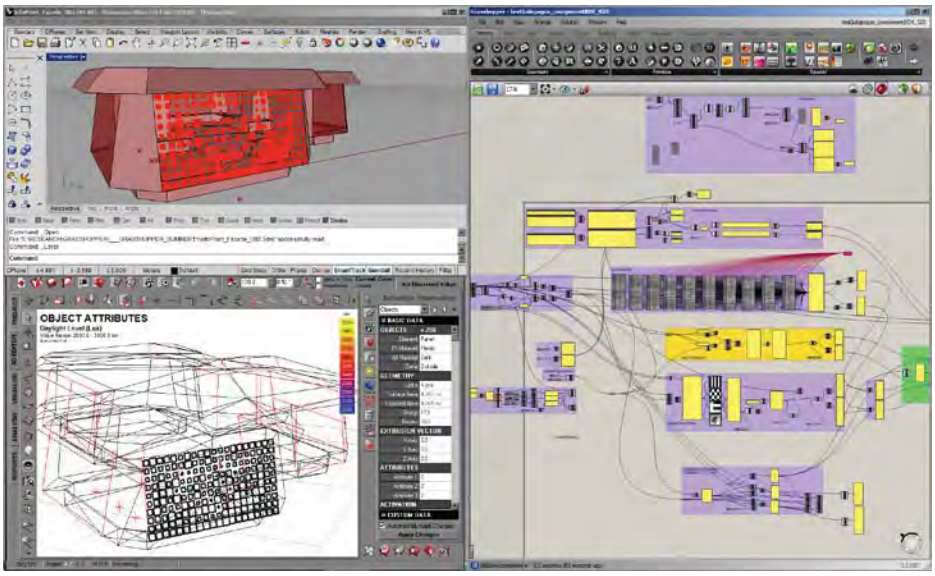


The facade collects data related to local environmental conditions through the Internet and the presence of people in the public space and spatial data with a Kinect device [6] through an infrared camera and depth sensors integrated in.
Processing [7] was used as a software platform for capturing and managing data from the Kinect. With the features of the libraries OpenNI [8] it was possible to identify people within the area of scanning and recording the coordinates x, y, z of the pelvis (identified through the function skeleton).

The platform Rhino Grasshopper [9] within different plug-ins (GHowl, Geco, Galapagos, Firefly) was used for the development and simulation of the digital model of the façade and finally, the management of the physical prototype.



The coordinates data of the people were imported from Processing through the UDP protocol, and were used to assess their position relative to the facade. The location was detected in real time and determined the different panel configurations that corresponded to the cases of the different behaviors of the facade. The configurations were the result of the optimization applied in the background provided by a genetic algorithm that computed the optimal solution to maximize the natural lighting inside the building. The genetic algorithm used a fitness function that evaluated the value of the illumination of a grid of 6 control points placed at a height of 1m from the floor. The calculation of the illumination (or solar radiation) occurred in real time by exporting the model into Ecotect and getting the sum of illuminance value in the control points.



The real-time interactive model needed very fast computational time to got solutions, and forced to set a lookup table with a set of optimal solutions calculated before. The set was updated constantly in the background taking into account the new conditions and any changes related to different environmental conditions.
The physical prototype was controlled by the digital model and used an Arduino board that controls a series of servo motors where were connected the façade panels.

3. Application

It was designed a prototype to simulate the interactive façade at the tourist info point of the city of Cagliari (Sardinia, Italy). The office is located in the city's main square, a meeting place where take place large flows of people from the adjacent railway station, bus and coach station. The office is a small structure and provides tourist information, and has large openings on all orientations of the building. The spaces adjacent to the building are large, which can allow different activities and can be adapted to the interactive testing of the facade. In the digital simulation and the prototype were tested a configuration in the south-east façade with 200 square panels of 20,5cm side, organized in a 20x10 grid.

4. Conclusion and future work

This paper has demonstrated that a facade could be in the same time an entertainment and advertising device while was a efficient and energy saving envelope that respond to environmental issues.
The work accomplished so far in the interactive simulation of the facade has demonstrated a possible application of genetic algorithms in interactive contexts, with some tricks to ensure a flow of data in real time. In this regard, it is believed that the research will be further developed towards the integration of a system of intelligent interaction that uses artificial neural networks to generate façade behavior and emerging patterns of interaction.

5. Acknowledgements

This work is part of an ongoing research supported with a scholarship by the Regione Autonoma della Sardegna (Italy) - PO Sardegna FSE 2007-2013 L.R. 7/2007 "*Promoting scientific research and innovation technology in Sardinia*".

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[2] Torres S. L., Sakamoto Y., "*Facade design optimization for daylight with a simple genetic algorithm*", Proceedings of Building Simulation, Beijing, 2007

[3] Wright J., Mourshed M., "*Geometric optimization of fenestration*", Proceedings of Building Simulation, Glasgow, 2009

[4] Gagne J.,Andersen M., "*Multi-objective facade optimization for daylighting design using a genetic algorithm*", Fourth National Conference of IBPSA-USA, New York (USA), 2010

[5] Glynn R., "*Conversational environment revisited*", 19th Meeting of Cybernetics & System research, Graz (Austria), 2008

[6] Kinect, http://www.xbox.com/en-US/kinect, Last Accessed: November 10th. 2011

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[8] OpenNI, http://75.98.78.94/default.aspx, Last Accessed: November 10th. 2011

[9] McNeel, http://www.rhino3d.com, Last Accessed: November 10th 2011

Filippo Pozzoli

GENERATIVE MUSICAL METAMORPHOSIS FOR MUSICAL ARCHITECTURE.
Case study: *Casa Da Musica*, Rem Koohlaas, Oporto, 2001

Topic:
Music/Architecture

Author:
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www.ingeda.polimi.it

References:
[1] C. Soddu, "*Città Aleatorie*", Masson, Milan (Italy), 1989
[2]D. Cope, "*Computers and musical style*", A-R Editions, Madison (Wisconsin), 1991
[3] T. Winkler, "*Composing Interactive Music*", MIT Press, Cambridge (Massachussets), 1998
[4] http://www.inmotionmagazine.com/eno1.html, B. Eno, A Talk Delivered in San Francisco, 1996

After attending Professors Soddu and Colabella's course in Generative Design, I started working on my own set of metamorphosis codes, matching simple IT cycles (still getting more and more advanced as my experience grows up) with basic fractal rules of 3D generation and transformation. My first aim was to develop a procedure that could express by itself my feelings and deepest visions – especially ones dealing with music - in a spatial and architectural way. I owned a Nintendo Wii console and I thought about how to get the most of its no-ordinary hardware, including dynamic and piezo-ringing sensors which allow the gamer to interact between virtual experience and real space. I then extracted some tabs – both for guitar and electric bass - from the popular videogame Guitar Hero and, after converting them in simple .txt files to be computed on my laptop, I wrote a JavaScript I could input in WiiFlash, the built-in animation and drawing software of the console. What I wanted was creating a Java-based software able to convert a digital musical sequence in a 3D pattern, after matching an original model to a chosen original sequence. First of all I worked out the original model you can see in the poster, Casa da Musica in Oporto, which I chose first because of its natural tie with the worlds I wished to connect – music and architecture. I chose Portugal national anthem as the original matrix for the existing architecture, in order to underline the bond with the actual and cultural ground, and then displaced its musical sheet in the script with tabs of songs meaningful to me, which I took from the videogame. I wanted to see whether the 3D architectural pattern newly generated would make me experience the same feelings I had when listening to that very music. I have to say only few of the attempts satisfied me, and for this reason I worked out a poster instead of a full paper: I consider this just as a starting point and my work, of course, is still in progress.

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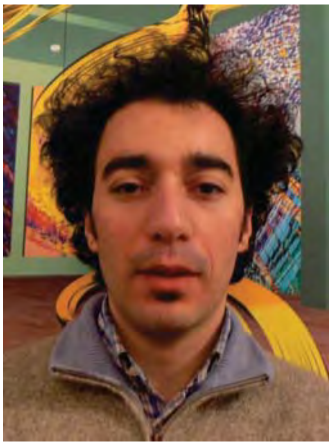
Keywords:
Music, Building Morphogenesis

Costantino Rizzuti

Live Performance: **EURISTICA**



Topic: Music

Authors:
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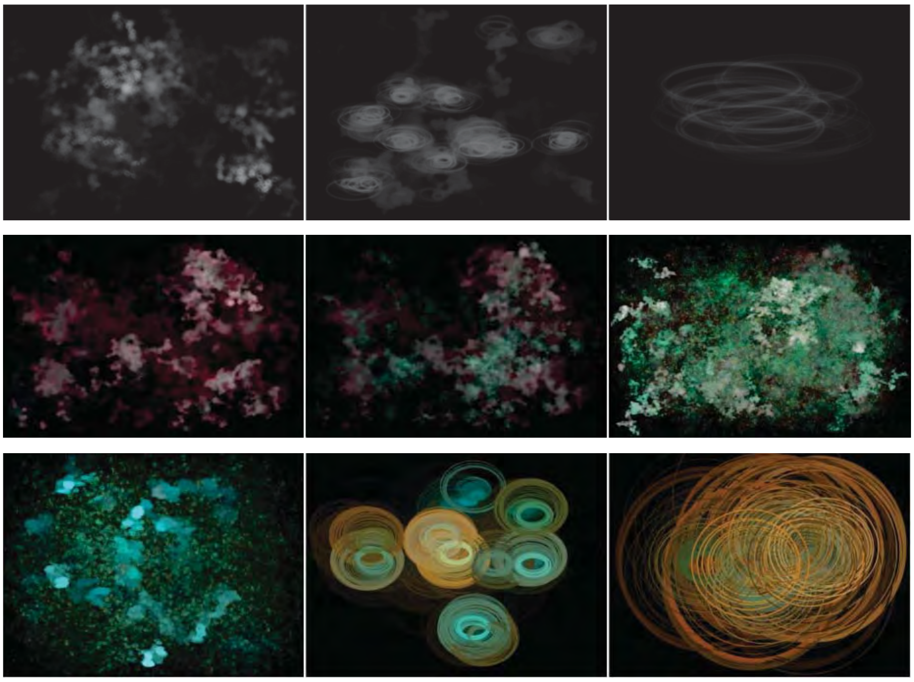
References:
[1] Iannis Xenakis, "*Formalized Music*", Pendragon Press, Hillsdale, 1992
[2] Iannis Xenakis, "*Universi del suono*", a cura di A. Di Scipio, Ricordi LIM, Milano, 2003
[3] puredata.info
[4] processing.org
[5] opensoundcontrol.org

Abstract:
Euristica is a composition for audio/visual electronics in real time. The piece is structured as a "path" through different behaviours both of the sound and of the visual material. Like an heuristics search, the temporal evolution of the composition is not a priori strictly determined, but it emerges also thanks to the choices and the actions of the performer. Euristica is constructed as a sequence of states among which the performer can make continuous transitions. The purpose of this path is to explore the possible changes among both different dynamic behaviours and various degrees of thickening of the sonic and visual material. Euristica is a generative live performance because the organization over the time of both sounds and visual forms is based on the use of generative procedures. The pioneering work of Iannis Xenakis about stochastic music [1,2] has widely inspired the development of this piece. The generative processes used in Euristica are based on the generation of uniform random number. The performer has only an high level control over the material through the change of the ranges used for the random generation of the parameters controlling the production of sounds and visual forms.
The architecture to generate the audio part of the performance has been created using the visual programming environment Pure Data [3]. Processing [4] has been used to develop the visual part. The communication between this two environments has been established by using the OSC (Open Sound Control) protocol [5].



Images from Euristica

Contact:
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Keywords:
Music, Visual Arts, Live electronics

LAURENCE GARTEL

TITLE : LAURENCE GARTEL, 35 YEARS OF DIGITAL ART Exhibition and Skype Lecture

Topic: Digital Art

Author:
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Digital Media Artist
http://gartelmuseum.weebly.com

References:
"Laurence M. Gartel: A Cybernetic Romance, Introduction by Nam June Paik, Published by Gibbs Smith, Utah, USA, 1989
"GARTEL: Arte e Tecnologia" Introduction by Pierre Restany, published by Edizioni Mazzotta, Milan, Italy,1998
"LA STORIA Dell Arte" published by Edizioni Giunti, Florence, Italy, 2001
"THE WORLD OF DIGITAL ART" published by HF Ullman, Germany 2010

As a pioneer of Digital Art for over 35-years I have seen the entire evolution of the electronic medium unfold before my eyes. Working with crude analog system computers at Media Study/Buffalo in the mid 70s. I worked side by side with video guru Nam June Paik. Those early days were with little technology but it took up the size of a warehouse. This was a very uncommon practice as the apparatus was proprietary and people were not using computers for anything except at government research laboratories. These dinosaur systems were mostly used for military simulation. I saw the opportunity to make art out of this technology for purely aesthetic purposes. This then was a brand new concept. I saw technology as a tool like a sculpture would use clay. One molds an image to the desired form. To harness that image, since there were no hard drives, I photographed the screen with a camera mounted on a tripod and threw a black cloth over my head so that no ambient light would effect the screen. There was such an arresting beauty from these images that I felt the potential future. At this early stage, I felt a new medium was born. Naturally it would take the agreement and collaboration of many in the world to be accepted and appreciated. Museum directors and curators dismissed the art from the outset. They did not recognize its future and what initial imprints I was printing them. In my estimation those were the "hieroglyphics" of images to come. Future vision is not something everyone possesses. It has taken have a lifetime to get the world on track. None the less, here we are and the aesthetics of electronic imagery is embraced all around the world for a myriad of categories. The digital form is used by all and appreciated by many. It has come full circle. Now it is time for the next generation to push the envelop now that the road has been paved. To me the single most important aspect is that the art have emotion. A person looking at a piece of art should cry a tear of joy, …a pleasure should overwhelm them. "Though technology is cold, the end result should be warm."

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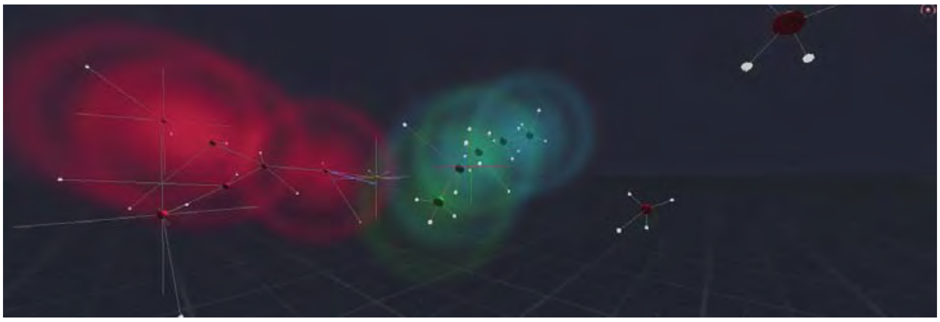
Keywords:
Digital Art, Digital Photography, Digital Media, Projection Art, New Media Art, GARTEL,

Davy Grégoire

BIPMAT 3.0



Topic:

Music performance

Composer:
Davy Grégoire

Bipmat is a musical interface consists of physical objects based on atom's behaviors. Basically, a sound particle is made of a core (sound source) interacting with one or more electrons (musical event).

The possibility to arrange several particles in order to create musical sequences or sound modulations leads us to consider the matter idea like a dynamic partition, made up of heterogeneous elements, more or less autonomous, in which the user can navigate freely.

The sound synthesis is at the same time led by user interactions(midi control) and generated by dynamics properties of an object (string, branching,membran...), as well as disturbed by external events.

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Keywords:
Electronic music,sound matter

Jason M. Reizner

Installation: **Walls Have Ears**

Abstract:

The recent onslaught of QR technology has meant that the occurrence of visual signifiers which only machines can read and write is becoming increasingly commonplace in areas once solely the realm of the human-readable. Designed to operate for the duration of GA2011, *Walls Have Ears* is a generative installation that gently prods this brave new world of synthetic literacy by also engendering the machine with the ability to listen. Continuously overhearing human presenters' speech direct from the lectern, this environment exploits the highly subjective nature of realtime artificial speech-to-text transcription to distill a dynamic, if not somewhat idiosyncratic, living document of the proceedings. Displayed on a subtle wall-sized QR video assemblage, the system's understanding of what is happening is both a compelling visual abstraction, as well as a reasonably faithful account, provided, of course, one has a machine that will graciously serve as an interpreter.

Topic:
Synthetic Literacy

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On two occasions I have been asked, — "Pray, Mr. Babbage, if you put into the machine wrong figures, will the right answers come out?"
... I am not able rightly to apprehend the kind of confusion of ideas that could provoke such a question.

– *Charles Babbage*

References:

[1] Babbage, Charles. *Passages from the Life of a Philosopher.* Longman, Green, Longman, Roberts & Green. London. 1864.

[2] Lyons, John. *Introduction to Theoretical Linguistics*. Cambridge University Press. 1968.

[3] Rothstein, Adam. *"City of QR Codes."* http://rhizome.org/editorial/2011/sep/15/qr-code-city/

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Keywords:
Eavesdropping, Procedural Linguistics, Visual Grammar

Laurel Johannesson

Art Installation: **ACQUA VELLUTATA SOSPESA**

Topic: Interactive Art

Artist:
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Computational Media Design
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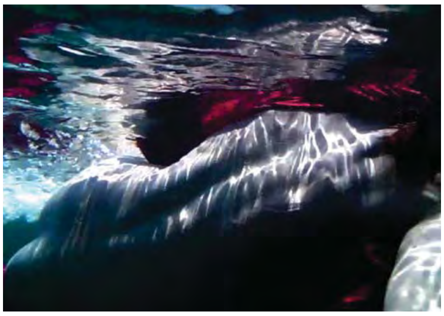
Abstract:
I have created a water environment that responds to viewer controlled movements and encompasses the viewer in the environment that I put myself into in my images. I want the viewer to experience the feeling of being submerged in and enveloped by the water and to be able to "paint" with the liquid video imagery.

Each stroke that I perform underwater pushes and drags millions of molecules along. The movie painting activity relates to this as the viewer interacts and drags dynamic pixels across the screen.

The open source programming language of Processing was used to create the project. The underwater video located in the sketch's "data" directory was inserted into a chunk of simple Processing code. The code gives the command to load and play the movie in a loop and the drawing function allows the video picture to be used to paint using the mouse, track pad or other device such as the iPhone. The image will move when the cursor is moved. The viewer begins with a blank black "canvas" and then "paints" layer upon layer of video to build a fluid image.

Viewers receive an instruction card when entering the installation. They may choose to download the MSA remote application to their iPhone or use iPads housed in the gallery space.



Still images of video footage.

Still image of video painting.

Installation view of video painting on wall screen.

Contact:
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Keywords:
Art, Installation, Interactive Painting, Interactivity, iPhone, MSA Remote, Painting, Processing, 3D imaging, Underwater Video, Video Art, Water.

INIRE

Live Performance: **Dante's Songs 2.011**

INIRE is an open project, composed by artists working on the mutimedial and experimental art fields. The most important audiovisual projects realized since year of it's creation (2001) are: „Hermetic Garden" (2001), "Septem Sermones ad Mortuos" (2004), „Traces" (2007), "Atalanta Fugiens" (2009), "chopintimacy" (2010) which fluctuated between philosophy, art history, structures of myths and communication theory, using new media ways of expression.

Performance is audiovisual processing on Dante's symbolic context of Divine Comedy, based on improvisation on instruments, voices and video action. Project has a structure of triptych, is composed of three independent interpenetrating levels: sounds, texts and video. Sounds are genareted by electronic and electroacoustic instruments (Electro Double Bass, analog synthesizer, samplers and softwares). Important element of it's construction is spoken language, singing and melodeclamations, which mix thorouhgly electronic world with natural human expression. It's realised on italian and english, where texts are taken from Divine Comedy original dialect verses. Video is used here for processing the activity on the stage with traditional images of the history of contemporary cultural heritage. Randomly screened picture sequences are composed of figures associated with the concept of spiritual being reinterpreted by postmodern reality. Pictures are rendering up to modifications in real time. Nine video sequences selected and processed in an interactive way with audio sphere are complementary for text. Eeach of these is parallel surface.

„Dante's Songs 2.011" is a multidyscyplinary stage project based on medieval imaginative vision of the afterlife journey through spiritual, psychological and philosophical european tradition. The project tries to find the answer to the perennial and ever seems less valid than in postmodern times question, whether the man equals the soul?

Topic: Art

Authors:
INIRE
Krzysztof Pawlik
Małgorzata Dancewicz
Wojciech Benicewicz
http://www.myspace.com/inire

References:

1. ***http://www.youtube.com/watch?v=edStSLPcKck&feature=related***
2. **http://www.youtube.com/watch?v=E7zacjmrsG4&feature=related**
3. **http://www.artcetera.pl/art/inire**

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Keywords:
Audiovisual performance, postmodern interpretation of allegorical epic poem.

Massimo Gasperini	*Spira Mirabilis*

Topic: Art

Author:
Massimo Gasperini

Independent Artist
Italy

Abstract:

Logarithmic spirals are everywhere in nature, from shells to galaxies to cyclones. My wood sculptures are interpretations of nature´s generative forms, creating new objects through 3D mappings of mathematical progressions.

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Keywords:
Spiral, logarithmic spiral, wood, sculpture, mathematical art

Matteo Codignola

Generative algorithms as engine for creativity: digital visions

Topic: Art & Architecture

Authors:
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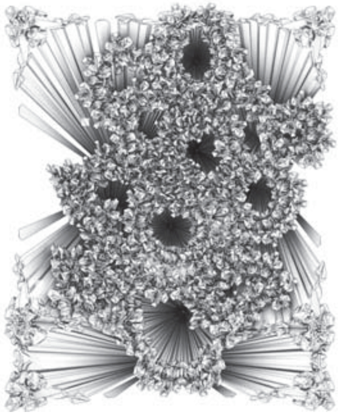
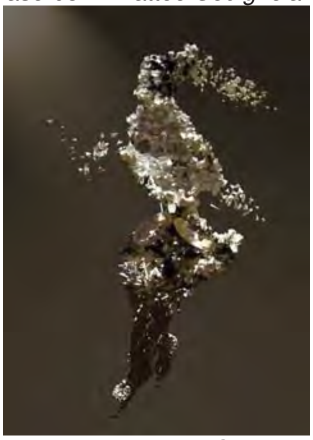
Abstract:
During the last couple of years I've been trying to define generative algorithms as expressive engine for my digital art vision. At the beginning the process was not so easy: I designed and test generative algorithms but the scenarios were not satisfying and I could not find the right objective of my subjective vision of art. These scenarios were only expression of scripting computation and it was not the goal I wanted to achieve. I needed to find a target for my personal imaginary. In the next phase I try to take inspiration from iconic works of art and this was the right way to overcome the critical stage. The most surprising aspect was that the results often differed from the original references. The generative process allowed me to create new forms of representation of my imagination. In the last period I'm following two ways:
1- Generative algorithms for 3d digital paintings.
2- Generative algorithms for architecture code representation.

"Vase of sunflowers"- Van Gogh



"Vase-08" – Matteo Codignola

A classic dancer



"Dancer-05" – Matteo Codignola

"Egs" – Matteo Codignola

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Matteo.codignola@arup.com

Keywords:
Generative art, 3d alghoritms, max script, parametric design

MEHRDAD GAROUSI *Artwork:* **SIERPINSKI DREAM**

Topic: ***3D Fractal Animation***

Authors:
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Freelance fractal artist
Iran
http://mehrdadart.deviantart.com

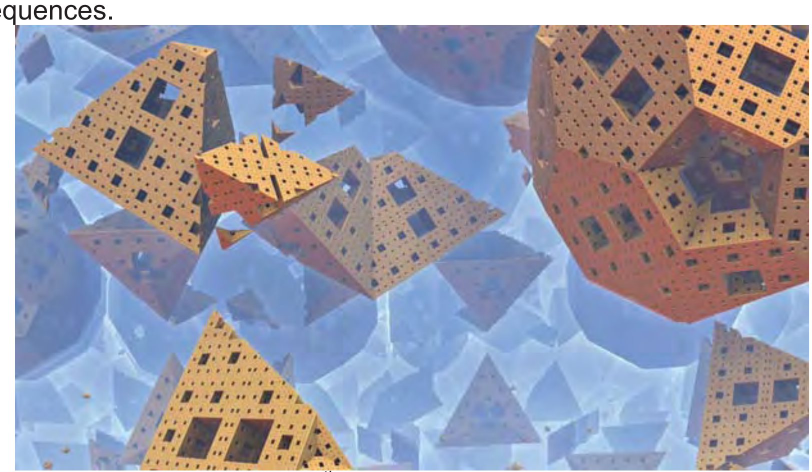
References:
[1] Mandelbulb3D, http://www.fractalforums.com/index.php?action=downloads

[2] FractMus 2000, http://www.gustavodiazjerez.com/fractmus_overview.html

Abstract:
This fractal animation is a journey through numbers and mathematical equations underlying the innermost and pure behaviors of our universe; a psychedelic journey that reminds of the most undisclosed initiatives lying in the subconsciousness of modern human. All the shapes and constructions which can be seen here are computer generated consequences of carrying out fractal geometric rules of nature in a 3D environment. In such animations fractal artist packing up their consciousness starts an unknown discovery toward nowhere and step by step defines key-frames to make a path to be able to chase it later as an entire animation. Experimenting different eventualities and playing around with numbers and parameters, they continuously go ahead until they give up and end it up somewhere deliberately or technical limitations necessitate them to stop.

In this certain fractal animation everything starts from an icosahedron on which faces Sierpinski triangular patterns are applied. The main mathematical property of this work is where after travelling through self-similar triangular paths, approximately in the middle of the animation, we suddenly encounter a completely different fractal pattern of cubes and squares that is Menger sponge. It is mentionable that our magnification rate at the latest frames, compared to the beginning point of the animation, is something about 1.322 E14.

In this project among a handful of pieces of software that can make 3D fractals one of the most awesome pieces, Mandelbulb3D [1], has been used. The music of the animation is also a complex of 11 instruments set according to five mathematical sequences and maps including Wolfram One-Dimensional Cellular Automata, Lorenz algorithm, 1/f Noise, Earthworm, and 3n=1 Numbers. It has been made in FractMus 2000 [2] software. This type of music contains dependent amounts of randomness and provides more mystically out of consciousness experiences with the ability of being played unlimitedly in circulative sequences.



The 2540th frame of the animation

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Keywords:
Fractal art, 3D fractal, animation, Mandelbulb3D, Sierpinski

Michael Burt Prof. Emeritus

BRIDGING THE MESSINA STRAITS

BRIDGING THE MESSINA STRAITS
An alternative design approach:
Habitable Bridge Avenues Combining Dwelling, Commerce and Transportation on Floating Platforms

M. Burt Prof. Emeritus, Y. Rosenfeld Prof. Technion, Israel Institute of technology

Abstract

'Bridge Avenue' approach is an ancient urban concept, generally applied to solve situations of urban discontinuity, mostly because of rivers and topographic raptures. The idea of 'Living Bridge Avenues' as generators of urban continuity between neighboring cities over marine straits is a modern and a novel one.

Bridging the Messina straits and integrating the urban entities of Messina and Regio di Calabria, Italy and Sicily, over a water expanse of 5÷7km's wide and 100÷200m deep, in the near proximity of the Etna, over a lane of ocean going carrier ships, is a great architectural, marine and structural engineering challenge, haunting Italian authorities for many decades.

The presently adopted solution of a hanging, ~3,3 km clear span bridge, at the most northern tip of the straits is and audacious, expensive and questionable.

The suggested conceptual bridging approach is in employing **bridge avenues, combining living and working urban environment with transportation and all the required servicing and infrastructures, supported on floating platforms, which, in themselves might sustain complementary attractive urban fabric, open public spaces and friendly pier environment.**

The proposal represents an alternative design strategy, applicable to a wide range of similar situations around the world, is especially suitable for the proposed case-study of the Messina straits because of its earth-quake resilience, although the main reasoning behind the solution is in the following: The generated bu±ilt assets of the bridge avenue and the supporting floating platforms (for rent or sale), free from real estate costs, generate enough revenues to cover all (or most) of the costs of the incorporated traffic-transportation solutions over the straits.

The paper considers architectural, structural, marine engineering and construction, logistics and management and delves into aspects of cost-effectiveness of the proposed solution and suggests its applicability to the general universal problem of the strait bridging.

Topic: Architecture

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Keywords:
bridge, design

Bridging The Messina Straits, An Alternative Design Approach: Habitable Bridge Avenues Combining Dwelling, Commerce and Transportation on Floating Platforms

Prof. Emeritus Burt M., Arch. D.Sc.,
Technion, Israel Institute of Technology, Haifa, Israel
Prof. Rosenfeld Y., Eng. D.Sc.
Technion, Israel Institute of Technology, Haifa, Israel

Abstract

'Bridge Avenue' approach is an ancient urban concept, generally applied to solve situations of urban discontinuity, mostly because of rivers and topographic raptures. The idea of 'Living Bridge Avenues' as generators of urban continuity between neighboring cities over marine straits is a modern and a novel one.
Bridging the Messina straits and integrating the urban entities of Messina and Regio di Calabria, Italy and Sicily, over a water expanse of 5÷7km's wide and 100÷200m deep, in the near proximity of the Etna, over a lane of ocean going carrier ships, is a great architectural, marine and structural engineering challenge.
The suggested conceptual bridging approach is in employing **bridge avenues, combining living and working urban environment, with transportation and all the required servicing and infrastructures, supported on floating platforms, which, in themselves might sustain complementary attractive urban fabric, open public spaces and friendly pier environment.**
The proposal represents an alternative design strategy, applicable to a wide range of similar situations around the world, is especially suitable for the proposed case-study of the Messina straits and that for the following reasons:

1. Fof its earthquake resilience.
2. The generated built assets of the bridge avenue and the supporting floating platforms (for rent or sale), free from real estate costs, generate enough revenues to cover all (or most) of the costs of the incorporated traffic-transportation solutions over the straits.
3. The living bridge avenues may promote the union of a new metropolitan entity, combining the resources of Regio di Calabria and Messina, and benefitting both.

Introduction

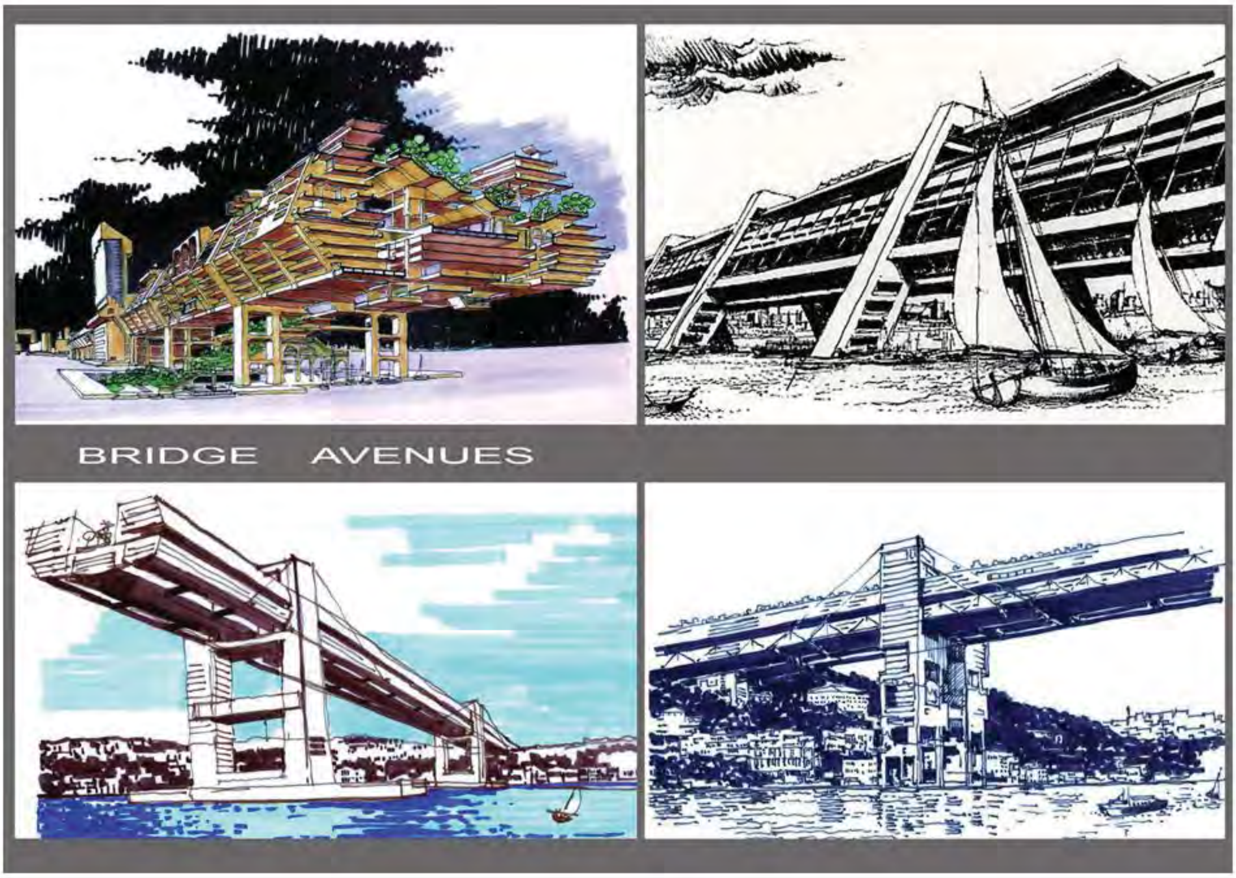
'Bridge Avenue' approach is an ancient urban concept, generally applied to solve situations of urban discontinuity, mostly because of rivers and topographic raptures. Most celebrated examples are those of the Ponto Vhecio (Florence) and to a lesser degree, the Realto (Venice) and the commercial bridge of Bath (England). History knows of numerous living bridges over the Seine in Paris (the Pont du Notre Dame) and over the Thames (the London Bridge), all of them just a memory and a testimony to our blindness at the time of their demolition, because of lack of awareness to their charm and historical importance.

The idea of 'Living Bridge Avenues' as generators of urban continuity between neighboring cities over marine straits is a modern and a novel one.
It is meant to solve a universal problem of cities, on two opposite shores of water expanse straits which are glaring at each other and dreaming of a union, with the **best of motives, social-economic-political.** Growing urban densities, swelling metropolitan urban sprawls, sky-rocketing real-estate costs and prospects of sharing in infrastructures, will turn it into a profitable enterprise.
Bridging the Messina straits, joining (at long last) Italy and Sicily, with 'dry' transportation means and integrating the urban entities of Messina and Regio di Calabria, over a water expanse of 5÷7 km's wide and 100m÷200m deep, in the proximity of the Etna, over a lane of Ocean going carrier, ships is a major marine and structural engineering challenge and an audacious urban-architectural mind-provoking aspiration, haunting Italian authorities for many decades. The presently adopted solution of a hanging ~ 3,3 km clear span bridge, at the most northern tip of the straits is and audacious, expensive and questionable, at best. [1], [2].

A cable hanging bridge, with 400m high support towers and middle span water clearance of 70m high, with a clear span of 3300m, leaves a hanging bridge with **structural height to span** ratio of 1:10 only, not to mention the proximity of the Etna and its vicious historical record of high magnitude eruptions and destruction.

The Alternative Conceptual Approach Solution

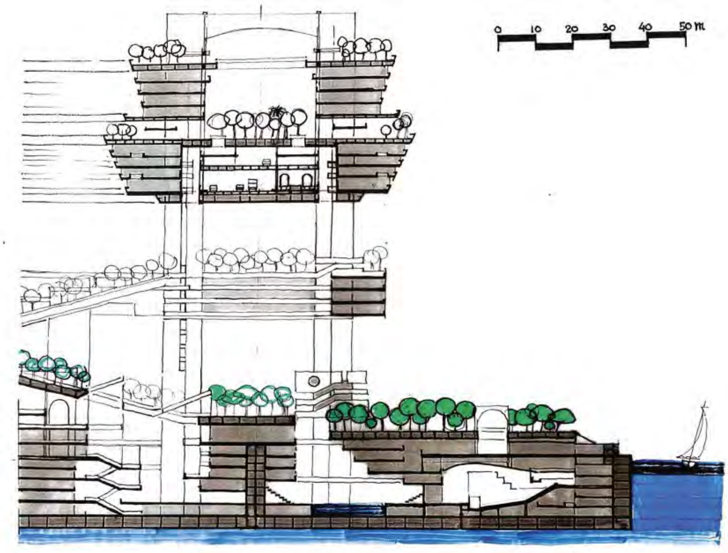
The suggested conceptual bridging approach is in employing **bridge avenues, combining living and working urban environment with transportation and all the required servicing and infrastructures, supported on sizable floating platforms which, in themselves might sustain complementary attractive urban fabric, open public spaces with friendly pier environment** and bustling, colorful marina compounds.

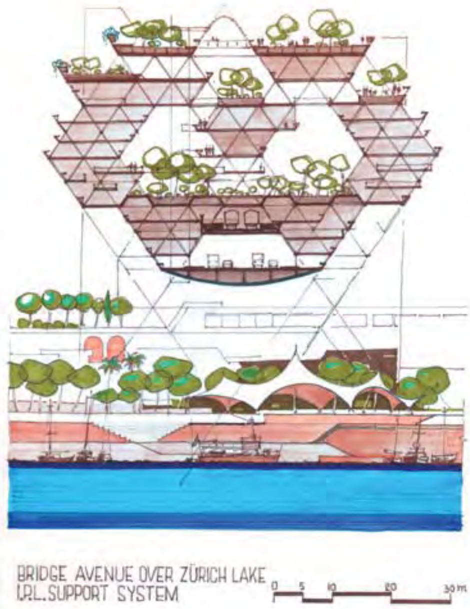


The proposal represents, an **alternative design strategy** and conceptual approach, amounting to no less than a paradigm shift and a **drastic departure from the existing axiomatic definitions of conventional urban development solutions:** No land parcelations and no familiar land ownership patterns and the resulting ‘interior politics’. No historic memories and architectural heritage preservation constraints and no existing biotic mass and geographic-topographic dictates, but just a **blue ‘tabula rasa’.**

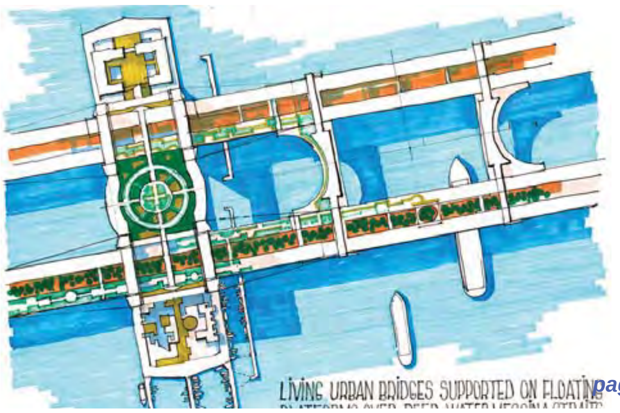
Given the contemporary technology developments in bridging and marine engineering mega-floats and mooring and anchorage solutions, what is holding back such projects is only our lack of imagination. [3], [4].

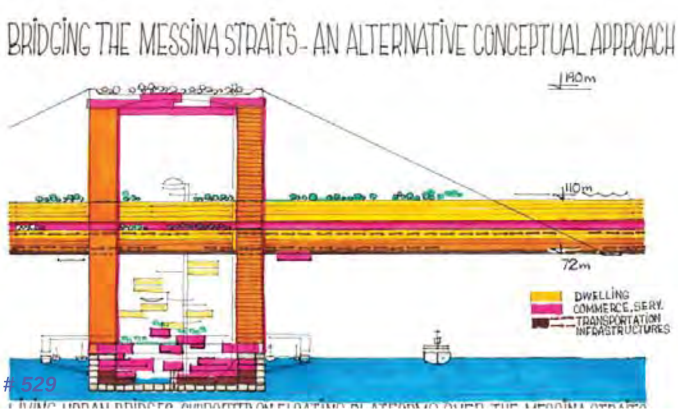
The proposal applicable to a wide range of similar situations around the world, is especially suitable for the proposed case-study of the Messina Straits, because of its earth-quake resilience, although the main reasoning behind the solution is in the following: The generated built assets of the bridge avenue and the supporting floating platforms (for rent or sale), free from real estate costs, generate enough revenues to cover all (or most) of the costs of the incorporated traffic-transportation solutions over the straits.



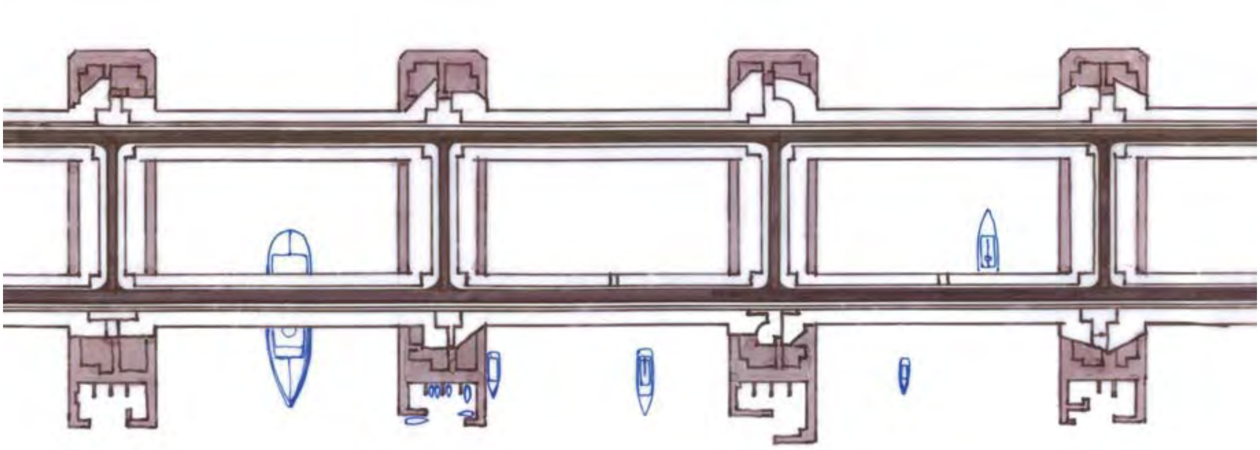


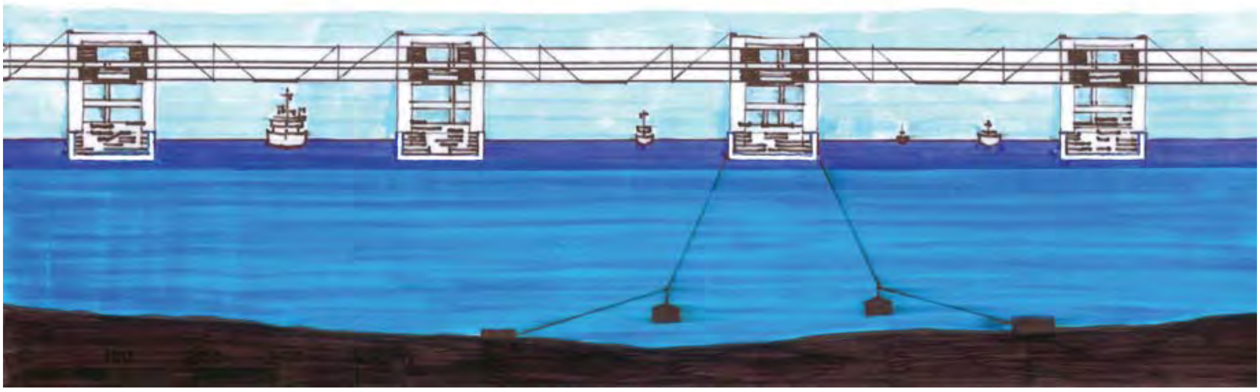
The solution envisages a living bridge with 6÷8 story dwelling mass and 2÷3 stories of commercial and working space volumes, agglomerated around a linear pedestrian-public mall, with vehicular and rail transportation (and parking) and supply-removal installation infrastructures below (see cross section) and roof-sky green promenades above. To ensure some urban articulation, a stretch of two parallel, interconnected living bridges and pedestrian malls, 150m ÷ 200m apart, simulating a horizontal ladder like structure, hovering 50m÷70m above the sea level, is suggested.





The floating platforms, about 120m wide and 500m long, with an interior depth of 15m÷25m below the pier level, are solved to carry two volumetric tower pairs, the supports of the living bridge avenues above, and in themselves housing 30÷35 stories of apartments and office space for mechanical, as well as social-recreational-educational and health related infrastructures, together with public open spaces and appropriate volume and spread of green bio-mass. [5]
The platforms will be spaced ~ 300m apart, except in places intercrossing with the major shipping lanes, where broader water stretches will be required,



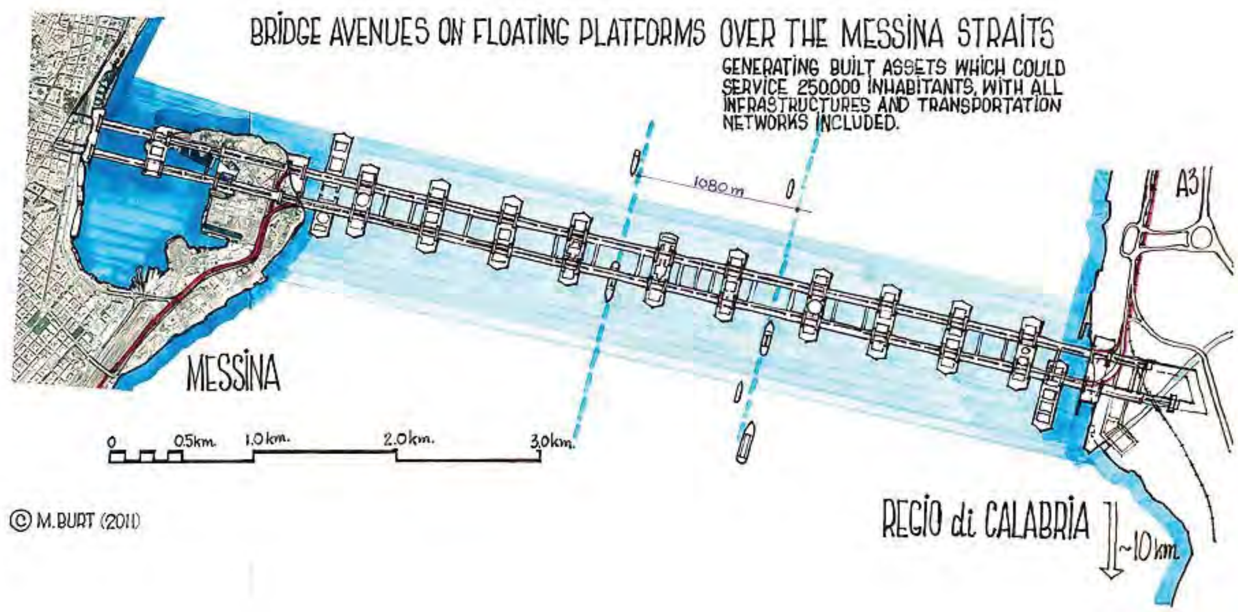


Quantitative aspects of the proposition

Programming the volume of the development may carry us into a wide range of pre-suppositions. The overall dimensions of the bridge avenues, the carrying support towers and the floating platforms, their number, their dimensions and utilization rates. But undoubtedly the predominant and the most deciding factor will be the overall length of the bridge avenues, as dictated by the specific location choices of the bridge, vis-à-vis Messina and Regio di Calabria

On the basis of very preliminary programmatic pre-suppositions and design considerations and a very scanty familiarity with the local data, a location was chosen, joining the center of Messina (Corso Garibaldi and via Vittorio Emanuel II) and south of

Catona on the Calabrian side, resulting in an overall length of about 7000m.



After deciding on rates of utilization and densities, which still preserve the urban and environmental attractiveness and well being, the following numbers emerge:
For every length-wise meter of the bridge avenue project we can generate
1200 ÷ 1400sq.m of built floor assets, for rent or sale. For 7000m of the entire project the gain is about **8.400.000sq.m ÷ 9.800.000sq.m,** transportation infrastructures not included.
When summed up and manipulated, these built assets may provide an urban habitat for approximately 250.000 inhabitants, with all the required infrastructures and servicing and public open spaces, and a sizeable floor space of business offices. [6], [7]
On top of that, the bridge avenues may provide about 850.000sq.m for transportation, about 40% of it for through-traffic of cars, automobiles and trains.
Great effort should be invested in mechanical traffic solutions (moving pavements, escalators, elevators and light electrical trams) to reduce dramatically (to a point of abolishing it) the reliance on private vehicular traffic within the bridge avenues bounds.
It is clear that the project will have to resolve many more critical problems relating to architectural-urban design and execution logistics, providing for staged completion and habitability along the process. Many marine and structural engineering and construction issues of the platforms, their contents and the bridge avenues above (complex anchorage solutions included) will have to be approached and resolved, as well as economic optimization and cost-effectiveness analyses conducted.

But, on the basis of preliminary conceptual evaluations, it is reasonable to assume that generating more than 20sq.m of commercialized built assets for every sq.m which is necessary for the through traffic, no public funding will be required.
It is also reasonable to assume that once the bridge connection over the straits will be established, it will generate a great uplift in the regions economic activity, generating in the process employment positions and opportunities and a dramatic surge in the demand for habitable space, thus fulfilling the rational and justifying the concept of the living bridge avenues project.

In conclusion

The bridging of the Messina Straits, with all the geographic-batimetric-geological-seismic uncertainties mostly, because of the proximity to the Etna), make conventional solution strategies questionable at best, and critically dangerous and costly, so as to encourage “out of the box” alternative conceptual approaches.
The Living Bridge Avenues On Floating (sizable) **Platforms** represent such an alternative design strategy and concept.
The most conspicuous aspect of this multi-disciplinary enterprise is its design and execution complexity. Many related issues remain to be researched and resolved, concerning its geography, architecture, regional planning, engineering and economics.
Deciding to live with the ‘complexity scare’ and sorting through the simple glaring facts, it is plausible to conclude that the concept is justified on engineering grounds: resilience against earth-quakes, and considerably shorter (and therefore cheaper) spans. On economic grounds: private buying power and economic resources may finance the desired transportation project, and the built habitable assets (real estates cost-free), may serve the regional surge in housing demand while contributing, in a very substantial way, to metropolitan development and expansion, based on the combined resources of Regio di Calabria and Messina.

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   Galileo - A quarterly for Science & Thought, Israel, 2010.

Miri Weiss Cohen

An Intelligent Learning Design Support System for Jewelry Features

Topic: ***Computer Aided Design***

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Abstract:

This work presents an Artificial Intelligence aesthetic-driven Decision Support System (DSS) for jewelry design. "Creativity denotes a person‘s capacity to produce new or original ideas, insights, inventions, or artistic products, which are accepted by experts as being of scientific, aesthetic, social, or technical value"[1].
Manual design of jewelry is in wide use, and requires creativity, craftsmanship, and is time consuming. When compared to designing using Computer Aided Design (CAD) systems, CAD systems, provide the designer with realistically rendered features which are available from various viewpoints, giving the designer a clear understanding of the final result. Tools for options of transforming each one of the features, are provided instantly.
Our approach is to try to understand design creativity by —mimicking it, using Artificial Intelligence (AI). Our goal is to build a Learning Decision Support System (DSS) which can be used to experiment the processes of a wide range of influences on the designed jewelry feature. We use Genetic Algorithms [2], in which, each chromosome is constructed with a wide range of geometric features, composition factors, symmetry and provided ratios. Each of the resulting changes on the designs is stored, by choice of the designer, and a learning framework is established for future work. The learning process is based on Case Based Reasoning (CBR) [3], where a character of the designer is learned by the system and produces a designers hypothesis. The proposed system is to be embedded in a CAD system and is aimed to provide the designer an ability to a more intelligent tool.

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[3] Aamodt, E. Plaza ‘Case-Based Reasoning System Approaches’. AI Communications. IOS Press, Vol. 7: 1, pp. 39-59.

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Keywords:
Computer Aided Design, Genetic Algorithms, Jewellery Features

Penny Feuerstein

Artwork: trees on path, trees

Abstract:

I am mimicking the 'digital revolution' when I work with the computer to integrate, replicate, and generate.

The paint represents the analog world. Nothing goes on or changes from one state to another without going through a transition. There is something so tangible about painting with oil - totally different from manipulating images on a screen. I like contrasting the thick juciness of the paint with the smoothness of the print.

In "trees on path, trees, I painted with oil on board and scanned it into the computer. I then manipulated the work by copying and pasting selected areas, pushing them around, much as a painter pushes paint around. The work is composed by integrating, replicating, and generating certain selections of the painting. I then printed the work onto a large canvas and finally applied paint to the print.

The unique vocabulary of "copy, paste, copy paste, copy, that runs throughout my collage paintings mirrors both the computational speeds of our digital age, which integrates unparalled amounts of information and the evolving technology of generation and replication.

Topic: Art

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www.generativeart.com

"trees on path, trees", *oil and inkjet print on canvas*

penny@penny feuerstein. com

How Does the Analog "talk" to the Digital?How Does the Bit Give Voice to the Atom?

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Abstract:
I am mimicking the 'digital revolution' when I work with the computer to integrate replicate, and generate. The unique vocabulary of "copy,paste,copy,paste,copy that runs throughout my collage paintings mirrors both the computational speeds of our digital age, which integrates unparalleled amounts of information and the evolving technology of generation and replication.

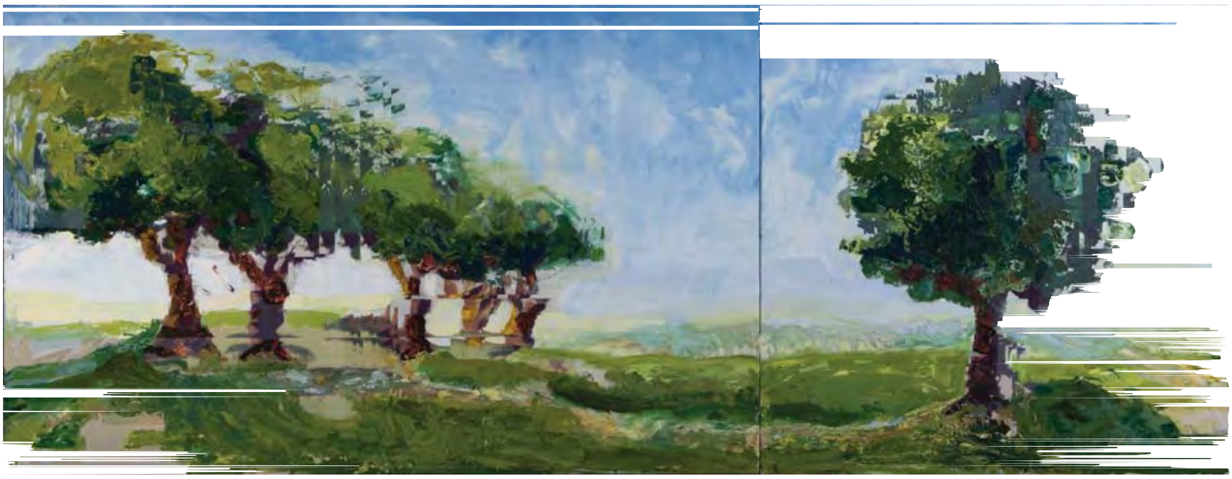
Having been passionate about painting since early high school, it was with great anticipation that I began my training as a graphic artist at Southern Illinois University (1978-1983) before ultimately receiving my MFA from The School of the Art Institute of Chicago (1999). During those years of initiation, I learned the essential principles and skills of illustration, layout, design and hand-lettering. My teachers were meticulous in their grading, using magnifying glasses to make sure each and every letter was perfectly drawn…and I, therefore, was equally meticulous, often working for hours on a single word. We also learned to use press type in our layouts; this involved the tedious transfer of letters from a font-filled sheet by rubbing or burnishing them on to a page with a ball-tipped stylus. While time-intensive, this was definitely more expedient than hand lettering, but letters could crack, descenders could separate on the descent, and alignment could easily stray offline.

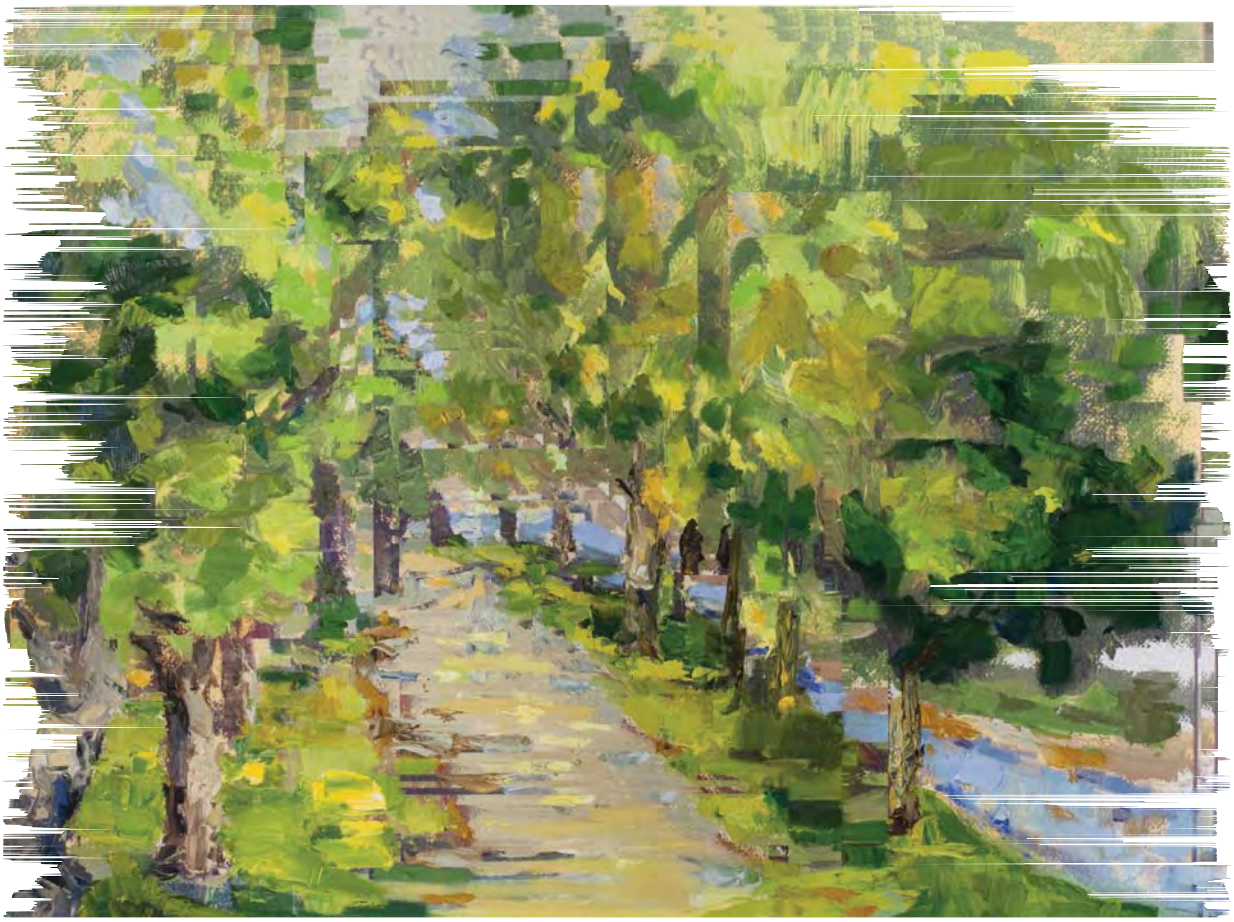
My first brush with technology, so to speak, occurred after my undergraduate studies while working at a package design firm. Here I sized and resized type and images on a photocopier to achieve scale and relationships. Compared to my student days of hand-lettering, you could say I was definitely picking up speed.

Fast-forward a decade to the early '90s and my first computer. Perfect lettering was all mine at the press of a button. The possibilities for manipulating images were not just fascinating, they were endless. Having lived the first half of my life without digital technology at my fingertips—and then watching how quickly it became imbedded in my world—compelled me to make art about this new Information Age.

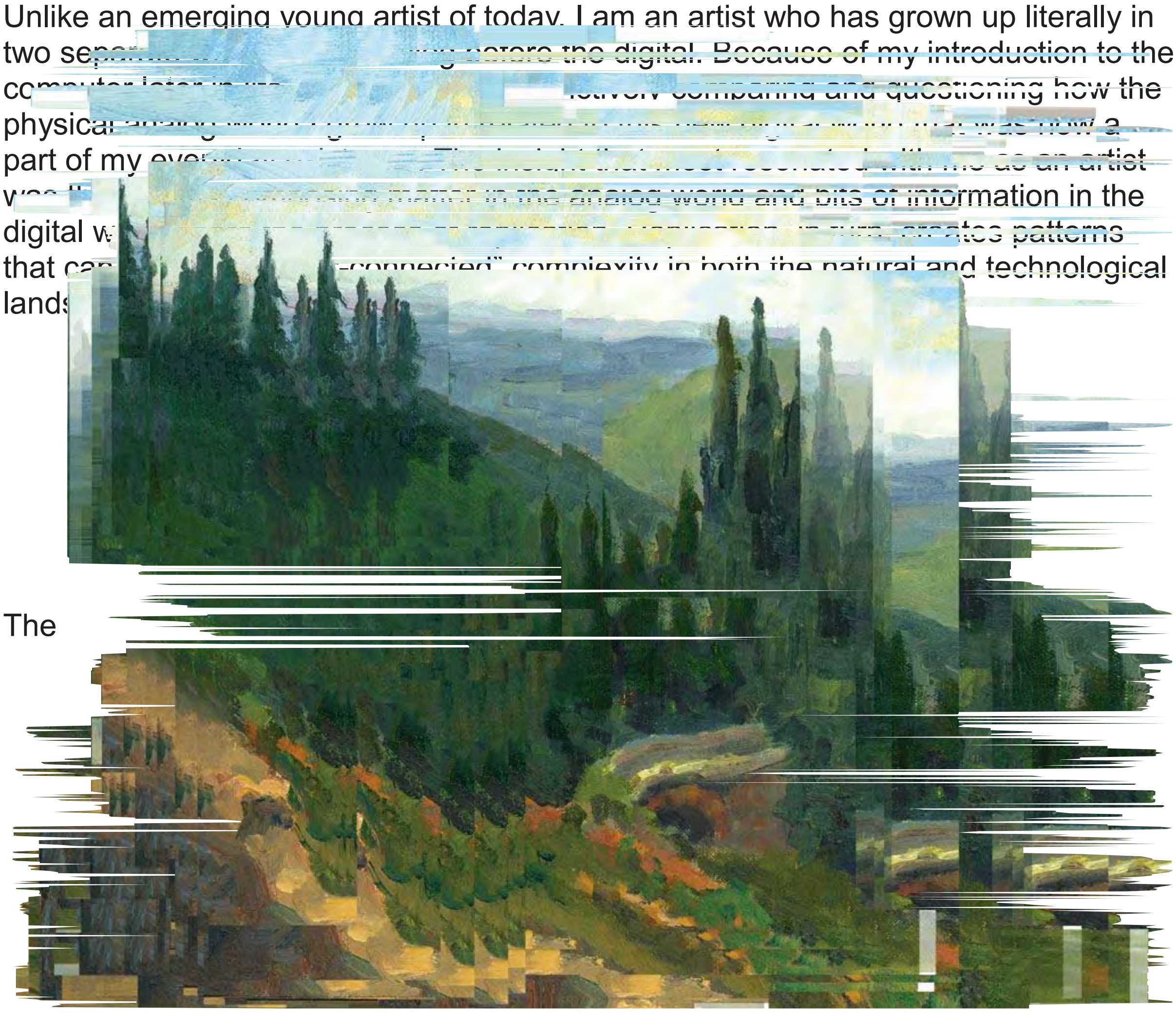
Just as the artist Léger based his art on the mechanics of the Industrial Revolution, my replicated works reflect the mechanics of the Digital Revolution. My method uses the copy/paste tools of the computer to make an image selection and then replicate multiple copies of that selection, creating compositional elements.

In the works below titled: “trees, trees”, “trees on path, trees,” “tuscan hillside, hill” and “trees on bluff, trees”, I first painted the landscape with oil on board, then scanned the painting into the computer. Next, I manipulated the image by copying and pasting selected areas—pushing these fragments around, in similar fashion to a painter pushing paint around with a brush or palette knife. Replicating and integrating certain selections from the original painting, I achieved a final composition that was then printed onto a large canvas. Lastly, I returned to the work’s original medium, applying paint on to the digital print.





Unlike an emerging young artist of today, I am an artist who has grown up literally in two se[illegible] before the digital. Because of my introduction to the co[illegible] comparing and questioning how the physical [illegible] that was now a part of my ev[illegible] with me as an artist w[illegible] matter in the analog world and bits of information in the digital w[illegible] creates patterns that ca[illegible] connected" complexity in both the natural and technological lands[illegible]



The [illegible] analog world is one made of matter, a world in which nothing can progress or change from one state to another without going through a transition. The digital world is made of bits, the smallest atomic elements in the DNA of information. Unlike matter, a bit has no color, size or weight and it can travel at the speed of light. It is a state of being: on or off, true or false, up or down, in or out, black or white. [1]

In my work, paint literally represents the matter of the analog world. There is something so exquisitely tangible about painting with oil—the texture, the richness of stroke, the saturation. My experience of paint lives at the total opposite spectrum from the calculated yet creative manipulation of digital images on screen. My work attempts to juxtapose these two worlds—the analog and the digital, the thick "juiciness" of the paint contrasted with the smoothness of the computer-generated print.

On an experiential level, working with the computer enhances my view of life from a subatomic or deconstructed perspective. The fractal nature of a fern plant, the DNA of a tree, the binary number system used in computers…these are all encoded with a set of instructions that repeat. Are these repeating patterns related? Do they influence one another? How do they affect their surroundings?

Patterns in nature are affected by the ecosystems they exist in and can only be described in terms of their organizing principles and the ways in which they relate to other complex dynamic systems. Even the smallest change can affect the whole as in the “butterfly effect.” This same phenomenon of cascading change is inherent in technology. As I work at the intersection of the analog and digital worlds, I question whether the onset of these complex new behaviors in technology will change the behaviors of nature. Stem cell research, global warming, nanotechnology, GMO, hybrid foods and plants…will all this change the way patterns in nature ultimately interact with one another?

My work expresses the simple idea of replication as I create scenes in nature. My vision is to emphasize that the very idea of replication is spinning off into complex systems in technology, analogous to the way in which DNA replicates itself to create interconnecting complex systems in nature.

As the Information Age continues to progress with its perpetually new complexities, we are experiencing a “hyper-connection” in almost everything imaginable. The digital world’s complex web of interconnecting algorithms dictates everyday decisions and is moving from the macroscopic systems like that found in large cities to the microscopic systems that affect almost everything we touch, from the products we design to the jobs we do every day. [2] These complexities are more complicated to predict because they interact in unexpected ways. Past behavior of a complex system may not predict its future behavior. In a complex system, the outlier is often more significant than the average.[3]

This constant progression of complexity is so pervasive that one need only look at ordinary events in our daily lives to witness its changing effects. One of my markers to gauge this has been the progression of my choice of grocery stores. In the ‘80s, I would shop at simple stores called Dominick’s and Jewel where I would buy canned soup and processed bologna. It reflected a time of mass culture, pop art, and advertising. In the ‘90s, shopping began to reflect global tastes, just as the world was becoming more global in nature. I now found myself in a more exotic market called Treasure Island, where I could find the latest gourmet fare from England, Spain, France or Italy. As life progressed, so did the complexity of my choices. Today you’ll find me shopping organic at Whole Foods, which seduces me with the promise of a healthier lifestyle with aisle after aisle of natural treats, hormone-free milk, free-range meats and holistic remedies. While my example of grocery stores is rather basic, it demonstrates that these complex systems are escalating us to a hyper-natural existence, streaming down music, books, Nooks, Skype, Internet, Siri and tomorrow’s next big techno advance, whatever that will be…but doing so in very simple intuitive ways that allow us access to anything we think about at the tap of a finger.

The vocabulary of “copy, paste, copy, paste, copy,” that runs throughout my collage paintings is the language I use to express the replicated and generated patterns in nature as well as the evolving technology of replication and generation used in computer-based algorithms. Nature and technology are both systems inherently programmed to operate in determined and patterned ways, but the interactions that can occur within those systems are always changing. The further we delve into complexity in the Information Age, the closer we are to embracing patterns in a ‘hyper- natural’ existence.

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Philip Galanter	*Artwork:* **ChromaVox**

Topic: Fine Art

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USA
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References:

[1] http://philipgalanter.com

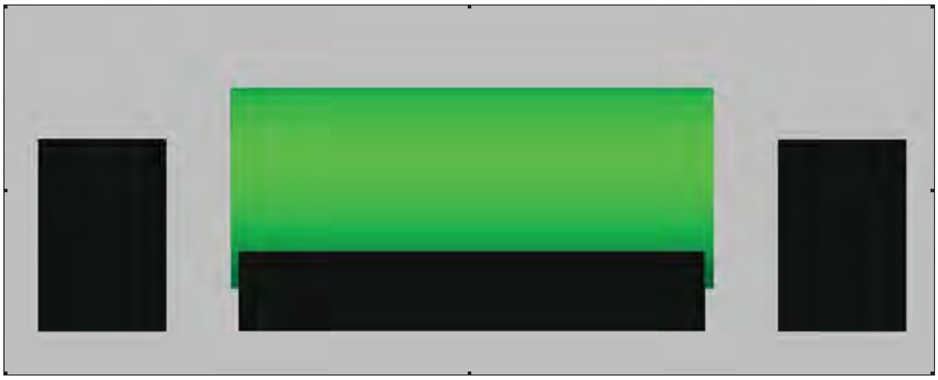
Abstract:
This is a work currently under construction and planned for completion at the end of October. It will require a plinth or other elevated stand about 80 cm square as well as 3 electrical outlets.

The work consists of 4 parts First there are two small audio speakers each about 15 cm tall and 10 cm wide. There is also a small 4 cm cube used as a color sensor. Finally there is the light unit about 20 cm tall and 45 cm wide. It consists of a glowing cylinder on a dark base.

The piece can run in an automatic or interactive mode. In interactive mode the visitor can place the color sensor on provided color samples or something they may have with them. The color sensed then slowly fills the light unit. Based on the color a generative system runs that produces 3 electronic-sounding voices that sing human-like phrases.

The music changes in tempo, register, and key depending on the color displayed. In particular, in the light unit there red, green, and blue LEDs that can be mixed to produce any color. Each is defined by 8 bits of color producing so-called 24 bit color. Those same 8 bits can be used to define the rule set for 3 cellular automata.

In this way the singing of the 3 voices corresponds to the 3 primary color components shown in the lamp.



ChromoVox planned construction

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Keywords:
Light sculpture, cellular automata, microcontroller

Dr. Pierre Pepin(PhD)

Live Performance:
BECOME A PART OF A MACHINE

Topic: Become a Part of a Machine
Live Performance

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Amman, Jordan
Department
Of Fine Art and
Computer Graphics

References:
[1] Pierre Pepin
The Multimedia interactive Book for Educators in Art 2009 thesis UQAM MONTREAL 2009
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Abstract: **Crazy** and **Wild** / **BECOME A PART OF A MACHINE**

The attendees and performers will become animators and will need to react constantly to all the situations. I will continually suggest a spontaneous adjustment of improvement to the action or scenario selected by the attendees or the animators. They will need to adapt themselves very quickly and will have no clue of what's going on during this performance. As soon as the attendees arrive on the site they will be confronted by a specific assignment, to do individually or with other people and without further preparations. It will be a ***very special and surprising performance.***

Become a Part of a Machine / Motion / Sound / Body expression working as a team. A short performance as a team 2 to 3 people as a group 5 to 7 people, as a big group everybody… The machine need to work very well with a lot of logic and a follow up from the start of the machine, the continuum and the running performance.

Contact: email
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Keywords: sound, motion, body expression, team works, logic of the continuum machine, running performance

Robert Spahr

Live Performance: **Red Queen's Race (surveillance machine)**

Abstract:
I am interested in how the ideas and images presented to us by the media affect our world view. As the ever present cable news cycle pushes a daily message of fear, filled with political polarization; domestic and foreign terrorism; recent kidnapped white girls; celebrity scandals; and the imminent threat of hurricane, earthquake or flood, I began to think about how these digital images and text operated, one day influencing our daily discourse, the next day vanishing without a trace. Digital leftovers reminded me of redundant computer programming. Code that was once useful, but later forgotten and obsolete.

This performance will appropriate and remix source material from online surveillance web cams, as well as text from the website of the United State's Department of Homeland Security, thereby creating it's own voyeuristic stream of processed information. The audience becomes the observer and given the power to observe. Using genetic algorithms, replication introduces artifacts, and the photos break down. Information is then lost and the surveillance becomes incomplete.

Red Queen's Race (surveillance machine) 2011

Topic: Computational Art, Appropriation, Remix, Surveillance, Genetic Algorithms

Authors:
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References:
[1] Michel Foucault, "*Discipline & Punish*", Vintage, New York, 1995
[2] www.robertspahr.com

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rspahr@siu.edu

Keywords:
net.art, surveillance, panopticon, appropriation, remix, genetic algorithms

Tatsuo Unemi

Live Performance: **SBArt4 breeding on site**

Topic: Audio visual art

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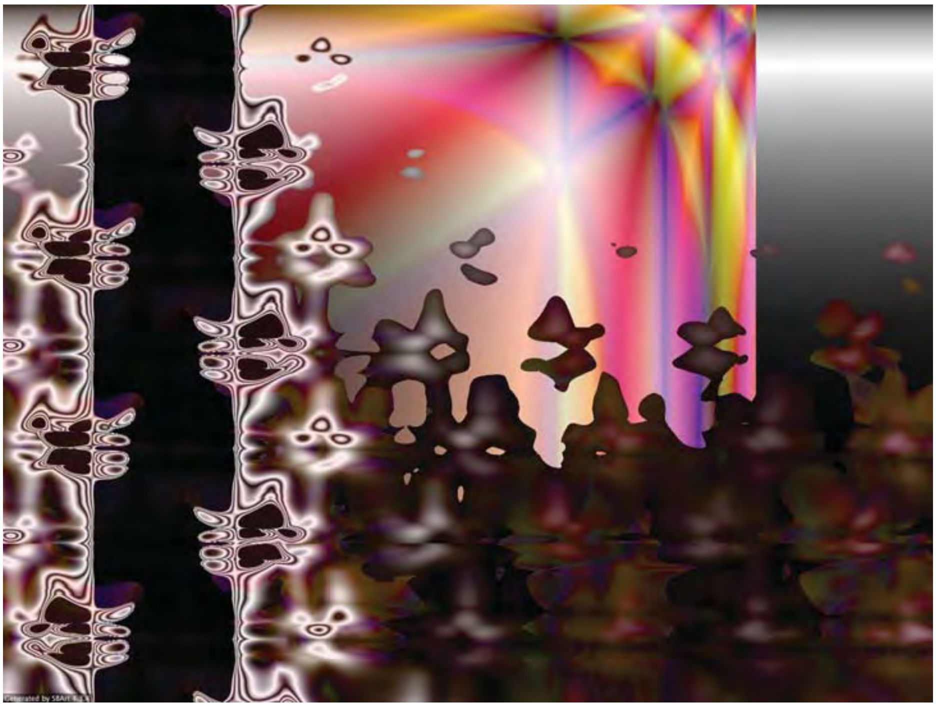
www.soka.ac.jp

Abstract:
SBArt4 is a breeding tool to produce abstract images and animations [1]. Newly developed accompanying software, SBArt4Player, realized seamless sequence of bred animations displayed on a remote machine. The performer breeds a variety of individual animations using SBArt4 on a machine at his front, and sends his favorite individual to SBArt4Player through a network connection. Each individual animation that reached to the remote machine is played back repeatedly with the synchronized sound effect until another one arrives.
Assisted by a mechanism of automated evolution based on computational aesthetic measures as the fitness function, it is relatively easy to produce interesting animations and sound effects efficiently on site. The performance will start from a simple pattern selected from the initial population randomly generated, and then gradually shifts to complex patterns.
Because the breeding process includes spontaneous transformation by mutation and combination, the animations shown in a performance are always different from those in another occasion. This means each performance is just one time. The duration is flexible in a range from three minutes to half an hour as requested on site.



A sample shot of bred animation.

References:
[1] Tatsuo Unemi, "*A Breeding Tool for Abstract Animations and Its Applications*", 13th Generative Art Conference, 451-458, Milan, Italy, 2010
[2] www.intlab.soka.ac.jp/~unemi/sbart/4/

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unemi@t.soka.ac.jp

Keywords:
Evolutionary art, real-time breeding, abstract animation

Yoshiyuki Abe

Artworks: **N220, N230, N240**

Topic: Art

Author:Yoshiyuki Abe
Artist, Tokyo, Japan
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References:

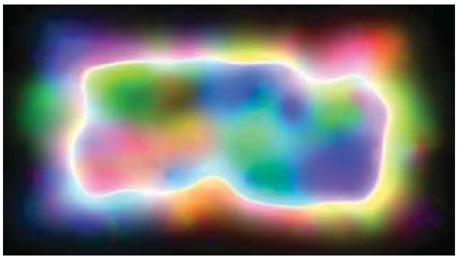
Hidden abstraction

In computer graphics, a technically correct rendering with accurate control of the quality of the lighting is a must if you want a photorealistic image but it is rarely required in abstract imaging. The fact, however, that faint control of the colour quality of illuminant may produce significant changes in the result is important for the abstract artist and the image generation using numerous light sources becomes almost out-of-control.

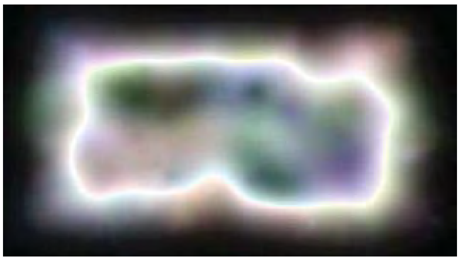
For my recent works I have been using an algorithm to reproduce a plate which is illuminated by 500 to 2000 light sources have varied values of luminous intensity and colour attributes. The distribution of the intensity of illumination on a plate shows various colour patterns.

Here, I present some images generated by a ray tracer and enhanced its colour purity. Original images have a flat plate primitive illuminated by 1980 lights in 3D space and the coordinates and colour of lights were generated by random process.

The reason I employ such process is I can get pure abstract images hidden in the computer generated scenery without modelling. They are not meaningless abstraction but often being narrative in the viewer's mind.



N220



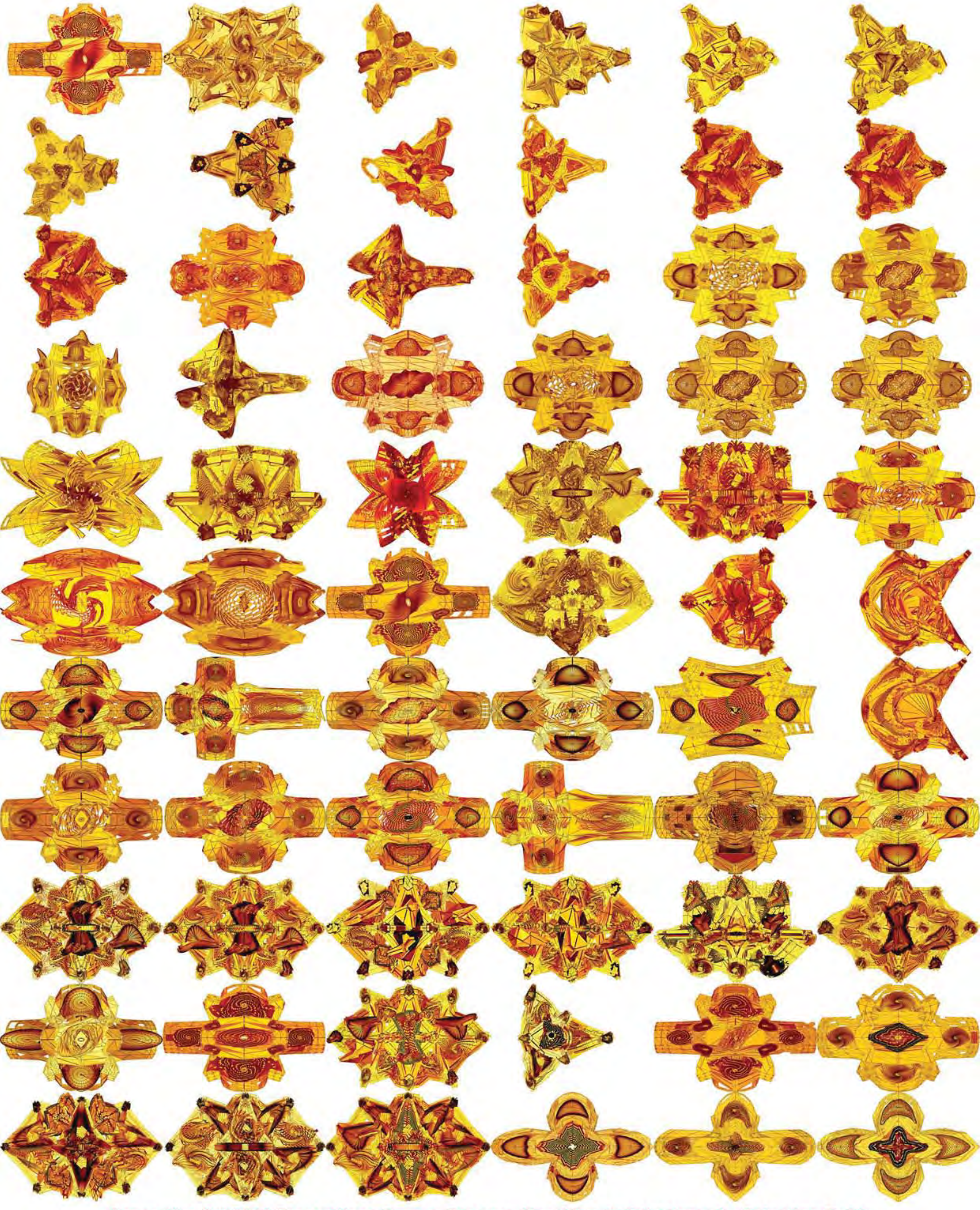
without saturation control

N240

without saturation control

Contact:
y.abe@ieee.org

Keywords:



Generative Art 2011 Proceedings Covers, Baroque Algorithm Architectures by Celestino Soddu