GA2007

10th Generative Art Conference

Generative Design Lab, DiAP, Politecnico di Milano University

edited by Celestino Soddu

Domus Argenia

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Papers

Performances, Posters and Installations

Endless interpretations, infinite in the mirror

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Abstract

Inquire about problems of design in our time of globalization, mainly the loosing of cities identities, of architects identities, differences and cultural heritages.
Philosophy, methodology and tools of Argenia, generative software able to produce complex architectural and urban scenarios connected with the cultural identity of each context.

Premise

Generative Design works defining how to transform the existing environment into scenarios more closed to a vision of future. The rules of these transformations are applied in concrete projects, from urban planning to architectural design, from product design to Art and Music.
Generative artworks are not only the result of these transformations but the operative concept. A structured Idea that is defined as a way to look at a possible future, how to build it transforming the existing environment.
Argenia is my generative software, as I have designed it in the last twenty years, operating from architecture to product design, from art to music. My first Argenia was, in 1987, a software able to generate endless 3D models of Italian Medieval Towns, a generative work inspired by Giotto frescos.

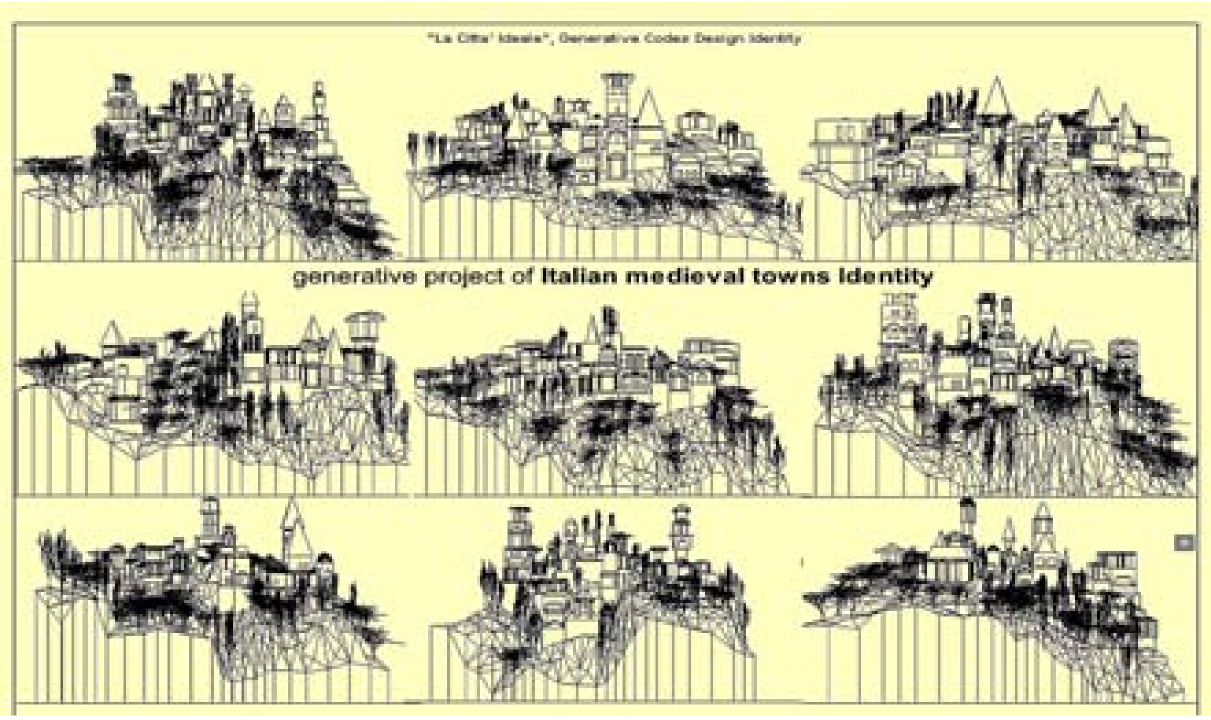

Fig.1. First Argenia. Generative design of Italian medieval towns. 1987. The main reference was Giotto's frescos.

Argenia is a generative system based on transformations. There are some points of interest that must be clarified and defined approaching architecture design.

1. The **starting point** of transformations. This is a main question involving also:
    a. *if* and *how* to use random into generative processes.
    b. the possibility to use forms as paradigm of relationships among 3D locations defined as parametric organization.
    c. Does a starting point exist in a generative process? If it exists which could be it? How this starting point is considered in Argenia?
2. The **logical structure** of these transformations and their applicability to architectural and urban design.
3. How we can **define and check the objectives** to be reached in an architectural project, from functional to aestetical needs? how we can reach and fit them through the dynamic generative process? This question involves **how to use references** in design processes for reaching predefined aims: copy versus interpretation.
4. **Context and project**.
    a. Generating architectures in a city, how can we manage the relationships with the **environmental and cultural context**?
    b. Which is the role of subjective architectural idea, of **designer identity** in fitting an increasing identity of a city and its cultural heritage?
    c. The question involves the respect of the cultural-environmental identity by using **interpretation and not repetition/cloning**. Interpretation is a subjective imitation of an existing process, mainly in nature, for getting comparable quality in fields identified as important.

1.The starting point

1st consideration.
Each project seems to start up from a blank sheet. But it is the development of two precedents: our architectural Idea and the exhisting environment. The existing environment is an external datum of the project. It conditions the project's development setting some needs and requests, also concerning the city environment identity.
It is like natural environment in which a seed of a tree is thrown: it strongly conditions the development of the tree but it doesn't act on its recognizability as identity of species. It interferes with the oneness of the tree but not with its "hereditary" characters. We know that an individual's existence, in Nature, starts from a seed and progressively will get transformation following the rules written in its DNA (contained in the seed) and managing the interactions with the external environment that will enrich its complexity because of the need to answer to subsequent unpredictable events, like winds and seasons.
From the side of environment, the insertion of the new individual will also increase (or decrease) the environmental identity. The increasing identity come from the increasing number of variations belonging to the same species: a wood of pines owes its strong image to the presence of numerous pines, all variations of the "pine". These variations contribute to create the identity of wood.
Also a city, Rome for instance, owes its identity to the progressive variations of its architectures, from the Imperial to Medieval era, from Renaissance to Baroque,

creating a wide range of variations that we can consider as possible multiple interpretations of this city. These events were realized varying in the time, but also with jumps, those that René Thom would call catastrophes. The running of a project is really a not-linear system.

This stratified mix of architectures have set up the uniqueness and unrepeteability of Rome's Identity as also happened for other cities with a briefer history, from New York to Hong Kong, from Chicago to Venice, but with the same fascinating strength to be in progress more and more unique and unrepeteable.

The starting point of a city and of an architectural project is similar. From what was New York born? Which was the starting point establishing Rome? The quality of the environment structure, obviously. Probably, as in the legend, a limit drawn around a person that traces the borderline between the inside and the outside. A limit tthat must be defended valiantly but that is destined to be shattered, but from the inside: as an egg or a seed. A limit therefore that cannot be a sphere, or a circle if we are working in 2 dimensions, but something that is "oriented" like an egg or a seed, or like a rectangle that marks the future boundaries of the city. Spheres don't have orientation but only spatial positions. And if we try a perspective view of a sphere from its inside, we are destined to failure. It is impossible. If we use the artifice to draw the meridians and the parallels, we have already oriented it: the axle north-south will exist, and the sphere will be different from all other with different aces.

Representing the space could mean, as first action, to orient it, and this can be a starting point of a generative process.

Second consideration

How much is the starting point important in a creative process?

Argenia is a process structured as a sequence of transformations in which each transformation works in two different fields: first, it answers to an external solicitation, to a need, to a client's request; second, it's an occasion to express the designer's own idea following own dynamic interpretation of the existing environment.

In this perspective, which is the sense of the starting point? What role does it have and how we can structure it in a generative software?

My hypothesis is that the starting point is not anything else than a catalyst, an help to enter in the designing field, applying our first transformation rule. At the end of the design process, the starting point will be only a marginal event that was progressively cancelled by the increasing of complexity owed to the following sequence of transformations. As happens in a fractal. If we get a shape and we apply to it iteractive transformations, or rather we repeat the same transformation (for instance scaling it and rotating it in a pre-defined misure) for many times overlapping the images as progressively they are produced, we will have, at the end, a complex result whose recognizability and character almost exclusively originate from the effected transformations.

The initial sketch has a marginal role in the final result, or it could have the role to differentiate each some possible results that appear as variations of a same idea. The idea therefore it is entirely contained in the rules of the variations, not in the initial input.

Even if we use a random/unpredictable event as initial input that could be, like in my Argenia, the 3d structure of virtual mountains in Italian Medieval towns project or the date and the time of the starting up of each generation in other Argenias, the characters and clarity of the idea inside the various results cannot be referred to such initial input. These intupts can operates in another field, i.e. becoming the generating input of oneness of every single variation.

2. Transformations

At the beginning of a generation I perform a void as representation and a full as concept. This void can be reported by a sphere represented by its inside. The full is its specificity that is not represented by results/forms but by attributes defining its possible characters, by adjectives describing the aims to reach. Attributes and adjectives built as codes of transformation, algorithms able, all together, to define an artificial Dna.

The beginning of the generative process is the orientation of the system. The sphere, suddenly becomes visible, its representation seems to be born from nothing, but it is only the passage from an event without orientation to one oriented. This is the first generative action.

The further design developments are nothing else than progressive and multiple transformations making the system more and more visible and complex. Trasforming it progressively into an habitable architecture, beautiful, leaned out on the environment, stately, technologically attractive, fantastic. A generative process imitating what happens in Nature.

The transformations, the generative algorithms that I write for representing and check them, were born from my interpretation of what surrounds us, of the environment as dynamic system tending to the beauty, to the functionality, to the correspondence to the manifold needs of the man. Geometry and Mathematics are the specific fields of this creative moment, because interpretation is the main creative moment. Transformations are easily representable as algorithms, and this is the most immediate and controllable way to conceive transformations, also before knowing on what and when they will be applied.

Argenia, the generative project of my architecture/object/artwork concept is to conceive, to manage, to reciprocally contaminate, to calibrate these transformations into a set of rules.

Designing transformations, rules of the mutual contaminations, calibrating the system in its progressive evolution is to build something like the Dna in nature.

Argenia, Generative Design is Artificial DNA, it is Identity's Design.

Every transformation is identifiable from:

1. the field in which is applied
2. how it happens
3. which orientation
4. which character / objective / function each transformation will add to the system.

The fields of application are born from each subjective interpretation of the Nature.

Generally the fields of transformation that I consider when I am designing architectures are:

a. How the architectural event wraps itself, how is oriented, how it becomes visible with its skin. As in Nature the flowers or fruits.

b. How the architectural event folds up. From hills to the branches of the palm, from the Gothic arc to the curve of a dam.

c. How the architectural event divides / articulates itself, from the articulations of the fingers to the flowers, from the petals to the structure of the branches, to the

tassellation of the floors, to the construction of the façades of the buildings.
d. How the architectural event extends itself. References could be from the bell towers to the fins, from the spiral dome of Borromini to the branches of a tree.
e. How the architectural event ends. Referencing from the hair to the helmet, from the dome to the top of the mountains, from the point of the arrow to the fingernails, to the hat.
f. How the architectural event start up. Getting interpretations from the roots to the foundations, from the legs to the shoes, from the clogs of the horses at the base of a vase.
g. And so on.

"How happens" defines the way of operating the transformation, It is the "know how" of each architect, and can be defined by algorithms, writing how it's possible to reach wanted results departing from a precedent that not necessarily is previously identified. An algorithm that traces the formalities of each transformation could be applied on what previously exists, without knowing it in advance. If we apply to a sphere an algorithm able to extend toward outside the previous event by using points identified by a division in 4, 8, 12, n parts the previous event we would have, as possible results, from a tetraedro to a cube to one of the solid traced by Luca Pacioli and Leonardo.

If the algorithm expresses formalities in more articulated way, we could have spaces with more complex characteristics able to answer to precise architectural intents. The advantage of operating through progressive transformations / algorithms is also the possibility to reach a multiplicity of objectives in each single results. We can run a sequence of transformations, each one operating on the result of the previous one, and not choosing among different pre-defined forms.
The transformation rules that I used in Argenia fit my architectural concept and cannot be used by other architects because they perform my identity ad designer.
My last work is an Argenia able to be performed by each designer creating subjective rules of transformation, subjective paradigms for controlling the generative process, subjective starting forms defined and parametric systems of relationships among different locations. It can also use an adaptive Cellular Automata engine for increasing the complexity of paradigm's relationships.

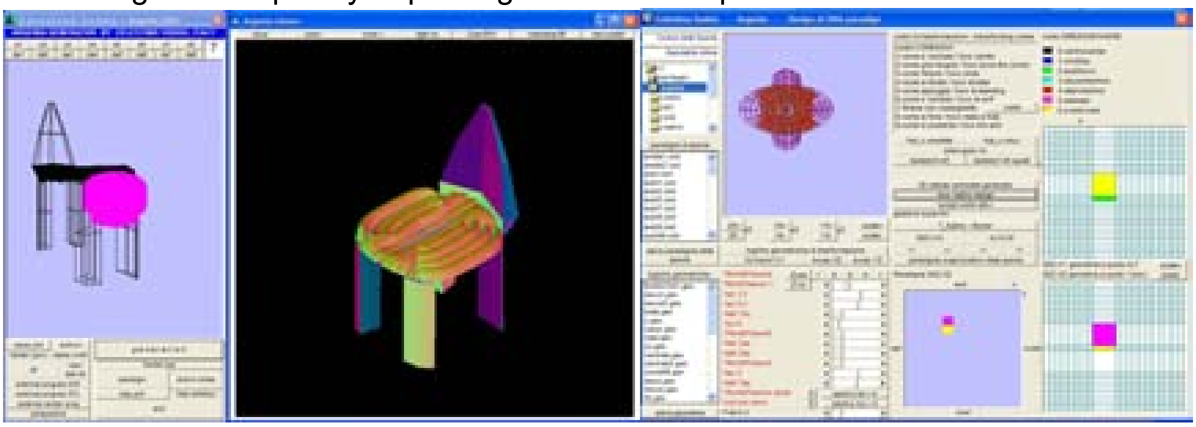

Fig.2 Screen dumps of last Argenia software. 1st version 1987, last version 2007.

3. Identification of aims and objectives

One of the activities more abused by designers is to copy from magazines. It is an activity that actually creates inurement that can arrive to dry up all creative subjective potentiality. Magazines follow fashion and the trend is to follow the fashion. This forces designers to conform themselves. Running constant progressive adjustments is an habit that risks to create dependence.

Alternative of copy is the subjective interpretation. In generative terms it is the construction of a rule, or a set of rules of transformation suggested by each reference. Operationally, if we appreciate something because it is beautiful, enthusiastically, light and technological, instead of copying it, we can create an algorithm of transformation - all the algorithms are logics of transformation - that operates transforming each input in an output that, keeping the previously reached qualities, should be more beautiful, enthusiastically, light, technological than before.

When Picasso repainted Velasquez he didn't copy but interpreted a way of construction of the picture defining a logic that didn't derive from a philological analytical approach to the composition structure of Velasquez. Picasso’s interpretation derived from his subjective creative moment stimulated by the appreciation of the painting of Velsquez. This interpretation supported him in constructing his own work, using his peculiar artist’s identity.

But he reached also another goal. The result, being a interpretation-variation of the original Velasquez painting, succeed also in widening the communicative strength and of the original. This is the reason why we call these works “homage to ..”

Contrarily of the copy, the subjective interpretation and the representation of references as logics of transformation doesn't create habit, but help the growing of own cultural identity, of subjective creative ability and clarity.

Generative art runs this approach, exalting own creativeness by the interpretation of the existing events as dynamic systems, managing their evolution with own rules of transformation.

Fig.3 Woman Portraits from Picasso realized with rapid prototyping equipment using STL files directly generated by Argenia.

In my Argenias from Picasso I have run again this type of approach, that was of Picasso toward Velasquez, proposing my interpretation of the woman portraits of Picasso through the construction of a generative code able to build such interpretations as endless series of three-dimensional models. And building them

physically with rapid prototyping tools.
In this case, for avoiding the copy, I managed the interpretation also by moving from two dimension (the original portraits) to 3 dimensions (the possible outputs)

My main reference in architecture is Gaudì. I have interpreted his works by building a generative project of towers that I have called "homage to Gaudi'". In this Argenia I don't use forms, like the forms of Gaudi's architectures, but I define a logic of reaching complexity and geometric contaminations able to allude to the work of this great master. In the same moment my aim was to follow my peculiar idea of architecture.

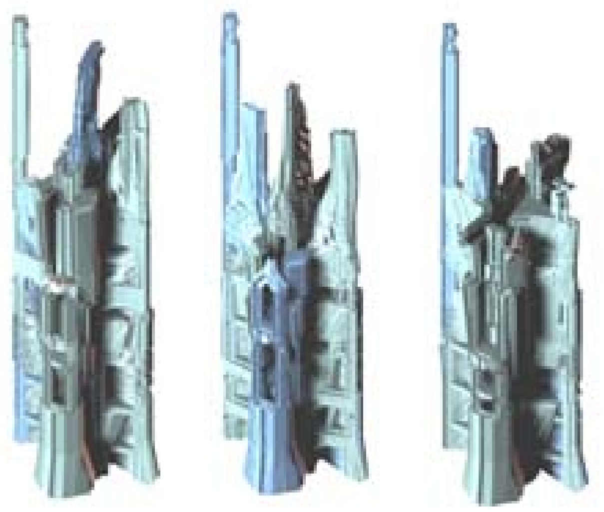

Fig.4 "Homage to Gaudì", generated variation of towers with codes fitting my interpretation of Gaudì. Realized with rapid prototyping equipment using the STL files generated by Argenia.

4.The impact with peculiar town environment and its local cultural Identity

Generative design is a design approach based on the imitation of Nature. Its results should be, like in Nature, strongly recognizable, functional and aesthetically fascinating. With a strong Identity of species, like in the best artist's artworks.
But such identity, if the generative approach is operated in architecture, is double: the identity of the architect's idea and the identity of the existing environment.
It's thinkable that the construction of an artificial Dna through the representation of own interpretations as rules of transformation brings to enhance the identity and recognizability of the architect, artist, or musician that designed the rules.
But in architectural design acts, the identity of the surrounding environment, the city and its local cultural identity directly enters in the creative process. Every architectural project should preserve not only the cultural identity of the existing environment but should increase it. The identity, in fact, is a dynamic system. If it is not increased, it decreases and disappears. A new architecture that not increases the city's identity destroys it.
I like to think that the city identity, its specificity and oneness, depends from the simultaneous presence of different architectures that we can consider as possible variations belonging to subjective interpretations of the city made by different

architects.
Every architecture, if it is in tuning with the city identity, should contain an interpretative representation of the city's identity together with a strong representation of the architect's idea able to make the difference among all other interpretations.

One of the characters of generative design is that a single result doesn't exist. As in nature, every individual is one of possible variations belonging to a species and every species is one of possible variations of a base-concept. A small variation in the natural Dna is enough, also only of 2%, for moving from human beings to monkeys.
In my experiences of generative design of urban identities I have realized that, as in nature, the rules of transformation, the generative code, the artificial Dna of my architectural idea is extremely sensitive. Small variations are enough, also only infinitesimal variations, for reaching different characterizations.
This gives a great potentiality to Generative Design. When built an artificial Dna or rather a code of transformations that correspond to my uniqueness as architect, I can, with small variations, to direct my project in a way that it will be an interpretation of "how to make Hong Kong more Hong Kong than before" or Chicago more Chicago than before. I work for increasing the identity of a preexisting environment by varying just a little the algorithms of my generative software. I have experimented how much is enough for reaching, with my Argenia, the possibility to increase different cities identity and keeping unchanged, or better increasing, the identity of my architectural concept.

Fig.5 Cities Identities and Argenia. Generated architecture for Chicago and Los Angeles.

Fig.6 Cities Identities and Argenia. Generated architecture for Hong Kong and Nagoya, 2001,2002

Fig.7 Cities Identities and Argenia. Generated architecture for Cagliari, 2007, and Beijing, 2004.

Fig.8 Cities Identities and Argenia. Generated architecture for Milan interland, 2001 and Tianjin, 2003.

Travelling through different and parallel cities identities over the world and structuring progressive variations able to answer to these cultural differences has been an enthusiastic and un-repeatable experience. Also because unpredictable correspondences emerged among very distant cultures, where the concept of fluidity

and wrapping of spaces is similar in China and in Sardinia. More, small differences on the degree of iteration of same transformations, that we could call fractal transformations of space and details, could define substantial cultural differences.
A clear example is that raising the fractal degree of transformations, it is possible to generate architectures answering to Indian cultural identity starting from paradigms and rules designed for Italian medieval castles.

Fig.9 Alpes Identity. A borgo on the lake referring to gotic cities environment, 2007.

Fig.10 Twin towers for increasing Shanghai identity, 2004 and the TV tower in Tel Aviv, 2005

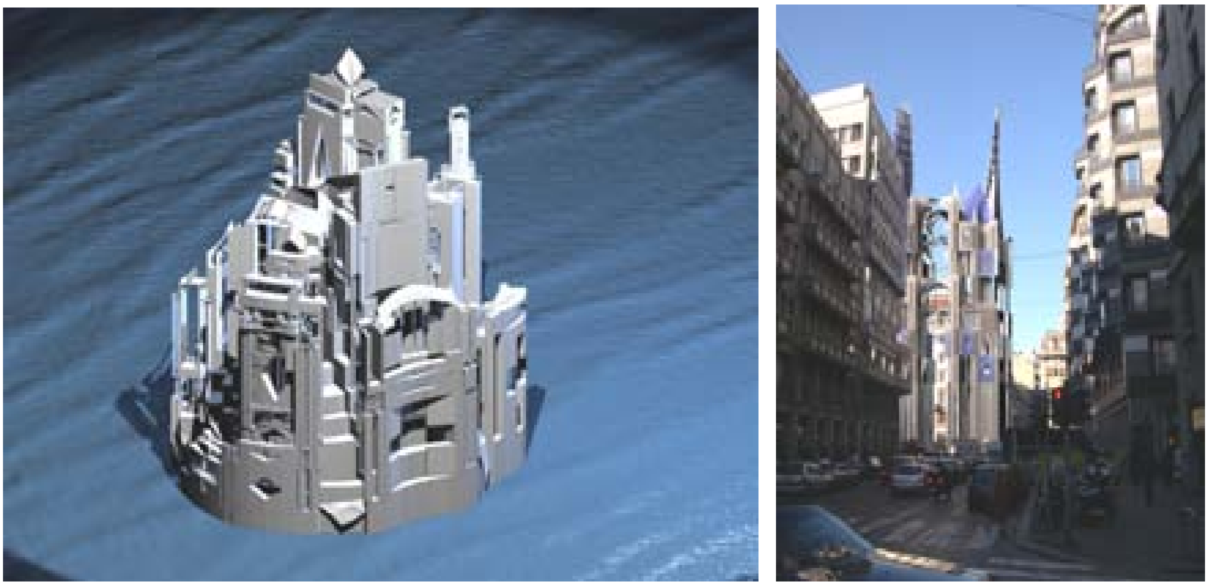

Fig.11 City on the water for Macau earth's recovery from the sea, 2004, and New Gallery in Milan, 2004.

Fig.11 Indian Taj generated by Argenia, 2006, increasing the fractal iteractive sequences of transformations for reaching “Delhi Identity” and Medieval towns, 1987.

More, each new generative project, through the plurality of algorithms set in every different occasion, can supports us in increasing and consolidating own professional and cultural identity. As happened for me with Argenia.

But how much the identities and recognizability of architects are useful to the quality of the urban environment? More the architect is recognizable, more his work could be a meaningful variation of possible interpretations of the city. A city that have manifold interpretations is a city that has its own identity. It has an history.

The variations of Bach don't destroy the identity of its work, but they consolidate rendering more clear the concept. The multiplicity of possible cats, different in aspect and color, don't certainly reduce the identity of cat’s species but consolidate it really through the variations. The cultural identities of the various European countries, in

their difference, increase the clarity of an European identity really because they can be recognized as meaningful variations of a same cultural approach.
Generative Design and Argenia, directly working on species of objects and producing not single results but variations of the idea is an essential tool against homologation and cultural leveling. It is against clones by supporting the plurality, against the repetition and the copy by supporting the variation of cultural interpretations and its aim is the generation of uniqueness.

References

Websites:
www.argenia.it
www.generativeart.com

Main Books about Argenia:
Celestino Soddu, “Città Aleatorie” (aleatory cities), Masson Publisher, 1989
Enrica Colabella, Celestino Soddu, “Il progetto ambientale di morfogenesi” (environmental morphogenetic design), Esculapio Publisher, 1992
Celestino Soddu, “Milan visionary variations, Futuristic Meta codes for Milan’s Identity”, Gangemi publisher, 2005 (in english and Italian)
Celestino Soddu (edited by), “Generative Art Conference”, proceedings of annual GA conferences 1998-2006.

Some articles:
C. Soddu, "Generative Design / Visionary Variations - Morphogenetic processes for Complex Future Identities" in the book Organic Aesthetics and generative methods in Architectural design" edited by P. Van Looke & Y. Joye in Communication&Cognition, Vol 36, Number 3/4, Ghent, Belgium 2004
C. Soddu, "变化多端的建筑生成设计法" (Generative Design), article in the magazine "Architect", December 2004, China
C.Soddu, “Generative Art in Visionary Variations”, in Art+Math=X proceedings, University of Colorado Boulder, 2005.
C.Soddu, “Visionary Variations in Generative Architectural Design”,article in Chepos magazine n.003, TU/e, Eindhoven 2005.
C.Soddu, E.Colabella, “A Universal Mother Tongue”, Leonardo Electronic Almanac Volume 13, Number 8, August 2005
C. Soddu, “Argenia, Artificial DNA and Visionary variations”, The Journal of designing in China, summer 2005, Hong Kong

Generative Post-processing as an Effective Approach in Art

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Abstract

This paper presents a specific approach in generative art, which is more known in the photograph and video area. It is the case of post-processing method, which could be used as an effective creative method producing abstract images based on master image mutations. A photo or previous generated image enters into the program as a raw material, which is strongly elaborated and mutated during the process in order to get an output completely different and never repeatable. To research post-processing possibilities in generative art I developed a generative program applying a post-processing algorithm based on my own concept. The algorithm consists of master image destruction and transfer of its pieces into intermediate image, which is, later, elaborated using another algorithm to produce the final result. Independently of the type of the input image, the result is always presented as an immense number of abstract pictures, which have nothing to do with master image.

1. Introduction

Generative art as the creative approach, which is generally based on proper program algorithms gives to the authors the opportunity to introduce very different and specific programming methods. Pragmatic programming concept requires abilities how to define complex objects using dynamic solutions in order to obtain high level of variety. Desired objects have to be drawn and recognizable otherwise the aim is missed. Algorithmic approach is much more free and opened for unusual and original ideas. Important is that the program code generates an image in which the primary artistic rules are respected: form and composition, color harmonization, aesthetic etc. Very similar results could be generated using different approaches and vice versa and the author’s choice depends on his inventiveness.

At the beginning of my generative practice I used simple mathematical formulas and expressions using gene variables and dynamic screen variables generally produced by simple kinematics process in the background. Combining those coloring algorithms inside multilevel program structure causes the creation of more complex and interesting images. In the next step of developing process I began to introduce the deformed fractal calculus which enables diving into the third dimension of the image looking for interesting motives. The research of the role of coloring palettes into final result offers the idea to use previous generated image as coloring palette [1].

The next step I have experimented in the recent period is so called post-processing of an image to generate an absolutely irrecognizable result which differs with all input image attributes. Depending on post-processing algorithms, the images generated using this method, are usually total abstracts with no color and form tracks of input image. Processed input image plays the role of first part of algorithm which is upgraded with program algorithm and both together produce a different result after each program cycle. For experimental purpose I developed a program, which is presented in this paper. The input image could be imported from outside into program or could be generated inside it with one of my previous program solutions. Once the image is saved into program operating memory the post-processing procedure starts. The program contains different post-processing algorithms which could be used separately or mixed all together. The main task of post-processing algorithms is to cut pieces of input image and past them into new picture using random positioning and color mixing with different intensity of existing colors. This procedure causes the appearance of new colors, which are not presented in the input image. Resulted image could be used as input image in the next program cycle and this property opens a new dimension of described concept. Finally the program enables mixing together different post-processed images getting absolutely unpredictable result in a form of total abstract picture.

The approach presented above finally resolves my old dreams about how to generate abstract images, color and form harmonized, using an autonomous generative process and with no use of random color and form selection. All image attributes are defined automatically by algorithm hidden inside input image and selected program algorithm.

2. Post-processing as the method

The term post-processing was primary used in the area of digital images and videos as a quality-improvement method especially inside image scaling routines which can be performed when increasing the size of images. During the time different post-processing routines were developed and some of them are applied in commercial graphics programs: image scaling (interpolations: linear, bilinear, cubic, bicubic, trilinear etc), sharpen – unsharpen, requantization, luminance alterations, blurring – denoising, deinterlacing and others [2]. The post-processing routines are applied in the post-processing software. The post-processing software is any software, which is used to manipulate a digital photo once downloaded into computer. That definition covers a lot of software, from the apps camera makers include their cameras that remove red-eye and make basic color adjustments to high-costing packages that can manipulate each bit of the photographs data. Every application has one goal, to help to make the photos better. The question is why to use the post-processing methods. The camera is just a recorder: a collection of lenses, sensors and processors that record light in an instance of time. Humans, however, see with our minds. The images that our eyes capture are immediately interpreted into something meaningful by our minds. The digital photographers have an endless list of tools to reach described goal: recorded image must be interpreted into something that our minds can understand and, hopefully, appreciate.

The post-processing application could be divided into three categories: light, medium and heavy weight [3]. Light weight tools can perform basic photo tweaking task like red-eye removal and minor color adjustments. They can also help with organizing and sharing photos. (Examples: iPhoto, Photo Story 3, Olympus Master, Picassa, Adobe Photoshop Album Starter Edition 3.0, Snapfire Plus). Medium weight tools can do a lot more to photos like allow refined exposure adjustments, basic photo blending, the use of filters which can do all sorts of interesting effects to pictures. (Examples: Photoshop Elements, The GIMP, Graphic Converter). Heavy Weight tools are used by professionals and can do darn near anything to a digital photo until the photo becomes irrecognizable. (Examples: Photoshop, Lightroom, Aperture, Paint Shop Pro Photo XI, Picture Window)

Fractals as digital art could represent a typical case of image post-processing. Fractal image has been post-processed when it has been imported into a graphics editor to adjust any of its original properties. The result is a modification of the master picture as it came out of the fractal generating software alone [4]. This is a normal practice in digital graphics creation, but still divides the group of fractal artists in two camps: those who prefer to leave the fractal as is (keeping its natural form) and those that routinely enhance its appearance with the intent of improving or increasing the artistic output. Ultra Fractal helped to change that perception because most fractal artists are using it almost exclusively, unleashing its power to combine several layers into a single image. Since all adjustments are done inside the same application, some people think they are not post-processing the picture, but the truth is that all those operations are altering the base image, equaling what will normally be post-processing.

Observing the way of my generative art project development I can recognize three conceptual views towards my personal influence into final results. At the beginning I absolutely didn't permit to myself to have any influence into generative results. My programs didn't enable any interactive action and I saved the image as it was generated or I rejected it away. I not even used anti-aliasing method. In the next phase I introduced "interactivity" which made my images better and more personal. Actually I'm study some post-processing concept and I have to recognize, that I am more satisfied with my generated images. In this paper I have intention to present one of my new generative program with post-processing routine built in.

3. Description of the Program "Mutate01"

The expression mutate, derives form the basic concept of the program: mutate an existing image to obtain an immense number of new images, all different and non comparable in any way with master image (input image). The generative approach is used in mutation algorithm which could be treated as a typical post-processing software. In this section I want to describe main characteristics of the program and its functions. The program is developed in Visual Basic programming language, with object oriented architecture applied and with no use of and library routines. The program could be run in any MS environment.

3.1 Functionalities of the program

The program enables the following basic functionalities:

- import an existing image to be post-processed (a photo or previous generated

image)
- create its own image to be post-processed
- call an other generative program to create an mage to be post-processed
- two types of post-processing routines
- draw an save post-processed image
- other useful facilities described in prosecution

Detailed description of the program function through command buttons (see user interface on Figure 01):

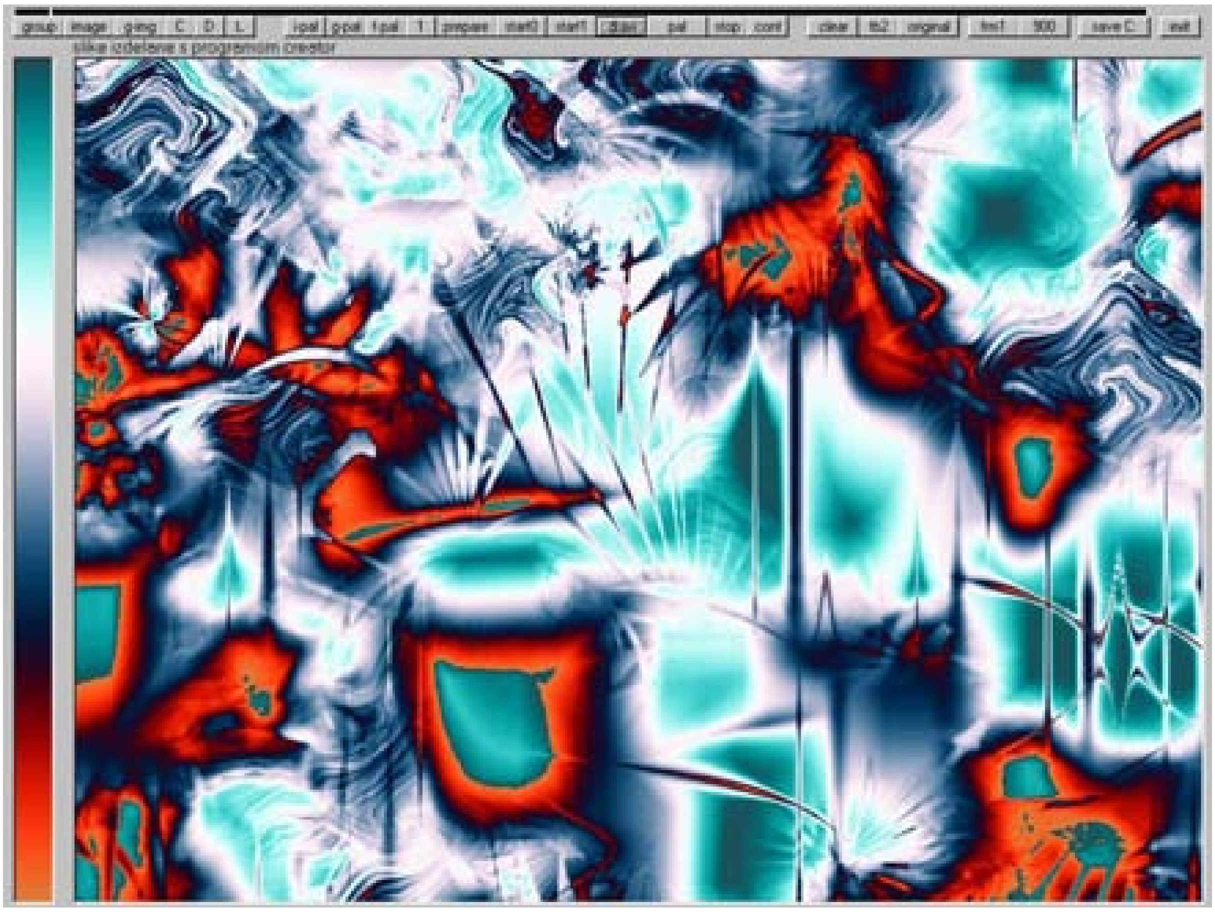


figure 01

- group: group selection of images
- image: selection of image to be post-processed (master image)
- g-img: generate program's own image to be post-processed
- i-pal: import coloring palette from outside
- g-pal: generate unique coloring palette
- t-pal: generate a group of coloring palettes
- n (numbers from 1 to 30): selection of coloring palette from the group
- prepare: move master image into working matrix (two-dimension data array)
- satrt0: simple post-processing routine
- start1: main post-processing routine
- draw: draw post-processed image
- img/pal: switch coloring mode of post-processed image
- stop: stop the main post-processing routine

- cont: continue the main post-processing routine
- clear: empty the main working matrix
- tb2: display actual content of working matrix
- original: display master image
- save C: save post-processed image into disk c:
- fm1/fm2: switch image dimension (900x675 or 1500x1100 pixels)
- exit: close program
- D: call program Designer to create new master image
- C: call program Creator to create new master image
- L: load master image created with Designer or Creator

3.2 The main user procedure

The user has the following possibilities using the program Mutate01: to import an existing image from data-base, to generate master image using a simple internal image generator or to call program Designer or Creator to create an image, to save it and to import it into the main program. To obtain good post-processing result is recommended to use at first the simple post-processing routine (image background) and then the main post-processing routine. Clicking on the button “draw” the user can control the actual status of post-processed result. Once satisfied the user can stop the post-processing routine and select a good solution clicking several times on the button “draw”. For other solutions the use can switch “img/pal” button to make possible the use of coloring palette. The post-processed image could be saved at any phase of the process. An interesting result could become the input into new program cycle where the post-processed image plays the role of master image. The user can repeat this procedure an immense number if times. Introducing new master image with no clear of the working matrix causes the crossbreeding effects and gives the opportunity to create very complex images.

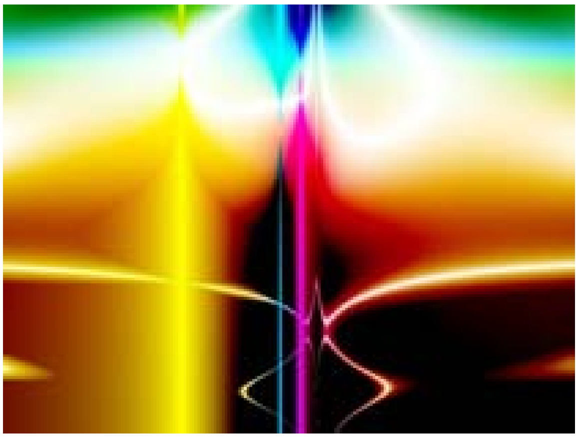


figure 02

figure 03

The kernel of the program Mutate01 is the main post-processing routine. The task of the algorithm is to take a part of the master image from random selected position and put it into main matrix into another random selected position using smooth gradient edge elaboration of taken form (circle, ellipse, square etc). Selected elements partially cover each another and make a kind of irregular, not sharpen kaleidoscope form. The second important phase is the drawing algorithm where the main matrix content plays the role of mutated image and coloring palette in the same time. The algorithm reads the main matrix and calculates a variable out of RGB components of the pixel color. Calculated variable represent the position of pick-up the color from main matrix and use it to define a color of actual pixel creating the final result. On the Figure 02 there is an example of master image, on the Figure 03 the corresponding content of working matrix after certain mutation steps and on Figure 04 and Figure 05, two corresponded examples of post-processed images.

figure 04 **figure 05**

3. Analysis of Program Results

In order to evaluate the idea it was necessary to create a large quantity of post-processed images using different input images and all possible program functions. It is important to know that all results are more or less complex abstract images, whish have no any likeness to the input image. The basic ascertainment is that, neither forms and shapes, nor colors of master image, have not any influence to the generated image. The master image practically plays the role of the coloring algorithm which could be very important conceptual approach in a way of developing of presented idea. To make the analysis of the program results there were generated images based on following input types:

- previous generated image – unexpressive form and light color iridescence
- previous generated image – expressive form and strong coloring
- simple algorithmic image generated by the program itself
- photo input – landscape (nature)
- photo input – portrait

- photo input – objects
- world famous artwork
- post-processed image as the input image
- using additional coloring palette generated by program itself
- using outside coloring palette
- mixing two or more images in the working matrix

From Figure 06 to Figure 13 there are presented some typical examples in pairs (master image and corresponded post-processed image):

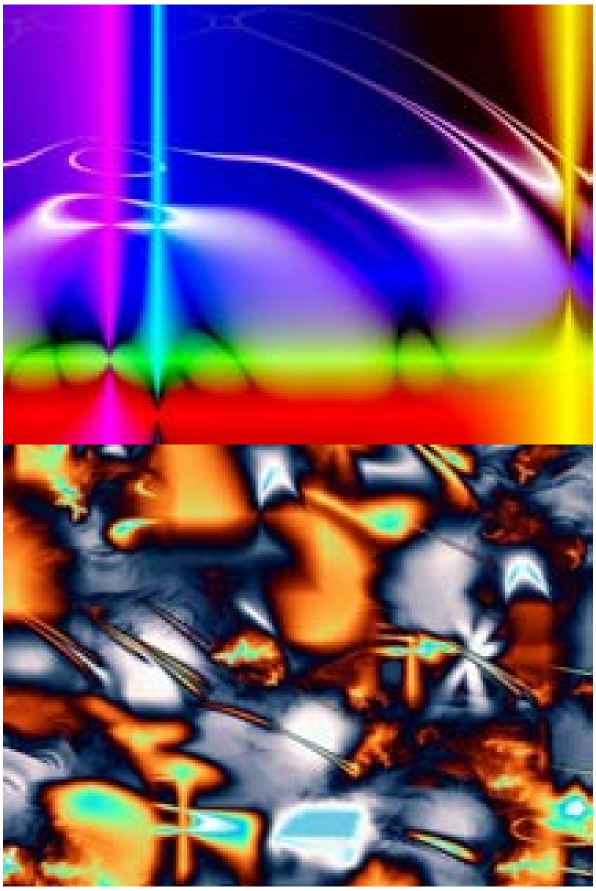
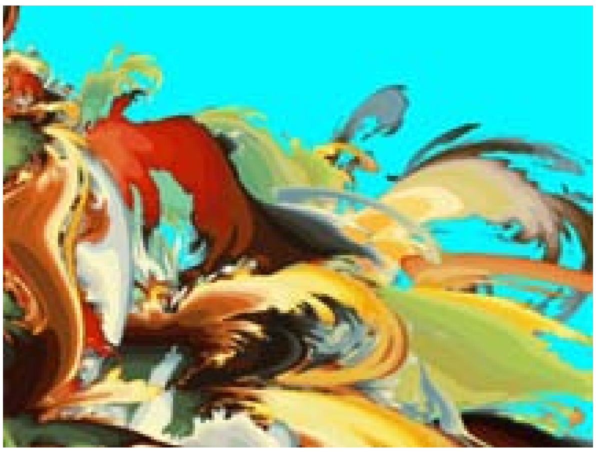


figure 06 **figure 07**



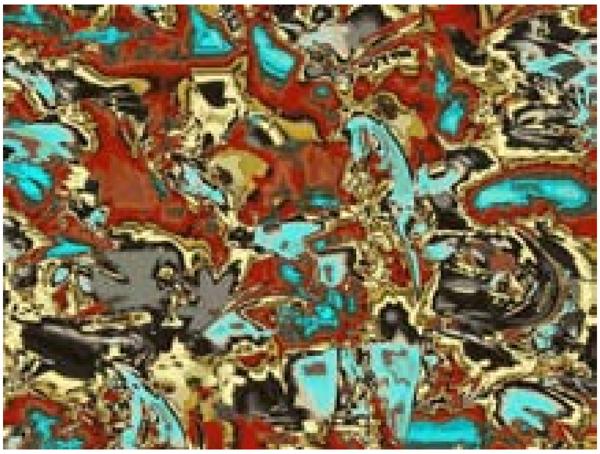


figure 08

figure 09

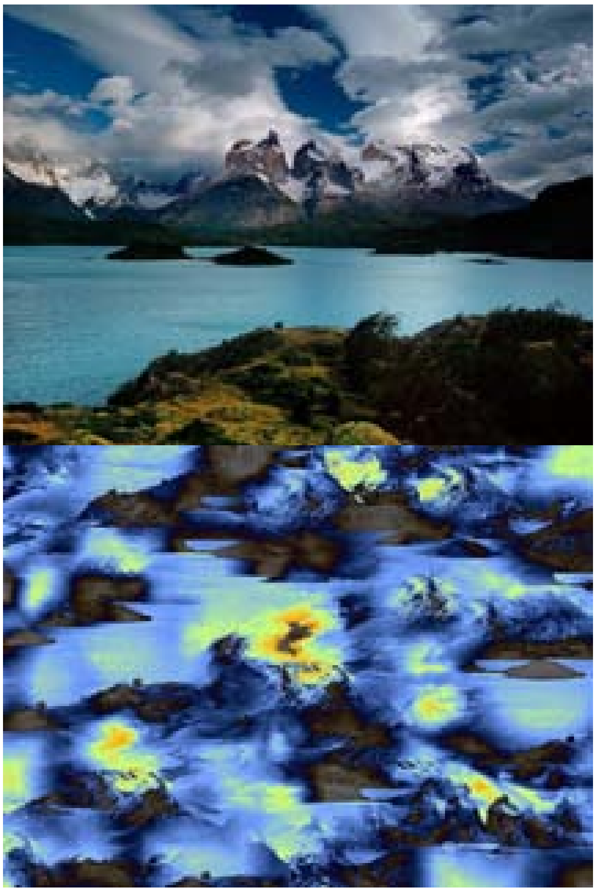


figure 10

figure 11

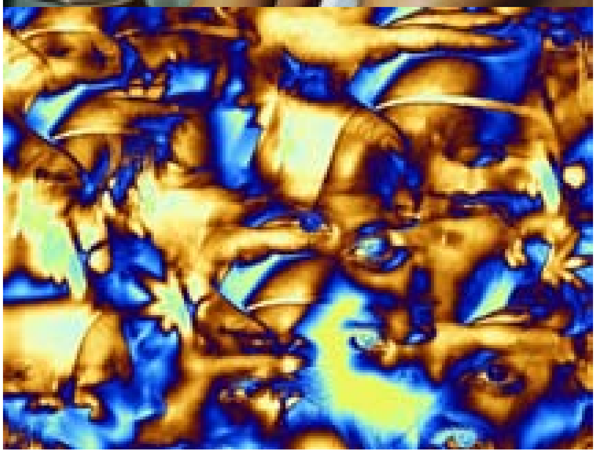


figure 12 **figure 13**

The analysis of results makes evident the following ascertainments:

- all results are absolutely not similar to the input images
- unexpressive forms and light color iridescence on input gives the best results
- for expressive forms and strong coloring on input is better the use of coloring palette
- the results of photo input depends on its expressivity
- the motif of photo input doesn't influence on the result
- the use of post-processed image as the input reduces the expressivity of the result
- mixing more input images causes more complex and interesting outputs
- the program needs to be improved in the palette area – frequent bad color combination
- the input image generated by the program has to be improved – it needs more complex solution to give better results
- the connection with the programs "Creator01" and "Desing05" gives surprised results
- the program needs to be connected with more other generative programs to generate different input images in real time

4. Conclusion

Developing his own generative programs gives to the artist a large possibility to introduce original and unusual methods and approaches to generate images. It needs to be innovative discovering new and unique concept and in the same time to be a good programmer. Both abilities give an excellent chance to be different from other artists under the condition to produce acceptable and good works. Generally it is not enough only to invent a new algorithmic procedure but it needs also to create aesthetic artworks [5]. Here I feel not to be enough good because there is never enough time in disposition to improve the basic idea until the satisfactory level. The concept described in this paper needs additional development especially regarding post-processing routine, which has essential influence into results. This could be the main direction of the further researches and future program development. It exist the real chance to generate nearly ideal abstract images I have always desired to create.

References

[1] Bogdan Soban, Generating Artworks Using Previous Created Image as Coloring Palette, GA 2005, Conference Proceeding
[2] Video post-processing, http://en.wikipedia.org/wiki/Video_post-processing
[3] Vern Seward, The Postulant Photographer – Post Processing Software, http://www.macobserver.com/columns/justathought/2007/04/24.1.shtml
[4] Tim Hodkinson, A Dream of Post Post-Processing, http://orbittrap.blogspot.com/2007/06/dream-of-post-post-processing_26.html
[5] Bogdan Soban, Generating Images Using Solar System Kinematics Parameters, GA 2006, Conference Proceeding

Internal Variations of Perceptual Image in Serial Drawings: A Problem of Identity in Perceptual Process.

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Abstract:

An experiment was made about the persistence in the memory of the perceived images when they had been manipulated by means of the drawing. In the experiment a series of subjects with differentiated abilities for the representation made successive series of drawings on an image displayed to them. A registry became of the time inverted in the development of the task, that revealed that as it were to wait for, in each successive drawing the inverted time diminished remarkably, but as finding were that the image manipulated by means of this procedure did not remain in the memory of the subjects identical to which it had been drawn, arising a surprise sensation from in the subjects in front of the image.
From this experience an investigation arose on the persistence of the image in the memory when an artistic work is carried out, derives from the experiment made a reflection about the differences in the creative process of the phenomenon from the persistence of geometry from the image in computer memory during the artistic work, as similar to the artistic work that uses the organic memory and analogical means of representation as the main resources for the work.
The materials from the experiment are exposed during the works. Such experiment was carried out in two phases: one in which a visual image was drawn and another one in which, in addition a tactile image was used. At this experiment the use of cognitive strategies for the memorization is conceived in such way, that later transform the image. Is it about the perception habits like the discovered ones during the accomplishment of spontaneous drawings in which the perceptual image uses order systems to fix the image which they are not present in which it is drawn, that comprises of a memorization strategy?
This work explores the representation capability and its potentiality to transform the memory, on the capacity for the artistic work to transform the artist's perceptual universe. This communication exposes the results about the experiment and their relation with the way in which the memory takes part in the perceptual act during the artistic experience when analogical or digital media are used to work over a visual material.

Statement of the problem and design of experiment.

After designing a series of experiences made in order to be behavior simulators of a designer in the exercise, were used to confirm the hypothesis that gave rise to the present research, but as often happens, the test, and simulation experience resulted in the enrichment of the body of this theoretical work, as well as revealing assumptions about perception and memory and how they operate during the synthesis of an architectural image. The assignment of a task became essential for the development of such tools, for this purpose, was used imitation of an object

observed. It adopted an attitude of observation as suggested by Gardner [1] to approach the study of levels of competence in carrying out a task; considering freedom involving the answers sought in the simulation, was preferred extensive monitoring attitudes form of execution, time involved in the resolution, background of the subject product characteristics, attitudes and responses to what occurred, and so on. Having in mind the pourpose to attract even more information than what could be achieved through a series of questions and answers to the intensive implementation of a test in the form of a survey.
One base which departed for the design of experiments, was the idea that a large part of the problem in the synthesis of the image could be understood from the designer's behavior during the execution of a task, and that the image represented was largely the strongest material source to observe this phenomenon in evolution. Both ideas led to the observation of subjects in action.
After the experiment, we proceeded to the products catalog for further analysis and interpretation. From the analysis of the physical structure of the scripts, and the subject’s behavior in resolving the specific task, it was possible to infer general features for grouping data After the data interpretation it was possible to infer assumptions about the persistence of the images represented in memory.

Experiment.

We depart from the observation of the behavior of some designers who tend to draw in the object repeatedly to go gradually learning it, and how by this behavior the image centers in a particular “plastic territory", as that one that makes appearance in the plastic infant from dominant metaphors in the continuous work [1]. This behavior resulted in a number of questions: Does the repetition of a repeated image through drawing or modeling, produces an effect of loss of meaning or a transfiguration in the ultimate physical structure? How do the repeated execution times behave in the successive approximations? What influence does the physical material handling exercises in the realization of the final image? Do the successive approximations generate changes in the structure and the length of the represented image?
The test was structured in a document of 32 pages. This was divided into three parts, one of submission; Another part was used to record the personal data of the subject, and educational background on the practice of arts or crafts.
The second part of the test consisted of three pages; One of instructions for the form and another pollster, where the instructions were given and a piece where the observer was able to write down the series of measured times and make a few observations about the subject in study, his attitude , concentration, and so on, at the time for work. The third part of the test consisted of material to memorize, blank pages numbered in the upper right to catalog order in the implementation and subsequent question and answer sheets for each set of drawings. The material consisted of four non abstract figures to memorize; they were grouped into four categories: amorphous images (in the sense that brought Arnheim [2] or Ehrenzweig [3] as a fund gestalt free), pictures of objects of simple manufactured geometry, pictures and images of anthropomorphic objects and complex manufactured objects. Before applying this test was thought that an abstract object lead to a greater or faster encoding process than an amorphous object, and the persistence of their essential characteristics in memory would be higher, also that would have been more freedom to accommodate a known pattern to an amorphous object thus generating an image with a strong gestalt.
During the test, the subject was provided with the work papers and a pencil. The

image to memorize was shown to the subject for a lapse of four minutes. The subject was told that the time referred before was the only opportunity to memorize, after that it was hiden from his sight to start the series of drawings. When the subject started another drawing he had to turn down the preious drawing and draw a new image from his memory. For each drawing the execution time was taken. The instrument used for that pourpose had four columns for the four sets of drawings and the necesary lines to record the starting and ending times for each drawing. One of the most important questions that arose as a result of the experimental observation and suggested one of the hypothesis of this work consisted in making the subject to watch the series of drawings, and then ask him/her to display the image he had seen and memorized at the beginning, then he was asked to tell if the image that he had kept in his memory corresponded to his display after he had repeatedly drawn it.

Study Group.

It was chosen to descart the variables associated with the development of the ability to build the environment [4]. The study group was composed by adults, college and post-college age. The experiment was carried out with volunteers and applied individually.

The study group was composed by 33 people: one industrial designer, one architect, five biologists, one linguist, two structural engineers, two architectural students, three athletes, four physical mathematics students, five law students, four surgeons, four civil engineers, and one industrial design student. In this group the subgroup of four people professionally involved in the design acted as a control measure for the variable occupation with respect to the variable coding measured by the runtime and structure of the shape produced, and the development of stroke.

The distribution by occupation and genre of the study group can be seen most clearly in the following table: (to keep the anonymity of the participants, the initials of their names were assigned to identify them).

Table 1. Study Group

Subiect	Place of	Age	Occupation	Art practice	Genr
GL	Colombia	29	Industrial	a.v.	m
AA	Monterrev	32	Architect	a.v.	m
AR	Tapachula	26	Biologist	--	m
ED	Venezuela	30	Biologist	--	m
RA	Monterrev	24	Biologist	a.v.	f
RT	Monterrev	29	Biologist	m	m
GG	Monterrev	26	Biologist	a.v.	m
AN	México.	29	Linguist	lit	f
JN	México.	28	Mechanical	--	m
FC	Tampico	26	Mechanical	--	m
AT	Monterrev	19	Architecture	m-a.v	f
LN	México.	17	Architecture	a.v.	f
AV	Allende.N.L	30	Sports	--	m
AS	Monterrev	21	Sports	m	m
AT	México.	21	Sports	m	f
MP	Revnosa	21	Phvsics student	--	f
LT	México.D.F.	18	Phvsics student	--	f
AC	Monterrev	19	Phvsics student	m	f
NG	Monterrev	22	Phvsics student	--	f
AM	Monterrev	21	Law student	m	f
AG	Monterrev	21	Law student	a.v.	f
GC	Saltillo	20	Law student	m	m
EP	Monterrev	21	Law student	m	m
MR	Monterrev	20	Law student	--	f

RM	Monterrey	45	MD	a.v.	m
EV	Monterrey	28	MD	a.v.-m	f
RG	Monterrey	25	MD	a.v.	f
DG	Matamoros	24	MD	a.v.-m	m
RB	Juárez.	30	Civil Engineer	--	m
AX	Monterrey	25	Civil Engineer	--	m
LN	Monterrey	38	Civil Engineer	m	f
LC	Monterrey	59	Civil Engineer	m	f
MN	México.	21	Industrial Design	a.v.	f

Description. Art practice or experience: a.v.: visual Arts, lit.: literary Arts, m: musical arts. Genre: m: male, f: female.

Parameters for the analysis of the results.

In order to determine the parameters on which to make a codification of the results a first review of the material was made to find within it the unique and repetitive aspects in the structure of the configuration, in the stroke, the mode of attack on the chart or three-dimensional structure in the total structure of the series of drawings, in response to the stimulus, the response to the questions raised by the test and the series of times. There were some features that were coded using one letter, which was very useful, because in reviewing the information again with this base of analysis, could be assigned a sequence of letters to the responses of the subject which could quickly identify recurring response patterns of the group or patterns of recurrence in the same subject which could talk about trends in personal or group performance.

Parameters were grouped into three classes: features on the configuration, on the line and on the sequence of Configuration and Stroke overall.

Configuration parameters C.

L. This parameter indicates a choice of image represented in relation to the model; It can be seen by comparing the model with the representation or series of performances.

Y. Transposition of self-image from portray an image of him/her self, which can go even introduced gradually in a series of drawings, to the interpretation of parts of a picture drawn by their selves as parts of the body or face. This trend is related to the interpretation of stroke as inextricably linked to muscular movement.

S. This parameter can be seen as a survival or details of significant elements in the picture; This can be seen in the setting of only certain details of the stored image in the picture; it can also be understood from the analysis of the sequence as a survival (gradual forgetfulness of other details) certain features across the series of drawings.

T. Translating the poetic image. This parameter is the comment made during the execution of the design on a meaningful analogy with an image or suggestive atmosphere that arises at the time of execution of the simulator or during the observation of the model. Images such as the drawing of a rock suddenly for a subject suggested a indigenous spearhead or the same picture a Chinese landscape, illustrate this parameter.

T. Stroke parameters.

A. Affirmation of contour. This feature can be seen in the tendency to use a line like defining the format, as opposed to the use of shadows and textures as a defining pattern. It can be understood from a parameter sequence (Q or B), as a gradual approach to the definition of a contour drawing from one continuous or discontinuous

or the tendency to "cleanse" shadow drawing as the subject moves into the stream.
R. Rupture of contour, is manifested as a tendency to make discontinuous line defining contour (as opposed to A), or work to achieve the texture in order to define the drawing figure. Just as in A, this parameter can be understood from the analysis of the sequence.

SC. Parameters sequence in the structure configuration.
Ss. It can be a analysis parameter of the configuration, but when the subscript s is added, it indicates a trend to survival of some significant details in the drawn sequence from the gradual removal of peripheral details until gradual focus over certain details. Undoubtedly an analogy of this parameter with the "plastic territory" as noticed by Gardner [1] can be drawn as a typical behavior in dealing with a piece of work.
C. Very codified drawing. A gradual trend to reproduce a formal reduced pattern to a constant feature; this parameter has a lot of connection with the gradual clearing of textures and shading and gradual contour affirmation; sometimes it runs parallel with a thickening of the line that defines the contour even the pressure increases to draw (increased tone in the stroke), this may be related to the gradual sense of certainty in the definition of the mental image.
N. Unlike C, this parameter defines a tendency not to encode the image, this parameter has a lot of connection with L., it can be noticed as associated with rotations in the series of drawings.
D. Tendency to symmetry. In this feature is notorious the gradual alignment pattern with respect to an axis of symmetry, providing parts forming an axial balance and / or focusing on the medium (paper or work table).
J. Tendency to assymmetry. Contrary to the tendency earlier described, in the series of drawings the parts balance with respect to the axis of symmetry get gradually lost. This parameter can be closely related to a freedom in the stroke, with the breakdown of contour or the tendency to rotate and move the object in the sequence; From there it keeps a very close relationship with the almost physical image.
F. Survival of all the details. This parameter, which is linked to the very encoded picture (C) or with the assertion contour (A) points to the almost exact repetition of the image in the entire sequence.º
P. Gradual Loss of details and gain of peripheral structures, such as stroke and shade patterns apparently encoded. This parameter is extremely rare, usually occurs in the sense of a gradual consolidation. It could be related to a dissipation of attention or tiredness for a job very monotonous.
U. Enriching the sequence by introducing new details. This parameter is strongly associated with J and their relative dependents. It is interesting to associate it to the tendency to spining or rotation in the sequence; although it may be - and perhaps more significantly- associated to sets that do not show a rotation or movement as explicit subject`s attempt.
Z. Changes of the image orientation. In some cases a shift in the image as shown on the mirror can be seen at the time of drawing. It is an extremely rare parameter and is not very likely to find connections with other parameters; although it might be related to events in the emotional development of the individual [5].
O. Survival of the composition structure: this parameter is linked to a tendency towards representation in abstract (X) may be closely related to the way of observing the figure, learnig from the formal structure reduced to linear patterns until the vision of the details. This phenomenon could have strong implications with the subject's

education, though, as it was able to show Marr [6], it could be very involved with the perception mechanics.
K. Juxtaposition of secondary images. This parameter can be seen when the original image was superimposed witth spontaneous images (perhaps closely associated to the subject) as important suggestions to the drawing. This parameter can be directly associated to the transposition of the image itself (Y).

ST. Sequence structure of stroke parameters.
I. No differential -encoded. This trend is characterized by the progressive definition of a boundary formed by patterns of spots or shade strokes and texture to an apparently accidental contour formed by a thickened line and is made making even more pressure on the paper. This parameter is closely related to the assertion of contour. Wt-coded undifferentiated. Although this parameter is extremely rare, it almost always occurs in the opposite direction, it may be seen a gradual breakdown of contour towards strokes seemingly senseless. This parameter might be associated to the loss of center into significant detail (P).
Q. In a sense very close to the previous one, this parameter is given, where the stroke texture is beating force to stroke contour.
B. Texture - Contour. This parameter is exactly opposite to the previous one.
E. Affirmation- contour break off. It indicates the gradual loss of continuity in the contours of the represented image. It should be noted that it is extremely rare.

General Stream parameters.
M. Handling-Movement. This parameter defines the sequence in which the movement to the image was given in a sense of rotating or showing it from different points of view.
X. Realistic - abstract Representation. This parameter group deals with the whole trends ranging from a representation that is very close to the real representation where distinctive traits and shape details are becoming increasingly a graphic feature of a direct evocation of the real. This parameter may be associated to the tendency of a gradual stroke contention with a clean contour drawing stroke shade and texture.
W. From abstract to realistic representation tendency. It has also been possible to observe a tendency to represent a structure composed of linear strokes to reach a close definition to the real. However, this parameter is extremely rare. It could be associated to an enrichment of the image (U).
V. The tendency to manipulation or motion (M) may have two alternatives, which it are to show a view of the object without any order that denote a rotation (as a sequence of common plant and elevations for example) and G. turning the object in which a numerical sequence of the drawings is an effective rotation of the image. This parameter is closely linked to a state of concentration at work and a great satisfaction for it.
H. To this trend to movement, can be added a tendency to show zoom in or zoom out sequences of the represented image. In most cases it is an effect beyond the volunteer control. It may be related to the increasing dominance on the picture, or with the detailed exploration of the figure and its parts.
Ic. Trend to compositional balance. This parameter is characterized by a gradual accommodation of the image to the limits of paper.

Description of the experimental results.

After codifying the subjects' responses, and have made an analysis on individual cases, taking into account representing individual trends and responses, the next step was to proceed on making a count of the parameters found in the cases in order to determine if there are constant trends or recurrent appearance of the parameters and to verify the relationship between the viewed image and some response pattern. Series of individual times were emptied into graphics, grouping them by individual series of drawings (S1, S2, S3, S4) to identify general trends in the graphic associating them with execution times.

In series number one, there is a general trend toward a very strong representation on the move. This trend is significantly more common in this series than in the other three, in fact, the number of individuals who used this resource, progressing gradually decreases under the series. This trend suggests a very important fact: the direct manipulation of the object (as opposed to the observation of a photographic image) guides the subject in some way to replicate the experience of multiple visions. The subject's sensitivity has a lot to do in this: it was performed a test with two subjects where the researcher repeatedly asked them to reproduce a three-dimensional object in clay, following more or less the methodology of the test image playback, indicating them to make a direct modeling. The trend of the series clearly pointed to a gradual adaptation of the modeled shape to the hand shape, and a gradual trend towards portraying most significant accidents every time more organized with regard to a symmetricaly and orderly pattern; when the subjects were questioned about the memorized image and theiri identity with respect to the presented image, although they again touched and moved by repeating the inictial test recognition movements, they indicated that it was not the same object. This could bring in the sense of an image transformation from the one that was generated in the mind of the subject, but also points to the effect of confirming the Gardner's [1] assumption related to dependence of touch and sight in the spatial shaping patterns or even in the development of spatial thinking skills; apparently the direct touch points to a more vivid creation of a spatial entity, the fact that the obbject is manipulated might be an evidence of it.

There is a very strong trend towards a gradual alignment to an axis of symmetry, the survival of certain significant details, the gradual contour statement and a very strong trend towards a representation of a perfectly undifferentiated contour to one differential (I) all these features appear to guide the tendency of the configuration of the series to a consolidation and development of a formal pattern made from a constant script (as a letter), but the tendency to not encode (N) is stronger in this series, although in the other series against C dramatically decreases. This could bring in the sense of a challenge to establish a formal repetitive pattern which is on the absolutely amorphous model configuration. From another perspective, this could be interpreted as an opportunity, given the nature of the material, so that the free structures find their way into the piece of work, because of the low capacity of centering the gestalt image and the large number of the details that offers a varied form and texture as [3].

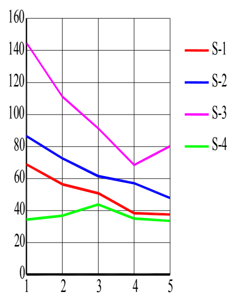
The trend of the different medium of the series of times but with wide variations is behaving in a general decline over the execution time of the first chart. Perhaps this trend is highly associated to the widespread tendency to appearing of simultaneous D I A and S parameters. It may be significant that most subjects did not recognize the model image as the one they had seen; this fact points to a transformation of the

image induced by the use of the representation means.
The second series show a marked trend towards showing a sequence in motion, although not as marked as in the series one, as it was, could be related to the direct handling of volume. At this case, however, could be related to an assumed management sequence of the first phase, and not directly related to the characteristics of the model image; it is very significant that the tendency to low in the second installment of a frequency from 10 to 5 and then in the third and fourth sets from 4 to 1 consecutively. There is a tendency in some subjects, to go from an undifferentiated drawing to a completely differential drawing; At the same time, a similar trend to go from a more abstract representation of realism to a search for the shadow and texture representation.
There are three trends with a very high frequency of occurrence in relation to other parameters; a marked gradual alignment and composition of the figure predisposition with respect to an axis of symmetry, a trend repeated representation of the most significant details of the object , which sometimes becomes a reproduction of a simple geometric pattern; and a strong trend towards gradual affirmation of the contour of the object, which is reflected in the continuity of the growing profile and the gradual increase in force implementation of pencil on paper. The simultaneous appearance of these parameters, seems to foreshadow a marked tendency towards a highly codified drawing. The frequency of this parameter seems to be closely related to the widespread trend of the number of times to have an average decline. Apparently, there is a significant correlation between this parameter and behavior of the graphical times; In a sense, this might indicate the trend as well as individual gradual alignment of the series of times in a common line: that after a recurrence of a settled formal pattern, as many architects do when they be design, come into play coding image mechanisms which are inherent in the process of drawing and have small dependency on the pattern to be reproduced.
In the third and fourth sets, it is unclear how the parameters C, D and S, are highly recurring; Series times generally tend to decline over the execution time of the first drawing, but this trend is stronger in the number three in the series four.
A comparative analysis on the parameters shows a remarkable inclination towards consolidation in response to a repeated pattern drawing, although is a resourse less used to reproduce a pattern without a regular morphology. There is a strong trend towards a gradual alignment with the axis of symmetry, to portray just a few telling details and a gradual contour affirmation. This fact could confirm the trend pointed before, of promoting in the individual the use of encryption mechanisms of the image that tend toward abstraction of the image in an easily understandable pattern.
Two points stand out in this little analysis of the individual behavior that is typical in charts of series of time, indicating a declining influence what is taking shape as drawn as advances in reproduction pattern, as indicated by the gradual alignment of time demanded in making the drawing on a common line, covers at the same time to reproduce any pattern. This marks the gradual use of encryption mechanisms to solve the task. The other aspect was the subject’s response when asked to recall after drawing the series, the model image and then compare it to the one presented to them. The typical response was not recognizing it even if and it was the same one. This indicates a change in the stored image that is inherent in the physical handling of the material and that is not related to trends toward consolidation or naturalistic representation: it has to do with a mind’s tendency, with an interference of the creative imagination and the memory.
The phenomenon of the transformation and typical behavior of the graph of times

can have a very significant correlation. A typical subjects' behavior at the time of presenting an image to them and not recognize it, was not to believe at first that it was the original model and then showed disconcerted. As if in advance they waited for a response to find and when they did not find it, the feeling of truth crashed with a very different reality (See tables 2 and 3).
The general phases of the experiment were repeated using computer graphics media with three volunteers trained to draw using CAD and the participants' general responses were the same as using drawing or modeling. That is interesting, because it indicates a structural mind pattern that takes presence during the development of artistic work, independently of the nature of the used media.

Conclusions.
The drawing has properties that are inherent in the means by which the image materializes, images in memory suffer a gradual transformation induced by the work in which the artist is not conscious so, the naturalist art is a re-creation of what is real, and that makes the art created enter into the world as something else, a higher level of abstraction with each transaction is made on the art piece. In this process are important the natural encoding processes of images that the human being perform as a strategy to isolate the complexity of the world. This tends to be "cleansed" of non-essential factors, but at the same time, tends to manage through compositional strategies that make it increasingly symmetrical, abstract and with a more visually harmonious relationship with regard to the media in which the object exists, thus it becomes more efficient for perception.
This has important effects on the growing complexity of the artificial environment and the gradual displacement of the non-manufactured in the shape taken by humanized environments. Through this experiment, it was found that these abandonment processes of the initial models of inspiration for the design of new objects are processes that have strong unconscious components. It also could prove, through an approximation that the central Worringer's [7] thesis, with regard to the evolution of the graphic signs, from the naturalistic to abstract representation is correct, and that is a mechanism that causes varying complexity of represented degrees tend to be more alike among themselves given the use of the same resources to imagine that they heavily depend of the manipulation of the object by means of artistic work.

Table 2. Average draw times during the experiment.



X axis: Succesive Draw, Y axis: drawing time in seconds.

Table 3. Experimental results

Configuration parameters														
L.A choice of	S-1													
	S-2													

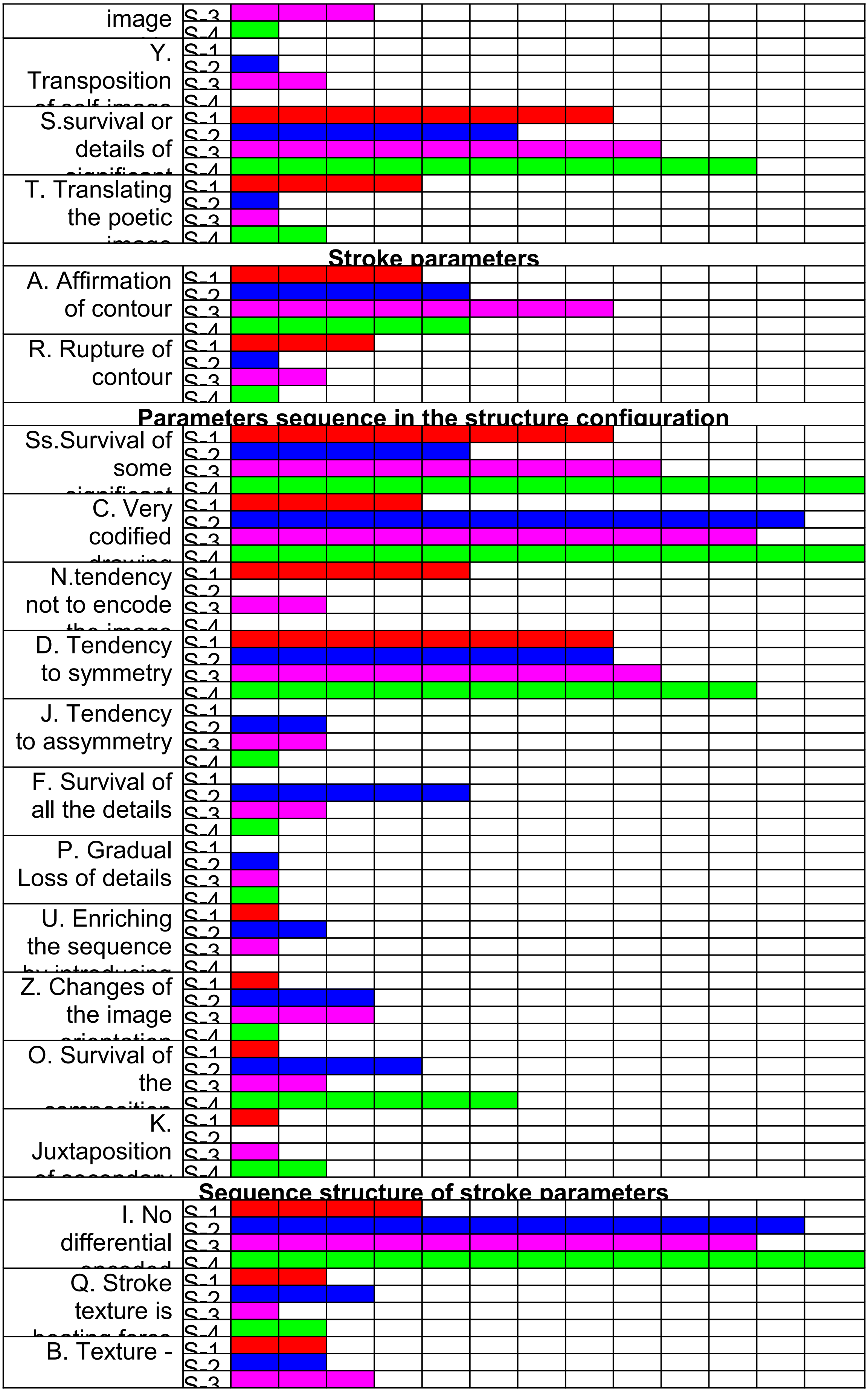
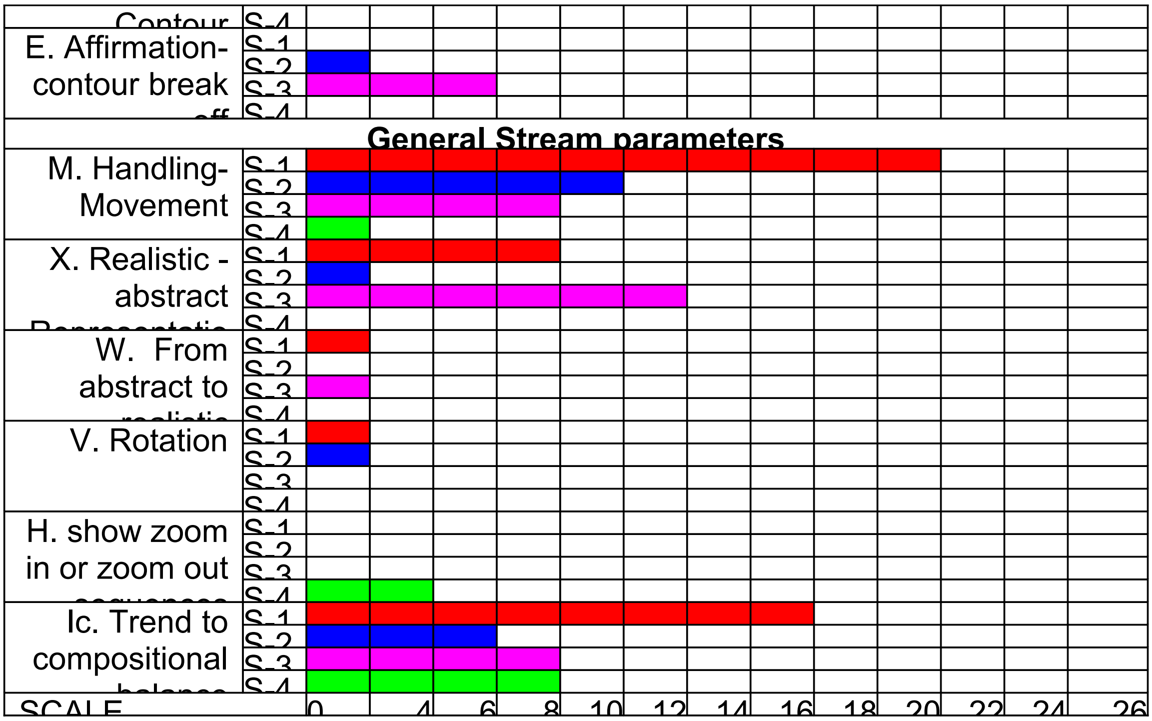


image
Y. Transposition
S.survival or details of
T. Translating the poetic
Stroke parameters
A. Affirmation of contour
R. Rupture of contour
Parameters sequence in the structure configuration
Ss.Survival of some
C. Very codified
N.tendency not to encode
D. Tendency to symmetry
J. Tendency to assymmetry
F. Survival of all the details
P. Gradual Loss of details
U. Enriching the sequence
Z. Changes of the image
O. Survival of the
K. Juxtaposition
Sequence structure of stroke parameters
I. No differential
Q. Stroke texture is
B. Texture -



References

[1] GARDNER, Howard (1987). *Estructuras de la Mente*. México, FCE,

[2] ARNHEIM, Rudolf (1970). La forma visual de la arquitectura. Barcelona, Gustavo Gili.

[3] EHRENZWEIG, Anton (1969). Psicoanálisis de la Percepción artística. Barcelona, Gustavo Gili.

[4] MUNTAÑOLA, Josep (1985). Comprender la arquitectura, Barcelona, Teide.

[5] SAMI- ALÍ, Muhmed (1974). El espacio imaginario. Buenos Aires, Amorrortu.

[6] MARR, David (1981). Artificial intelligence: a personal view. In Haugeland, J., editor, *Mind Design*, chapter 4, pages 129-142. Cambridge, MA., MIT Press.

[7] WORRINGER, Wilhelm (1966). *Abstracción y naturaleza.* México, FCE.

Hypergraph-based Evolutionary Design System

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Abstract

This paper deals with applying evolutionary methods in computer aided design. The design process is an iterative one consisting of several steps. It starts with a preliminary or conceptual design, which is then analyzed or tested in order to find out which of its elements must be redesigned or refined. The process of evaluation and optimization is repeated until an acceptable solution is found. Since designing can be treated in computer science as a search process, where all possible designs form a search space, it is possible to use search techniques such as evolutionary ones.

As evolutionary search consists in evaluating and refining possible solutions, it can be seen as analogous to a human design iterative process of analysis, testing and optimization. Similarly to the refinement step in human design, in evolutionary search designs to be transformed are determined according to their evaluation (fitness). The refinement step is often performed not on actual solutions (phenotypes) but on their coded equivalents (genotypes).

Since in design problems genotypes in the form of binary strings are very often insufficient we propose to use a graph-based representation of genotypes which enables us not only to express geometrical properties of an object but also its attributes (like color, material etc.) and relations between object components.

In this paper we adopt hierarchical hypergraphs as they can represent an artifact with both multi-argument relations and hierarchical dependence which are impossible to express by other structures. The greatest advantage of this representation is its ability to describe in a uniform way all types of relations and objects and to produce highly fitted individuals.

Using hypergraphs in an evolutionary search requires the adaptation of traditional evolutionary operators like cross-over and mutation. As the hypergraphs selected to be transformed by the evolutionary operators at the subsequent stage of the evolution and their structures are not known a priori the operator must be defined in a way which allows for an "online" computation of new hypergraphs. Genetic operators working on hypergraphs and the structure of an evolutionary design system is presented.

The method is illustrated by examples of floor-layouts generated by a house design system, where structures of floor-layouts are represented by hypergraphs. In our approach a cross-over operation exchanges subgraphs representing the functional

areas with different internal arrangements, while mutation affects local and global attributes as well as the graph structure (by adding or deleting subgraphs)

1. Introduction

The design process, computer aided or traditional, is an iterative one consisting of several steps [1]. It starts with a preliminary or conceptual design, which is then analyzed or tested in order to find out which of its elements must be redesigned or refined. The process of evaluation and optimization is repeated until an acceptable solution is found. Still, majority of computer aided design systems focuses on refining parameters specifying design and optimizing it. They usually work on a single design at a time. Since designing can be treated in computer science as a search process, with all possible designs forming a search space, it is possible to use search techniques used in other domains.

There is a number of search methods well established in computer science that can also be used in the space of designs. [15]. One of them is an evolutionary technique. Instead of one solution at a time a larger subset of the search space, known as a population, is considered. As evolutionary search consists in evaluating and refining possible solutions it can be seen as analogous to a human design iterative process of analysis, testing and optimization [1,3]. Similarly to the refinement step in human design, which is based on earlier analysis and testing, in evolutionary search designs to be transformed are determined according to their evaluation (so called fitness). The refinement step is often performed not on actual solutions (called phenotypes, in this paper - designs) but on their coded equivalents (called genotypes).

In design problems genotypes in the form of traditionally used binary strings [1,4,11,14] are very often insufficient as not only geometrical properties of an object has to be represented but also its attributes (like color, material etc.) as well as relations between object components.

The methods used in CAD problems like boundary rep resentations, sweep-volume representation, surface representations or CSG (constructive solid geometry) [10,12,13] allow only for the "coding" of geometry of an object being designed and do not take into account the inter-related structure of many design objects i.e. the fact that parts (or components) of an object can be related to other parts in different ways. Such a structure is usually represented as a graph.

Different types of graphs have been used in this domain, for example composition graphs [6,7]and hierarchical graphs, in which relations such as being a part of or being included in were allowed [8]. An evolutionary design system based on these types of graphs was presented earlier in [18]. These graphs proved useful in different domains of design [2], but they lack the ability to represent structures in which more than two elements are related by the same relation. Such a possibility is given by a so called hypergraph. But traditional hypergraphs are in turn unable to represent hierarchical relations. Therefore in this paper we adopt hierarchical hypergraphs to evolutionary design as they can represent an artifact with both multi-argument relations and hierarchical dependence which are impossible to express with the use of traditional graph structures.

Using hypergraphs as a representation in an evolutionary search requires the adaptation of traditional evolutionary operators like cross-over and mutation. As the hypergraphs selected to be transformed by the evolutionary operators at the subsequent stage of the evolution and their structures are not known a priori the operator must be defined in a way which allows for an "online" computation of new hypergraphs. Thus the operator has to be specified by an algorithm rather than a set of rules.

An example of the application of this method is shown and some advantages and disadvantages of this approach as well as possible future research directions are briefly discussed. The method is illustrated by examples generated by a design system based on the proposed method.

2. Representation

Hypergraphs (HyGs) are a generalization of traditional graphs. They consist of nodes and hyperedges. What makes them different from standard graphs is that hyperedges in HyGs can connect an arbitrary number of nodes. The hyperedges are used to represent both relations and geometrical objects.

A hyperedge in a hypergraph may thus represent a geometrical object or a relation between a group of objects. These hyperedges are called object hyperedges and relational hyperedges, respectively.

Moreover in a hierarchical hypergraph a hyperedge may also be used to hide certain details of a designed object that are not needed at a given stage of design or to group object having some common features (geometrical or functional). Hyperedges that do not represent actual geometric entities or relations but are used to represent a hierarchical structure are called hierarchical

An example of a hierarchical hypergraph and a corresponding floor layout and layout design diagram are depicted in fig.1c, 1a and 1b, respectively. The hyperedges depicted as rectangles are object hyperedges, while the oval ones represent relational hyperedges. Nodes are depicted as small black filled circles.

Nodes and hyperedges in hypergraphs can be labelled and attributed. Labels are assigned to nodes and hyperedges by means of node and hyperedge labelling functions respectively, and attributes - by node and hyperedge attributing functions. Attributes represent properties (for example size, position, colour or material) of a component represented by a given hyperedge.

A labelled attributed hierarchical hypergraph may represent a potentially infinite number of designs having the same structure. To represent an actual design we must determine an instance of a hypergraph. An instance of a hypergraph is a labelled attributed hierarchical hypergraph. where to each attribute a value of the attribute domain has been assigned.

As such a hypergraph defines only a structure of a design, to create a visualisation of an object an interpretation is necessary. The interpretation determines the assignments of geometrical objects to object hyperedges, correspondence between relational hyperedges and sets of relations between objects (components of a design). The geometry of these objects may be internally represented by means of any known representation that allows for easy application of similarity transformations. Geometrical objects used depend on the domain of application, for example when designing a house the set of geometrical objects could contain some primitive objects, or some predefined domain-oriented objects like doors, windows, stairs and other parts of a house and a set of relations could consist of an adjacency and accessibility relations.

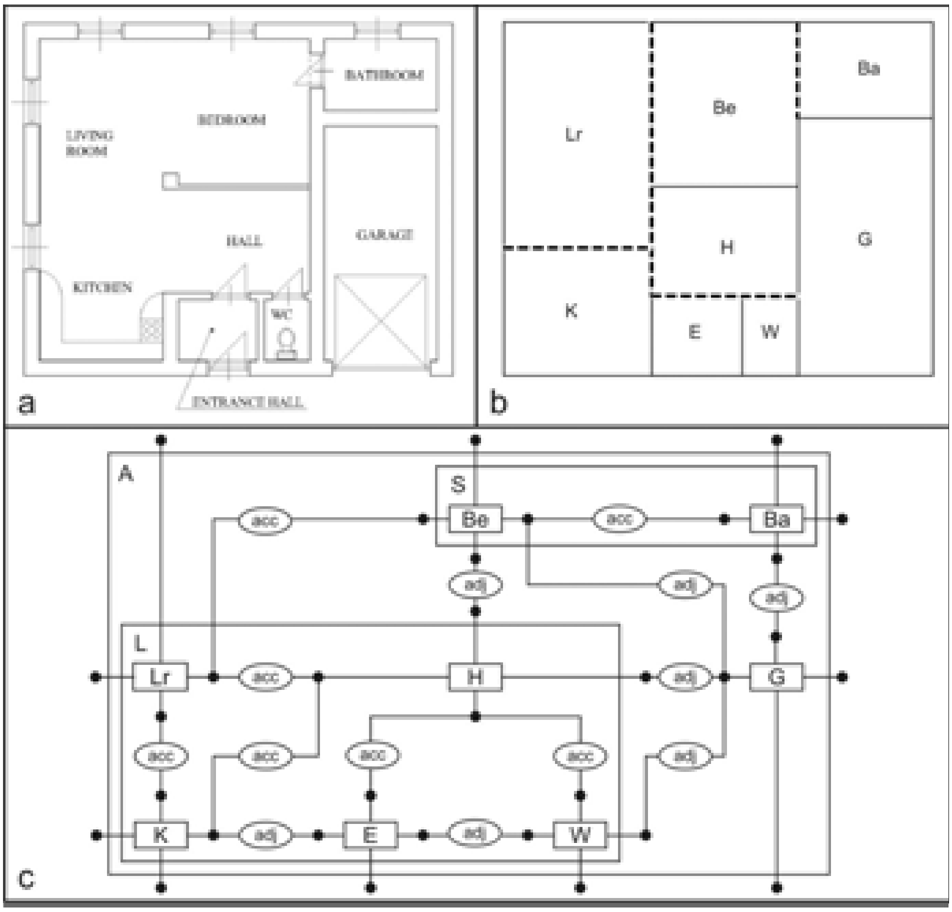

Fig. 1 A floor layout, a layout diagram and a corresponding hypergraph

A floor layout shown in fig.1a is the one of many possible designs the hypergraph from fig. 1c can represent. The layout was obtained after choosing an instance of this hypergraph and then interpreting it.

2 Evolutionary Design System

As it has been mentioned, a binary coding of design solutions is very often insufficient. This paper proposes to replace this standard coding by a hypergraph representation. To use such a representation in an evolutionary design system a number of elements of this system must be defined.

Firstly a method of initialization must be chosen. One of the possibilities is to generate a population of random hypergraphs consisting of nodes and hyperedges from a given set. Although this method is easiest to implement in any design system it is usually very slow in producing acceptable or feasible designs as many designs are rejected. The other possible mechanism is known as a *graph grammar* and it has been successfully used in many domains to generate graphs [17]. Such a grammar describes all syntactically correct solutions, for example layouts.

It also possible to allow the user to generate an initial population of hypergraphs or to use hypergraphs generated by another program. Hypergraphs can be also generated using operations performed on hypergraphs [5].

2.1 Evolutionary graph operators

The genetic operators (usually a crossover and a mutation) constitute the next element of an evolutionary algorithm. As in this paper a nonstandard representation is used, new genetic operators have to be proposed.

The hypergraph based equivalent of a standard crossover operator requires establishing subgraphs that would be then exchanged. When a crossover is performed on two selected hypergraphs, H_1 and H_2 the subgraphs h_1 and h_2, respectively, are selected in these hypergraphs. Then each subgraph is removed from a hypergraph and inserted into the second one. As a result two new hypergraphs are generated. However there may exist hyperedges connecting nodes belonging to a chosen subgraph with nodes which do not belong to it. Such hyperedges are called embedding of a subgraph. So removing a subgraph from a graph and inserting it into another requires a method allowing for proper re-connection of these hyperedges. The underlying idea is that all hyperedges should be re-connected to nodes similar to those they were connected to in the hypergraph from which they were removed. There is probably more than one possibility of defining nodes' similarity.

In this paper a similarity-like relation is used. This relation is called {\it homology}. The name was inspired by the gene homology in biology. This relation is responsible for establishing subgraphs of selected hypergraphs that are homologous - or similar in some way- and thus can be exchanged in the crossover process. The definition of this relation is based upon the assumption that both hypergraphs selected for crossover code designs consisting of parts having similar or even identical functions (even if these parts have a different internal structure, material or/and geometrical properties).

In other words both hypergraphs are assumed to belong to the same class. The homology relation is defined on three levels that differ in terms of requirements put on hypergraphs to be in the relation. The weakest of these relations is called context free homology and it only requires two subgraphs to have the same number of object hyperedges with identical labels. It is the least restrictive of the three relations and it allows for higher variety of new hypergraphs to arise from a crossover but at the same time it is able to produce the least meaningful hypergraphs or, in other words, the most "disturbed" ones.

On the opposite side the strongly context dependent homology is defined. It requires the top-level hyperedges in both subgraphs to have not only identical labels but also to have identically labelled ancestors up to the top-most level of the hypergraph hierarchy. Nevertheless the internal structure of a hyperedge and its attributes are not taken into account so even exchanging strongly homologous subgraphs may still produce considerably different new hypergraphs. When the context free relation is too weak, i.e., it results in too many hypergraphs being unacceptable (rejected by fitness function) and the strong homology is too restrictive or results in designs that are very similar or even identical to its parents the weakly context dependent homology may be useful. It takes into consideration direct ancestors of a given hyperedge but not any ancestors of higher levels in the graph hierarchy.

Formally, a crossover operator *cx* is defined as a 6-tuple (H_1, H_2, h_1, h_2, T, U), where H_1, H_2, h_1, h_2 are hierarchical hypergraphs and their subgraphs, respectively. The crucial elements of this operator are T and U that are called embedding transformations, i.e., they describe how hyperedges of the embedding are to be re-connected. They are sets of pairs of the form (n, n'), where n denotes a node to which a hyperedge was assigned originally and n' - the one to which it will be assigned in a new hypergraph.

It is important to notice however that the hypergraphs to be crossed over and their respective subgraphs are selected during the execution of the evolutionary algorithms so the embedding transformations can not be defined a priori (as it is in graph grammars [6,17]. Hence probably the most difficult problem is to find a method allowing us to establish these transformations. The algorithm generating these transformations requires only the subgraphs being exchanged to be homologous. For each level of homology a crossover operator is defined, thus we have three crossover operators having different levels of context dependence.

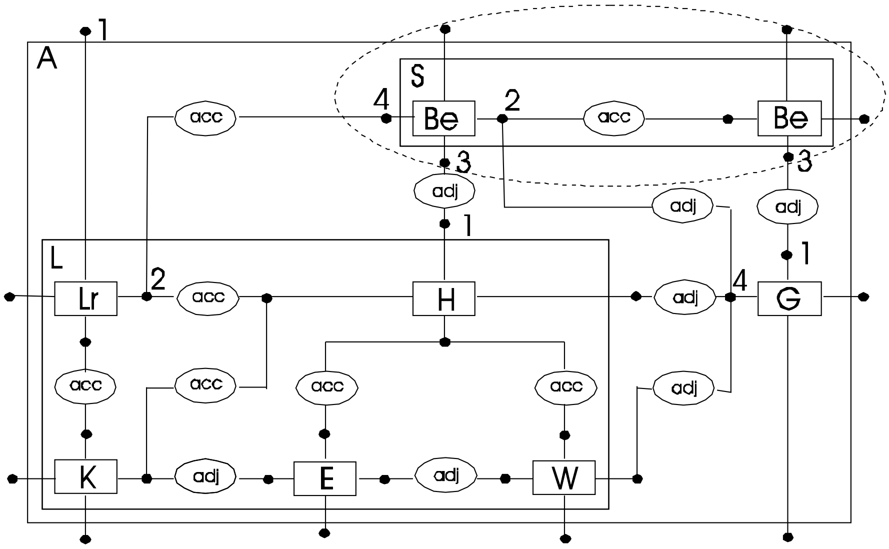

Fig. 2 A hypergraph H_1 representing a floor layout with selected subhypergraph h_1

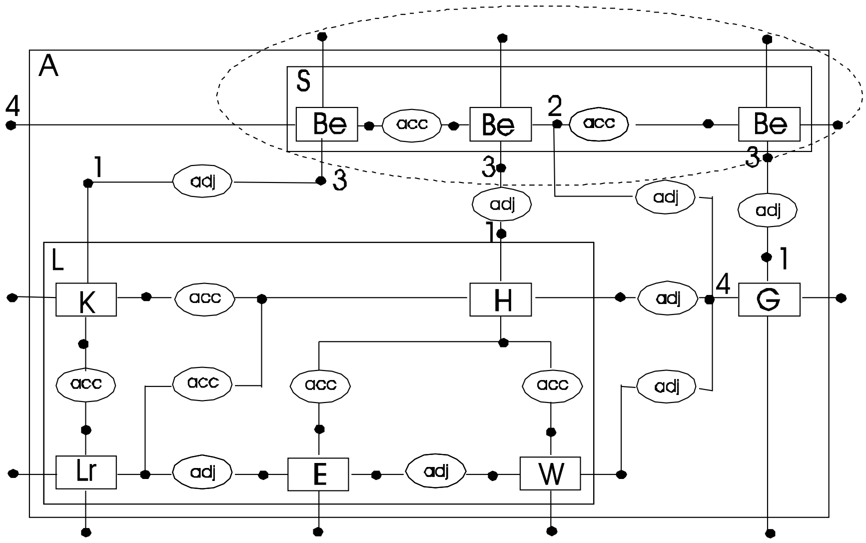

Fig. 3 A hypergraph H_2 representing a floor layout with selected subhypergraph h_2

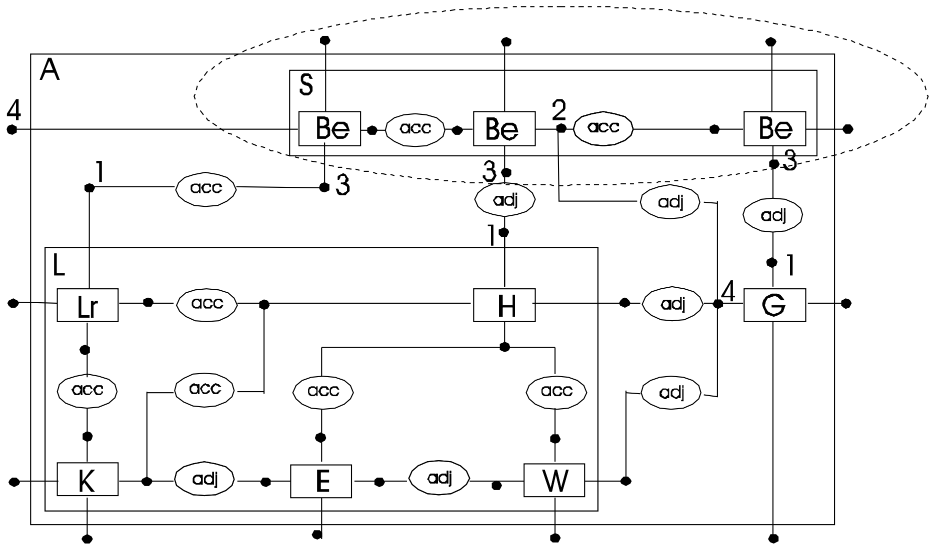

Fig. 4 A hypergraph H'$_1$ representing a floor layout resulting from cross-over operation

The idea behind the algorithm that generates automatically such an embedding transformation is to preserve the relations between the object hyperedges as much as possible i.e. to connect each hyperedge removed from one graph to a hyperedges in the second graphs that represent the same or similar object (i.e has the same label).

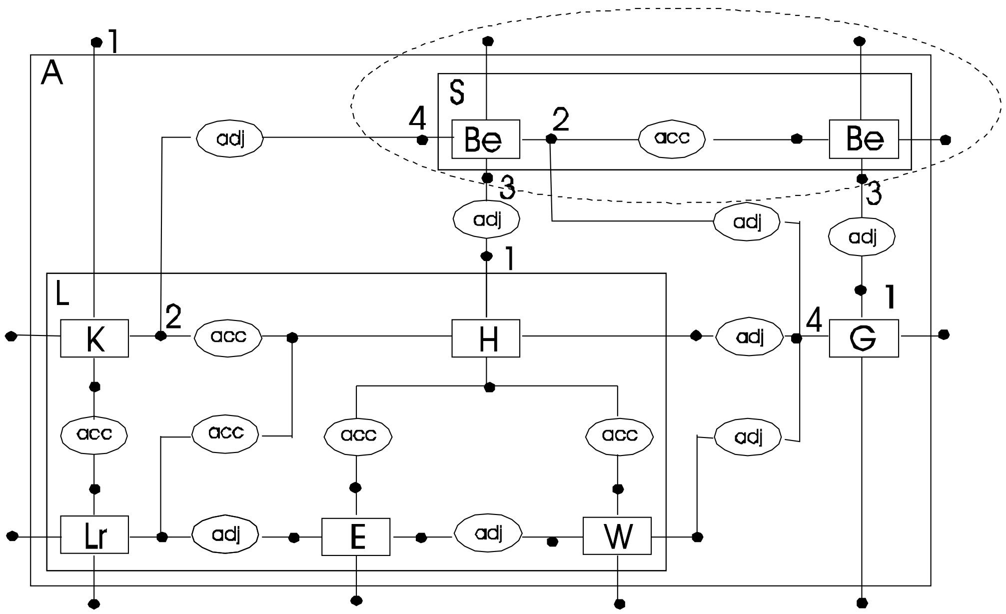

Fig. 5 A hypergraph H'$_2$ representing a floor layout resulting from cross-over operation

Example

Let us consider a house design system, where structures of floor-layouts are represented by hypergraphs. These hypergraphs are determined by a functional graph in which all required modules, represented by subgraphs, are defined. In this example the required functional modules include: a sleeping area, a living area and a garage. Other functional modules usually used in a house design include a communication area, a cooking area and sanitary one. In our example these functionalities are contained in other modules.

Applying a cross over operation we can exchange subgraphs representing the same functional areas: for example two living areas or two sleeping areas or just hyperedges representing single rooms that may have different internal arrangements. In fig. 2 and fig. 3 two hypergraphs, H_1 and H_2, representing layouts of two apartments (shown in fig. 6a and 6b, respectively) are depicted. Object hyperedges represent components of the apartment, while relational hyperedges, labelled *acc* and *adj*, represent accessibility and adjacency, respectively. The nodes connected by hyperedges are numbered and they denote walls of the rooms. For reasons of clarity in all figures numbers of nodes are shown only for nodes participating in crossover operator.

The subgraphs selected in H_1 and H_2,denoted h_1 and h_2, respectively, are surrounded by a dashed line. In this example a subgraph h1 consists of a hierarchical hyperedge labelled *S*, representing the sleeping area, and all its descendants (hyperedges and nodes assigned to them). In hypergraph H_2 a homologous subgraph h_2 was selected, that is one with the same label *S*, marked as the dashed oval in fig. 3.

The first step of crossover consists in removing selected subgraphs and their respective embeddings. The embedding of subgraph h_1 in H_1 consists of four relational hyperedges: a hyperedge labelled acc which connected node *4* of hyperedge labelled *Be* in h_1 and node *2* of hyperedge labelled *Lv* in H_1 - h_1, and three relational hyperedges labelled adj which connect nodes assigned to object hyperedges of h_1 with nodes assigned to object hyperedges of H_1 - h_1.

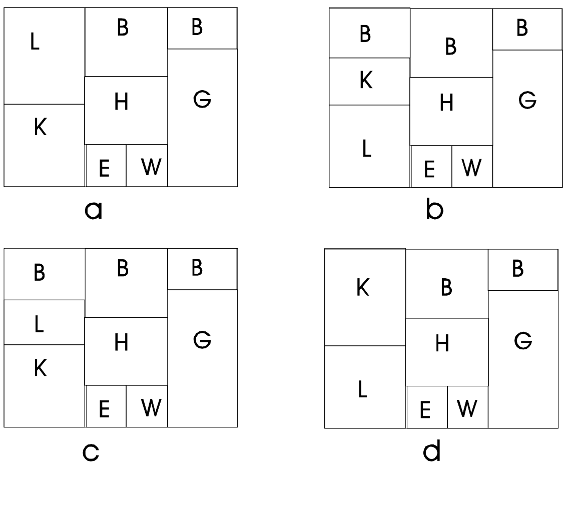

Fig. 6 a, b, c, d: Floor layout diagrams represented by hypergraphs from figs.

2,3,4 and 5.

Then the subgraph h_2 is put into the hypergraph. If an object hyperedge is connected to the object hyperedge with the same relation as in the source hypergraph the relation is preserved. Otherwise the relation is taken from the destination hypergraph. The hypergraphs resulting from crossing over the hypergraph depicted in fig.2 with the hypergraph in fig. 3 are shown in fig. 4 and fig. 5. The layouts represented by these hypergraphs are depicted in fig. 6c and 6d, respectively.

2.2 Mutation

As the second genetic operator mutation is usually used. This operator is much easier to be defined for hierarchical hypergraph-based representation.

The mutation operators may be divided into structure changing mutations and attributes changing ones. The second group can be further divided into local and global mutation operators.

The attribute changing operators change values of attributes of a selected object hyperedge (local mutation) or all object hyperedges (global mutation). As a result it changes geometrical properties of objects assigned to this hyperedge or hyperedges by the interpretation. However it is also possible to define mutation operators introducing structural changes to an artifact being designed which would not be possible using a binary representation. Such mutations could consist in adding or removing hyperedges from a hierarchical hypergraph. In the layout design system these mutations may for example result in adding or removing rooms.

So while crossover allows us to generate artifacts being combinations of previously existing designs, mutation may introduce wholly new elements into the object being designed.

3. Conclusions

Applying evolutionary methods to the design domain poses many problems. One of the main problems concerns representing designs in such a way that they can be easily modified during an evolutionary process. In the proposed approach a hierarchical hypergraph is used as a genotype and equivalents of standard genetic operators are defined on hypergraphs. Hypergraph-based operators are more complex than standard binary ones but we think that the benefits of using a hypergraph representation (possibility of coding multiple-argument relationships between components of an artifact and ability to introduce structural changes) compensate for it. The strongest point of a hypergraph-based representation is its ability to represent in a uniform way all types of relations and objects and to produce highly fitted individuals.

The use of graph grammars makes it possible to generate an initial population of graphs representing designs belonging to a desired class. Thus the graph grammar and fitness function are the only elements of the evolutionary design system that has to be changed in order to design different objects.

In this paper we evolve hypergraphs representing the structure of the whole design. In future we plan to run evolutionary process separately for each functional module. Then the resulting solutions could be combined into one hypergraph structure, which can be farther evolved. Such an approach leads to a hierarchical evolutionary algorithm.

References

[1] P. J. Bentley, Generic Evolutionary Design of Solid Objects using a Genetic Algorithm, PhD thesis, UCL London 1), 3-38, (1997).
[2] Borkowski A., Grabska E., Nikodem P, and Strug B., Searching for Innovative Structural Layouts by Means of Graph Grammars and Evolutionary Optimization,, Proc. 2nd Int. Structural Eng. And Constr. Conf, Rome, (2003).
[3] De Jong K, Arciszewski T, and Vyas H, An Overview of Evolutionary Computation and its Applications, in. Artificial Intelligence in Engineerig,9-22, Warsaw, (1999).
[4] D.E.Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Reading, MA, Addison-Wesley, (1989).
[5] E. Grabska. A. Lachwa, G. Slusarczyk, K. Grzesiak-Kopec and J. Lembas; Hierarchical Layout Hypergraph Operations and Diagrammatic Reasoning, Machine GRAPHICS and VISION, (in print)
[6] E.Grabska,Theoretical Concepts of Graphical Modelling. Part one: Realization of CP-graphs. Machine GRAPHICS and VISION, 2(1993).
[7] Grabska, E.. Graphs and designing. Lecture Notes in Computer Science, 776 (1994).
[8] E.Grabska, W. Palacz, Hierarchical graphs in creative design. Machine GRAPHICS and VISION, 9(1/2), 115-123. (2000).
[9] Hajela P. and Lee, J, Genetic Algorith in Truss Topological OpJournal of Solids and Structures vol.32, no 22 , 3341-3357, (1995).
[10] Hoffman, C. M.,Geometric and Solid Modeling: An Introduction, Morgan Kaufmann, San Francisco, CA, (1989).
[11]Holland, J. H. Adaptation in Natural and Artificial Systems, Ann Arbor, (1975).
[12] Mantyla, M.,An Introduction To Solid Modeling, Computer Science Press, Rockville,MD,vol.87, (1988).
[13] Martin, R R and Stephenson, P C Sweeping of Three-dimensional Objects? Computer Aided Design Vol 22(4) (1990), pp. 223-234.
[14] Michalewicz, Z.: Genetic Algorithms + Data Structures = Evolution Programs. Springer-Verlag, Berlin Heidelberg New York (1996).
[15] Michalewicz, Z. Fogel, D. B.: How to Solve It: Modern Heuristics.. Springer-Verlag, Berlin Heidelberg New York (2000).
[16] P. Nikodem and B. Strug. Graph Transformations in Evolutionary Design, Lecture Notes in Computer Science,vol 3070, pp. 456-461, Springer, 2004.
[17] Rozenberg, G. Handbook of Graph Grammars and Computing by Graph. Transformations, vol.1 Fundations, World Scientific London (1997)
[18] B. Strug. Hierarchical Representation and Operators in Evolutionary Design, Parallel Processing and Applied Mathematics (PPAM 2005), LNCS vol 3911, pp.

447-454 Springer 2006.

An Enchanted Aisle
Integrating Sound and Visuals in Performance

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Abstract

A series of performance works will be presented that explore the processes of integrating sound and visual counterparts. ‘Frenetic Illusion’, ‘Strings’ and ‘Memories of a Shadow’ for clarinet, live interactive audio and visuals (DVD).
The works explore the sonic vocabularies of extended clarinet acoustic micro-tonality techniques, interactive mapping audio devices and visual components. The performance works are an interaction between the performer, computer and real-time digital audio and visual devices. The interactive audio techniques used are pitch-shifters, frequency changes, room placements and granulation. All these filters and parameter modulations can be controlled in live performance using a mapping software device. The visuals go through similar processes as the audio samples but are pre recorded and include video footage of dancers, photos and drawings.

1. Introduction

The aim in ‘Frenetic Illusion’, ‘Strings’ and ‘Memories of a Shadow’ is to make sound and image structurally integrated. To achieve this integration in performance of these works, the audio is analyzed and used directly to control the manipulation of specific aspects of the audio guided by the fixed visuals. The real energy of this idea comes from combining the strength of the interaction, real-time processing and sound/image linking and mapping into the singular work that explores all forms of expression. When linking the music and visuals I question whether there are any real correspondences between sound and vision. The computer has helped this interaction especially in my recent works. A relevant quote from Kapuscinski is “Even an unlikely collision of sound and image can cause both of them to be evaluated with equal attention. It may even combat the usual dominance of sight and hearing’. He also notes that it is not the equity between the media forms but how different the media interacts. In mapping audio through various programs it has given me endless possibilities that I can vary from piece to piece. I am using the live interactive audio program AudioMulch and software developer that allows me to facilitate this flexibility and allows me to address mapping in a modular way that is easy to reconfigure throughout performance.

2. Process

When creating these compositions I examine the media elements I am going to use in the composition/improvisational elements. I think about basic audio elements:

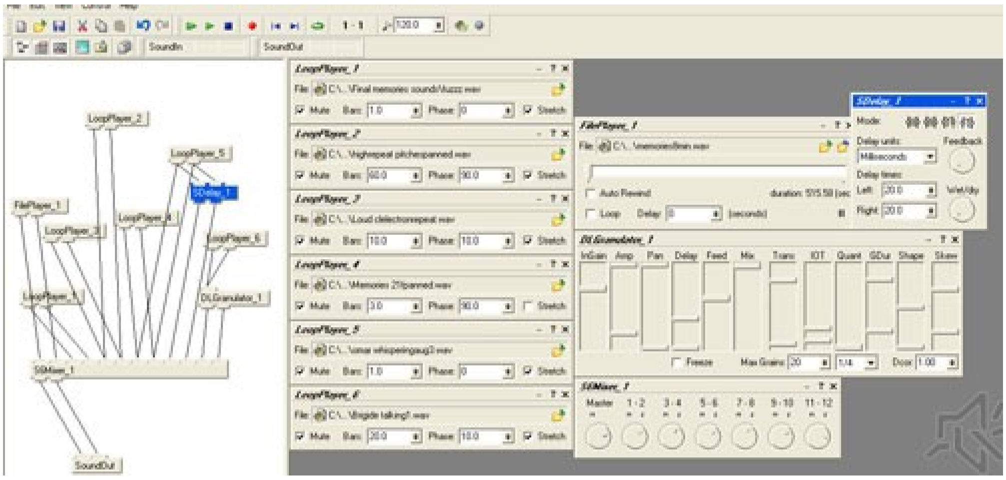
sonic realm, amplitude (volume), pitch, timbre (tone quality), duration, tempo, rhythm and density. I then take these forms and add extended clarinet techniques (micro-tonality, voice, key clicks, multiphonics, monophonics, quarter tones, over-blowing and interrupted tones) and filters (pitch shifters, reverbs, flangers, room placements, harmonics, sine waves, ring modulators, delays, phases, granulation and EQ.) The process continues with manipulation of files into different layers and multi channels, concentrating on microtonal interaction between the samples. 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.

The other added facet is to combine live acoustic clarinet. Audio Mulch controls the modulating parameters (for example pitch shifters, granulators, phases, loops, switches) controlling the amount of dynamics, on and off switches and loops during performance on the clarinet. A pressure pad controls the computer, which is situated under the thumb set of the clarinet, which is attached to a Pedal Midi Controller Box. The Pedal Midi Controller Box is a device that controls the selected Midi parameters in the computer in real time. At the moment I am controlling each sample manually reacting off the visuals.

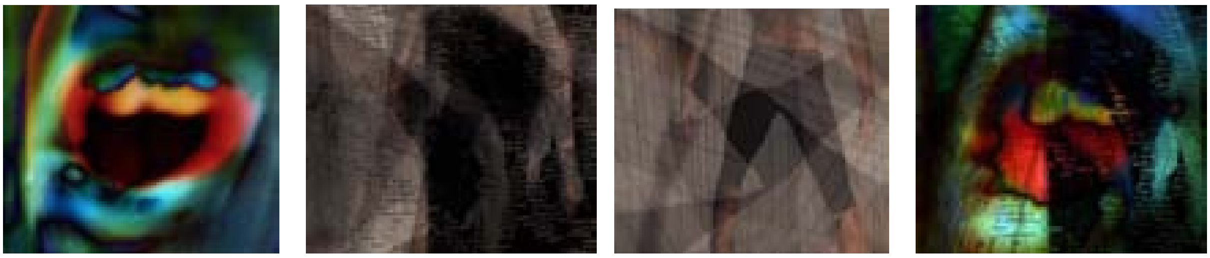
3. Compositions

3a Memories of a Shadow

A visual and sound composition, using shadows of a figure (Omar Rigo) moving through confined spaces and language that will depict memories and snap shots of individual's dreams. Sigmund Freud's, book of 'Interpretation of Dreams', inspires the text quoted throughout with the famous dream of the Guillotine by Maury**.** It explores inner thoughts of identity, acoustic and manipulated language to create sound, movement, performance, line and colour. These ghost like shadows appear and recede in a dark space depicting the wanderings and shapes of figures. The outcome is an entwining of audio murmurings, drawn shadows, limited edition prints (silk screened), and mixed-media art works on canvas and video footage. The audio uses much spacialization and morphing of Maury Freud's Dream as it comes to life using acoustic and modern filter techniques including ring-modulation, vocoding, flanging, multi-channelling, granulation and equalization. The opening is a mixture of female and male voices telling us of the dream. The speech is interspersed with speech rhythms and ring modulators that create hollow and bell like sounds with slight reverbs and a small delay added to make the whispers inaudible. One hears the air sounds at ends of phrases that are granulated. Single words in the middle section are fragmented – slight delays are added and microtones and multiphonics are played on the clarinet. These clarinet sounds are treated with pitch shifters, spacialization and reverberant harmonics. Throughout the work the granulation of the text occurs and as a whole is stretched, compressed and multi-channelled. The textual fragments are reshaped, spiralling in and out of understanding and audibility. This fragment of text can never be viewed as a fixed object as the content is hundreds of years old and has been handed down through generations by oral poets.



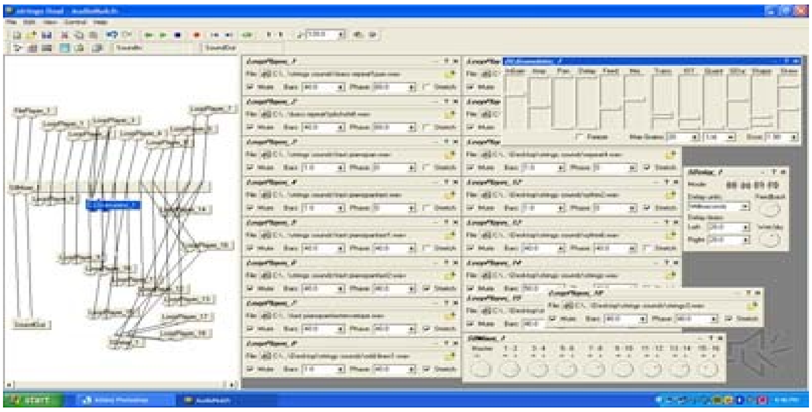
Example of AudioMulch Patch for ‘Memories of a Shadow’



Memories of a Shadow stills from DVD

3b Strings

The concept of the composition is to transform the acoustic prepared piano to another timbral plane of textural colors. The sounds and transformations came from images of strings, wiring systems that connect urban cities and how strings and manifestations of these communication systems connect our lives. The visuals are heavily manipulated in various ways to create surreal imagery creating density of the wiring systems. The source of these images is from a series of silkscreen prints I created in 2006 based on the wiring systems of Inchigaya in Tokyo Japan. The video footage is boiling pots of string, spaghetti and food colouring. The aim of the transformation of the sounds is to match timbres to give off a rich canvas of sonorities around similar pitches and rhythms. These are all interwoven with live electronic and effected clarinet textures.

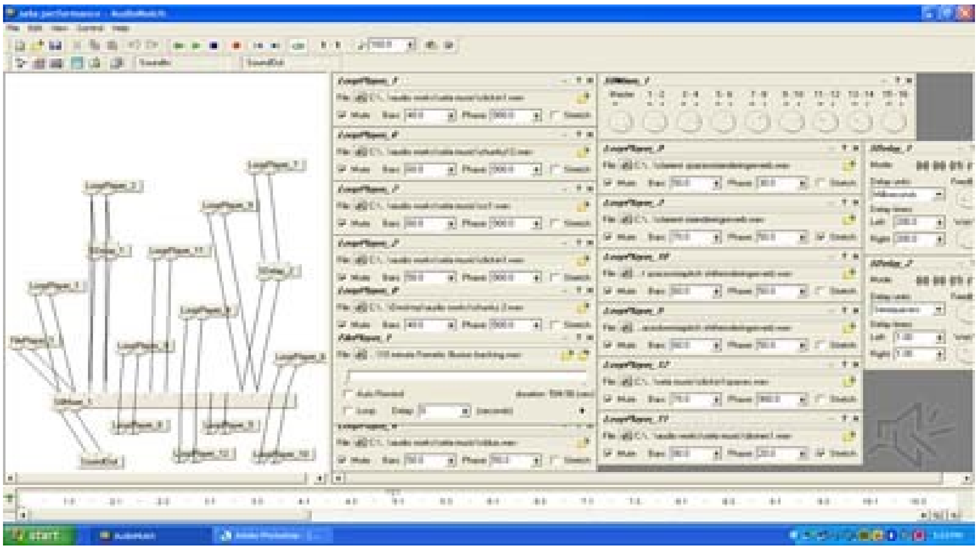


Example of AudioMulch Patch for Strings

Strings stills from DVD

3c Frenetic Illusion

This work is a collaboration resulting in an integrated sound and video work, which fuses dance, layered digital images, film footage and live acoustic and digital sound. The dancer (Sela Kiek) merges with my line and ink drawings and paintings. These multi-layered projections ripple and distort as the dancer moves in and through hanging cloth, reflecting the activities of insects or animals, constructing, burying, fixing and struggling to control its fragile environment. Frenetic Illusion explores the ephemeral, fragile, natural world and its ability to create complex structures that both sustain and ensnare its inhabitants. The piece echoes the natural cycles of growth and decay as the music, dancer and layers build and pulls apart sculptural forms with the cloth. The sound-scape, echoes the often-frenetic activities of construction and degeneration found in nature at the microscopic level. Frenetic Illusion was developed into a live dance, sound and video work to be performed in July 2007. The visuals were projected on a huge web-like cloth structure suspended by ropes, as though emerging organically from one corner of the space itself with images of the projected dancer. Working with the visual imagery and with the fabric used for projection, Sela created a series of phrases and structured tasks to produce movement, and the character of the duet began to emerge. The digitally manipulated sound created in rehearsal also influenced the development of movement vocabulary. This project has provoked both of our interests in the connection between music and dance in live situations and experimentation of both artists moving together, sharing the same space.



Example of AudioMulch Patch for Frenetic Illusion

Frenetic Illusion stills from DVD

4. Conclusion

Interaction with the visuals and sound through analysis and mapping offers new opportunities and challenges that deserve original and creative application. The conclusion I can only draw from the performance works I will present, is currently the interactive performance applications available cannot compare with the practice of years of training. Immediate reactions and vocabularies are hard for the computer artist to compete with as technology is forever changing giving more scope for artists to work with, but also creating more problematic situations to cope with in performance.

5. Acknowledgment

“This project has been assisted by the Australian Government through the Australia Council for the Arts, its funding and advisory body.”

6. References

Kapuscinski, Jaroslav Compositions with sounds and Images, http://www-crca.ucsd.edu/njareh/ideas_top.html
Rush, Michael. *Video Art* Thames & Hudson
Eldridge, Alice. *Fond Functions*: Generative processes in live improvised performance.
Woolman, Matt. *Sonic Graphics Seeing Sound* Thames & Hudson

The ‘Un-Authored’ Object

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Abstract

This conference is made up of a collection of people who use arranged systems in art pieces. A prominent aspect of systems in art is the creation of products that are separate from the artist’s creative decisions. In Hans Haacke’s *Condensation Cube*, he didn’t decide the arrangement of the water droplets as they formed on the acrylic. The responsibility of that was given over to the system and gallery conditions.

The main themes of the paper are separateness and otherness in art. The study will focus on four case studies: ‘*Slumber*’ by Janine Antoni, an in gallery performance work; the status given to meteorites in early cultures; Andy Goldsworthy’s work; and an example of an ‘un-authored object’, something awe inspiring formed by chance. Two ideas develop from the analysis of these sources; shared human experience is essential to art; and that chance happenings create an otherness which put all people in the same position of separateness.

Essay

The ‘un-authored’ object idea; objects formed out of chance and accident, that are then noticed and valued in equivalent ways to the art object is theoretically interesting because it questions the technical relationship between seeing and creating, and more broadly the dynamic of the viewer and the artist. In ‘*The Origin of the Work of Art*’ Heidegger defines the creative act as “bringing forth a being such as never was before and will never be again”[1]. The moment of making art manifest and the moment of noticing, are both inside the “bringing forth” creative moment. There are different sorts of creating; realist drawing, imagining etc. which have related sorts of noticing. To draw a realist piece is to notice; and then employ hand eye coordination to translate the observation. In making up stories, the creator can build a fantasy but his only power is to combine[2]. Language in its basic sense is a collection of signs; one sign is put with another to make an interesting connection that is accessed through knowing what the original signs are. Language is learned. The beginning of language must have happened through focusing sensory experience; the creators of language would notice something and wish to indicate it specifically to others. You look at something, then I look at it, then you check with me, that I see what you see and we decide a term to use to refer to it. At the root of our ability to imagine; from where we would invent the signs; is ‘constructive’ imagining; that is the psychological act of ‘reviving’ sense experience in our mind. This allows the beginning of our inner conception of the world, our specific perspective to form. So creating, “bringing forth”, perceiving (sensing, ‘reviving’) and then making; is fundamentally individual because we have each developed a sensory relationship to the world prior to learning any communal linguistic conception of it. Agreeing that we both see the same thing bonds us and inventing a sign for it commits us to our agreement. With a view of society that holds a one to one relationship as the way society bonds, the art object presented in a gallery doesn't engage the primary social relationship. It is secondary, the viewer perceives the art object, as they would a Natural 'un-authored' object, the dynamic part of perception that can bond people is absent from the artist's manifested perspective placed in a gallery and the viewer's perceiving of their perspective. Art doesn't have the luxury that language enjoys of its elements being previously agreed; the sensory aspect of art is utterly subjective. The viewer perceives the object but isn't given the opportunity to have a balanced relationship with the artist; they are left to project personas.

I will study three cases which elaborate on the artist, viewer dynamic and then show the place of un-authored objects within the discussion. Janine Antoni's 'Slumber' is a work which physically includes her in a practical passive manner. She would sleep in the gallery at night attached to an EKG machine to record her R.E.M. brain activity. During the day she would weave the blanket that she slept under, and with torn pieces of her nightgown she would weave the pattern of her sleeping brain's activity into her bed cover. The viewer's experience of her work is entwined with their consciousness of her presence. Martha Buskirk, a writer and curator, has analysed Antoni's piece in her book 'The Contingent Object of Contemporary Art'; and puts Antoni forward as someone who unites the viewer, the gallery, and the artist.


[3]

Allan Kaprow in his essays ‘Education of the un-artist I, II, and III’, argued dissolve into the experience of the moment of its creation. She grounds this thinking in the pragmatics of the necessity of telling people about it; interesting culture will out, in one way or another; so the artist may as well shack up with the gallery and approach the viewer in an ordered manner, as Antoni does fascinatingly, using language of institution and tradition to intimate effect. Another artist that Buskirk may have been interested in is Kirsty Stansfield. She made a work, ‘Object Scores’ which invited the viewer to explore the work. It was an installation which, when the viewer moved around it, or touched the taught guitar wire, made ethereal sounds. It was a piece that took investigating; the viewer’s presence completed the art work. When Jacques Ranciére discussed the object that is individually interpreted he gave the example of a book. The book is something complete, in Object Scores, Stansfield re-defined the art object to require a physical contribution from the viewer. In Slumber, Antoni was the one to provide the physical contribution expanding the relationship of individual to object, and making it about reacting to a person and their environment. It’s about the place of the person.

The second case is the meteorite’s place in early cultures, the majority of the information for this comes from the book ‘The Forge and the Crucible’ by Mircea Eliade. The kings of Malaya venerated a sacred block of meteorite iron and some tribes that weren’t familiar with smelting took other tribes arrows and worshipped them. Eliade explains this behaviour thus:

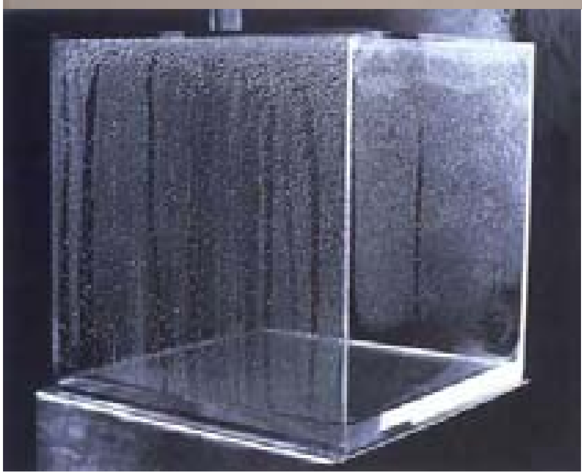
> “It was not a question of fetishism or of the worship of an object for its own sake, it was not a matter of superstition but a sacred respect for a strange object outside their own familiar world, an object coming from elsewhere and hence a sign or token of the ‘beyond’, a near image of the transcendental.”[4]

What’s specifically interesting about this sort of object relationship is the place it puts the perceiver in terms of Nature. Looking at the meteorite history, tribes valuing meteorite iron more than gold, building a history of how people have looked at Nature, objects and sanctity; the position of objects in that dynamic. In the tribes they made rituals, they carved the meteorites like stone, the people incorporated them into their culture. It wasn’t a straight position of awe. In a lot of the myths the meteorites were sacrifices by God to create people, so the people sacrificed back, it was relational. The sacrifices in Aztec culture are examples of this. This put man in a position of power; the shamans would partake in sorting out Nature. Today the larger meteorites are on exhibition in museums, presented to be observed. This makes them a very different kind of object from those that were made into items of religious significance. Here the object is dead, perhaps it has a nifty piece of museum writing beside it telling its interesting origin and where and how it was found, but it is taken out of a cultural dynamic with Nature and sanctity. Eliade towards the end of the book writes about that shift in the social position of sanctity and its impact on work ethos, in early cultures people ceremonially shot the arrows to worship the Gods, now they are put in museums. What is art’s place in contemporary culture? In 1972 Rebecca Horn performed an atheistic ritual; ‘pencil mask’, she strapped a leather mask to her face which had short pencils attached all around it, she then moved her head back and forth in front of a white wall, making the work about time and her presence. What’s different is the purpose and mapping of meaning in Horn’s piece. Her person is a generator of meaning, the mask is a generator of meaning; the viewer perceives and makes the meaning. They’d watch the video of her doing it, in the room with all the pencil marks on it. Or now just watch the video. The marks are supposed to be inane, no God to be worshipped by them.

With the Land Art of the seventies to the present, there is an element that can be suggested as being an attempt to connect to a quasi-spiritual relationship with Nature. The philosophy of phenomenology and its presuppositionless stance on our experience; that there is always empirical experience before abstract thought; is relevant to this. A major idea in phenomenology is the essential place of man as part of Nature. From the position of my discussion about perceiving the object; the separation of looking and articulating is key. With the work of Land artists, focussing specifically on Andy Goldsworthy, the trace of creativity left in Nature, attempting to enhance our experience of Nature, it is important to remember the effect of the human ego. The psychology of object relations conceives of our sense of ourselves as relational, rather than Freud's concept of an enclosed personality. The interesting thing about this track of experiential philosophy in terms of art is that the construct of the gallery system is of the individuals experience. Goldsworthy's current exhibition at YSP attempts to colonise the gallery using an overwhelming amount of raw natural materials. He and local helpers covered the walls and ceiling of one of the exhibition spaces with mud and human hair.

The Un-Authored Object

Finally, a piece of wax, which accidentally dripped off a rose coloured church candle onto a plate.



[4] [5]

This object is 'un-authored'. It was caused by coincidence. It is more than the sum of the intention that was put into it. It's a document of the process of the wax cooling, its proportions resonate with those of clouds; the way the blobs have cooled beside each other is familiar to how organs sit together. Its proportions, form and texture all resonate with the physics of everything which causes other things we are surrounded by to operate in a similar manner. I picked it up and found it valuable. I can drip wax onto plates on purpose but it won't be as interesting, the chance which authored this makes it much more interesting than my contrived attempts could be. Pollock said he entered a Zen like state in creating his paintings. But even with him, there is an intention over it, willing it to be interesting and so it would succeed or fail according to his decisions. This piece is not a success or failure, it's a find. I project value onto it. There are many attempts to bypass this 'desire' aspect of art making. Hans Haacke's 'Condensation Cube' is about minimalism, control and physics but also in viewing the drips of the water on the acrylic there is a sense that no one has desired this particular Natural arrangement, the viewer is having an unadulterated moment with Nature. This can be seen in Ceal Floyer's work too. In their work they deal with the art gallery as a site, a situation of references and defined social actions, looking. If we think of this 'un-authored object' not in the individualised, structured experience of the gallery but in the everyday space of my living room and ask if the object would be valued so much if one of my flatmates would have picked it up rather than me. I have a desire for visual experiences which are not pre-defined, which we are not encouraged to enjoy, which we choose, through our looking to enjoy. I loved it for its unintended creation. I assign approval to the object and show it to my peers to enjoy. There is no author, so all people have the same separateness from the work, it is an egalitarian experience.

References

1 Martin Heidegger, The Origin of the Work of Art p.159
2 Roland Barthes, Death of the Author p.4
3 Janine Antoni, Slumber, 1994, New York
4 Wax, 2007, Flat of Christine McLoughlin, Glasgow, UK
5 Hans Haacke, Condensation Cube, 1963, Museu d'Art Contemporaini, Barcelona, Spain

Bibliography

Books

Buskirk, Martha, *The Contingent Object of Contemporary Art,* 2003, The MIT Press

Eliade, Mircea *The Forge and the Crucible*, 1967, The Anchor Press Ltd.

Freud, Sigmund *Beyond the Pleasure Principle*, 1920, Norton

Galanter, Philip *The Art of Artificial Evolution*, 2007, pre-publication draft

Ed. Hannula, Mika *Stopping the Process? Contemporary views on art and exhibitions*, 1998, NIFCA

Kaprow, Allan, *Essays on the Blurring of Art and Life,* 1993, University of California Press

Krokatsis, Henry & Walwin, Jeni *You'll Never know, Drawing and Random Interference,* 2006, Haywood Gallery

Merleau-Ponty, M. *Phenomenology of Perception*, 1962, translated by Smith, Colin, Routledge

Moran, Dermot *Introduction to Phenomenology*, 2000, Routledge

Ranciére, Jacques, *The politics of aesthetics*, 2004, Continuum

Storr, Anthony *Freud: A very short introduction,* 1989, Oxford University Press

Articles

Badiou, Alain, *On truth process,* 2002, www.egs.edu/faculty/badiou/badiou-truth-process-2002.html

Barthes, Roland *The Death of the Author*, 1967, trans. Richard Howard, Aspen

Cazeaux, Clive, *Interrupting the artist: theory, practice and topology in Sartre,* in: Ed. Macleod, Katy, *Thinking Through Art*, 1992, Glasgow Press

Iversen, Margaret *Readymade, Found Object, Photograph*, summer 2004, Art Journal

Galanter, Philip, *What is Generative art? Complexity Theory as a Context for Art Theory,* 2003 http://www.philipgalanter.com/downloads/ga2003_paper.pdf

Heidegger, Martin *The Origin of the Work of Art,* 1935, Ed. Farrell Krell, D., *Martin Heidegger Basic writings*, 1978, Routledge & Kegan Paul Ltd

Karamitsos, S. *The Art of Janine Antoni: Labor, gender, and the Object of the performance* www.artic.edu/~skaram/karamitsos_antoni.pdf

Kant, Immanuel, An Answer to the Question: What is Enlightenment? 1784 http://www.english.upenn.edu/~mgamer/Etexts/kant.html

Klein, Joanne *Looking at Looking (at Looking): Experiments in the*

Interrogation of Spectating,
Ed. Kattwinkel, S., *Audience Participation, Essays on Inclusion in Performance*, 2003, Praeger

Lye, John — The 'death of the author' as an instance of theory http://www.brocku.ca/english/courses/4F70/author.html

Ranciére, Jacques — *The Emancipated Spectator*, March 2007, Art Forum International

Ward, Adrian — *How I Drew One of my Pictures: or, The Authorship of Generative Art*, 2006, unpublished

Wilson, Vicky — *Rivers and tides*, Sight & Sound no. 10 October 2003 pg 59-60

Appendix

Tramway, — *"Kirsty Stansfield: Object Scores"*, Glasgow, March 2007

Yorkshire Sculpture, Park — *Andy Goldsworthy*, Yorkshire, May 2007

Autonomous Systems for Interactive Digital Art

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Abstract

Being an artist as a researcher, the main author searches a *magic wand* to compose a *visual* symphony through her pictorial forms in motion. How could these shapes self-organize, evolve, and keep up themselves perpetually together in such a way that the space-time composition of the artwork emerges from the system?

This paper presents some digital and artistic creations centred on Artificial Life where autonomous virtual creatures form a virtual ecosystem. Through the interactive installation *Quorum Sensing*, these virtual creatures embody themselves into reality; visitors can contact them and become an integral part of this virtual, imaginary and artistic world. Another artwork, entitled *Light Alive in situ*, they quit the "camera obscura" to enact itself within the great Nature and closer to a larger audience!

About Digital Art

Artists and Researcher

It has been years that artistic creation has entered an era where everything is digital. Back to the root of the word 'Art', the artist becomes again a researcher and a scientist. For, their art creations come from the osmosis based on two complementary approaches, on two differential attitudes. The scientific mind is an adventurer of the unknown, which draws this open mind to explore new universes and use them to go ahead. On the other hand, the artist's mind operates in a sceptical and revolutionary tendency to be against the social conventional codes. This reverses surprises and sparks off our perception. The artist's subversion alarms/warns our conscience of the world and compels it to reorganize itself: A new meaning, emerging from our old unconscious (instead of background) conceptions are stirred by this creative attitude of having "untamed eyes" [1].

During the 1990s, the computer expanded enormously with the improvements of the computational and representative capabilities, and the access of general public to the telecommunications networks. Therefore, there was a spreading wave of new expressions using the prefix “Cyber-”, such as Cyberspaces, Cybersex or Cyberart… etc.. This new trend suits to the artists who remains bounded to their sensitive world. They appropriated these media and these researches to create a new form of expression — Digital art which integrates a widened sensitivity due to the external sensors – data glove, 3D glasses and so on. Further more, they established a new aesthetics connecting Arts, Sciences and Technologies. All above provide a “technesthesic[1] experiment” (Edmond Couchot [11]). For this reason, human perception and man-machine interaction which are now combined into a space where reality, virtuality and artistic imagination hybridize themselves.

Machine’s Intelligence

With the improvement of computers, two fields of researches encounter nowadays within the new technologies. These are Artificial Intelligence and Artificial Life.

In the mid 1980’s, new models providing a better answer to the contingencies of a real environment appeared in cognitive sciences, such as Bottom-Up or Situated Artificial Intelligence (Rodney Brooks [2][10], Jean-Arcady Meyer [3]), Connexionism (Hopfield and Kohonen [4]) and Genetic Algorithms (John Holland [5]). This concept that addresses the entity’s embodiment sets cognition within the mutual influences of perception and action. It tries to reach, through training and self-organization, the flexibility and the improvisation needed for the emergence of clever behaviours within a sensitive world that is physically embodied. Methods that take advantage of the plasticity of Neural Networks and the evolutionism of Genetic Algorithms can be found into the virtual world and the art. Such artistic researches have produced virtual creatures (Karl Sims [6]) or Artificial Beings who interact with spectators inside a virtual environment (Michel Bret [7]).

Artificial Life grows up into silicon, the new substrate of today’s technologies, to give birth to artificial entities located into our real universe or within the cyberspace. Originated from J.H. Conway’s game of the life [8], Artificial Life brings together the principles of natural sciences and cognitive sciences. Its essential field activity probes the origin of the identity of the living and aims to construct autonomous entities. According to the definition Christopher Langton, who created the term Artificial Life: “Artificial Life relates to the study and the realization of systems conceived by men that show behaviours characteristic of living systems”. [9]

1 The french word *esthesie* means how the body perceive the outer world. Combined with the prefix techno, it hightlight the idea of extented perception.

The quest of Artificial Life

In parallel with this comprehension towards the beings, Artificial Life simulates and helps to understand the nature of autonomy. This concept of autonomy constitutes the main thread of our artistic work. This step towards Artificial Life thus exceeds the mere simulation of biological phenomena into silicon. Computer Animation of each entity of this "unknown life" can no longer be satisfied with a simple interpolation between two positions fixed in advance (like in key framing), but permanently require an extrapolation on the future, continuously questioned by its own contents. Our researches aim at conceiving a complex system that generates forms that are in motion and filled with emotion. Gifted with autonomous behaviours, how could these silhouettes be able to self-organize, to evolve, and to keep them up perpetually together so that the space-time composition of the artwork emerges from the system?

The virtual world ontogeny

As biologists make cultures out of living matters in Petri dishes, we make “*cultures of artificial life*” inside the computer with our programs. These researches are directed towards the creation of a virtual world where “*autonomous creatures*” live on resources they draw from an environment conceived like a substrate.

These virtual creatures are born from the implementation of a morphogenesis process that involves genetic algorithms which enables them to self-generate. Their morphology has a simple or an articulated body. They are endowed with a virtual metabolism that controls their capacity of action and their behaviour. Immersed into a virtual environment, they are able to move, to grow up, to perceive the world that surrounds them, and to communicate either directly with the other entities, or indirectly through the environment that diffuses the signals they emit. The environment of this virtual world looks like a micro-organic substrate. An autotrophic process regenerates this substrate. It grows according to a nonlinear law taking into account its state in the neighbourhood and the actions of the virtual creatures. Thus, the regenerative behaviour of the environment is a compromise between the dynamics of cell automata and the dynamics of a diffusion process.

When an organic part does not assume any more its function, this degradation leads the organism to death. Implied into a process called the “migration biogene”[2] [14] by Vernadsky, its body decays and becomes a nutrient or a resource that can be assimilated by other life forms. After death, a "spontaneous genesis"[3] emerges and Life continues to proliferate. This idea has been integrated into the virtual world. When a virtual creature dies, its body narrows to only one line, and then, spontaneously, new organic forms appear: Its corpse breaks up into effervescent bubbles. They fly away, then burst out and project on the ground their “biogenic”

[2] The term “migration biogene” represents the process by which, the organisms transform the atom and the organic molecules within the biosphere.

[3] This term, introduced by Pasteur, is used to describe the development of micro organism into a dead body.

matters - source of regeneration for the environment. These three elements form a food chain: A society of agents, who live on and respect their vegetal habitat coming from a self-regenerating environment. Among them, an intermediate form coming after the virtual creatures' death, considered as the "biogenic mass" returned to its host. This metaphorical association creates a reciprocal connection between the creatures and their environment.

While observing these interdependent cycles of life which are regulated by the alternation of death and birth, we wondered how long will these cycles ensure the permanence of this virtual world, according to which evolutions and under which conditions?

Figure 1: ***A Virtual Biosphere***

Towards an evolving adaptive system

Within an Artificial Life system, the first virtual creatures appear in a virgin world without any legacy from the past. It is up to its originator to set the initial conditions and the processes that will start the ontogenesis and the epigenesis of this virtual world's inhabitants. As a first approach, it seems necessary to us, that several embedded layers of complexity have to coexist, at the virtual creature individual level but also at the level of creatures groups. We tried to design a network of concurrent processes, either co-operative or antagonistic, whose results and particularly the interactions set up and self-organize the virtual world, by giving it, its own structure.

The virtual metabolism

The behavioural engine of the virtual creatures is built around a concept of virtual metabolism. Based on an autopoietic principle, this metabolism is a set of *constructive* and *dissipative* processes. The constructive processes control the creatures' capabilities for mechanical actions or for the absorption of the external elements coming from the environment and their transformation into energy-giving resources. They determine the rate and the conditions of realization of their morphogenesis, and which also influence the reproduction mechanisms. Thus, since their birth, their body grows and metamorphose itself depending on their living conditions. Conversely, the dissipative processes tend to degrade their own resources into external products that are then excreted. To survive, the virtual creature must maintain a relative balance between the processes that make it grow and those that destroy it.

The introduction of this characteristic of living organisms gives a survival instinct to the virtual creatures. These processes take part in the making of indicators symbolizing their challenging desires and influence the virtual creatures' behaviour. Similarly, the availability of energy resources conditions the possibility to perform elementary actions and their efficiency. In this way, the variations of the parameters in the model of metabolism feed the behavioural engine, internal to the virtual creatures, and become the source of their actions.

The behavioural engine

The control architecture internal to the virtual creatures aims at satisfying the metabolism needs, by organizing sequences of regular actions that highlight an autonomous behaviour. Based on the concepts of genetic programming and classifiers, this internal control architecture includes a set of rules, designed as short programs made up from a sequence of elementary instructions connected by logical operators. These elementary instructions execute sensing actions such as perceiving the state of the inner or outer world, physical action as body movements, or virtual biochemical acts simulating the absorption and secretion of products and the synthesis of resources. Using a syntactic structure, rules are subject to an evolution mechanism, by application of genetic operators such as crossover, mutation and inversion. Thus, by applying genetic operators during breeding, a creature will get new aptitudes that its parents do not have.

A virtual biosphere in symbiosis

Each virtual creature is a small complex system that attempts to survive by maintaining its balance at every moment. The dynamic composition between metabolic needs of the virtual creatures and the environment's local state creates a network of complex interactions that always involve reactions within this virtual world.

When their exchanges and their concurrent or divergent actions take place, these small subsystems succeed in creating and maintaining group behaviour globally organized when their interactions. An ecosystem is formed, a higher level system emerges: a biosphere similar to a living organism appears! This emergent property, as the biologist F. Varela underlines it, comes from “the global states of your variables set, because there is an intrinsic interdependence. There is no need for hierarchical level or a conductor to coordinate the thing. It is the dynamics which will carry it”. [15]

Creating a *visual symphony* through the space-time composition of the pictorial shapes was one of the initial ideas of this research. Within this virtual biosphere, the musicians are the elements of this ecosystem. Endowed with artificial life and with autonomous behaviours, they play together, self-organize, self-compose, and take part in the music -- a rhythm *tuned* with life!

Embodiment of Virtual world

The Interactive Installation *Quorum Sensing*

A free and sensory space

Through my interactive installation *Quorum Sensing* [12], these virtual creatures embody themselves into reality; visitors can contact them and become an integral part of this virtual, imaginary and artistic world. The installation “*Quorum Sensing*” is laid out in a rectangular room. A video projector hanged at the ceiling. The room floor is white and serves as a projection screen. An electronically sensitive carpet, containing sensors, enables the computer to capture and to determine the position of the visitors. When visitors enter this space, virtual creatures immediately jump forward to greet them and follow their steps. The slightest act of the spectators influences the virtual world’s conformation that changes and retracts fugitively on the ground where the abundance and the fleetingness of Life unveil itself at their feet. Likewise, their footsteps transgress the quietness of the place and trigger series of strange cries yelled by these creatures… Although being present but in the background, the new technologies are hidden in favour of artistic creation. This installation wants to be a free and sensory space. Visitors are not constrained to wear sensors or to handle buttons. They are simply there, quite naturally. Only by their presence, they discover together the virtual biosphere.

Figure 2 & 3: *Quorum Sensing* -- An Interactive Installation

Entwined behaviours

Let us imagine a visitor entering this installation: he will be surprised by the virtual creatures that follow him incessantly. Depending on the reactions of these creatures, the spectator tries every means to communicate. Since this space is empty, body motion becomes so free and so expressive that, going beyond simple footsteps, his feet trample on the spot, lift up while shaking themselves, and slip or stamp the floor while attempting to catch or reject these creatures. Or else, with his hands and body, the visitor turns round on the ground or jumps in the air, to seize them or allure them. A kind of body language is outlined, almost like a solo dance, taking place within the coloured substrate where these small virtual creatures survive.

The discovery of this biosphere engages the visitors to multiple body motions, going from the simple gesture to almost ritual dances when mutual comprehension occurs...

This interactive installation can be a very intimate experiment for one or two people, or several in a shared way. The wealth of its interactivity modes weaves links between the participants and the virtual world, and especially between the participants themselves. The plasticity of this interactivity relates to a collective interaction mode fully and freely built by the spectators. This causes the emergence of a shared behaviour. This interactive installation *Quorum Sensing* establishes an “in & out” communication between the virtual world and the real world, echoing back the biological process called "Sensing Quorum"! ([13])

Light Alive* in *Situ

After the meeting between the spectators and the virtual biosphere through the installation *Quorum Sensing*, our team had a dream similar to the impressionist painters who left their workshops to embrace the great light of Nature: We wished the virtual world not only appear in projection room darkness but also that Artificial Life leaves the darkroom – the “camera obscura" – to act and enact itself within the great Nature and closer to a larger audience! Taiwan’s government on-going construction of a scientific park in Taipei gave us the opportunity to create an interactive digital artwork. This piece of Public Art, still under construction, will be installed in front of an exhibition hall dedicated to biotechnologies and computer science, and will last for ten years.

How digital art, with all the assets of new technologies, their magic and their power, can help to the metamorphosis of public art into such a significant site? This project leads us along three research orientations resulting into the artwork *Light Alive*. This digital artwork is shown on nine triangular columns, in stainless steel, laid out in arc of circle and equipped with a LED screen on one side. This architectural composition adds a singular note, almost abstract, in unity with the site’s urban landscape. By putting emphasis on simplicity, sciences and technologies are in harmony with Nature, and gives place to imaginations, to men’s thoughts.

A Permanent Interactivity bounded to Nature

The LED screen, displaying the artwork, takes part in problems of outdoor installation such as night and day visibility, energy saving and resiliency to bad weather. The lights of these LEDs get their life “in situ” into this public art, thanks to the implementation of virtual agents endowed with Artificial Life. Previously described Autonomous Systems has been adapted to generate the behavioural engines of these agents considered as virtual cells. They communicate between them through networks, similar to cells automata. Inspired by the principles of autopoiesis, they grow within this scientific park. From meteorological sensors, they retrieve weather data about their climatic environment. These atmospheric parameters constitute elements promoting or degrading their artificial metabolism. Through their growth and their metamorphoses, the public perceives the quality of the park’s environment. Born from a marriage between Science and Art, these virtual cells watch, in return, over Nature, which is at the origin of arts and sciences.

Figure 4: *Light Alive* -- A Digital Public Artwork

A Spontaneous Interactivity with public

The other kind of interactivity of this artwork resides in its ludic style: The virtual cells react spontaneously to the audience's presence and to its distance to the artwork. Tied together, they form a colony akin to a cellular tissue. Their twitched or peristaltic reactions spread by diffusion of rotational moves over the whole colony's surface at various paces.

On a bright sunny day, the steel surface of the triangular columns mirrors the passers-by and their bustling surroundings; the electronic display shows the "*Light Alive*" interactive artwork. *Light Alive* consists of rolling cells that resemble a Rubik's Cube. Endowed with Artificial Life, *Light Alive* will change its colours as the season's change. It also sense time and natural lighting. For instance, all cells will ring and dance on the hour. The Lights Alive shown on the display will elegantly dance when the audience outside the hall moves close to the nine triangular columns outside.

"*Light Alive*": the name of this 3D interactive animation artwork was inspired by two Chinese ideograms meaning "brightness, chip" and "mind, spirit." Chip symbolizes the today's computer technology into our civilization, while spirit is related to the presence of Artificial Life and Natural Sciences into this artwork, thus conferring it its own soul.

This artistic project aims at promoting scientific culture, social communication and respect of the environment into a long lasting perspective.

- References

[1] : André Breton, "*Le Surréalisme et la Peinture*", in *La Révolution Surréaliste, N°4 du 15/07/1925*, p. 26, New edition Jean-Michel Place(ed), Paris, 1975.

[2] : Rodney A. Brooks, *Achieving Artificial Intelligence Through Building Robots*, in MIT AI Memo 899, MIT Press (ed), May 1986, p.7

[3] : Alexis Drogoul, Jean Arcady Meyer, *Intelligence artificielle située, cerveau, corps et environnement*, Hermes, 1999, p. 9.

[4] : Eric Davalo, Patrick Naïm, *Des réseaux de Neurones*, Eyrolles (ed), 1990, pp. 143-182.

[5] : John H. Holland, *Adaptation in Natural and Artificial System*, MIT Press 2001, (First Ed. 1975).

[6] : Karls Sims, "*Evolving Virtual Creatures*", in *SIGGRAPH'94, Computer Graphics Proceedings*, Annual Conferences Series 94 (ACM-0-8991-667-0/94/007/0015)

[7] : Michel Bret, M., "*Virtual Living Being*", in *Virtual Worlds, 2nd International Conference*, WV 2000, Lecture Notes in Artificial Intelligence 1834, HEUDIN J.C. (éd), Springer-Verlag, Wien, 2000, pp. 119-134.

[8] : John Horton Conway. "*What is Life?*", in *Winning Ways for Your Mathematical Plays*, E. Berlekamp, J.H. Conway et R. Guy (éd.), Vol 2, chap. 25, New York, éd. Academic Press,1982.

[9] : Christopher G. Langton (ed), *Artificial Life*, Santa Fe Institute Studies in the Science of Complexity, Proceeding Vol 6, ed. Addison Wesley, 1989.

[10] : Rodney A. Brooks, "*A Robust Layered Control System for a Mobile Robot*", in *IEEE Journal of Robotic and Automation*, Mars 1986, pp. 14-23

[11] : Edmond Couchot, *La technologie dans l'Art*, Jacquelin Chambon (ed), 1998.

[12] : Chu-Yin Chen, "*Quorum Sensing: An Interactive installation*" in the revue *Léonardo*, Vol. 37, N°2, 2004, MIT Press Journals (ed). pp. 101.

[13] : Term of Bacteriology created by pr. Gordon Steward in 1990 to describe the following mechanism: Bacteria communicate by diffusing chemical signals in order to coordinate their behaviour according to the population's abundance. It is a first evolutionary step towards multi-cellular organisations. (See http://www..nothingham.ac.uk/quorum/steward.htm)

[14] : Wladimir Vernadsky, *La Biosphère,* Seuil (ed), 2002, pp 260-262.

[15] : Kempf, H., "*Entretien avec Francisco Varela*" in *La recherche,* N°308, Avril 1998, 109-112

Interactive Swarm Orchestra

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Abstract

The project Interactive Swarm Orchestra (ISO) employs flocking algorithms to control computer sound synthesis and 3D sound positioning. Synthesis, positioning and movement of several simultaneous sound events are modeled according to swarm behavior. Camera-based tracking allows visitors to interact with this acoustic flock and thereby change its spatial distribution and synthesis properties. This paper focuses on the description of the software components that have been developed specifically for this project. These components encompass of a sound synthesis framework, functionality for 3D sound projection based on Ambisonics, a generic multi-agent simulation environment, and video tracking software for conventional video cameras and for SwissRanger 3D cameras. All software source code is publicly available.

1. Introduction

The field of computer music and its performance provides a vast territory for artistic experimentation. The qualities of synthetic sounds are not predefined by the physical properties of musical instruments nor is the creation of these sounds compulsorily associated with the manipulation of traditional interfaces. Furthermore, computer music is unbiased towards particular performance styles and freely shifts in a continuum between improvisational and compositional as well as presentational and participatory styles. Accordingly, computer music practitioners see themselves confronted with an almost unlimited number of choices for specifying and controlling the sound generation process and for defining the relations between composer, performer, machine and audience. For this reason, current research in computer music has shifted somewhat away from the development of sound synthesis techniques and becomes increasingly engaged with issues that traditionally belong to the field of human machine interaction (HMI). This comprises novel interface designs, improvements in perception and feedback (e.g. 3D sound projection or multi-modal feedback), the creation of intuitive interaction modalities (e.g. camera-based full body tracking), and novel control algorithms for sound generation that simplify real-time performance.

We believe that the application of concepts and techniques from Artificial Life (ALife) research can greatly contribute to this research topics. ALife explores artificial complex systems that exhibit life-like properties such as adaptivity, autonomy, diversity, self-organization and emergence. Complex and self-organized systems have great appeal for art, since they can continuously change, adapt and evolve [1]. By adding means for interaction to algorithms and simulations from ALife, these systems may become flexible and powerful tools that contribute to all of the previously mentioned research topics and thereby possess the potential to establish a unified foundation for interactive algorithmic forms of computer music.

Swarm simulations form an important part of ALife research and explore principles of self-organization and emergence in the appearance of group behavior [2, 3]. Such simulations are particularly interesting since they can express a large variety of different types of behaviors that range from very simple and reactive organizations up to highly complex systems that can learn and evolve. Furthermore, swarm simulations can easily be adapted to deal with any number and dimension of parameters (e.g. sound synthesis parameters). In addition, swarm simulations lend themselves very well to intuitive and natural forms of interaction. There exist several projects by researchers and artists that apply swarm simulations for the generation of music. For example, Tim Blackwell has applied swarms that act as artificial musicians during a life improvisation with human musicians [4]. This system employs a combination of swarm and stigmergic behaviour [5] and has also been employed to control granular sound synthesis [6]. A collaboration of Tatsuo Unemi with one of the authors of this paper has resulted in the realisation of several interactive systems that rely on swarm behaviour to generate both visual and acoustic feedback [7 - 10]. Finally Yuta Uozumi has realized a software for live composition based on a predator-prey simulation [11]. These projects illustrate the impressive creative and aesthetic potential of swarm-based computer music. Unfortunately, these efforts represent idiosyncratic combinations of very specific interaction forms, swarm behaviours and sound generation types and make no attempt at providing generic tools to explore the vast space of possibilities of swarm-based computer music. The ISO project [12] is an attempt to create such a generic tool and supports a wide variety of research and performance in swarm -based computer music.

2. Concept

The ISO project is a manifestation of our belief, that practical and conceptual ideas from Artificial Live (ALife) provide an excellent foundation towards the establishment of a coherent approach to several important aspects of computer music (sound synthesis, composition and interaction). Our approach employs a generic swarm simulation as intermediary between musician(s), sound generation and acoustic projection. It is the simulated agents' behaviors that affect the mapping of the performer's activities into musical structure and its timbral, temporal and spatial development. We intend to shift the creative focus of a musician's work towards the design of properties, behaviors and interrelationships among agents and their musical dependencies. Depending on the agents' capabilities, autonomy and reactivity, the resulting music may have unexpected and emergent properties or resembles a manually scored composition. Since the agents' characteristics can change over time, the music may progress through improvisational and pre-planned phases and can alternate between presentational or participatory performance styles. These principles can be applied to high- and low-level musical structures. For instance, the musician may choose to directly control the global development of a piece but employs generative principles for sound synthesis. Or he might link the music's long and short term temporal changes to the same agent behaviors but acting on different time scales. Finally, the musician can apply the agent simulation to create musically meaningful correlations among sound synthesis parameters. For example, these correlations can be derived from neighborhood relationships among agents. Such correlations help to reduce the dimensionality of the musical search space and thereby simplify the musician's explorative and improvised music creation during life performance.

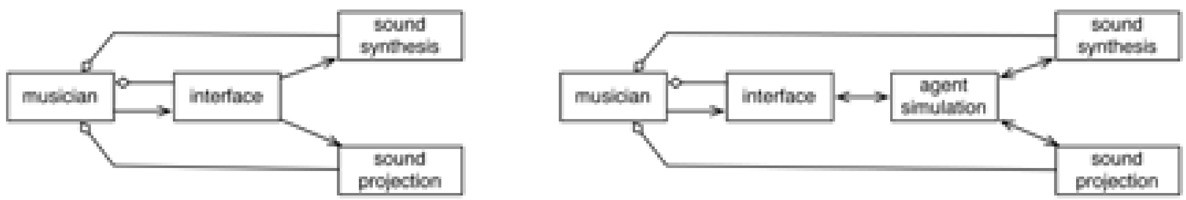

Figure 2: Highly simplified schematics of a traditional (left) and simulation-based (right) computer music performance. Normal arrows indicate control relationships. Prism shaped arrows denote perceptional feedback.

3. Implementation

An important aspect of the ISO project concerns the development of software and hardware tools that support the application of swarm simulations for the creation of computer music. To account for the huge diversity of different types of computer music and swarm-based simulations, our implementations try to be as generic and flexible as possible and minimize interdependencies among individual components. Correspondingly, we don't attempt to compete with more specialized tools with regard to user friendliness, simplicity or computational performance. With the exception of our camera-based tracking software, all software tools exist as C++ libraries. Accordingly, our system takes a programming type of approach to the creation of computer music. We admit that this approach limits our musical target audience considerably since the visual programming style of such programs as Max/MSP or PD has won over almost all practitioners in computer music. For this reason, some of our future plans concern the establishment of interfaces between our system and these highly popular music programs. All our software is based on cross platform libraries that are available under an Open Source license for Mac OSX, Linux, and Windows. By distributing the ISO tools as Open Source software and hardware, we hope that their usage will transgress the confinement of our own institute and help to create a community of programmers, musicians and researchers who contribute to their further development.

At the current project stage, we have developed individual software components for sound synthesis, sound projection, swarm simulation, and camera-based tracking.

ISO Synth

ISO Synth is a C++ library for real-time sample- and synthesis-based computer music creation, which we have developed from scratch. We resorted to this effort in order to guarantee a common implementation standard and optimal interoperability with other ISO tools. ISO Synth implements an event-based score mechanism and supports sound spatialization via two and three-dimensional ambisonic projection [13]. It supports a variety of standard signal processing and sound synthesis techniques. For signal processing, these are: sampling, pitch shifting, time stretching, conversion between time and frequency domain and filtering. For sound synthesis, these are: additive, subtractive, wavetable, granular, frequency modulation, amplitude modulation, waveshaping, phase distortion, sample-based synthesis.

ISO Synth implements the widespread "Music N" unit generator concept [14]. A unit forms the basic building block for the creation or processing of audio signals. Depending on the their functionality, units possess a variety of ports that allow them to exchange audio data and communicate with other units in a patch (see Figure 3).There exist four different types of ports. Input ports retrieve audio data from connected units. Output ports pass audio data to connected units. Control ports retrieve both audio data and events and thereby change some properties of the associated unit. Switch ports are intended for infrequent changes that alter a unit's behavior more substantially than control ports do (i.e. setting a unit inactive, loading a new amplitude envelope etc.). A list of currently available units is presented in table 1. ISO Synth possesses some less common properties, which contribute to its flexibility and form the basis for its interaction with other ISO tools. Every port and every unit can possess a different audio rate, channel count, and buffer size. The connections between ports automatically take care of necessary signal

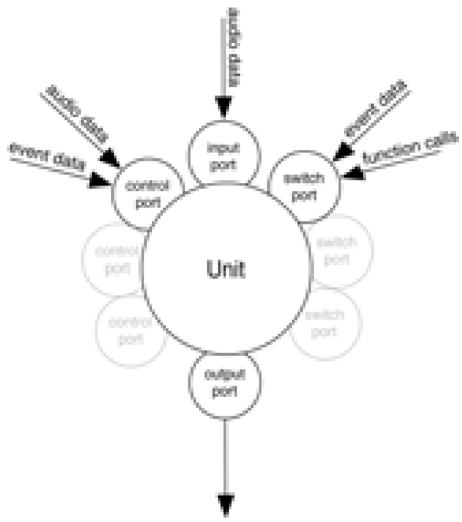

Figure 3: ISO Synth Unit Properties. Arrows indicate any number of inputs. Audio data stands for continuously changing input data. Event data represents data values that change at discrete and possibly irregular time intervals. Function calls allow the re-configuration of ports during run time.

conversions. There exists no explicit distinction between audio and control rate. All control ports operate at audio rate unless explicitly set to a lower rate. Unit patches are not restricted to directed graphs but may contain cycles (including connections from the same unit's output port into its input or control ports). Units can be nested and communicate via internal ports. An entire patch can be serialized, saved and restored at any time during its operation. Patches can exchange arbitrary data via UDP with other ISO tools.

Unit Class	Function	Unit Class	Function
FFTUnit	Fast Fourier Transform	BWFilter	Butterworth Filter
IFFTUnit	Inverse Fast Fourier	CombFilter	Comb Filter
SampleUnit	Loop, Transpose,	FSMFilter	Frequency Sampling
PointEnvelop	Break Point Envelope	ResonFilter	Reson Filter
BLPulseGen	Band Limited Pulse	VocalFormant	Vocal Formant Filter
DCSPulseGen	Dynamically Controlled Spectrum Pulse	FFTStrech	Spectral Frequency Stretching
NoiseI	Interpolating Uniform	FFTThreshold	Spectral Amplitude
NoiseS	Stochastic Noise	FFTPhaseMul	Spectral Phase
WaveTableOs	Wavetable Oscillator	FFTAmpDeriv	Spectral Amplitude
DelayUnit	Delay Line Unit	GranularUnit	Granular Synthesis
WaveTableSh	Wave Table Shaping	Decoder	Ambisonics Decoder (2D
AllPassFilter	All Pass Filter	Encoder	Ambisonics Encoder (2D

Table 1: A Selection of ISO Synth Unit Types.

ISO Tracker

At the moment, ISO allows interaction via Midi or camera-based tracking. Midi-based interaction is implemented as part of the ISO Synth tool. Camera-based interaction is realized as two separate applications that rely on Intel's computer vision library [15]. Our focus on camera-based interaction (instead of other technologies such as wearable sensors, electromagnetic or ultrasonic tracking) is based on reasons of cost and flexibility and because an untethered setup simplifies participatory or casual forms of interaction. ISO Tracker detects the motion, position and orientation of an arbitrary number of persons and transmits these data via UDP to ISO Flock. Motion tracking is implemented via a pyramid approach as described in [16].

Motion segregation usually allows to distinguish between different body parts (i.e. hands, head, and feet) as long as a person is moving. The tracking software exists in two versions. One version supports standard video or web-cams that capture 2D color or grayscale information. A second version of the tracker software has been specifically written for the SwissRanger SR-2 camera [17]. This camera employs the time-of-flight principle by emitting modulated infrared light. The time of arrival of the reflected light allows the computation of a “distance image” at a resolution of 124 x 160 pixels. Thanks to the availability of distance information, this specific tracker software version exceeds the capabilities of the 2D tracker in that it tremendously simplifies occlusion problems. Furthermore, if the camera is pointing straight down from the ceiling, it allows the calculation of a person’s height, vertical motion and vertical orientation. Unfortunately, the SwissRanger camera suffers from a serious draw-

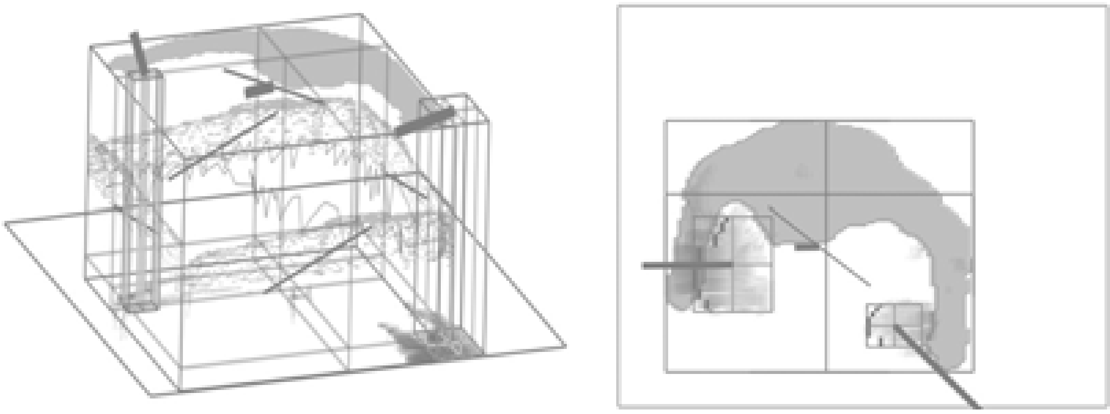

Figure 4: SwissRanger SR-2 based tracking. The screenshots depict a person’s outline, bounding box, orientation (thin lines) and motion (thick lines). The person’s moving hands are distinguished via Motion Segregation. In both images, the camera is mounted to the ceiling and points straight down. Left side: sidewise tracking view illustrating the

back with regard to our application. The fixed focal length characteristics of its lens in combination with a maximum tracking distance of 7 meters results in a very small surveillance area. This camera is therefore unsuitable for tracking people in a space larger than a few square meters.

ISO Flock

Most of our implementation effort has been put into the development of a generic swarm simulation library. The main non-generic aspect of this library concerns its focus on simulating large numbers of agents each of which possesses a very simple morphology. In particular, there are currently no

facilities for modeling segmented body architectures that exhibit rigid or soft body dynamics. Apart from this restriction, the library allows the realization of a vast variety of swarm simulations.

The implementation of ISO Flock defines a small set of main classes (see figure 5) from which simulations can be built either by configuring these components or by creating derived classes. The simulation class manages all agents and updates all other classes at regular intervals. The swarm class acts as a labeled container for agents which are functionally equivalent. It provides functions for creating or deleting agents at runtime

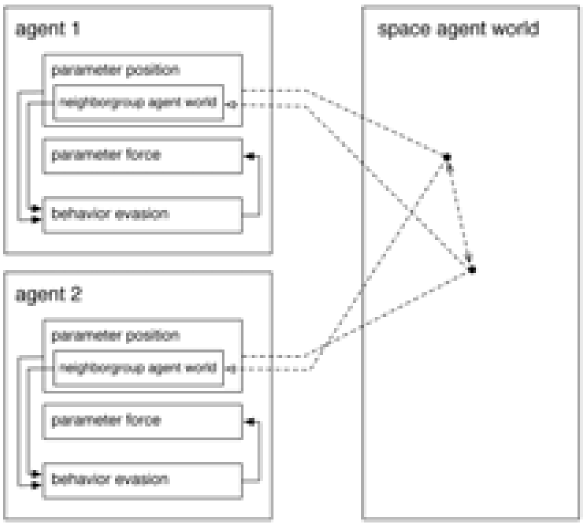

Figure 6: Evasion Behavior. For simplicity, only two agents are depicted. At the beginning of a simulation step, the location of the parameter position is updated in the space entitled "agent world". Then, the distance between the two position parameters is calculated and their neighborgroups are updated. Subsequently, the evasion behavior within each agent changes the force parameter based on the values of the position parameter and its neighbors. At the end of a simulation, all parameters update their values based on the changes that have been caused by the behaviors.

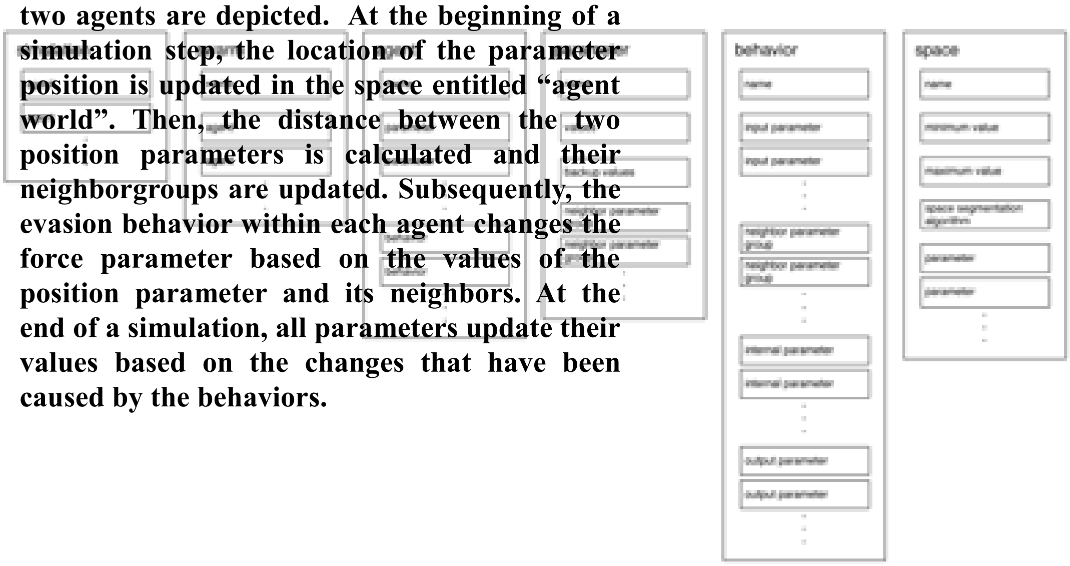

Figure 5: Main Classes of the ISO Flock Library.

and manages the exchange of data via UDP with other ISO tools.

Agents are labeled containers for parameters and behaviors. Parameters represent labeled vectors of arbitrary dimension and manage relationships (euclidean distance and direction) with other parameters organized in neighbor groups. Agent behaviors define functional relationships among parameters. Behaviors distinguish between input parameters, internal parameters and output parameters. Internal behavior parameters are specific to a particular behavior and are created when the behavior is instantiated for the first time.

Whenever a behavior is executed, it reads from its input and internal parameters as well as neighbor groups and writes into its output parameters. These changes are buffered within the output parameters. This helps to avoid that the simulation output is affected by the particular sequence in which behaviors are executed. All parameters are normal agent parameters and their distinction into different types (internal, input, output) applies only for a particular instantiation of a behavior. Whenever a new behavior is created, the supplied parameters can have entirely different types. It is important to note that parameters cannot only be changed by behaviors but also by an event-based system. The event system provides the same functionality as in ISO Synth and permits score-like choreographing of agent parameters. Events can also be created on the fly such as for example when certain conditions are observed by the camera tracking software. The last fundamental ISO Flock class deals with spatial calculations. This space class contains spatial partition algorithms for the calculation of euclidean distances among parameters and thereby manages their neighborhood relationships. Parameters can simultaneously exist in an arbitrary number of spaces. One of the consequences of the generic nature of agents, parameters and spaces is the somewhat counterintuitive fact, that it is not the agents that exist in a particular space world but rather their parameters. It is not necessary to take this peculiarity into account when designing fairly standard types of agents (i.e. agents that possess the properties of position, velocity and acceleration and that only map their position into a space that would conceptually correspond to the classical agent world). On the other hand, our generic parameter neighborhood approach allows for unconventional interactions among agents based for example on character trait relationships. Figure 6 depicts the relationship between agents, parameters, behaviors and spaces for a simple evasion behavior.

In its current implementation, the ISO Flock library provides a group of specialized spaces and behaviors that inherit from the generic base classes. The “point space” class manages distance calculations among point-like spatial objects (i.e. parameters) via a Quadtree, Octree or higher dimensional space partitioning algorithm.

Behavior Name	Function
AccelerationBehavior	Limit linear and angular acceleration of parameter values
AlignmentBehavior	Push parameters (typically velocity) towards similar values depending on the neighborhood of other parameters
BoundaryWrap	Wrap parameter values when they exceed certain limits
BoundaryRepulsionBehavior	Update a parameter (typically force) when other parameter values exceed certain limits
CohesionBehavior	Push neighboring parameters towards similar values
DampingBehavior	Push parameter towards a fixed value
EvasionBehavior	Push values of neighboring parameters away from each other
GridAverageBehavior	Change parameter value based on the averaged vector field values in the parameter’s neighborhood
SplineFollowBehavior	Push parameter value towards and along a spline line extending through parameter space

Table 2: A Selection of ISO Flock Behaviors.

The “shape space” class implements an R-Tree algorithm for the calculation of distances among objects in space that possess a shape (as opposed to point like objects). This allows agents to move along splines or on the surface of triangulated meshes. Such spatial objects can be employed to structure the environment within which agents exist. An example application transforms the tracked outline of people into a spline that serves as movement guide for agents. For a similar purpose another type of space manages the distribution of vectors on an n-dimensional regular grid. Such grids can serve for example as static or dynamic force fields and propel or slow down agents as they move through space. Another example application updates such a force field based on tracked visitor motion. With regard to behaviors, there exists a small selection of example implementations. Table 2 lists some of these behaviors.

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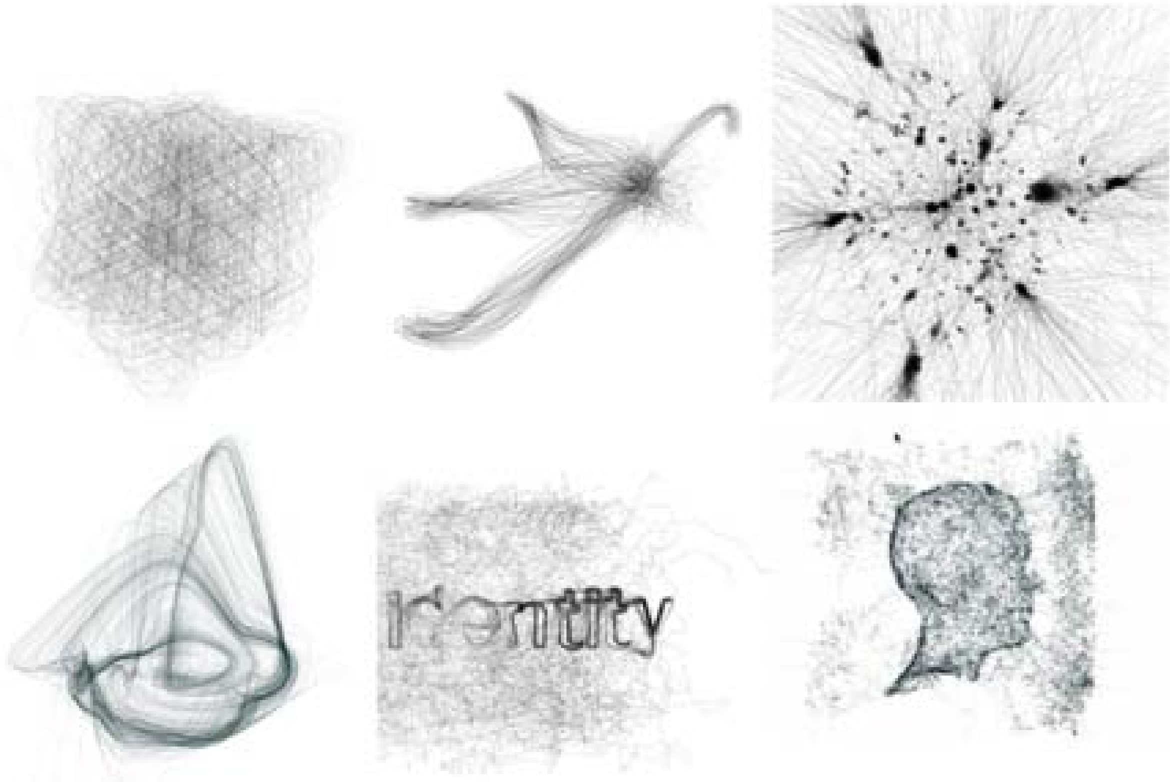

Figure 7: A Selection of ISO Flock Simulation Applications. The visual output is created by drawing the agents' trajectories for the duration of 1000 simulation steps. Top row from left to right: random agent movements within repulsive boundaries, standard BOIDS type of flocking, agents moving towards point attractors. Bottom row from left to right: agents moving within a force field created from a Roessler equations, agents following splines created from letters, agents moving towards the surface of a human head mesh model.

4. Results and Discussion

Our implementation efforts have led to the creation of a series of ISO tools that should be sufficiently generic and flexible to create a wide variety of swarm simulation-based computer music. The stability and performance of all tools have been tested when running for extended periods of times (several days). We are therefore confident, that the tools reliability is perfectly sufficient for critical real-time performances or long-lived installation projects. All tools are extensively documented on our project site [12]. Apart from implementing the desired functionality, all ISO libraries have gone through several cycles of evaluation and feedback by musicians working at our institute which helped us to simplify the APIs. For this reason, the ISO project is on the verge of going beyond its pure implementation stage and can now be employed for research and music creation. Several composers at the institute have started working with the software. We are in the early stages of planning a dance choreography that employs ISO Flock to link the dancers' motions with a live computer music improvisation. At the current project stage, we believe it is crucial to start establishing and maintaining a community of users and programmers who contribute to the further improvement of the ISO tools. For this reason, we have started to provide workshops for interested musicians and artists and added some online community tools to the project site such as a Wiki and a Forum. A first workshop has taken place at our institute and a second one will have been conducted by the time this paper is printed at the Tama Art University in Tokyo, Japan. A further workshop is planned in Bangalore, India in the beginning of 2008. Due to the fact, that the project just recently started to focus on the promotion of its tools for application in art and science, we are not yet able to present artistic realizations or scientific experiments that help to evaluate the suitability and limitations of our approach to computer music generation. This activity will form the main focus throughout the planned extension of the ISO project.

5. Conclusion and Outlook

So far, the ISO project has successfully created a coherent and flexible software infrastructure that will help to realize swarm simulation-based computer music for research and performance. Due to the project's initial focus on implementation and documentation of these software tools, the evaluation of the general suitability of our approach to computer music generation needs to be postponed to another paper.

Feedback from our first ISO workshops indicates that many computer musicians express curiosity and interest about the combination of swarm simulations and computer music. On the other hand, most of the workshop participants possessed little more than a vague and abstract idea concerning the properties and capabilities of swarm simulations and how these properties could be linked to computer music. Hardly anybody in our workshop audience was aware of existing examples of simulation-based computer music let alone experimented with these possibilities. For these reasons, we conclude that our effort to provide an coherent and (at least for musicians with programming experience) simple to use hard- and software infrastructure constitutes a very important step towards the promotion and exploration of ALife-based computer music.

We currently hope to extend the ISO project for another two years. This extended period of time will allow us to focus on the main questions concerning swarm-based computer music and give us the opportunity to realize a variety of performances that hopefully highlight the aesthetic potential of this approach. Of particular interest are the following questions: How does swarm-based computer music improve explorative composition and improvisation styles? Does swarm-based computer music redefine the relationship, role and authorship between musician, the machine and the audience? Will swarm-based music enhance the application and control of traditional forms of sound synthesis or might it even give rise to entirely novel forms of synthesis? Is it necessary and possible to establish psycho-acoustic principles and guidelines for swarm-based computer music? Will spatial sound projection significantly contribute to and improve the perception and appreciations of swarm-based computer music? Will swarm-based computer music help to create novel forms of art collaborations for example between computer music, dance, interaction design and visual design?

So far, ISO Synth implements a variety of popular and widespread sound synthesis algorithms. None of these algorithms is of particular interest or suitability for swarm-based computer music. It would be much more interesting to experiment with entirely novel synthesis techniques that are closely related to capabilities of swarms. For example, physical modeling techniques that rely on the interaction of non-stationary objects, changing topological relationships and dynamic alterations of object properties, such as for example chemical reactions or grainy or powdery materials, might be particularly interesting. It might also be interesting to devise biologically inspired synthesis techniques the rely on swarm behavior. For example signaling among songbirds, or mating call strategies during rutting seasons.

While developing the ISO Flock library, we relied on visual feedback for debugging and analysis of the agents' behaviors. The aesthetics of this visual feedback and its possibly important role in creating multi-modal feedback have entirely changed the priority of this initially circumstantial activity. For this reason, we plan to create an additional ISO library that will take on the role of a visual synthesizer and complements the functionality of ISO Synth.

So far, we rely entirely on camera-based interaction for controlling the swarm simulation. This type of interaction excels with regard to cost and flexibility but otherwise suffers from severe limitations. Camera-based interaction is notoriously prone to calibration and occlusion problems. Furthermore, its is very difficult to derive accurate and semantically meaningful information from camera images. Finally, camera-based interaction does in itself not provide any feedback for the performer. It will be interesting to envision novel types of interfaces that provide for example haptic cues and are specifically designed to improve the performance of swarm-based computer music.

References

[1] Sommerer, C. and Mignonneau, L. (2000). Modeling Complex Systems for Interactive Art. Applied Complexity - From Neural Nets to Managed Landscapes. Institute for Crop & Food Research, Christchurch, New Zealand, pp. 25-38.

[2] Martinoli, A. (2005). Swarm intelligence: emergence and self-organization in natural and artificial systems. Course notes, EPFL.

[3] Eberhart, R., Shi, Y. and Kennedy, J. (2001). Swarm Intelligence. Morgan Kaufmann.

[4] Blackwell, T. (2003). Swarm music: improvised music with multi-swarms. Artificial Intelligence and the Simulation of Behaviour, University of Wales.

[5] Blackwell, T. and Young, M. (2004). Self-organised Music. Organised Sound, Cambridge University Press, 9, pp. 123-136.

[6] Blackwell, T. and Young, M. (2004). Swarm Granulator. EvoWorkshops 2004, Coimbra, Portugal, pp. 399-408.

[7] Unemi T. and Bisig D. (2007). Identity SA - an interactive swarm-based animation with a deformed reflection. Proceedings of the Generative Art Conference. Milano, Italy, in print.

[8] Unemi, T. and Bisig, D. (2005). Music by Interaction among Two Flocking Species and Human. Proceedings of the Third International Conference on Generative Systems in Electronic Arts, Melbourne, Australia, pp. 171-179.

[9] Unemi, T. and Bisig, D. (2004). Playing Music by Conducting BOID Agents. Proceedings of the Ninth International Conference on Artificial Life IX, Boston, USA, pp. 546 - 550.

[10] Bisig, D. and Unemi, T. (2006). MediaFlies - A Video and Audio Remixing Multi Agent System. Proceedings of the Generative Art Conference, Milano, Italy, pp. 63-74.

[11] Uozumi, Y. (2007). GISMO2: An Application for Agent-Based Composition.

Lecture Notes in Computer Science, Springer Berlin/Heidelberg

[12] ISO website: http://www.i-s-o.ch

[13] Malham, D.G. and Anthony, M. (1995). 3-D Sound Spatialization using Ambisonic Techniques, Computer Music Journal 19(4).

[14] Dodge, C. and Jerse, T.A. (1985). Computer Music, Schirmer Books, New York, USA.

[15] OpenCV website: http://www.intel.com/technology/computing/opencv/index.htm

[16] Davis, J.W. (2001). Hierarchical motion history images for recognizing human motion. Proceedings of the IEEE Workshop on Detection and Recognition of Events in Video, pp. 39-46.

[17] SwissRanger specifications: http://www.csem.ch/detailed/pdf/p_531_SR-2_Preliminary-0355.pdf

Genetic Algorithms in Architecture: a Necessity or a Trend?

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Abstract

Genetic Algorithms (GAs), a computational technique based on the principles of evolution, have been recently introduced in architecture to address problems of complexity in the function and the form of architectural projects. While there has been an increasing interest in the use of GAs in architecture, there has not yet been a systematic study of the operation of GAs and their application in architecture yet. This paper investigates whether the utilization of GAs is a necessity or a trend; whether GAs are used to accommodate specific needs of architecture or merely to bear innovative and complex forms; and consequently whether GAs serve reality or utopia. In order to answer these questions, the paper examines the operation of GAs in other disciplines and in architecture as well as the implications of its applications in architecture. Finally, the paper demonstrates the premises for a successful operation of GAs in architecture.

Introduction

Since the 1990's a shift has been noticed in the way avant-garde architects have used new technologies of evolutionary biology to address or depict the increased complexity that is noticed in today's architecture. Indeed, the layer of complexity that is introduced cannot be resolved by conventional design methods. Likewise, the quantity of information and the level of complexity involved in most building projects surpass designers' abilities to thoroughly comprehend and predict them. Genetic Algorithms (GAs), among many other evolutionary techniques, have been used in architecture as optimization tools or as form-generation tools. In the former, GAs address well-defined building problems, such as structural and mechanical. Genetic Algorithms are used as stochastic methods for solving optimization and search problems, operating on a population of possible solutions. Hereafter, this utilization of GAs is addressed as "necessity". In the later utilization, GAs are used under the scope of the concept of *emergence*. Genetic Algorithms are used to produce innovative representations and descriptions of processes by which emergent structures, often with tremendous complexity, are derived. Hereafter, this utilization of GAs is addressed as "trend".

While the interest in the use of GAs in architecture is increasing, no systematic investigation of the operation of GAs has yet been performed. The goal of this paper is to investigate whether the use of GAs is a necessity or a trend; whether GAs are used to accommodate specific needs of architecture or merely to bear innovative and complex forms; and consequently whether GAs are used to serve the

architecture of a real world or abstract shapes of a conceptual world. To answer these questions I will examine how GAs are used in other disciplines compared to architecture so as to come to a conclusion whether architecture can adopt this process. If so, I will inquire whether GAs can be used in every phase of the design process or if their characteristics constrain their utilization to a very specific phase. Finally, I will investigate whether GAs' utilization have changed the conventional design process or the role of architects.
This study is divided in three main parts. The first part examines the function, the operation and the applications of GAs in other disciplines. The second part investigates the dual utilization of GAs in architecture and analyzes two representative examples. The third part examines whether architects use GAs today due to necessity or due to trend, how the design process and the role of the designer changes, and through what criteria the final output is selected. Moreover, the third part promotes an alternative use of GAs in architecture: the combination of the both utilizations: the "necessity" and the "trend".

GAs in science

The introduction of computers into scientific and engineering fields has been one of the most revolutionary developments in the history of these disciplines, affecting many aspects of research. Most importantly, this revolution has helped humans explore, predict and control nature in ways that were inconceivable even fifty years ago.

Evolutionary Biology

Evolutionary biology studies the origin, the change and the multiplication of species over time. In evolutionary biology, the enormous set of possibilities of prospective genetic sequences, and the desired "solutions" are the results of highly fit organisms that are able to survive and reproduce within their environments. Due to that fact, evolutionary biology is an appealing source of inspiration for addressing complex computational problems that require searching through a huge number of possible solutions. Moreover, evolution can be seen as a massively parallel search method; rather than work on one species at a time, evolution tests and changes whole populations of species simultaneously. The natural procedures of life evolution and the techniques that are used in evolutionary biology have influenced many other disciplines that use evolutionary algorithms to solve complicated problems. A particular class of these computational algorithms is Genetic Algorithms.

Genetic Algorithms

Genetic Algorithms were invented by John Holland in the 1960s and since then they have been used as stochastic methods for solving optimization and search problems, operating on a population of possible solutions. According to Darwin's Theory of Evolution, the repetitive application of the aforementioned procedures alters an initial species into various other species; however, only the stronger prevail. Genetic Algorithms perform the same operations on the population of possible targets with only those that fit the solution better surviving.

Even though there is no formal definition of GAs, all of them consist of four elements. The first is the populatio*n* of chromosomes which represent the possible solutions of the problem. Selection is the second element and it refers to the part of the population that will evolve to the next generation. Selection is performed based on a fitness function, that determines how "good" a solution is. The selection process is applied to each generation produced. Crossover refers to the combination or exchange of characteristics between two members of the elite group defined by selection, by which offspring is produced. There are various types of crossover but the most frequently used are: the one-point crossover, in which the parents are cut at a specific point and the head of the first is pasted to the tail of the second or vice versa; and the two-point crossover, in which a part from one of the parents is obtained and exchanged with the part that lies in the same location of the other parent.

Parent 1	110 / 0100110	Parent 1	110 / 0100 / 110
Parent 2	101 / 1010101	Parent 2	101 / 1010 / 101
Offspring 1	110 1010101	Offspring 1	110 1010 110
Offspring 2	101 0100110	Offspring 2	101 0100 101

Table 2 - One and Two points Crossover

After the application of crossover on the population, a new generation is produced. Whether parents are part of the new generation or not is an option that depends on the problem. In any case, before re-applying selection to the new population, mutation takes place. Mutation is a random event, occurring with a user-defined probability to only some of the new offspring. It is used to maintain genetic diversity by altering only a little piece of the new offspring.

Parent 1	110 / 0100110
Parent 2	101 / 1010101
Offspring 1	110 1010101
Offspring 2 *(mutated on the 1st bit)*	101 0100110

Table 3 Mutation

All the methods described above rely heavily on the nature of the problem to be solved, the domain in which the solutions are to be found, and the encoding of the solutions. More complex encoding structures, such as digital trees, allow more difficult problems to be solved, but also require more complex methods to be defined for the manipulation of the generations. However, the basic structure of the GAs remains the same and is outlined below.

1. **[Start]** Generate random population of *n* chromosomes (suitable solutions for the problem)
2. **[Fitness]** Evaluate the fitness *f(x)* of each chromosome *x* in the population
3. **[New population]** Create a new population by repeating following steps until the new population is complete
    - 3.1. **[Selection]** Select two parent chromosomes from a population according to their fitness (the better fitness, the bigger chance to be selected)
    - 3.2. **[Crossover]** With a crossover probability cross over the parents to form a new offspring (children). If no crossover was performed, offspring is an exact copy of parents.
    - 3.3. **[Mutation]** With a mutation probability mutate new offspring at each locus (position in chromosome).
    - 3.4. **[Accepting]** Place new offspring in a new population
4. **[Replace]** Use new generated population for a further run of algorithm
5. **[Test]** If the end condition is satisfied, **stop**, and return the best solution in current population
6. **[Loop]** Go to step **2**

Table 4 Outline of the Basic Genetic Algorithm

Applications of GAs

Like other computational systems inspired by natural systems, GAs have been used in two ways: as techniques to solve technological problems and as simplified scientific models that can answer questions about nature. Genetic Algorithms address quite a large number of problems including image processing, face recognition, protein structure prediction, time series analysis, computer software automatic evolution, cellular automaton rule evolution, robotics, control, aeronautics, and many more. Fields in which GAs have been extensively used include Optimization, Automatic Programming, Machine Learning, Economics, Immune Systems, Ecology Population Genetics, Evolution and Learning, and Social Systems. These lists are by no means complete, but illustrate the variety of applications that GAs offer in various fields.

GAs in Architecture

While other disciplines have adopted computational tools based on the principles of evolutionary biology, in architectural design evolutionary processes have not been broadly applied. Only recently has there been a noticeable shift in the way architects explore such techniques to address complex problems. Indeed, one of the main problems in architecture today is the quantity of information and the level of complexity involved in most building projects.
Genetic Algorithms offer an effective solution to this problem by solving optimization and search problems, operating on a population of possible solutions. In architecture GAs operate in two ways: as optimization tools and as form-generation tools. In the first way GAs address well-defined building problems, such as structural, mechanical, and thermal and lighting performance. In the second way GAs are used

under the scope of the concept of *Emergence*. The dual operation of GAs in architecture will be analyzed hereafter.

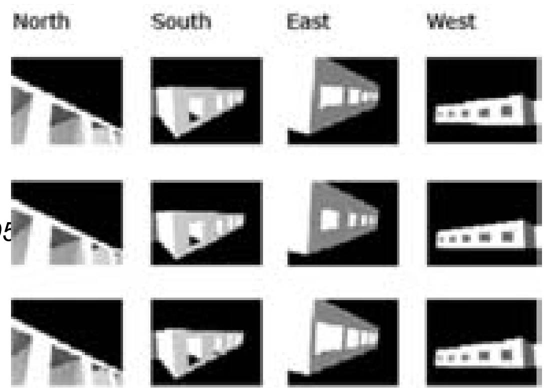
GAs and Design Optimization

Design optimization has been introduced to building industry as a tool to achieve the best possible building performance, the highest reliability and / or the lowest cost. Building performance includes among others the structural, acoustic, lighting, energy and spatial attributes/properties of a building. For example one of the basic aims of structural optimization is to minimize the overall weight so as to minimize the material cost. With the increased demands of the global market for more effective and complex buildings, the utilization of GAs, as one of numerous optimization techniques, is a necessity. Especially for large-scale structures with thousands of elements or structures with very complicated geometry manual calculations can not satisfy the increased demand so the use of optimization techniques is inevitable. For example, in the project for the Aquatics Centre for the 2008 Olympic Games in Beijing, the new automated approach for selecting section sizes and checking them to design codes for all 25 000 steel sections was crucial for the feasibility of the project's roof.

Most optimization problems are made up of three basic components. The first is the objective function which we want to minimize or maximize, the second component is the designation of a set of design variables that affect the value of the objective function, and the third component is the determination of a set of constraints that allow the design variables to have certain values. For instance, in terms of the structural performance of a panel, we determine what we want to minimize that might be the stress in a particular region, and then we determine the variables, that could be the geometry and material of the panel, and then we set the constraints that could be the minimization of the weight of the panel.

For a thorough investigation of the operation of GAs as an optimization technique in design the Genetic Algorithm Tool for Design Optimization implemented by Luisa Caldas and Leslie Norford in 1999 will be examined. The Genetic Algorithm Tool [3] explores the use of GAs in the context of generative and goal-oriented design in order to develop and evaluate criteria related to the environmental performance of a building. The tool searches for the optimal window size in a building in order to optimize three characteristics of the adjacent room: lighting, heating and cooling performance. Environmental conditions including climate conditions, window orientation, and glazing, are parameterized since they influence the achievement of low-energy consumption solutions.

Two office buildings are examined, both with controlled internal climate and artificial lighting. The buildings are located in two different cities: Phoenix, Arizona and Chicago, Illinois. After the GAs have generated possible design solutions, the designs are then evaluated in terms of lighting and thermal performance through a detailed thermal analysis program (DOE2.1 E). Then the GAs use the results from these simulations to further investigate towards finding low-energy solutions to the problem under study. Solutions are visualized using an AutoLisp routine, since AutoLisp procedures allow the results to be visually inspected as AutoCAD drawings.



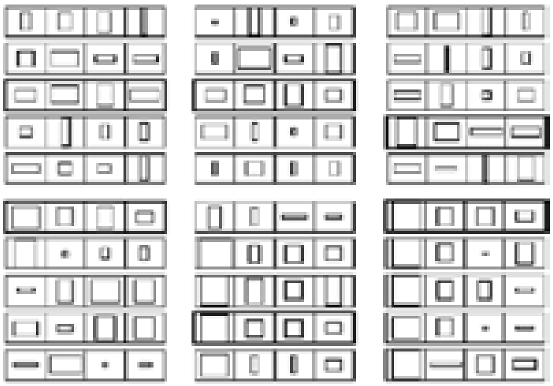
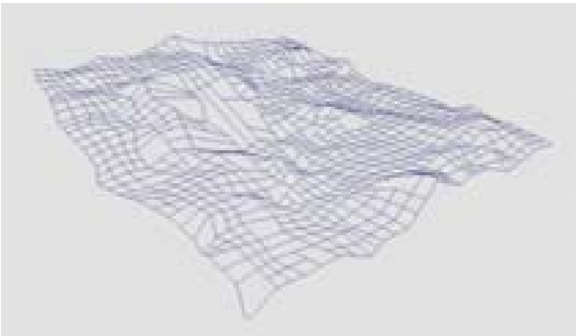
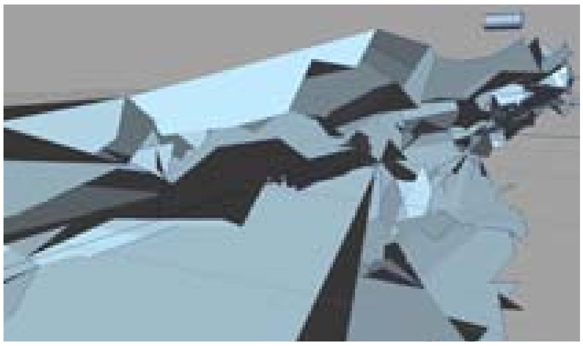


Figure 1 Generations for Phoenix project Figure 2 Final solutions for Phoenix project
hhttp://cumincad.scix.net/sci-bin/works/Show?b5d2

GAs and Emergence

Emergence was introduced as a subset of complexity theory in the 1980s and it is linked back to the development of systems theory in the 1920s. Emergence refers to the universal way in which small parts of systems in nature driven by very simple behaviors are tended toward coherent organizations with their own distinctly different behaviors. Vivid examples from the natural world are the hive, swarming, and flocking where independent parts are formed into one system with a complex or / and random behavior.
While such models are used to generate novelty design or evolving forms, only recently have architects started to explore the ideas of Emergence and examined the new technologies in the natural science to enrich the scopes of architecture, redefining new formal paradigms. Avant-garde architects have referred to theoreticians such as Rene Thom and D'arcy Thomson to investigate the ways in which biological ideas can operate and be generative in architecture. The term of Emergence equates architecture with nature assuming that design is dominated by the same principles as the natural world. Architects attempt to create architecture as nature; architecture that is nature. That is why the notion of emergence is linked tightly with the notion of growth, evolution, continuity and behavior. Indeed, behavior is a dynamic process of feedback between states of forming no axis or center. However, if architects want to use this concept, they have to equate buildings with the living organisms, parts with the whole and function with behavior. In this case, each unit is a part of an environment defined by the building and its neighbors. To produce such environments, architecture must be expressed as rules of generation, in order to allow evolution to be defined.
In this context GAs are introduced, offering a bottom-up approach in multiple cycles of evolution. For a thorough investigation of the operation of GAs as a form-generation technique the *Generative Form Modeling and Manufacturing (Genr8)* [4] developed by the Emergent Design Group in 2001 will be examined. The Generative Form Modeling and Manufacturing is a tool that combines a generative design algorithm -- Map L-systems -- with evolutionary search algorithms -- GAs. Through the combined use of these two algorithms, Genr8 designs the geometry of surfaces and allows the user to interfere with growth, by stopping evolution, altering fitness and run-time parameters, including the environment in which growth takes place. Genr8 was used to conduct an experiment to explore the potential of achieving a coherent

coexistence of the logic behind manufacturing, constraints implied by construction materials and complex geometrical forms.
The development of the surfaces is an outcome of two processes: definition and re-writing rules. The application of these rules to the initial definition and any subsequent development alters all parts of the surface, and the results are continuously translated into three dimensional drawings. The conditions that influence the growth of the surface also influence the grammar of the GAs and along with innate factors define the form of the surface. Growth is achieved with the use of the GAs. A critical issue in the use of the GA is the definition of the fitness criteria. These are defined as mathematical functions representing properties of the form of the surface including size, smoothness, soft boundaries, subdivisions, and symmetry.

Figures 2-3 Images generated by Genr8,
http://mit.edu/edgsrc/www/genr8/media.html

GAs: Necessity or/and Trend

GAs in architecture and other disciplines

Based on the former analysis, we can argue that there is a basic difference between architecture and other disciplines in the utilization of GAs. Unlike other fields that address problems whose targets are well-defined, many of the problems that architecture deals with are ill-defined. Liddament, in his article “The Computationalist Paradigm in Design Research,” [5] shows that although computational tools, such as GAs are powerful in scientific domains to solve many problems, they do not adequately fit the actual design activity. He acknowledges the fact that the computationalist paradigm presents itself as a “scientific approach with a correspondingly rigorous methodology.” Design intention, for example, is usually an ill-defined problem. Even if designers finally manage to code design intention, this process will not be enough to guarantee a successful design solution. This is because an architectural project is a composition of design performances including spatial, structural, lighting, acoustic, and thermal. These elements continuously interact during the design process. Consequently, the optimum solution of one of those elements does not lead to a successful combination of all elements, hence, to a global optimum and successful design solution.
Another noticeable difference between architecture and other fields is that architecture is not just a rule-driven science. While architecture primarily serves the

function of the buildings, it also deals with cultural, social and aesthetical notions whose codification and fitness is subjective, but still could be encoded into rules.

GAs: Necessity or Trend?

Despite the difficulties in coding many architectural problems, algorithmic processing of GAs -- as a way that builds human's thought to solve problems -- can be used in the design process. Taking this into account, the next question that is addressed is whether the use of GAs in architecture today is driven by necessity or trend.

Necessity

The increased human needs and the today's lifestyle call for more complicated functional requirements and the quest for more innovative forms augments the complexity of the formal manifestation. The level of complexity that is introduced and the quantity of information that it entails constitute one of the basic problems that architecture must deal with today. This problem cannot be resolved by conventional design methods. Likewise, the constraints of this problem surpass designers' abilities to thoroughly comprehend them and predict their solution. Seeing GAs as tools that can answer to the specific needs of practical architecture and not merely of experimental design, the notion of *necessity* of GAs arises.

Genetic Algorithms, as stochastic processes for solving optimization and search problems, go through thousands of iterations in a second and find the solution sets, extending designers' thoughts into a once unknown and unimagined world of complexity. Under the scope of *necessity* architectural projects utilize GAs as optimization tools to address well-defined problems, such as the structural, mechanical, thermal and lighting performance of a building. In this case, GAs serve design for architecture, design for the real world. This is the reason why this utilization of GAs is called a *necessity*.

However, even in the case of necessity there is a possibility for architects to select GAs -- among numerous other optimization techniques -- just because GAs are a cutting edge method. Indeed, there are many other optimization methods, including hill climbing, simulated annealing, tabu search, stochastic tunneling, and harmony search. The selection of a particular optimization method should be based on the specific needs and nature of a problem and how efficiently the method can respond to these demands and not how trendy a method is. For example Prof. Kristina Shea used the method Structural Topology and Shape Annealing (STSA) to develop EifForm, a stochastic optimization software demonstrator for generative structural design. [6]

Trend

On the other hand, we have noticed a more generalized utilization of GAs as form generation tools. Influenced by the concept of emergence and evolutionary architecture, architects use GAs as means of exploring innovative forms. The number of architects who adopt these techniques is rapidly increasing. Likewise, their designs are getting more and more complex. Reading the description and observing the final output of those experiments, one could argue that formal complexity is the primary consideration for those architects. The fact that these forms often do not follow or serve any functional or structural requirement boosts this argument. At this point, a sequence of questions is raised:

> Why should the complexity of buildings be increased today if it is not to justify functional or structural requirements?
>
> Do those architects believe that only through complexity they will achieve formal innovation?
>
> Do they believe that the formal complexity of buildings can reflect the complexity of the building environment and everyday life?
>
> Why is formal complexity their primary task anyway?

The fact that those architects utilize GAs merely as form-generation tools, omitting spatial and structural performance, in conjunction with the fact that most of those projects do not produce architecture but rather abstract shapes which are difficult to be translated into architecture could lead to the conclusion that in this case, GAs serve design for abstract shapes, design for a conceptual world. This is the reason why this utilization of GAs is called a *trend*.

Also most of these architects do really respect the notion of Emergence or they have not truly understood the real meaning of this notion. Emergence is not interested in parts; it is the science of wholes. And since design process is comprised of many parts they should not omit them and focus only in formal representation. However, even if architects are able to combine many building requirements and performances with formal generation, a fallacy still exists in this attempt. This fallacy is based on the equalization of architecture to biology. Indeed there are some similarities between architecture and biology, both are materially and organizationally based, both are concerned with morphology and structuring. Nevertheless, those similarities do not lead to the perception of building as artificial life form, which is dominated by the same principles that the natural world is dominated. This speculation equates cultural evolution with organic evolution, which is the same as to equate the Darwinian with Lamarckian theories of evolution. Since form in architecture is a cultural artifact, imaging numerous abstract meanings as previously mentioned, form can not be subjected to the Darwinian definition of evolution. Architects must clarify where architecture is literally considered as part of nature, where there are analogies or metaphors, and where nature is a source of inspiration.

There is no doubt that abstract shapes of a conceptual world may be implemented in the future, opening the path for new formal expressions. However, the real challenge would be to use GAs in real-world architectural contexts. Indeed, it is very difficult for a designer to combine complexity and constraints imposed by the design problem with evolutionary formal generation. Possibly this is the reason why architects use GAs either as a tool to solve structural and mechanical problems or as a tool to generate forms.

Design process and designer

The changes in the design process and the role of design are one of the most important implications of the utilization of GAs. In the case where GAs are used as an optimization method those changes are not that important. Even if at first glance it may appear that those methods lead to the replacement of the designer from the design loop, this is not really the case. Indeed, the designer or the engineer is the one who decides what will be optimized setting the variables and the functions of the problem while the optimization techniques are just another tool available to the designers shorting the design cycle times and performing the calculations.

On the other hand, when GAs are used as a form generation tool these implications are more important, since GAs are used during the conceptual design phase. Evolutionary simulations replace the traditional design processes and the designer in a sense is neutralized and marginalized. This is because most of the designers use GAs to breed new forms rather than merely design them. As fascinating as the idea of breeding buildings inside a computer may be for some designers, it is clear that merely using digital technology without functional, structural and topological thinking will never be adequate for real architecture. Consequently, the main role of the designer is to be the judge of aesthetic fitness. In the words of Steadman: “Just as Darwin inverted the argument from design, and ‘stole away’ God as designer, to replace Him with natural selection, so the Darwinian analogy in technical evolution removes the human designer and replaces him with the ‘selective forces’ in the ‘functional environment’ of the designed object.” [7]

Selection

The selection of the final output is another issue that is derived by the use of GAs. In the case of *necessity* the target is well-defined and consequently the selection of the result is based on the optimal solution. For example, in the project of Caldas and Norford that was previously examined the target was the optimal window size, in terms of lighting, heating and cooling performance. Based on this, the final output the sizes of the windows were selected based on the lowest-energy consumption. However, in the case of *trend* the target is ill-defined and the criteria for the selection are only aesthetic. At this point a sequence of question is raised:

> Why should designers follow such a strict, logical, and subjective process, if they eventually base their selection on abstract and objective aesthetic criteria?
>
> Why do they not design something similar to the final output at the very beginning?
>
> Is it because some architects merely use GAs as a tool to surpass their limitations of creativity?
>
> Is it because they believe that the utilization of GAs document their design process, providing it with a “theoretical” and conceptual substance?

GAs: Necessity and Trend

Undoubtedly there are many difficulties in the application of GAs in architecture. However, GAs have the potential to play a more effective role in the future of architecture. On one side it is the architectural problem that has a “reason” and a fundamental “factor.” The “reason” is the increasing quantity of information and the increasing level of *complexity* involved in most building projects today. The “factor” is the various building *performances* including spatial, functional, aesthetic, structural, energy, and lighting. All these performances interact and interlink and can not be considered separately. On the other side there is the potential of GAs. Genetic Algorithms are search methods for addressing *complex* problems, finding optimum design solutions from indeterminate search spaces constrained by *multiple input* factors. If architects want to use computational design to address architectural problems Generative Algorithms can be one of possible tools to do so; they can solve the “reason”, taking into account the primary “factor”.

Yet, in order for GAs to be applied in architecture, some things must be done. Today the usage of GAs is local; that means that GAs are used merely for form generation or for optimization of one building performance. The problem in today's utilization is that the local function of GAs is influenced during the design process and, in the end, the local "optimal" is lost. For example, if a designer utilizes GAs so as the form of a building to be emerged, in the next step of the design process he/she will need to change the form partly or radically so as to fit the function. The same will happen if a designer uses GAs to find the optimal form minimizing the cost and maximizing daylight. Then, if he/she tries to calculate the thermal performance with the conventional tools the design will risk loosing the local optimal which has been calculated in the first step, since in the next step of the process another performance must be calculated and new functions will be introduced.

A possible solution to this problem is the coordination of generative tools with optimization tools; the combination of dual utilization of GAs: trend and necessity. The form will emerge by the simultaneous calculations of most of the performance-driven functions. This process can be seen as a potential effort to achieve the design goal finding the 'fit' between form and context, defining the context as "anything in the world that makes demands of the form" [8]

-- including meanings, aesthetics, environment, and function -- as Christopher Alexander stated. Indeed, for Alexander "the form is the solution to the problem; the context defines the problem." [9]. This process will help architects to find global "optimal" or satisfactory solutions, aid multi-disciplinary negotiations, shorten the project delivery time and cost, and find feasible design alternatives. However, some potential negative consequences will be derived by the application of this process. Architects must make sacrifices related to the generalizations and reductionisms of some of the design problems. Those must be done in order to transform most of the ill-defined problems -- that are related to the subconscious and subjectivity of the architect, such as the design intention -- into well-defined ones, by coding them. Undoubtedly, this transformation will be very difficult to achieve. Many authors have referred to the difficulties of coding the very complex and unexpected way that the human mind functions. On the other hand these transformations seem inevitable since the constraints of recent architectural problems surpass designers' abilities to thoroughly comprehend them and predict their solution. Another aspect that architects must take into account applying this method is the fact that many problems emerge or diversify during the design procedure. Consequently, the interactivity between designer and computational tool must be accommodated allowing the designer to add/reduce the variables or changing the fitness functions.

Conclusion

One of the problems that contemporary architecture has to deal with is the quantity of information and the increasing complexity of most of the architectural projects. Only recently have architects started to utilize Genetic Algorithms (GAs) to address this problem. This paper demonstrated the dual operation of GAs in architecture: as optimization tools, and as form-generation tools, addressing these as necessity and as trend respectively. This paper also indicated the implications of GAs' applications. Some of these implications include the replacement of the traditional design process by the evolutionary simulations, the neutralization and rescission of

designers, the abstract criteria of the final selection, and the local utilization of GAs only in some of the design phases. However, GAs have the potential to play a more effective role in the future of architecture. Indeed, GAs can answer the architectural problem taking into account the processes of the design, if they are properly utilized. A possible solution to this problem is the coordination of generative tools with optimization tools so as to achieve a simultaneous calculation of the performances and a global evaluation of the design which will be emerged by the performance-driven functions.
The methodology of incorporating a number of search spaces has been applied in other engineering fields, such as aeronautics and astronautics, leading for example to lighter, stronger, stiffer, and often cheaper automotive bodies, airplane wings, and ship keels. This method is called Multidisciplinary Design Optimization (MDO). Through the utilization of GAs and other evolutionary techniques, MDO solves complex coupled systems, exploring the interacting disciplines or phenomena at every stage of the design process. Further research in the application of GAs will involve investigating the operation and possible application of MDO in architecture.

References

[1] William Lethaby, Architecture: An Introduction to the History of the Art of Building, (T. Butterworth Ltd; Rev: 1911), 25.
[2] Micheal Hensel, Achim Merges, “Emergence in Architecture”, Architectural Design 74, no 3 (May/June 2004), 6-9.
[3] Luisa Caldas, Leslie Norford, A genetic Algorithm Tool for Design Optimization, Media and Design Process [ACADIA ‘99] Salt Lake City, (29-31 October 1999): 260-271, http://cumincad.scix.net/cgi-bin/works/Show?b4d2, retrieved November 01, 2007.
[4] Peter Testa and Devyn Weiser, “Emergent Structural Morphology”, Architectural Design 72, no1, (January 2002), 13-16.
[5] T. Liddament., “The Computationalist Paradigm in Design Research.” *Design Studies,* Vol 20, No 1, (1999) 44.
[6] Kristina Shea, Robert Aish, Marina Gourtovaia, “Towards integrated performance-driven generative design tools” [eCAADe ‘03] Graz University of Technology (Austria): 553-560, http://iam.tugraz.at/~e/cd/ecaade_ files/pdfs/Friday/149_shea.pdf, retrieved November 01, 2007.
[7] Philip Steadman, The Evolution of Designs: Biological Analogy in Architecture and the Applied Arts. (New York, Cambridge University Press: 1979), 189.
[8] Christopher Alexander, Notes on the Synthesis of Form. (Cambridge, Harvard University Press: 1964), 15.
[9] Ibid.

Emergent Form from Structural Optimisation of the Voronoi Polyhedra Structure

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Abstract

In the course of the exploration of computational means in the architectural design process, in order to investigate more complex, adaptive geometries, the Voronoi diagram has recently gained some attention, being a three-dimensional space-filling structure which is modular but not repetitive. The project looks at the Voronoi diagram as a load-bearing structure, and whether it can be useful for structural optimisation. Hereby the edges of the Voronoi polyhedra are regarded as structural members of a statical system, which then is assessed by structural analysis software. Results seem to indicate that the Voronoi approach produces a very specific structural as well as spatial type of order. Through the dislocation of the Voronoi cells, the statical structure becomes more complex through emergent topology changes, and the initially simple spatial system becomes much more complex thorough emerging adjacencies and interconnections between spaces. The characteristics of the emerging form, however, lie rather in the complexity how shifted spaces and parts are fitted together, than in a radical overall emergent geometry. Spatially as well as a structurally, the form moves from a simple modular repetitive system towards a more complex adaptive one, with interconnected parts which cannot stand alone but rather form an organic whole.

Introduction

Alongside the introduction of computation in the design process, architects and structural engineers have been exploring the possibilities of more complex geometries and adaptive forms and structures. The Voronoi diagram has recently gained some attention in this field, being a three-dimensional space-filling structure which is modular but not repetitive, and implicitly introducing the notion of spatial relationships through adjacencies of Voronoi cells.
However, the actual geometry of the Voronoi polyhedron is difficult to predict and control, as the shape of a cell is always dependent on the configuration of the entire neighbourhood. The geometry and the topology of the polyhedron – like size, proportion or the number of edges – of each cell is highly sensitive to even the

slightest change of position of any point in the neighbourhood. Being precise about the geometry of space and structure, however, is what architecture is concerned with in the first place. So although the Voronoi diagram seems to work well in optimising topologies, it remains unclear in how far the difficulty to control the cell shape is a limitation for its use as a design tool in architecture.
This project explores emerging geometries of the Voronoi diagram under special regards of geometric properties of the Voronoi polyhedra. The project looks at the Voronoi diagram as a load-bearing structure, and whether it can be controlled to be useful for structural optimisation. The Voronoi structure, regarding edges of the Voronoi polyhedra as structural members, is determined statically using structural analysis tools. The system aims to optimise through systematically moving the Voronoi points. – Although the emerging geometries are assessed statically in the first place, the project aims to commence a discussion about the emerging architectonic space which develops from this.

Related work

Research has been done to investigate the potential of the Voronoi structure as a means of generating adaptive parametrised topologies, given parameters of the topology of the system [1][2]. By optimising the topology of cells the emerging geometry of the Voronoi structure is suggested to be a suitable geometrical solution for the problem, or at least to a good starting point for further optimisation.
The Kaisersrot project [1] generates layouts for housing developments, given complex input parameters like desired adjacencies, attractors and plot sizes. The process of generating the layout proceeds in two stages: At first, the topology is optimised according to the affordances of the input parameters. Having found an acceptable solution, the actual geometry is improved for example through operations like straightening out edges.
Furthermore, the Voronoi structure has been formally associated with foam-like structures such as sponges, bone structures and crystals [3]. The tradition of these formal associations reaches back to the famous work of architects like Toyo Ito, Buckminster Fuller or Frei Otto, who looked at formation principles, geometries, spatial effect and constructions in nature, using these ideas as a formal, spatial and/or constructive inspiration for architecture.

This project takes the approach to assess the geometry of the Voronoi structure rather than its topology in the first place, in order to investigate if it can be controlled sufficiently to act as a statical structure. It shall be suggested that this is possible, and, furthermore, that the emerging geometric and spatial features of the optimised structure reveal distinct characteristics which are different from former formal associations like foams, sponges or bubbles.

Setup

The software which was developed for this project consists essentially of two interacting components: a program written in Processing [4] to generate the three-dimensional Voronoi diagram and to create a statical structure from it, and the structural analysis program Oasys GSA [5] to assess the structure. GSA can be controlled remotely via a com-interface, so the process of analysing models and reimporting results can run automatically, triggered by the Processing applet.

The three-dimensional Voronoi structure is created from an initial configuration of points. Some of these Voronoi points are declared as 'structural points' which means that their Voronoi cells shall be members of the structural system, and be subject to further analysis, whilst other points are just 'surrounding cells'. The cells of the structural points are confined by the cells of the surrounding non-structural points, and are clipped at the bottom plane. During the optimisation process, the structural Voronoi points are moved in order to seek a configuration which generates statically improved Voronoi polyhedra.

In order to translate the Voronoi polyhedra of the structural points into a statical system, the Voronoi edges are regarded as beams, interconnected through rigid nodes. The beams are assigned some material property – a circular hollow steel profile with a diameter of 0.3 m and a wall thickness of 0.02m. Beams which connect to the bottom plane are defined as fixed supports.

Several simple load cases have been tested. The structure is always considered in terms of self weight. Additionally, in some cases a moderate wind load has been applied which means horizontal force, 1 kN/m^2, and suction on roof areas.

Oasys GSA calculates the values of forces, moments and displacement of the structure. The analysis results are then reimported into the Processing applet. Now the optimisation target is to minimise the maximum displacement value of the nodes, by stepwise amending the structure through movement of the Voronoi points.

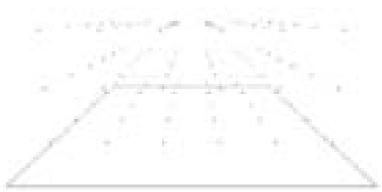


Fig 1a Configuration of points

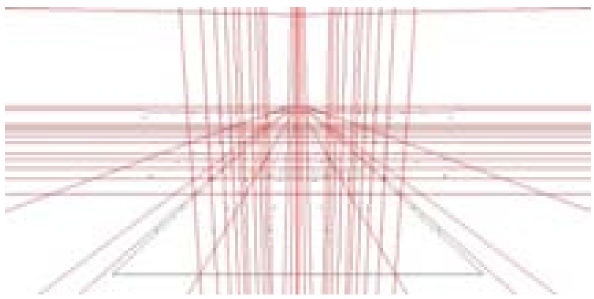


Fig 1b Voronoi polyeder

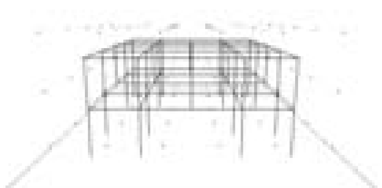


Fig 1c Polyhedra of the structural points

Fig 1: The Processing applet

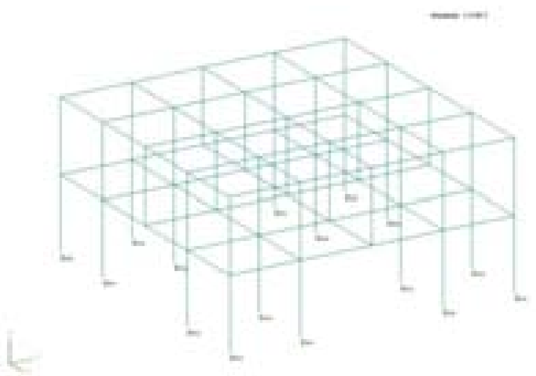


Fig 2a Beam Structure

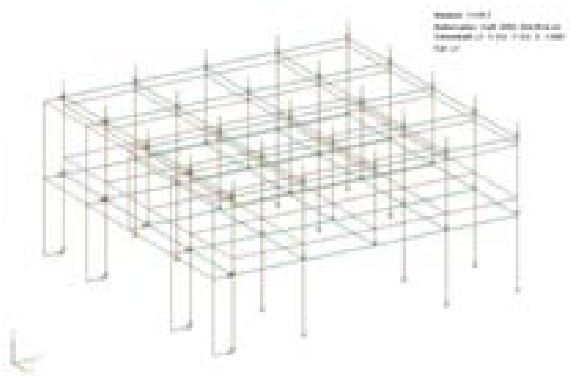


Fig 2b Loads of self-weight and wind load

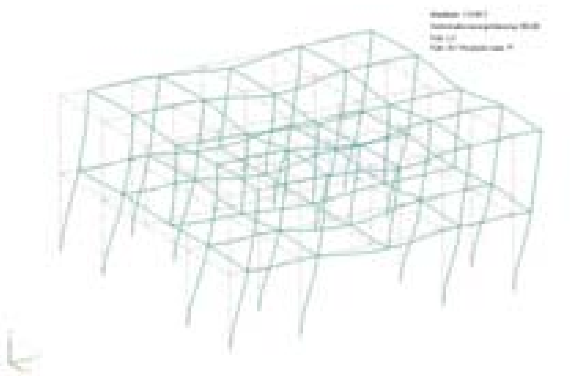
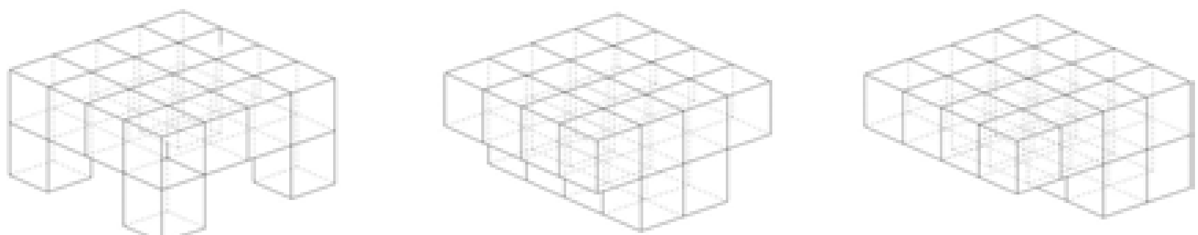


Fig 2c Displacement of nodes and beams due to loading

Fig 2: Oasys GSA

Optimisation

As initial configurations, several simple point arrangements have been tested. As all points are initially located on a grid, polyhedra are simple cubes.



type 1 **type 2** **type 3**

Fig. 3 Initial Configurations

Three optimisation techniques have been tested. The first one moves one point at a time. An array of movement vectors is created, which holds 26 normalised vectors for all directions between (-1.0,-1.0,-1.0) and (+1.0,+1.0,+1.0) One point is chosen, and the program evaluates the impact of the movement of this point, applying successively all movement vectors, then in the end the best option – if there is one - is chosen and the point is moved in this direction. Then the program moves on to the

next point.
The second strategy implements a gradient descent algorithm. Hereby, any point does a trial step in any x, y and z direction. After each point has been tested in any three dimensions, the 'best move' for each point is guessed from the results of the trial steps, by multiplying the amount of success from each trial with the respective coordinate, creating a movement vector for each point. Finally, all points are moved simultaneously according to their movement vector.
However, both optimisation strategies do not seem to be able to effectively optimise the structure. As the cell geometry is extremely sensitive to even the slightest movements of the points, the relocation of a single point often leads to abrupt changes in the topology of the structure. For strategy one, this causes the optimisation process constantly being trapped in local optima. For example, if a point already is in line with its neighbours, and the edges forming continuous elements, any movement of a single point out of this line means a decline of stability through the loss of connectivity to the other principal elements (Fig 5). The optimised results of strategy one seem quite random, with large - and critical - areas remaining unchanged as no better solution could be found for them.
The second strategy is also constricted by a lack of topology control: As Voronoi points are moved, one point and one dimension at a time, and a guess for the best move is made from this isolated movement, it often occurs that none of the topological features which would be of advantage actually happen in the end, when all points are moved simultaneously. - The resulting structure also seems random, and does not improve steadily, but oscillates between extremes of better and worse results
Considering the condition of the Voronoi diagram that a particular edge of a polyhedron is always dependent on the simultaneous influence of neighbouring points, a third strategy has been adopted, which groups similar and adjacent points, and moves them in respect to each other in any possible direction, to evaluate the best combinational move. This technique allows the structure to change gradually whilst maintaining continuously linked members between cells where necessary. (Fig. 6)

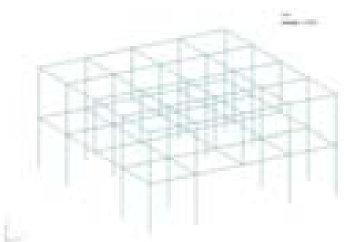


Fig 4a Initial configuration

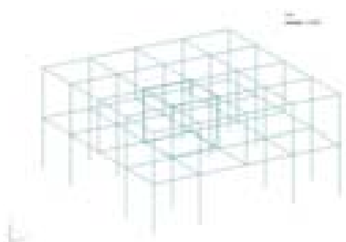


Fig 5a Moving one point

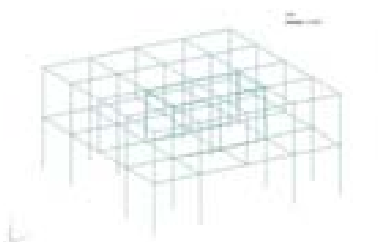


Fig 6a Moving two points


Fig 4b Elevation

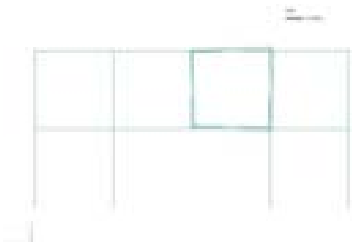


Fig 5b Elevation

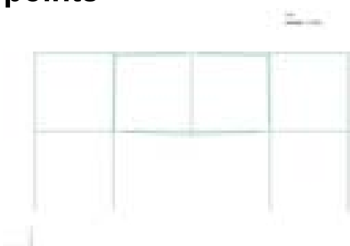


Fig 6b Elevation

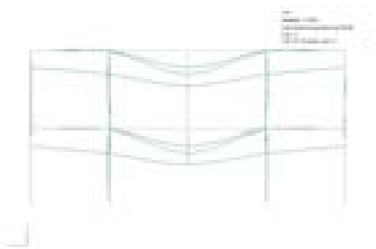


Fig 4c Deformed Elevation: max. Displacement = 89.62mm

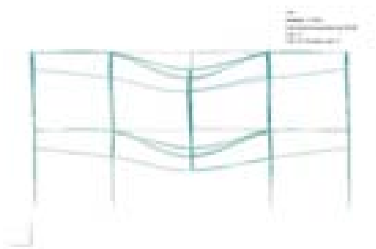


Fig 5c Deformed Elevation max. Displacement = 102.1mm

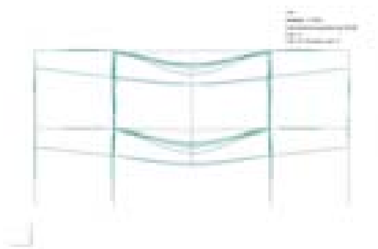


Fig 6c Deformed Elevation max. Displacement = 82.44mm

Test cases

Each of the three configuration types have been tested under self-weight conditions as well as with additional wind loading (Fig 5).

Fig 5a Test cases

					1.01. 001					
				1.02. 001		1.01. 013				
			2.01. 001		1.02. 013		1.01. 025			
		2.02. 001		2.01. 013		1.02. 025		1.01. 061		
	3.01. 001		2.02. 013		2.01. 025		1.02. 061		1.01. 097	
3.02. 001		3.01. 013		2.02. 025		2.01. 061		1.02. 097		1.01. 193
	3.02. 013		3.01. 025		2.02. 061		2.01. 097		1.02. 193	
		3.02.		3.01.		2.02.		2.01.		

025		061		097		193
	3.02. 061		3.01. 097		2.02. 193	
		3.02. 097		3.01. 193		
			3.02. 193			

Fig 5b captions of test cases

The optimisation process starts by slightly contorting and twisting the cubes against each other, and then moving on to developing more strongly distorted and deformed polyhedrons.
Under self-weight conditions, displacement of the nodes is predominantly in the vertical direction, leading to tilts of the horizontal members. Considering more complex load cases including wind load, the contortion is more complex and includes shifts of the vertical members more frequently.
Fig 5a shows the six test cases as they develop over time. The captions should be read

1.	*01.*	*001*
Type	*load case* *01 = self weight*	*time step*

During ongoing transformation, the structure seems to pass through several typical formal stages (Fig 6, 7 and 8). The first stage is characterised through slightly twisted elements. In the next stage, the polyhedra dislocate more strongly, whereby more complex adjacencies between formerly not connected spaces appear. Finally, the spaces transform into complex polyhedra with strongly tilted planes, with little similarity to the original shapes.

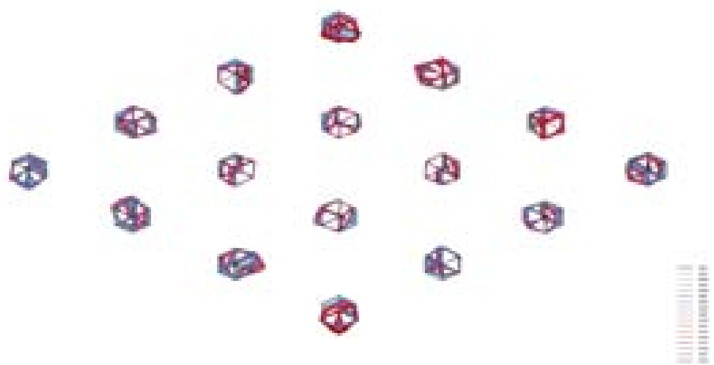


Fig 6 Type 1.02: Overlaid shapes of cells during optimisation

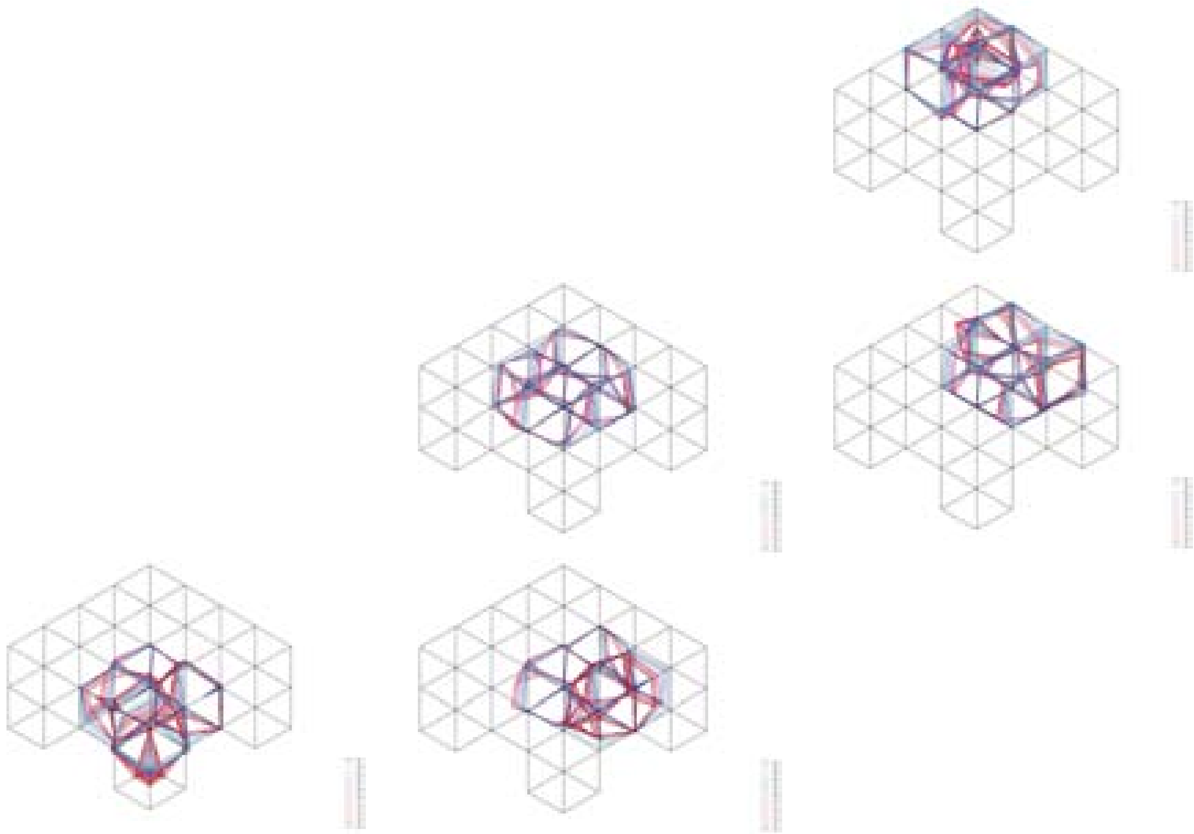
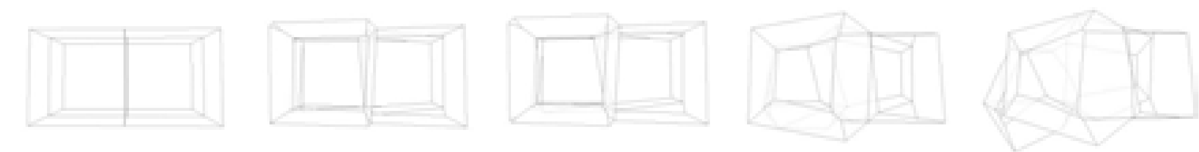


Fig 7 Type 1.02: Overlaid shapes of respectively four adjacent cells during optimisation



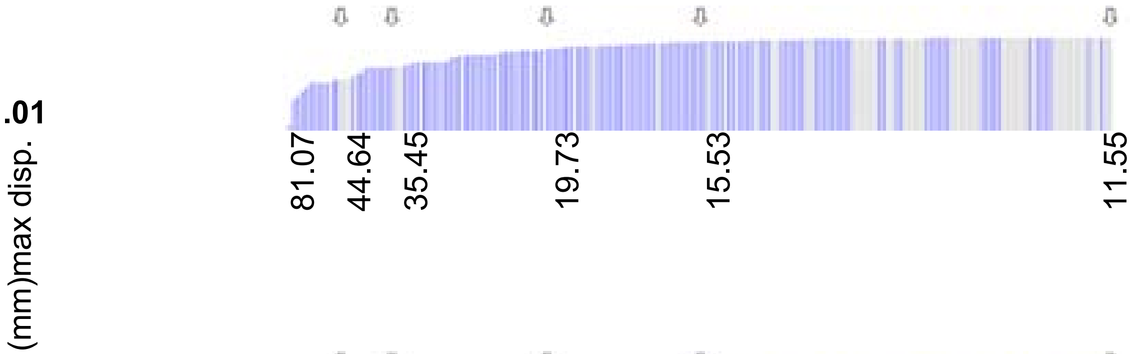
001 025 061 097 193

Fig 8 Type 1.02: Perspective of four adjacent cells during optimisation

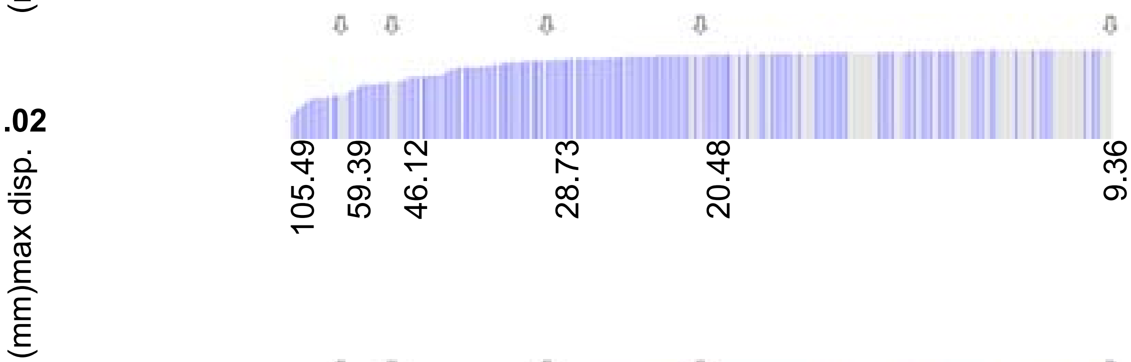
What happens in the first stage is that, although the cubes do not change radically in shape and proportion, so does the topology of the beams (Fig 10). The beams tend to double up

time step	**001**	**013**	**025**	**061**	**097**	**193**
(mm)max disp.	89.61	45.82	36.38	22.15	15.09	12.20

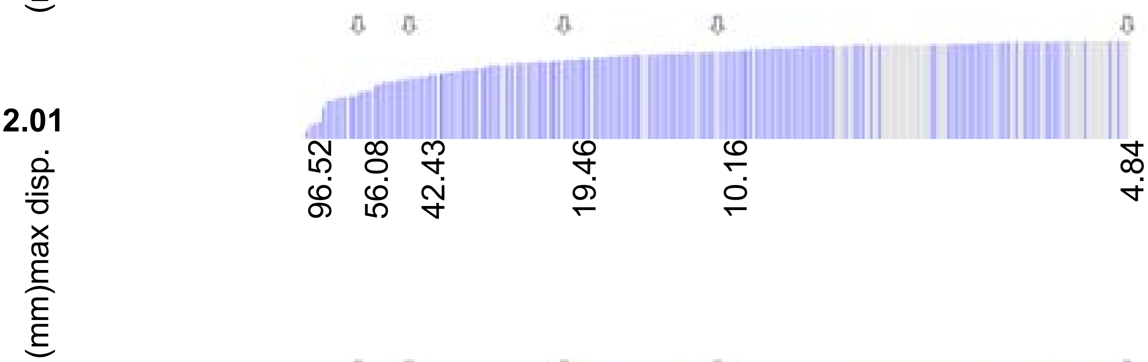
1.01



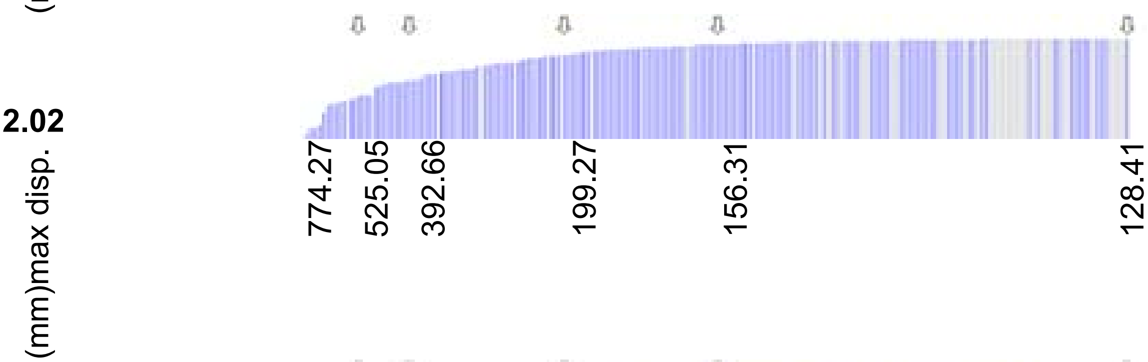
1.02



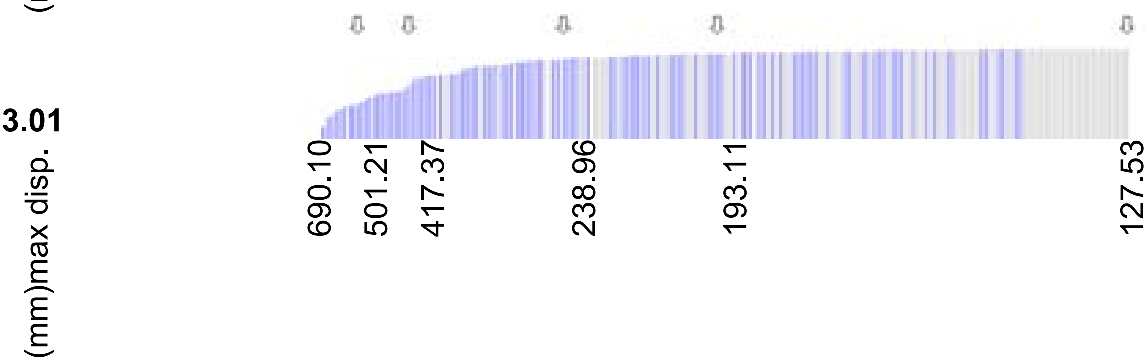
2.01



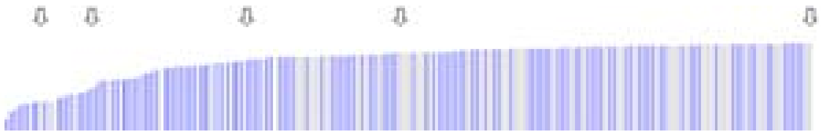
2.02



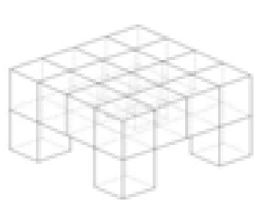
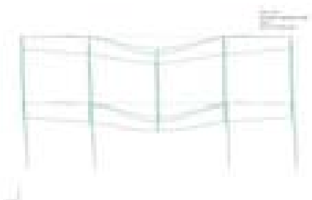
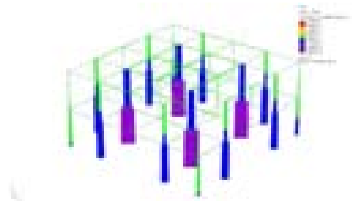
3.01



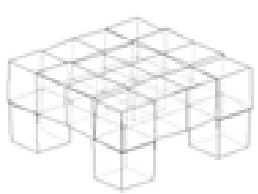
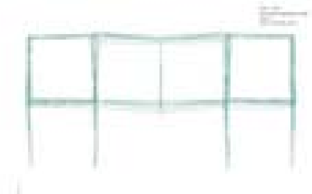
3.02



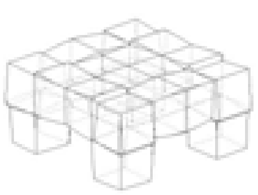
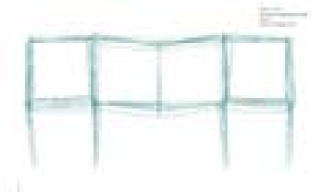
02 = self weight + wind load The optimisation statistics (Fig 9) reveal that, in all cases, there is a significant improvement even in early stages, as optimisation success usually happens to follow a logarithm - shaped curve. Although in later stages the structure changes strongly – the twisted cubes turn into more bubble-shaped complex polyhedra, the increase in fitness is relatively lower than in the first stage.

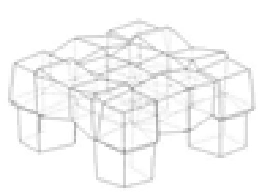
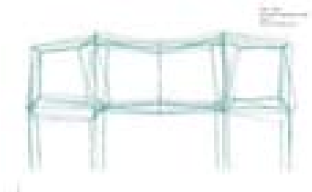
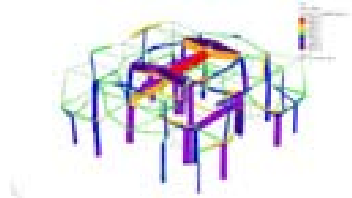
1.02.001 **Displacement** **Axial Forces**

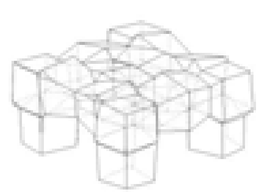
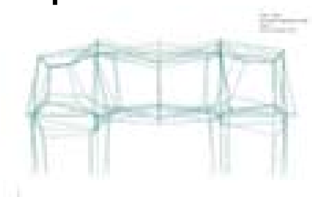
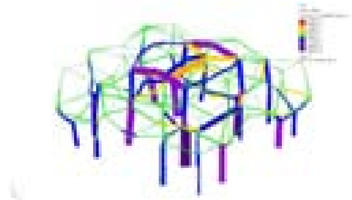

1.02.013 **Displacement** **Axial Forces**

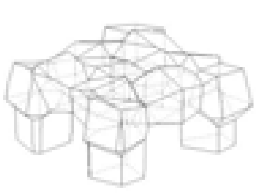
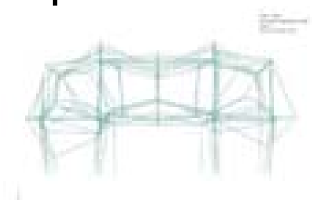

1.02.025 **Displacement** **Axial Forces**

1.02.061 **Displacement** **Axial Forces**

1.02.097 **Displacement** **Axial Forces**


1.02.193 **Displacement** **Axial Forces**

Fig 10 Type 1.02: Geometry, displacement and axial forces during optimisation

Fig 9 Optimisation statistics

when the cells move out of the grid, and the members themselves contort against each other making the overall structure more stable. – The axial forces diagram reveals that, in opposition to the original structure, which is predominantly stressed by pressure forces, the doubled edges have a pressure and a tension stressed member (colours red to yellow represent tension, green to lilac indicate pressure). This effect diminishes in later stages of the optimisation.

Conclusion

These findings seem to indicate that a considerable improvement in structural performance can already be achieved through slight contortments and topological local changes of the structure. The usage of the Voronoi diagram as underlying system hereby plays a crucial role, as these emergent topologies are a key property of the Voronoi diagram itself. It shall be suggested this property of the 'instability of the topology', which has initially be considered as a threat, has turned out to provide rather interesting system conditions, which can be exploited for optimisation in a very distinct manner, and produces rather unique structural systems.

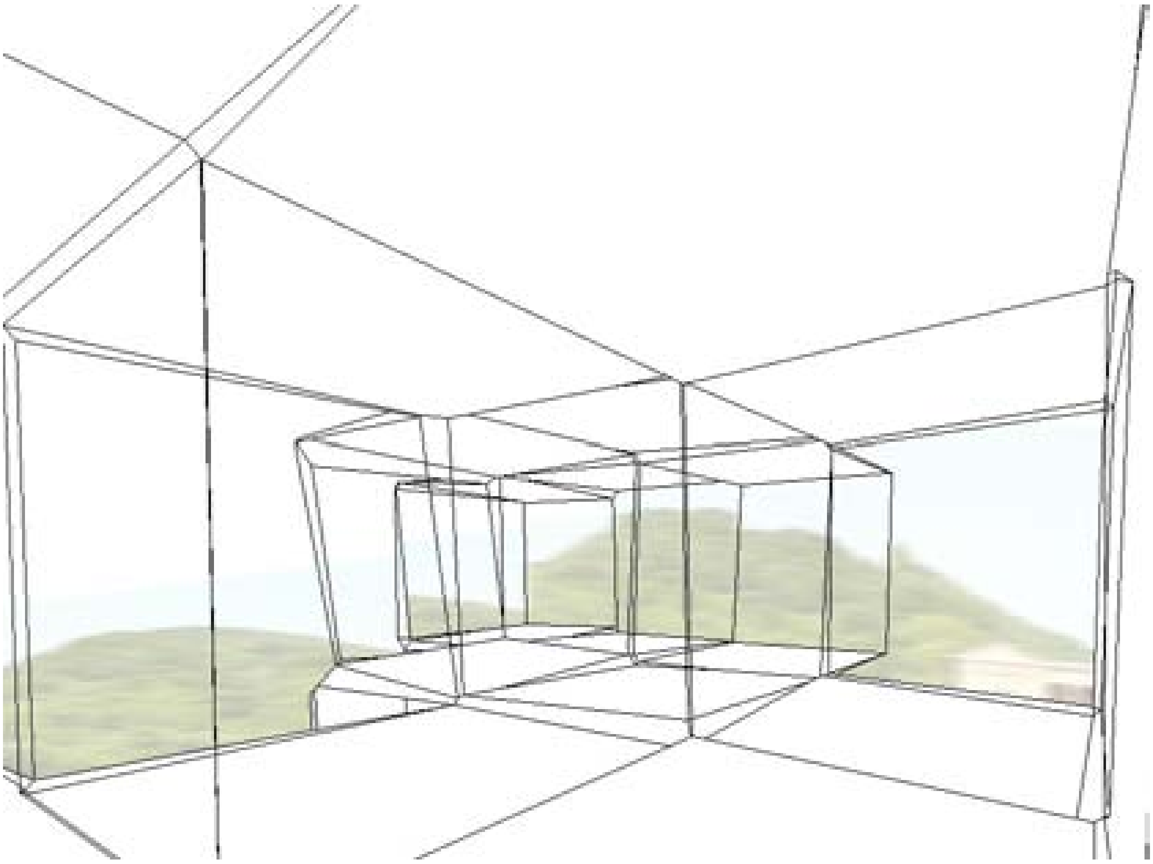


Fig 11 Interior perspective of an optimised structure in the early stage

Furthermore, it shall be suggested that the emerging geometries might provide an interesting research field in terms of their spatiality. In the course of optimisation, space undergoes certain distinct 'phases': from a cube-like additive space to a stage where spaces are contorted, still 'Cartesian' but more interwoven, until in the end orthodox geometry gets lost and gives way to more 'organic' bubble-shaped forms. It shall be suggested that it might be the earlier stages of the process which might be of special interest, structurally as well as spatially.
Here it shall be referred to some work of the Swiss Architect Valerio Olgiati, who, in his built and theoretical work, has been deliberately developing the distortion of simple geometries as an architectural as well as a structural means.

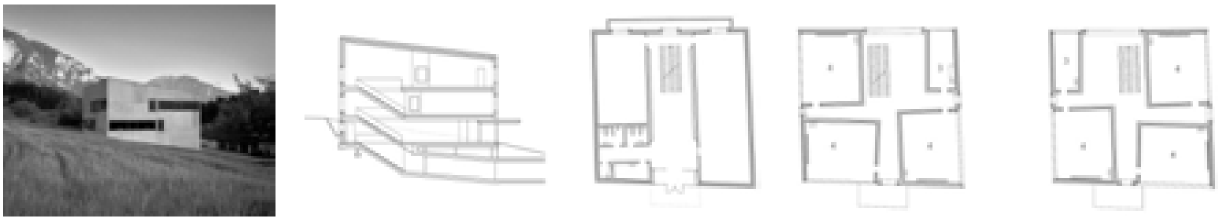


Fig 12 V. Olgiati, School in Paspels, 1999 [6]

For example, Olgiati's school in Paspels seems to be a simple-shaped building at first sight. However, the seemingly simple geometry is distorted slightly on the verge of degree what is perceivable, following only a limited number of shifts and contortments "which might seem imperceptible but produce a variety of chain reactions ... this spatiality provide the chance to take up many viewpoints, all different, impossible to locate within a system of orthogonal axes, providing a variety of perspective views...." [7]. From these spatial operations, Olgiati develops a very unique architectural expression of complexity which acts as a self-contained frame of reference for this very unique building. Olgiati is interested in the contrast which is created through the shift which cause the building to step away from being 'Cartesian' and modular, but rather being an 'organic whole' [8] (without being 'organically' shaped in a ostensible formal manner).

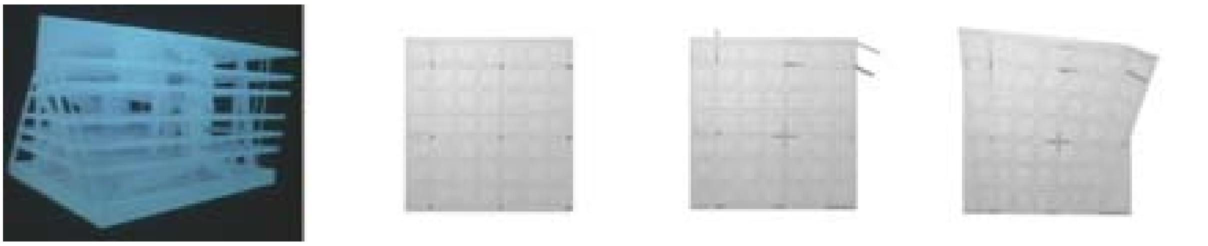


Fig 13 V. Olgiati, University in Lucerne, 2003 [9]

The design for the University of Lucerne was a winning contribution to a competition tendered in 2003. The statical structure, distorted and seemingly coincidental, is in fact precisely derived from static and functional preconditions. The slight contortion of the building is exploited to stabilise the structure in any three directions, with as few pillars as necessary. There are two types of pillars, the main load-bearing ones which are mainly stressed by pressure and which push up, accompanied by additional thin pillars which pull down at certain points where the horizontal beams cantilever and tend to bend upwards. This interplay of supporting and tearing elements 'makes the structure thinner and more efficient' [10], 'The building is a skeleton building, but on the other hand it is also an organic building, that is not modular anymore, even though it is based on the typology of a piloty system.' [11]

It shall be suggested that maybe an approach as outlined above can provide a field of research to explore optimised statical systems on the one hand, which improve through topological changes and contortments, and on the other hand, to explore a certain type of spatiality, which brings about a complex 'organic' adaptive space, without being ostensibly 'organic-shaped, an adaptive spatiality different from known metaphors and analogies of 'organic architecture'.

Credits

Many thanks to Tristan Simmonds for his introduction to Oasys GSA, his advice on the analysis setup, and the very helpful reviews of the analysis results. Many thanks also to Daniel Glaessl for architectural and conceptual discussions!

References

[1] Kaisersrot: M.Braach in collaboration with Kees Christiaanse Architects and Planners (KCAP) www.kaisersrot.com
[2] P. Coates, C. Derix, P. Krakhofer, 2005: Generating architectural and spatial configurations. Two approaches using Voronoi tessellations and particle systems. GA 2005
[3] m-any: T. Bonwetsch,S. Gmelin,B. Hillner,B. Mermans,J. Przerwa,A. Schlueter,R.Schmidt. www.m-any.org
[4] www.processing.org
[5] www.oasys-software.com
[6] Valerio Olgiati. 2G Architectural Review 2005. N.37 nexus. Images p.44 ff
[7] Jaques Lucan in: Valerio Olgiati. 2G Architectural Review 2005. N.37 nexus. p.6 f
[8] Valerio Olgiati, 2006: Inventioneering Architecture. Lecture accessible at: www.architecture-radio.org/inventioneering
[9] Valerio Olgiati. 2G Architectural Review 2005. N.37 nexus. Images p.99 ff
[10] Valerio Olgiati, 2006: Inventioneering Architecture. Lecture accessible at: www.architecture-radio.org/inventioneering
[11] Valerio Olgiati, 2006: Inventioneering Architecture. Lecture accessible at: www.architecture-radio.org/inventioneering

Cities of the inhabitants or Megalopolis of the nets " Systems Design" between Sensitive and Intellective

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Hard life for contemporary design without context or Community

The Rome ISIA started in 1973 as an experimental design school of the state, and for many years has been renewing conceptual design paradigms, recently setting up a graduate course in "Systems Design". The intention was to deepen the sense of a constellation of meanings around the new geography of knowledge, technologies and creativity, in contemporary society. In a particular way design is involved in the relational and systemic aspects of the human landscape, both material and immaterial. Systems Design is drawn to the Sciences of Complexity, to the elaboration of non-linear thinking, and observes with much interest the self-building principle, dealing with features of a system as they emerge. We are committed to making a contribution to these theories which are part of consolidated experience in the area of the product, the morphogenesis and above all, the Metadesign that it has inhabited for many years, making use of the stimulating contribution of mathematics and systemic courses of high profile. We want to be far away from the actual formative trend, overly close to the market catalogue, and to confirm our experimental research vocation, to better explore the Innovation problems.
A careful reading of modernity, complete or incomplete as it may be, shows how the culture of design came into being within a multifaceted laboratory, around a shared project of possible Community in the industrial era, a philosophy based on metanarrative thought of many sides which differ from each other, but which are united by ultimate desire for community. In spite of the wealth of this diversity, Modernity in the end, has been witness to the emergence of metanarration as the dominant philosophy in interpreting reality of the linear perspective type, using as its emblem modular geometry and the numerical approach to the project.
The relationship between subject and object has lived through many seasons from the Renaissance and the discovery of America, shifting the initial focus away from the center of the drawing as a fixed, explanatory, cognitive principle of Renaissance perspective, that is also an explicit metaphor for the figure of Machiavelli's Prince. Therefore it is a principle of absolute objectivity and recognizability that allows construction and representation, and includes the

multiplicity of the world into a single vanishing point.
Starting from the Reform with the birth of Capitalism, of scientific and technical development, the subject-object equilibrium has shown much instability, especially during the XX century, until the present post-industrial society, in a globalized, information landscape that it is rebuilding around the requirements and conditions of its own human time-space experience, and the general energy-matter exchange too. Everything leads us to think that the contemporary subject is shifting from a “perspective society” to an “a-perspective” society, that redesigns the assumptions of social semiotic praxis of knowledge and languages around this new axis of the sense. The contemporary postmodern condition appears therefore like an infinite probability of "relational models" within an Hypertext scheme that, as in the observations of Z. Baumann, [1] is lacking a final design or a complete script. Baumann himself says that the term postmodernity is in part inadequate, in the sense that modernity is an indefinite process, possibly even infinite, and replaces the term with "liquid Modernity" [2].

Perspective and a-perspective society, imagination as project

The eclipse of perspective after four hundred years of supremacy coincides with emergence of the opposite condition that focuses on subjectivity the more important weight of the new metanarrations, operating a massive critical review of those project categories that, as an example, explained architecture as the phenomenology of urban planning, and design as the phenomenology of architecture. Therefore entire families of signs and meanings, of semiotic praxis and of methodologies, appear and disappear, depending on how the equilibrium of the subject-object relation within historical and social dynamism is interpreted.
Since properties which, in the world of modernity, were believed to be part of things, have become in fact the properties of the observer, subjectivity has assumed today an enormous value, able to make a difference.

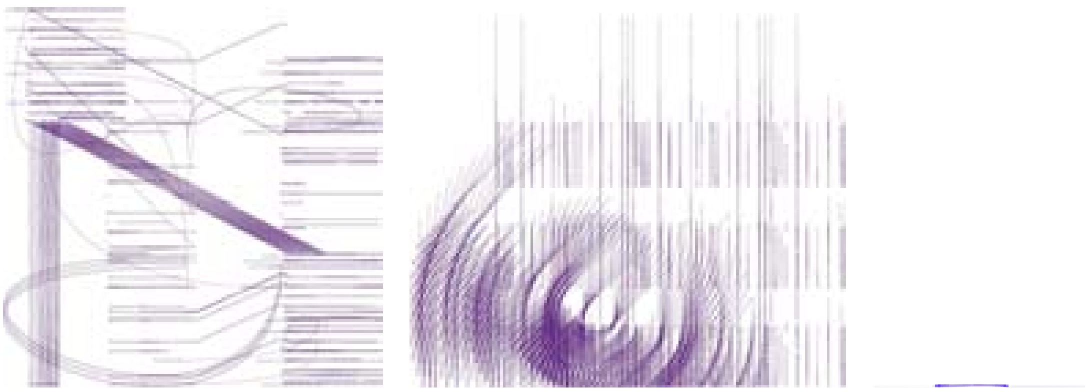
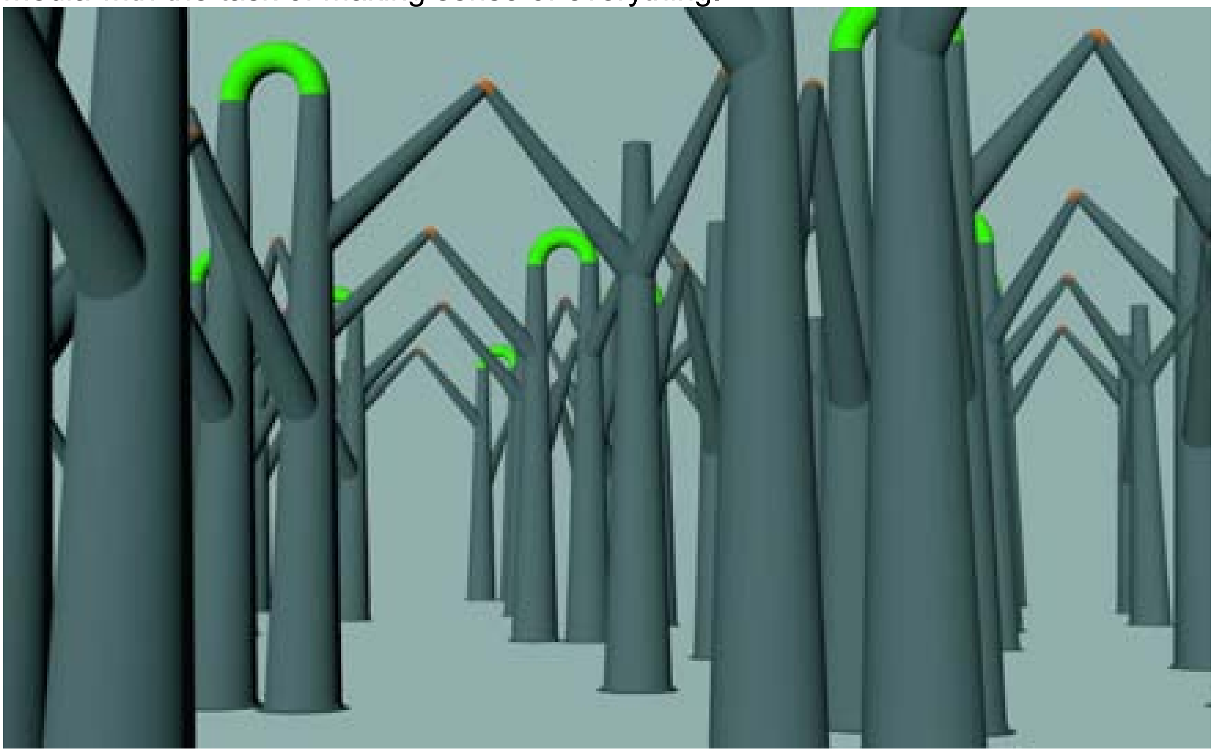


Figure 1. Fabio Pulsinelli, from matrix to the system

It is important that the deal of design’s culture today embraces an immense kaleidoscope of differences and regards the person in a direct way, deeply attempting to design and to answer to new needs through design. The aspect which may make the difference is for us to understand whether in the end, the person should be perceived as unlinked to a community or collective destiny, as

the world of technology and aggressive marketing makes us believe, or not.
"To celebrate the unfinished in this era of digital ubiquity is to laud process rather than goal - to open up to third thing that is not to resolution, but rather to been of suspension.... The question becomes how to categorize such to fast-moving set of objects and concepts." [3]
In other words if design is to express a culture able to follow its user-mutant, offering meaning coordinates able to tie the Sensitive to the Intelligible giving indications of a reasonable community, design can have a remarkable impact on history.
"As relevant not only to the centered human but also to the decentered human as pertinent the human heart, body, and spirit as well as the human mind". [4]
If the model of modernity has created "leftovers" at a conceptual level but also at an urban and social level, the model emerging from postmodernity appears quite founded on production discards, in the sense that they trigger continuous chaotic processes, generate continuous physical and mental “peripheries”, continuous marginalities and differences, entrusting the ever-present new media with the task of making sense of everything.



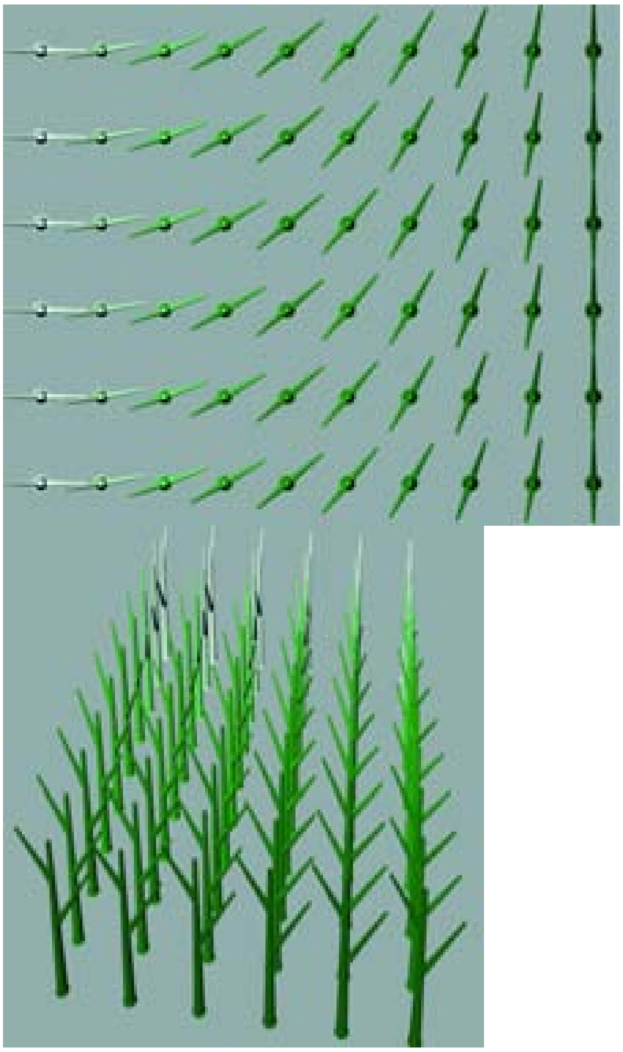


Figure 2. Fabio Pulsinelli, hypotheses on a-perspective evolutive landscape

We assume the travel of the contemporary subject in the urban drifting of metropolis and in computer networks, as a basic condition in which it lives, as the starting point of our research, but we ask what can be, the praxis of creation of a "self" that is an hostage of a such extreme subjectivity, intentional, tried or found. In the post-modern fragmented imagination, the expression of a "self" speaking "about himself" into the mirror, activating a labyrinthic circuit of pure images. On the contrary, the effort to produce an "imaginary" lies the expression of a "self" who has the mission to give himself an address, or destiny or addressee, and therefore renders its message accessible to reason that route which tranforms the inner world, his own memory, into a "system". This map of reconstruction of the "self", becomes "storytelling", and the intelligible aspect becomes the other pole of the inner dialectic, that removes the subject from the a-prospective dimension as chaos, and puts it in the a-prospective dimension as a plan. In other word: accept to "live the chaos" looking for don't live "within the chaos".

From form to process, from object to the nets,

the metaphors we need

It is undeniable that for centuries the perspective condition has focused on the "Figure" as the core of its own metanarrations. This figure, in the fast and dynamic circuit of industry, began as early as the XIX century to fragment. As this process reached its height an excessively unifying and standardising praxis emerged guided as it was by the rationalist movement.
The rationalist movement accepted courageously the challenge of industrial mass production, creating practically from zero a new dictionary through the linguistic synthesis of the abstractism, also because it included a principle of universal abstraction, an integral part of the conceptual geography of human culture.
In achieving this transition to post-industrial society, the conceptual exodus from the world of the figures towards the digital world is evident. This means that design becomes aware of the scale leap of its coordinates and that the digital era launches a probabilistic scheme of generative possibilities which helps understand and reposition the “world of the shapes” which comes from consolidated morphogenesis. This phenomenon occurs as the complexity in which we live is grasped and as a result of the speed at which complexity is manifest. It is both a challenge and a remarkable opportunity to understand something which is essential, yet fleeting - that is, where the level of the coherence of sense or speech has shifted - where the point of equilibrium that allows a link from sensitive to intelligible data is located. Therefore not only a datum that can be grasped by the senses but also a hypothetical datum: in other words trying, and producing, traces of meaning in an unstable and complex geography.

Disappearing time, remodelling space

"To the time-matter of the hard geophysical truth of the Places modification succeeds the Time then Light of a virtual truth that even the truth of every duration, causing therefore, with the Incident of the time, the acceleration of every truth of the things of the beings of the social cultural phenomena" [5] The difficult cohabitation of the material and immaterial world produces a kind of permanent pre-semiotic chaos between those who must "guide" the narrations in the human landscape, between the material languages and the immaterial processes of new communication and the new media. Peter Lunenfeld for example, is very clear in emphasizing the most frequent misunderstandings in the dominant culture of communication which tends to equate data with information. The culture of the project aims, in our opinion, at something more authentic, in underlining such "misunderstandings", at the very moment in which software protocols are unable to read the "World of the signs" or “The signs in the World” that they themselves produce and distribute, but that the world of marketing succeeds in imposing as the new collective lexus, available in the immaterial catalogue.
It appears just because it redistributes them downgraded from sign to marks. It is also a paradox because essentially computer science has transferred one language into another.

This limited availability or structural accessibility appears today as rather spectacular; since the modern linear world, the so-called "universe of precision" still can be managed to a certain extent effectively even within non-linear systems or visions, since no process in history is complete because it says so itself, but because it proceeds in an interdependent way, "chaotic" way, as described by the theory of catastrophes.

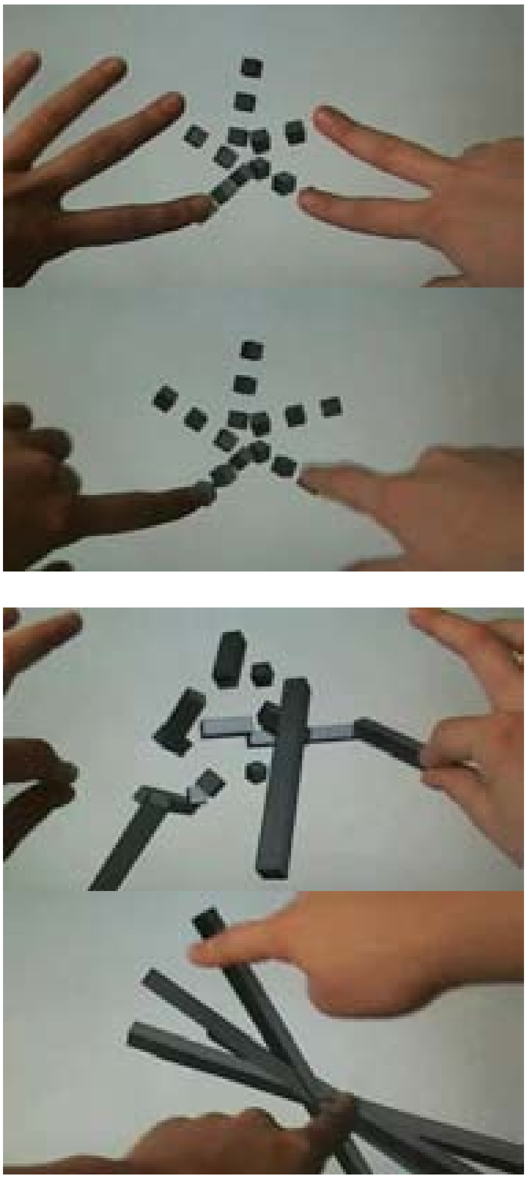


Figure3. Valeria Fuso, Cubic, gesture based 3d modeler

In the interactive development of a project, the cognitive dynamics always define a code that contains rules and behavior that in turn, provide the guidelines not so much for a project with a specific purpose but for different possible outcomes. At this point we are no longer dealing with a controlled event, but an idea of "possible" creativity where a process of direct interaction is replaced by another process central point of which is to avoid control. The act of designing outlines the transformation and not the shape because every shape, from this point of view, is only one of the possible parallel results of the idea. In this process the ideas are transformed via software into systems of

rules. Today, considering the evolution of computing possibilities, we know how very simple rules can generate much more complex results. So, the real meaning of delinearization appears to be a process that produces ideas, and not un-idealized procedures.
The digital world means that a single language is available for representing information of different kinds, leading to an integration of codes and languages - considered distant - more closely and totally than ever imagined. In this perception of distance, the methodologies to eliminate or to resuscitate according to the situations comes into play. One of the contradictions of modernity also consists in the inability of successive technologies to resolve the problems of the previous ones, giving rise to a theatre of technological, social, aesthetic, political events which today, in the digital era, can be better defined in a temporal scale need often a morphology structure based on a “rewording“. Perhaps today it would be right to speak not about the “past” but about the “past-past” and consequently, the “future-future”. The simultaneous presence of the nanotechnologies and the lack of water for millions of human beings on the planet is in some ways an image that clarifies the idea.
It is here, in these scenarios made up of the “past-past” and the “future-future”, that the project of industrial design - but architecture has a very similar role - tries to blaze its paths, since paradoxically the immaterial civilization creates continuously around its edges, an amount of waste, which in turn demands another environmental plan to the scale of the problems arising from unsustainable daily activity and requires the reconstruction of limits, not necessarily in the Euclidean sense, indeed often and more readily in topological sense.

The role of Metaproject design

Metaproject design plays in this scene an important role because it reopens, reactivating the world of the imaginary, exactly what the linear numerical dimension of the modern had closed, but at same time joining what the postmodern deregulated dimension of the chaos leaves free at the molecular state; into a perennial state of transformations without shape, information without contents, contents without meanings. Losing the interest to the metaphors we lose an important instrument to give hypotheses, even fragmentary, of collectivity and community.
Metaproject design, working on the world of the metafunctions, opens an important creative space to the world of the "word", to the complex “dictionary” of meaning non reductables to the biunivoc interpretations, taking with himself the implicit diagonality existent inside the concepts. The philosophical backstage reaches comes opportunely, from the reflections on the strategies of the knowledge and the narrations of the decostructionist philosophy of french philosophers Derrida and Deleuze, and in Isia they are inquired from many years, and that we would want to combine to the sistemic thinking about which we spoke to the beginning.
Regarding the well structured praxis observed in the present of the neo-Moebius morphology,
as example in the Theory of the Catastrophes, the conceptual approach, including the opening fields launched by free and symbolic links created by the

poetry or the literacy or the painting, indicates a real issue to re-joint, and heating, the affective tie between the figure, and the net, the abstraction and the materic world, the concept and the sign, the technology and the problem to resolve.

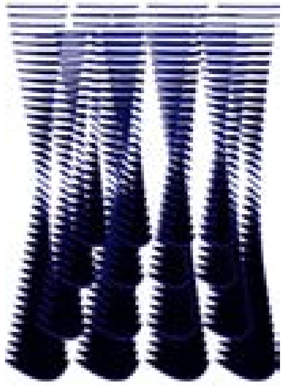
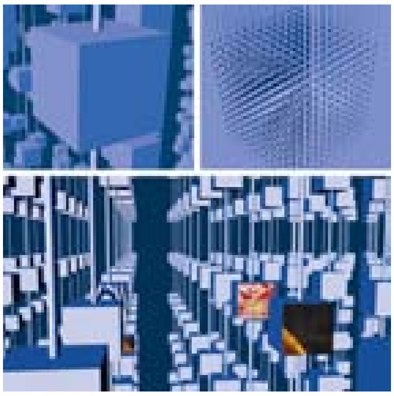
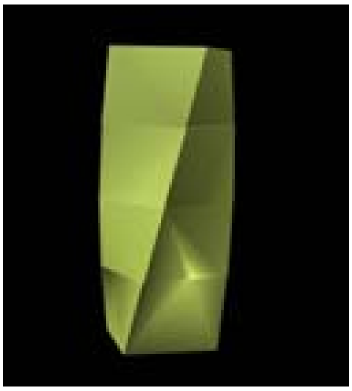


Figure4. Barbara Garzia, network structure development

The metaproject strategy adopted in Isia of Rome since many years tries to include in its transdiscilinary laboratory something speaking about the "story of the sites and the things".
Starting from traces and leaving traces, starting from the semantically closed art-work of modernity, and to proceede in to defragmentate, something able to let us to wander on, using the literature, poetry, architecture, anthropology, film. The aim is just to put us in a situation of hearing and dialogue with these praxis, and not to leave alone the morphologic searches on one side and conceptual expression from the other, to manage an enormous problem, projectual and logic or estetic, in which they are absolutely not equipped to answer.





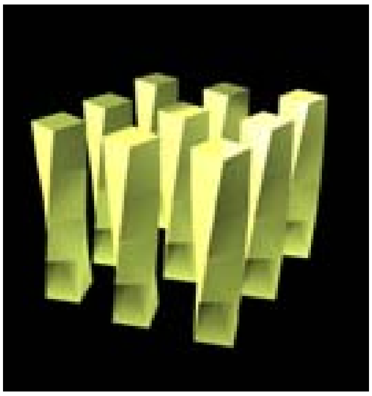


Figure 5. Giuseppe Marinelli, Alto Foti coll. Infinitive space
Figure 6. Ana Carolina Luciow Frossard, Deformation of the modular landscape

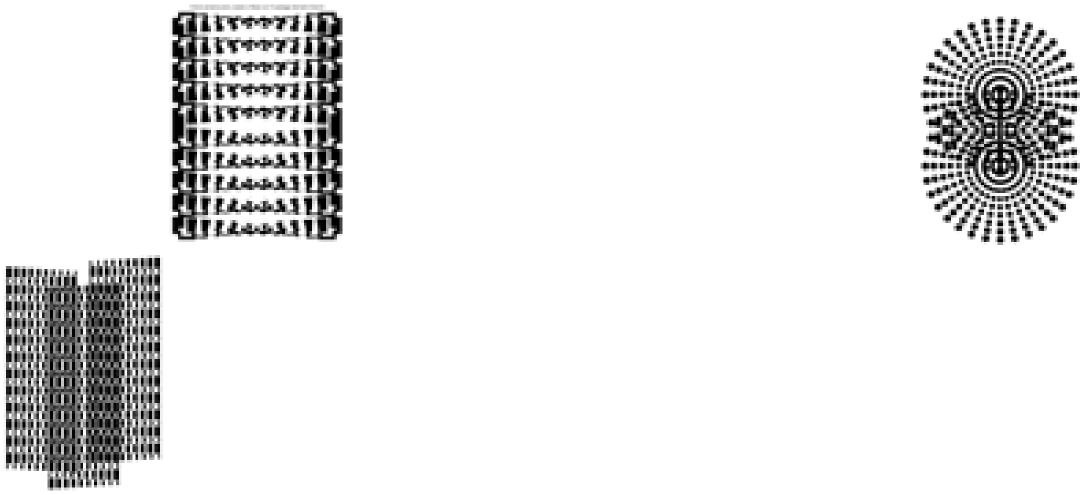
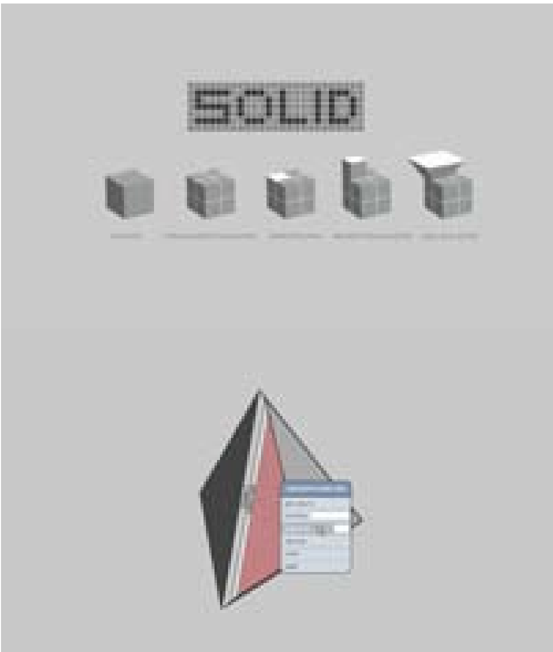
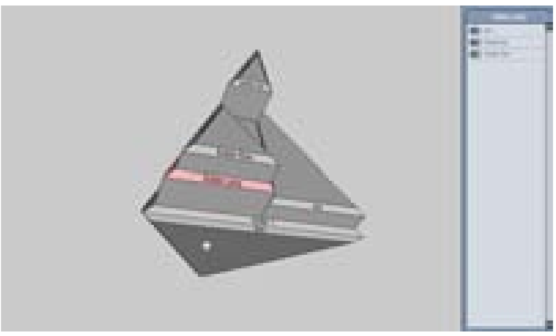


Figure 7. Barbara Garzia, virtual rotation of solids





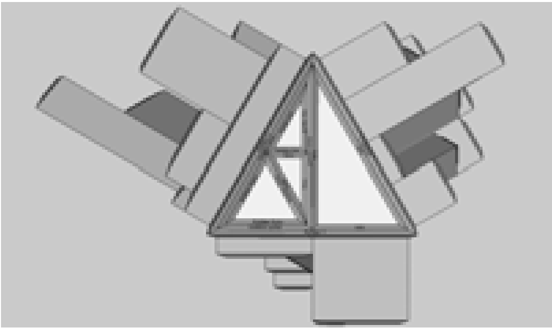


Figure 8. Andrea Della Vecchia, solid,software for tridimensional visualzzation of virtual data

Metafunctions	to offer, to see, to carry, to contain, to distribute
Concepts	measure, density, speed, transparency, crowd, solitude
Situations	eges, folds, regions, borders, center, periphery, margins
Relations	within, outside, under, over, throught
Sintax	study of morphogenetic materials, morphologic strategies
Typologies	tunnel, passage, door, room, square, corridor
Geographies	nets, frames, structures, trees, gulfs, bays
Maps	levels of communication between signs and situations spaces
Interaction	cognitive behaviors, patterns, usability models, control, technology

We would to signal like the definition of non-site, [6] by now famous in the sociology and anthropology literacy, unfortunately today is stretching to a more large landscape of situations, and giving to this one more extensive and genuine interpretation. The non-sites lack of spatial meaning or typologic, therefore they felt of storytell, the “work of the sign” is absent. It doesn’t regard only the great centers trades them since the landscapes without identity of the postmodernity, and they are much more numerous than what we believe.
Also the kitch entrance hall of the luxury five stars hotel is a non-site, the Eiffel Tower is non-site, even if in this case we have an is intelligent non-site, also many stations, airports, suburbs. The dress of Smith, the program rival the elect Neo, also Smith is non-site, while the proto-industrial engine of the city basement of Zaion is a site, dramatically suffering, but site.

Folders, edges, elements and nodes

Without shape there is no information, useless to remove this topic, the future will be the era of the shape, but it will not be the perfect shape coming from the history of the shapes, as well as from the morphogenesis that we well know. The ability to figurative abstraction will have to focus on flows, processes and contaminations in intellectually and morphologically cultured way. Even media are in continuous evolution, comparate to the human abilities, the redefinition of the meaning giving value in the space, are based exclusively on our human characteristic to understand the complex relations between "objects" and ideas.
The contemporary cities are not simply an immense agglomerate of spaces waiting for solutions, but above all an immense superposition of nets and

systems, a mix of material and immaterial relations, such a variety of bounden bifurcations into the massive social economic processes taking today the name, by now mythical, of Globalization.
On one hand the city combines, decomposes and recomposes, the new multitudes that “deliver“ impressive building configurations, from the other hand, cause the speed with which the digital economy moves, the human environment creates continuous systemic emergencies (as described in the book “emergence” of Steven Johnson [7], generating at its edges. Considering this permanent critical mass which the Media reset in real time, dissolving the center concept.
New geography of the knowledge is taking care today about the urban "drift" under the topologic profile, in other words under the profile of the sustainables relational qualities into the its inner one. The conceptual passages through topologic regions, borders, reveal a very interesting field of acting, because they express those scale leaps and those cross of edges so important in the processes of urban liveability.
A deeper vision of the complexity and the speed with which the borders constitute the space, make appear to their inner one folds and corrugations, in which it’s possible to backtrack the peculiar work of the sign due also to the any aleatory praxis, subjective and temporary, as a telephone booth or graffiti, but all participate to the drawing up, moment by moment, the Hypertext, as it we spoken at the begin.

Figure 9. Giorgia Lorenzi, Valentina Pirritano, File Not Found

The interaction project, as an example. studies how acting within this instability without to interfere with the deep inner messages, but also without too much kindlyness or goodwill towards the instinctive and not communicative treatment dragged behind, and that now becomes residual. Making oneself as promoter of a expressive and logical continuum, the design that interests to us can activate just this “incomplete script” on which we can pursue to write again.

Notes

[1] Zigmunt Baumann "Interview on the identity"
[2] Zigmunt Baumann "Liquid Modernity"
[3] Peter Lunenfeld "The digital Dialectic" The Mit Press, 2000 page.8
[4] Robert Jacobson "Information Design" The Mit Press 1999 page 43
[5] Paul Virilio "the computer science bomb" Raffaello Curtain and. 2000 page 110
[6] Marc Augé "Non-sites" Laterza publisher 2003
[7] Steven Johnson “Emergence: the connected lives of ants, brains, cities and software” Scribner N.Y 2001

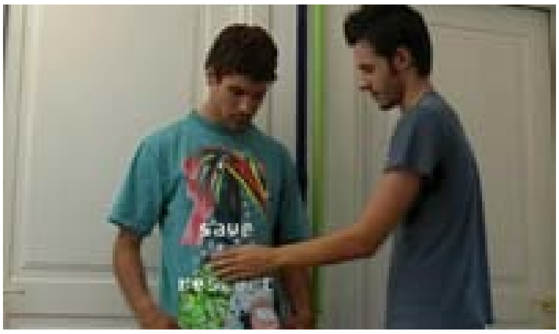


Figure 10. Eleonora di Nolfo, T-shirt Experience, interactive dress

Uncovering social urban form in dynamics

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Abstract

In the 20th century, there are many overlapping labels debated for the modern city, such as urban sprawl, network city, shrinking city, carpet metropolis, and generic city. All of these labels attempt to describe emerging, dynamic phenomena in the modern city, including economy, politics, culture, migration, and the impact of capitalism [1]. Nevertheless, the question of how to set up a framework for measuring, representing, and explaining urban dynamic forces remains to be answered.

By computerizing manipulation and satellite inspection devices such as General Packet Radio Service (GPRS), Global position system (GPS), the urban "contexture" can be recorded and represented not as a static city map, but a dynamic one like "*Nude Descending a Staircase"* drawn by Marcel Duchamp. It uncovers the layers of the invisible fragmentation and synthesis of an urban fabric. This study employs Sony GPS-CS1 (GPS Implement) in corporation with Google Earth (global platform), to investigate the dynamic force caused by residents' migration in cities. It selects nine types of residents and investigates their daily movements in the city of Taichung for five weeks. The database recorded by Sony GPS-CS1 and diagrammed on Google Earth shows how the interrelations exhibited in the residents' living purposes connect the points (places) to draw a dynamic force (fluid intensity) and form the living circles (network). Based on these concrete observations and experiences, the urban subtle effects are derived and presented in the paper including "injection" and "evacuation", which emerge from the interrelations between places. The study deepens our understanding about how the flowing strength affects the modern city. This is a good opportunity to measure and represent the city through a scientific methodology to exclude dubitable phenomenology.

1. Literature Review

Cartography is a way for measuring, representing, and explaining urban phenomena. By employing the figure-ground, the figure and background information of the urban context can easily be distinguished; however, it is difficult to launch the urban form into dynamics. Fields other than cartography, such as psychology, EBS, and computer science, have studied differentiation of figure from ground. Many studies have employed different experiments, communication, and computational simulation to determine the best way to find another possibility to use cartography to draw the dynamic forces of the modern city. Current trends in cartography are moving away from analog methods of mapmaking and toward the creation of increasingly dynamic or interactive maps that can be manipulated digitally. It seems more important now to create a "map" that could be studied by integrated science, even if this implies occasionally leaving the realm of factual discourse to enter a world of speculation [2].

In the Real Time Rome project by MIT SENSEable City Lab, the wireless detectable devices contribute and introduce digital cartography to understand how urban dynamics can be observed in real time. The project aims to show how technology influences the way of mapmaking and helps individuals make more informed decisions about their life. In today's world, the digital technology not only gathers and exposes the information in an "ubiquitous" connectivity environment, but also expands our understanding into the Earth's atmosphere. From the MIT News report, space-weather research uses GPS and space-based sensors to map the weather in space. It is not a typical forecast, but the operators of the hundreds of active satellites provide real-time images of weather dynamics. The images present the invisible variation in ionospheric density to explain how nature influences the artificial earth. After being engaged in research of wireless detectable devices, the discussion on human environmental dimension is no more limited within the artificial sphere. Wireless detectable devices provide a unique environment to embed information in applied geography.

From the description above, a way of cartography is shifted from a passively informational platform to an actively informational diffusion. By the resarch of "Real Time Rome project" and "Space-Weather research", the city is exposed by unceasingly diffused phenomena exceeding our perceptions. The purpose of "Uncovering social urban form in dynamics" would go further from this standpoint. Exploring GPS (Global Position System) as an investigative tool does not only extend perception, but also records the process of experience. The question of using GPS is like writing a diary in the movie "The Butterfly Effect"; it is possible to survey the key factors which affect the urban configuration. In order to examine the possibility of GPS study, the interactive platform is used in tandem with GPS technology to exhibit the daily life in "Taiwan Avantgarde Documenta (Co6)" in Taichung. By involving the participants' interactions in the exhibition, the people could help researchers to survey the possible points which could be discussed as key issues in this article. Firstly, the small scenario is tabled below to design interactive platform:

Table 1 **Urban Dynamics**	**Index** **[Ud]**
Description: In Taichung City, there are nine actors invited to write a "mobile diary", they accessorize GPS implement to move by different ways, such as taking a taxi, shuttle bus, bike, or just walking, when they move, simultaneously, the video camera is assigned to track and shoot. From the video record, the actor's conversation attracts us to expand environmental perceptions objectively. On the other hand, compared with the actors' experience, the distinct demands in the place are observed.	**Scale** ● local ● regional **actors/agents** **1.** Business man **2.** Craftman **3.** Artist **4.** Merchant **5.** Reporter **6.** Production manager **7.** Hotel executive **8.** Student **9.** Traveller

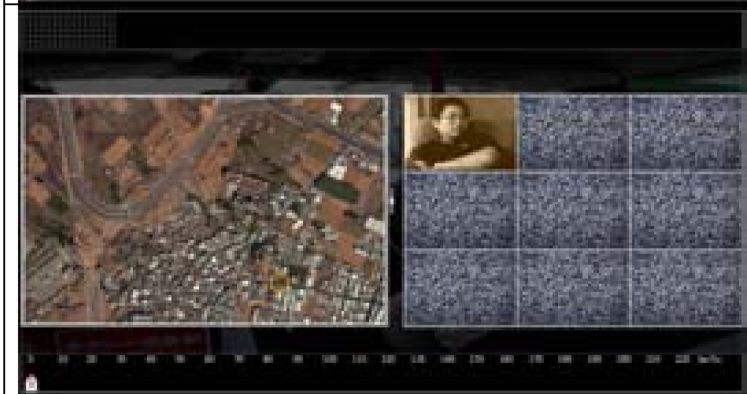
BRANDING	**Co6 Exhibition**
The interactive platform is a sensorial cartography which employs GPS to collect and represent the urban dynamical data on a web platform. Through the platform, the city should not be considered as an integer, but as a cooperation of urban fractions.	
EARTH	
The interactive platform can be used to record and represent the urban dynamic in real time	
FLOW	
The dynamic exchange would be influenced by consumption, politics, education, cultural events, and so on.	

2. The Mobile Diary

The interactive platform is designed as a kind of informational “container” to store spatial information obtained from satellites; such as time intervals, spatial positions, orientation flow, and frequency of move. A variety of issues could be possibly extracted from the container to show how actors migrate; how long to travel; who the people are they meet in places. In order to examine these possibilities, there are nine actors, including a business man, a craftman, a merchant, a reporter, an artist, a production manager, a hotel executive, a student, and a traveller, who accessorize GPS implement (Sony GPS-CS1) to record the trajectories of their daily migration. In addition, camcorder is assembled with actors to seize on their remarks and images. After a day, the dynamic data (voice / video) captured from camcoder is tagged on a map by longitude and latitude captured from GPS implement to create urban profiles. After generalizing the database, the research integrates it into interactive platform to visualize geographic data (business locations, scientific observations, events, people, geotagged photos, etc.).

The interactive platform is divided into two windows: the window on the left shows how actors move and draw the trajectories on maps; and the window on the right shows the simultaneously geotagged images to illustrate where the visualized geographic data take place. On the interactive platform, there are lots of occasional places registered and shown at third step in Table 2. At those places, different actors are involved. In “Taiwan Avantgarde Documenta” Project, the participants were given a lot of questions: Why do they go to that place? Who are the actors that I can meet at this place? What do they do at that place? What is the meaning of those places? In order to answer these questions, the research would go further and focus on the places. All manipulative processes about the interactive platform are shown in Table 2:

Table 2: the interactive platform with GPS and camcoder records

	**Interactive Platform** The work includes the voice, video, and the Google Earth Map. The people can choose a substitute on the right window to re-experience the life in the city.
	**The first step :** Clicking on the map where you are. A small scenario will start at that moment, the window on the right starts to download images to help people to experience the city.
	**The third step :** Occasional place emerges, caused by the participation of other actors. What do we do at this place?
	**The final step :** After finishing small scenarios, the routes show how you occupy and territorialize the realm in the city.

3. Drawing the Profile of Urban Contexture

Seen from an orbiting satellite, Taichung is a city where all that can be perceived are the geologic traces that the different levels of urban events have successively imprinted. In Figure 1, the actor's record is mapped, a certain interpretation of the sequence of Taichung's urban events is linked by the actor's small scenarios. The interactive platform shows that actors occasionally meet with each other to involve their physical and mental demands in different places, hence, the places are realized as the extension of these demands [3]. After presenting the exhibition "Taiwan Avantgarde Documenta (Co6)", the research is interested above all in questions of specific urban characters at places.

One day itineraries are shown in Figure 1 and diagrammed in Figure 2 to sound out the idea of GPS research. The diagram draws two dynamic forces in which the research is interested. Firstly, the occasional places where the actors meet with others are marked as the joints from A1 to E1 to represent the intensity of urban events and density of actor's demands. Secondly, the junctions between places represent the fluid intensity. From the idea of fluid intensity, Figure 1 indicates that the high fluid density is located along "Jhong Gang Road", especially in the central district in Taichung City. Going back to the actual urban development of this area, there is an important commercial area called "Sogo Business Field" which relies on the conveyance on Jhong Gang Road to maintain and territorialize its realm. After

Figure 1: Actor's migration

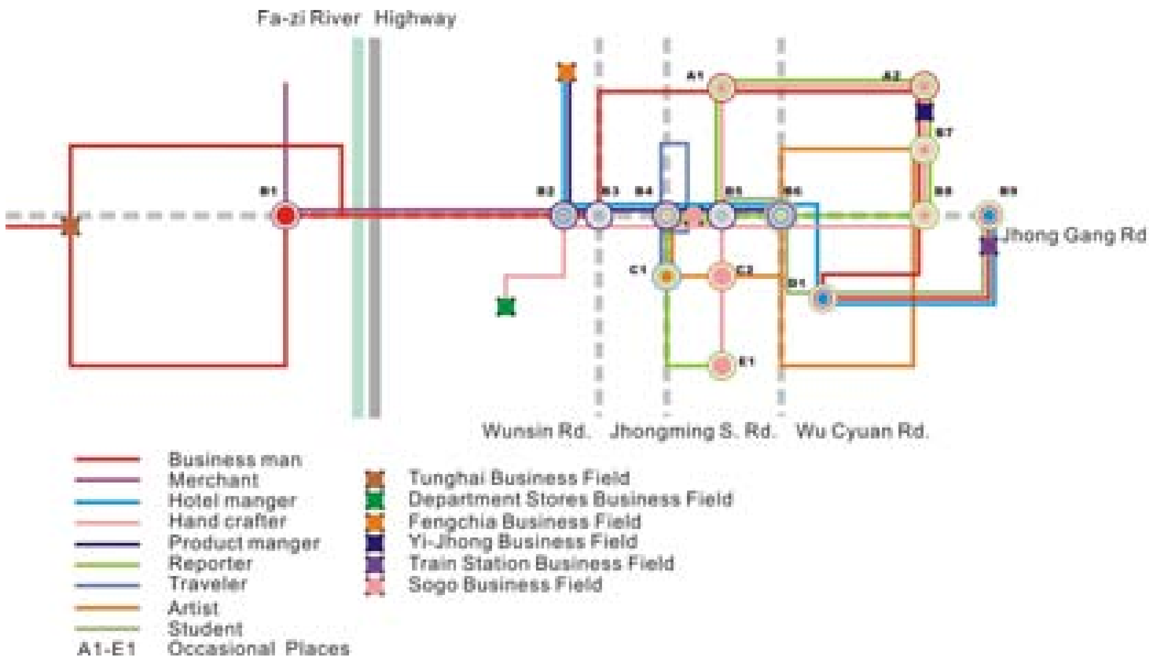


Figure 2: Intensity and Places

comparing these two flow perceptions, roughly, there is a relation between "Places" and "Intensity" in the city. "Places" and "Intensity" indicate that the development of the city cannot be considered as an integer phenomenon, it should be deliberated on dynamic forces. The city was born and throughout its growth, it is created in temporal forms of organization [4]. It is like a tree, the environmental changes influence the portage of nutrients to shape the tree, and these variations in growth cannot be told until observed in a section of the trunk. After understanding those environmental changes, the scientific research would effectively and precisely devote itself to improving the advantage of growth. In this chapter, we can't deny the influences from "Intensity" and "Place" in a city. A place could have connections with more than one place to derive demands from them; a place could be mixed ground and spatial uses. One day itinerary shows the possibilities to frame these questions, but, the research is interested in an ultimate result about dynamic forces. In order to throw light on this question, the research attempts to continually record the actor's migrations.

4. Two Dynamic Forces: Intensity and Place

After the exhibition in "Taiwan Avantgarde Documenta", the actors continue to accessorize GPS implement to record their migrations in Taichung City. Five weeks later, the whole records of daily migrations are integrated with Google Earth and shown in Figure 4. The fluid intensity and the form of urban composing are different from Figure 3. Comparing intensity in Figure 3 and Figure 4, the highest intensive area has shifted from the "Sogo Business Field" to the "Fengchia Business Field". Besides, there is a subtle variation between the old downtown area and the "Fengchia Business Field". In order to visualize these dynamic changes, the research tries to use the perspective of intensity and the historical perspective to explain them.

In 1966, the First Highway and Taichung Harbor were constructed. Taichung City became the metropolis in central Taiwan. Simultaneously, the old downtown area was overcrowded with industrial and commercial businesses. Through the attraction of the highway and the harbor, the commercial and residential areas followed “Jhong Gang Road” and “Wu Cyuan Road” to spread to the west part of the old downtown area called “Central District". There is a famous area mixing shopping and banking called the “Sogo Business Field” in the Central District now. In 1990, many large constructions went on to increase urban development; including the Second Highway, the High speed railway, the East-west highway, and the Ching Chung Kang international airport. Since there is a lot of money involved, there are lots of commercial and marketing organizations which continue to expand along “Jhong Gang Road” to fill in the west part of Taichung City called the “Situn District”. From a historical perspective, “Jhong Gang Road” played a great role in Taichung City to convey a flow of economy and people. It is not difficult to understand why the highest fluid density is located along “Jhong Gang Road” in Figure 2. In addition, “Jhong Gang Road” also plays the character to redistribute and gather the resources from the places where it connects.

During the duration of record, two interesting points are framed. The actors are used to travel along certain routes to exclude redundant possibilities; the main structural connections between places are visualized. On the connections, the traveling flows penetrate through places, the dynamic fluidity never stops to change along the roads. This might be caused by “injection” and “evacuation”. In Figure 2, when actors pass through the places, the place shows the different opportunities to connect with other places, hence, there is a distinct

Figure3: GPS Analysis: the fluid intensity of a day

Figure 4: GPS Analysis: the fluid intensity of five weeks

connective intensity in places. This connective intensity interprets a variation of fluid frequency. In a high fluid area, on the one hand the place is injected with people flow to function as commercial demand, such as the B5 place in Figure 2, an area called "Sogo Business Field" mixed with shopping and banking, while on the other hand people flow could get a good opportunity to escape from the place, such as the B6 place in Figure 2 located at the intersection of "Jhong Gang Road" and "Wu Cyuan Road". This place plays the role as a pivot. In order to perceive and comprehend the phenomena of "injection" and "evacuation", the research translates the records of GPS into a map of fluid intensity to show how it occurs and interacts in Figure 3 and Figure 4.

From the observation of intensities given by Figure 3 and Figure 4, "Jhong Gang Road" is focused on how to string the "Fengchia Business Field", the "Sogo Business Field", and the old downtown area together. The "Fengchia Business Field" is a famous commercial area located in the "Situn District"; the "Sogo Business Field" is an area mixed with banking and marketing located in the Central District.

1. The fluid intensity between the "Sogo Business Field" and the old downtown area has a relation of direct proportionality. When the fluid intensity penetrates through the "Sogo Business Field", the strength of fluidity continually declined in the old downtown area, on the other hand, comparing the intensity in Figure 3 and Figure 4, the "Sogo Business Field" seems to play a role to promote the condition in the old downtown area. The more fluid intensity concentrated in the "Sogo Business Field", the more opportunities are injected into the old downtown area.

2. It seems that the “Sogo Business Field” performs as a fulcrum to adjust the fluid intensity between the “Fengchia Business Field” and the old downtown area. In Figure 3, when the fluid intensity is violently increased in the “Sogo Business Field”, the fluidity in the old down town area becomes stronger than it is in the “Fengchia Business Field”. In Figure 4, the fluid intensity decreased in the “Sogo Business Field”, the strength of fluidity in the old downtown area becomes weak, on the contrary, the fluidity enhanced in the “Fengchia Business Field”.
3. Focusing on the connections between the “Sogo Business Field” and the “Fengchia Business Field” in Figure 3 and Figure 4, there is an inverse proportionality between these two places; when the fluid intensity grows on the “Fengchia Business Field”, it decreased in the “Sogo Business Field”. On the contrary, if fluid intensity increased in the “Sogo Business Field”, it would be decreased in the “Fengchia Business Field”.

This mathematical proportionality might be caused by the maturity in the network. In Figure 4, the network between the “Sogo Business Field” and the “Fengchia Business Field” is more mature than it is in Figure 3. Like synapse, the more mature network creates more connective places to inject or evacuate the conveyance of people flow and economy. Consequently, the question about how to formulate the index number to measure the maturation of a network should be proposed to uncover the threshold when the flow is injected or evacuated from the place. The place could be regarded as a constant container, if the place is overloaded with people flow or economy, the fluidity of these factors would be diffused. After the index number for the maturation of network is brought on the table, the influence of dynamic force would be brought to light.

5. Potential of GPS Research

In this research, the property of dynamic forces is found to flow in non-fixed orientations, but they still show certain regularities. The observations from “Place” and “Intensity” try to explain how the spatial order and urban space are dominated by this regularity. Bill Hillier mentioned that the pattern of intensity creates different types of social and required different kinds of control on encounters in order to be that type of society. If this is so, we could reasonably expect it to be the deepest level at which society generates spatial forms [5]. In order to examine the possibility of this statement, the cartography of GPS is introduced as an investigative tool to visualize the pattern of intensity in city. It is like Computerized Tomography (CT), the primary benefit of GPS could be the ability to record geographic informations at different depths within the city in the real world and help a policymaker to diagnose urban problems.

6. Reference

[1]. Hans Ulrich & Rem Koolhaas. 2000, “Project On The City 2 : An Interview with Denise Scott Brown and Robert Venturi”, Taschen Press.
[2]. Manuel Castells. 2000, “The Rise of the Network Society”, Blackwell Publisher Ltd.
[3]. William J. Mitchell. 2003, “Me++ The Cyborg Self And The Networked City : Boundries/Networks”, The MIT Press
[4]. Carmona, M.,T. Heath, T. Oc &S. Tiesdell.2006, “PublicPlaces -Urban Spaces

: The Dimension of Urban Design", Burlington, MA : Elsevier/Architectural Press
[5]. Bill Hiller & Julienne Hanson, "The Social Logic of Space", Cambridge University Press.

You Get as Much as You Generate

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This year we celebrate the tenth anniversary of the ‘Generative Art Conference’ – congratulations and many returns of this occasion.

It is on days like these that one remembers, or even contemplates, one’s own endeavours and, in some respects, achievements in the field of generative design. What came to my mind were two projects which I would like to present here, one from generative design in the proper sense, the other from generative storytelling.

What both these projects have in common is the interaction of several computer programs; however, this does not mean that the focus is on demonstrating the technological possibilities, rather it is on examining the aesthetics of form and content.

A major interest of all our research projects in generative design is to find out about the basic conditions of automatic generation avoiding randomness. These conditions will probably vary depending on the type of application and would have to be formulated accordingly. With these brief considerations in mind, I will now take a closer look at the two projects.

My first example is a rather experimental concept of applied transformation –

A Generative Corporate Design “Motion I Change” (2002)

In order to give you an idea of the requirements the corporate design was supposed to meet, let me briefly describe the institution for which it was developed.
The Institute for Media Design is a research institution of the Mainz University of Applied Sciences. As such it aims to meet the academic demands of experimental research as much as the economic requirements of profitability of its partners and customers from the economy and from the public sphere. What was expected was a visualization uniting and expressing both these dimensions thus allowing the Institute a comprehensive representation of its aims and fields.

The media to which the corporate design should be added were paper sheets, calling card, internet presentation, presentation film, newsletter ‘update’, brochures, notes, labels, rubber stamps, texts.

The very core competence of the Institute – developing and designing images in motion – led directly to the keywords of the concept: Motion I Change.
This claim does not only include a reference to the actual demands of working with images in motion, and to the fact of having to face the never ending technological changes and revisions caused by innovation and development, but it also includes

the Institute itself. The peculiar conditions of a research institute are characterized by the two keywords as well – an institute is involved in continuous processes; it is subject to dependencies, concerning finance, personnel, sometimes even politics, all of which keep it going, and moving on.

All of this had to be thematized and visualized – the task was to create a design of utmost variation which still had the quality of being recognized, whose complexity and multi-layeredness could still be conceived as a whole, as one, while it also represents, in form as much as in content, the Institute of Media Design.

All of these aspects went into the resulting corporate design:
Motion I Change.

At the centre of the image is the sign. With the former logo of the Institute as a starting point, a three-dimensional object was created continuously regenerating itself in form, size and colour according to mathematically defined parameters.

The former square shaped logo became a three-dimensional cube with six slice-like layers. Each layer displayed a sequence of colour variations to be found in the former logo, meaning that in the starting phase the new sign relied on the traditional logo.

The individual layers are flexible within the whole set and can be controlled, a prerequisite for the beginning metamorphosis. Once the image has started, an algebraic program continuously calculates and directs the further development of the individual layers, resulting in an ever developing form with unpredictable design variations.

By way of an ‘automatic chain of utilization’ the current shape of the generated sign is transferred to all the media involved. The starting point here is the three-dimensional program ‘Maya’ which develops and transforms the sign and regenerates it according to algebraic parameters. All generated phases and stages are then processed in the ‘photoshop’ and saved in the internal network server. By way of programmed processing (macro) the sign in its present shape, size and colour is then made into a ‘Word’ file and is placed on the media. Thus every single use of the sign will produce a unique realization, an original.

As all media coming into use allow for the possibility to place the sign at the centre of, say, a sheet, using fuzzy logic, the colour design was given special attention. In a series of experiments a closed circuit of colours derived from the three basic colours red-yellow-blue was created. Colour choice can be random as well as following the chronology of a given sequence. A 25 percent brightening of colours produced a second circuit which was primarily used for combinations of the sign with texts.

Being the major characteristic of the design and representing algebraic randomness, the sign had to be counterbalanced by the design characteristics of the remaining elements – they were very tightly and minimalistically ordered. The sign is accompanied by a massive grey bar, the font chosen is bold, the segmentation of the surface constructivist. All of this is meant to emphasize the principle of chance as deliberately made central for the design, and also concentration on the many options of associating the sign is supported.

One further characteristic of the corporate design should be mentioned – its random selection of sign and text position on the format. This characteristic is particularly important for the print media, as here the unique and in this sense ‘original’ positioning of both sign and text contributes, along with changeable forms and colours, to illustrate process and change.

The corporate design I have presented here is used this day and has been supplemented by various additions.

A self-generating Movie "Posing at Three Thirty" (2005)

The following project is a generative film which represents a completely different area and handling of generative art. Free abstract association is now enlarged and supplemented by storytelling.

"Posing at three thirty" did not invent the category of the generative film. Rather, it rests on the experience made with projects like "Waxweb" (1994) by David Blair or "Grammatron" (1997) by Mark Amerika. It differs significantly from these works in that no parts of the storyline were pre-arranged. The underlying working assumption is that by stringing together simple actions (a door opens, a glass is raised, a train passes, an actor poses a question etc.) simple stories can be told. Since there are neither pre-arranged nor pre-selected acts there is no viewer interaction.

As a precondition for this project, it was necessary to systematize aesthetic parameters of cinematic storytelling so as to ensure that a computer program can generate the entire film.

“Posing at three thirty” is a self-generating film on the internet. There is no screenplay. There is no beginning and no ending. Instead, there is a multitude of opportunities for developing and dramatising stories.

The film is generated by way of an input from a database of almost 12,000 small film sequences (approximately 30 hours of material). These sequences are very short: each sequence is composed of only one take, for example “the Old Lady enters the bar-room” or “the Anarchist meets another character”.

The film is generated by several generators that have been networked.
These generators not only develop the story line but they also make basic aesthetic decisions. For example, whenever the camera is used in a shot–countershot setting or in an overshoulder take the scene is dramaturgically charged using background music or the atmospheric sound of the room is the only thing you will hear..

The basic story line is created by the main generator which decides whether or not two characters meet in a set place. If the characters meet, the generator also decides whether or not the characters will engage in a conversation. Where this is the case, the dialogue generator takes over. The dialogue generator decides how long the conversation will last and what is being said. Picture and sound tracks run simultaneously yet independently of each other, so that the generator can also decide on the appropriate camera take. In addition, it decides whether or not additional film sequences are to be included in the conversation setting (like a third character enters the room). The dialogue generator informs the sound generator when spoken text is used, so that background music can be regulated accordingly where applicable. Once the conversation is over, the main generator takes over again; the latter then decides whether a singular action, a mood etc. should follow and 'hands over' to the relevant generator.

In all the following generators are applied:
main generator
dialogue generator
sound generator
action generator
mood generator
camera generator

The central story line takes place in a hotel in which a total of 12 persons are present. Two of these (the Barmaid and the Singing Lady) are given special functions. All persons have individual characters. Their interests focus on certain themes, and they have been named accordingly.
The Old Lady
The Anarchist
The Aesthete
The Deliberate
The Baroque
The Cocoonist
The Cultural Old Dear
The Moralist
Mr No Doubt
Miss Destiny/Chance

Special Characters:
The Singing Lady
The Barmaid

All of these individuals pursue their occupations in the hotel where they do, or do not, meet and interact. Their personal profiles permit interaction and confrontations; however, these are not necessarily actualized. Never does one know what is going to happen, and you surrender yourself to the self-generating film. Predictions as to what will happen are virtually impossible, as there is an algebraic multitude of possible dramaturgical turns.

Main attention during the making of this generative film was given to the production of sequences that were as universally usable as possible. Instead of the usual smooth story connections log-in spots were prepared through which the actors could interact with each other. Characters do not evolve together, rather they circle individually around sets of topics. Storylike events emerge merely from the random combinatoric options of the software.

As the main generator decides on length of a scene as well as on the selected camera position, only one definite orientation was chosen for the actors: they all speak head-on to the camera. At this point the quality of the work of the actors has to be credited, as they did not know the context in which they were supposed to act, nor the final results.

Defining precisely which creative decisions the individual generators should make, turned out to be the biggest challenge of this project. Finding the right mixture of maximum freedom of choice for the algorithm and minimal framing by the author was essential for the project. The right balance here allows for markedly surprising (even for the author) twists and combinations without transgessing an aesthetic frame.

The result may surprise in different ways: as being downright incoherent, or as pointed and bold. Expectations of a conventional movie experience will be frustrated as there is no continuous plot. However, anyone enjoying cinematic images arranged in a rather musical sense can, for a while, be well engaged in this generated and generative film.

Critical Questions

Quite naturally critics after having been confronted with this film, have had their doubts about this experiment and have asked questions such as 'does it make sense?' and 'what is this supposed to mean?' These legitimate questions are grounded on the assumption that there are known and feasible patterns of how films function. Audience expectations as to what makes a good film have not been irritated by even the most ambitious high-tech projects of the past; this phenomenon can be observed in literature as much as in film.

Now this observation should be given some weight and it should not be too easily dismissed as being 'hostile to progress'. Even if one does not share this attitude one would have to admit that obviously to emotionally involve considerable audiences has so far not been achieved. Mind you – I am not here craving for the applause of big audiences, all I am saying is that so far little 'identification by emotional involvement' has been reached – and it is this emotionality which is most important. Only if there is an emotional radiance there can be hope for a new mode of expression. So far, it is only a field of research.

Yet it is of utmost importance for us as researchers to see how differently the projects of generative design are received. The documentation of the two projects reveals that the corporate design Motion I Change has not been criticized for its generative mode of creation, rather it is measured by the usual standards of design and is approved even by traditional observers. Against that, the project in film 'Posing at Three Thirty' requires much more explanation and discussion.

A first hint as to the different reception and evaluation of the two projects can be found in their differing degrees of abstraction which the observer has to face. The corporate design is a purely formal item. Existing variations are accepted as means of a formal aesthetics, even if an extremely odd positioning of the sign on the media has been selected by the computer program. The questions about the

meaningfulness of such procedures were considered irrelevant, even in the starting phase.
Quite different the generative film.
The overwhelming question of sense-making emerges even after those happy moments when the generators have produced sequences of five or seven minutes length with seemingly coherent dialogue and camera takes; here content dominates formal abstraction.

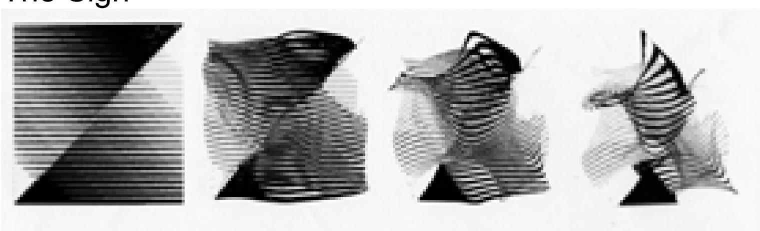
Our early hopes of being able to produce for the audience an experience of 'film formality' like one would get in watching music videos or in VJ-ing, were obviously frustrated. Maybe the very mention of the concept of 'film' already gave rise to false expectation. In addition, it seems to us to be essential in projects to come to render the technological processes of generating the sequences understandable. For it has been repeatedly observed that by detailed presentations the pleasures of reception are increased. In order to give the internet visitors highly authentic impressions we abstained from any didacticism on the website 'three-thirty.com'. As soon as you have opened the site the film is loaded and begins to stream without further ado. We shall continue with this method of direct confrontation in the future, even if for this project a little detour including some extra information might have been helpfull.

We consider all of these critical reflections to be contributions to our future projects in interactive TV and film, the more so as the present realisations or just announcements of industrial products are restricted to transfer, usage and distribution of contents, and less on generating them. But it is this challenge that the creative designer should be facing.

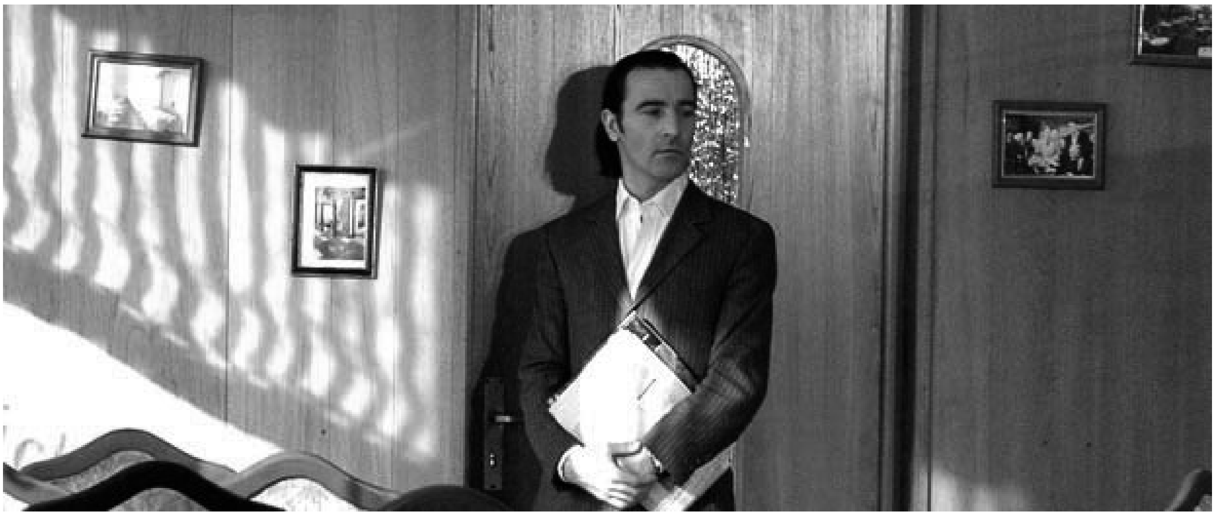
Our project has been a first step. We are certain that our method of bringing together a large amount of gradable and scalable material is promising. We are also certain that action in this medium must result not from preconceived structures but must emerge intrinsically. This action does not have to be dramaturgically structured, it can also be developed following aspects of form. Only it has to address the observer's emotions for identification.

Further experiments and more research will be following. Investigating the basic conditions of deliberate design is the most urgent challenge in the realm of generative art. Automation of design processes can only be applied successfully if the author provides sufficient framing to adequately implement intended creative goals. This may involve smaller or larger degrees of freedom or constraints in the use of parameters. The crucial part, however, is always a deliberate definition of those basic conditions that influence generation.
You Get as Much as You Generate.

The Sign



Sign Evolution



Three terthy

Identity in the Work of Tadao Ando
An exploratory essay on the problems of how to model identity

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The growth of the global economy carries with it a enormous range of products around the world and the tendency for them to be used uncritically, both regional products and imported ones. This has affected our architecture and cities around the world which are becoming generic: generic cities without history and without identity. Is there no way to escape from this monotonous world? The critical regionalists believe that there is. They do not long for a city that never changes, they long for a city which critically changes, critical towards products of our global economy as much as critical of the region itself. This critical architecture is related to what we could call critical identity, which we want to explore in this article.
The objective of this article is to describe what a critical identity could be and its dynamics using a project of the Japanese architect Tadao Ando called Museum Langen Foundation in Neuss, Germany, 2004. Thus the article tries to make a first step toward modeling the concept of identity.

Keywords: identity, place, critical regionalism, architecture

1. Introduction

How can we generate designs which reinforce the identity of a place? How can we model it?

It seems that the first question to be answered is what the meaning of identity is. The concept of Identity has multiple facets which were discussed at earlier GA conferences. One may speak for example, about the identity of the architect, the identity of the users of a future building, as well as about the identity of the building and the identity of the place. Critical Regionalists make a plea for a critical identity arguing that architects should critically consider the use, the potentiality of the place (including cultural and political backgrounds) as well as the use of products of globalization (including new technologies and new materials). They speak about an identity with reference to continuation and change but also about an identity which is produced by a critical position away from the picturesque due to the use of defamiliarization.

This article explores how architects deal with the identity of the place during the design process and takes the position of the critical regionalists toward a critical architecture. However, it also gives attention to the architects' identity. The research is based on the analysis of one case. First, the article gives its approach toward the concept of identity and its role within the critical regionalist's theoretical approach; secondly, the article describes Tadao Ando's design approach. The description of the designer's approach toward identity is intended to give insights into how the architect deals with this concept; thirdly, the article describes Ando's design for the Langen Foundation in Neuss, Germany 2004; and finally we identify the sort of identities and the identity dynamics that we could recognize in his design approach and in this project.

The ultimate goal of this article is to assist researchers in the difficult task of modeling identity.

2. The concept of Identity[1]

What is identity? One may talk about reinforcing the identity of a place or creating a new identity such as, respectively, Ignazio Gardella's Casa Zattere (1953-1962) in Venice and Le Corbusier's Unité d'Habitation in Marseilles. The Critical Regionalists, whose approach is analyzed in this article, seem to propose something in between.

Does identity refer to a constant, unchanging, permanent condition? It seems interesting to note that although the notion of identity seems to be directly opposed to the notions of change and time, this is not strictly true. Adolf Loos, in his story "The Poor Rich Man" (Loos 1921), depicts the life of a newly rich man living in a house furnished by a designer who also designed the owner's clothes and defined where he had to use each of the garments (even his shoes) throughout the house. For the designer, nothing should change, neither by moving them around nor by adding new objects such as family portraits on the bookshelves. The objective behind Loos' story was to show the architects of the Secession that their houses were like a sarcophagus (Heynen 1999, pp. 75-76) because life was frozen in the perfection of an unchangeable moment. The owner was living in a house that reflected his new status of a rich man, his "new identity". However, a person's life is about change and his/her identity changes accordingly. Identity is about continuation and change.

Manuel Castells, in The Power of Identity, speaks of the dynamics of identities which switch power over time[2]. So an identity of resistance can transform over the years into an institutional, political power in society. Wherever people conduct normal, everyday life, there will be still changes related to political, economic and social issues and consequently changes to the physical environment itself (Castells 2004). He is speaking about the dynamics of identities on the level of the society.

1 The main ideas of this part of the essay were discussed in GA2004 article "Precedent & Identity"

2 Manuel Castells divides identity into three kinds: legitimizing identities (such as those which refer to an institution or the civil state; resistance identities which are formed by agents marginalized by legitimizing identities and which may also become very oppressive toward their members; and project identities. Project identity is often created around resistance identity, but in contrast, it is not focused on resistance but on constructing a new situation.

On the level of the individual, identity refers to perception. We identify characteristics in people, series of objects, buildings, cities and so forth, classify these elements and compare them all the time. Abrupt changes in the direct environment over time are thus part of the creation of a new identity. If a city loses its current identity, it is simultaneously creating a new one.

3. The role of Identity in Critical Regionalism

The main task of Critical Regionalism[3] is, according to Lefaivre and Tzonis, "to rethink architecture through the concept of region." Critical Regionalism differs from Regionalism because it "does not support the emancipation of a regional group nor does it set up one group against another" (Tzonis, Lefaivre 1990, p. 31). Critical Regionalism is critical of the products of globalization as much as it is of regionalism itself. In Tropical Architecture: *Critical Regionalism in the Age of Globalization*, Tzonis and Lefaivre maintain: "Critical regionalism should be seen as complementary rather than contradictory to trends toward higher technology and a more global economy and culture. It opposes only their undesirable, contingent by-products due to private interests and public mindlessness" (Tzonis and Lefaivre 2001, pp. 8-9).
For Critical Regionalists, region/place does not coincide with a nation or a territory of an ethnic group as in the Heideggerian way of thinking. But it is mindful of local potentials. As Tzonis says in *Critical Regionalism, Architecture and Identity in a Globalized World*, critical regionalists are "opposed to mindlessly adopting the narcissistic dogmas in the name of universality, leading to environments that are economically costly and ecologically destructive to the human community" (Tzonis, Lefaivre 2003, p. 20).
Considering that this critical position separates them from the picturesque and kitsch, we may say that for the critical regionalists, places are being continuously reinvented, and this everyday "reinventing" of a "place" seems to be linked to Castells' "project identity", which critically refers to continuation (local potential) and change (new technologies, new materials, products of globalization); to the homely and unhomely.
Lefaivre and Tzonis do not provide a checklist or a method for designing a "proper" architecture. However, they suggest the use of the modernist technique of defamiliarization to deal with an often over-familiarized idea of home and place. They argue: "Defamiliarization is at the heart of what distinguishes critical regionalism from other forms of regionalism and its capability to create a renewed versus an atavistic, sense of place in our time […] The critical approach of contemporary regionalist architecture reacts against this explosion of regionalist counterfeit setting [as used in Romantic regionalism] by employing defamiliarization. Critical regionalism is interested in specific elements from the region, those that have acted as agents of contact and community, the place-defining elements, and

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[3] The notion of Critical Regionalism was introduced 25 years ago by Alexander Tzonis to draw attention to the approach taken by a group of young German architects in Europe. This group was working on an alternative to the postmodernism that, with few exceptions, had not really taken architecture, as it meant to do, out of a state of stagnation and disrepute by the reintroduction of historical knowledge and cultural issues in design (Tzonis, Lefaivre 2003, p. 10).

incorporates them 'strangely', rather than familiarly, it makes them appear strange, distant, difficult even disturbing. It disrupts the sentimental 'embracing' between buildings and their consumers and instead makes an attempt at 'pricking the conscience'."

Defamiliarization, a word coined by Russian Formalist critic Viktor Shklovsky[4], is in Critical Regionalism a device which makes the familiar strange and makes the recollection of a precedent critical rather than a picturesque manifestation of the past.

Linking this defamiliarization with the work of Tadao Ando that we will analyze in the next section, we refer to an interview of Tadao Ando with Philip Jodidio for the book "Tadao Ando" (Jodidio 2007). In this interview, Ando says, "I am interested in a dialogue with the architecture of the past but it must be filtered through my own vision and my own experience. I am indebted to Le Corbusier or to Mies van der Rohe, but in the same way, I take what they did and interpret it in my own fashion." This refers for a kind of defamiliarization and it seems that this defamiliarization is not only used in his autonomous moment but it is used to enter in dialogue with the users of his designs. For this we can take as an example the use of nature in its abstract form in most of his buildings referring to the use of nature in Japanese everyday life which is being lost in the metropolis of Japan.

4. Tadao Ando's Langen Foundation Neuss, Germany: a case

Tadao Ando was born in Osaka, Japan in 1941. He is an autodidact architect who traveled to Europe, the United States of America and Africa from 1962 to 1969 to study the architecture of these continents. In 1969 he opened his architectural office in Osaka. In 1976 Ando receive the Japanese Architectural Association Prize for his Azuma House in Sumiyoshi and after many other prizes he won the Pritzker Prize in 1995.

The reasons for choosing Ando as an object of study are the availability of written material, especially that of Kenneth Frampton who links Ando to the Critical Regionalists and phenomenology as well as the availability of designs. One of the main sources on the characteristics of Ando's world view is Frampton's "The Work of Tadao Ando" in *Tadao Ando*, edited by Yukio Futagawa (Frampton 1987.

The Museum Langen Foundation was selected because it is a project conceived for Germany and not for Japan, which can give insights into the purpose of using traditional Japanese architecture.

[4] According to my editor Marcus Richardson, he didn't coin the word as such. He coined a word in Russian which has been translated into English as "defamiliarization", but a more literal translation of the Russian word would be "making strange".

4.1 Tadao Ando's design approach

In "The Work of Tadao Ando", Frampton describes Ando's design strategies. He describes a set of principles followed by Ando, mentions the influences of Le Corbusier and Louis Kahn in Ando's work, as well as the relationship between Ando's work and phenomenology.

I will briefly describe here some of these characteristics with particular reference to the identity of the architect and of the place. The aim here is to identify relevant sources of identities represented in the work of Ando. As mentioned above, we try to discern an identity of the architect that he carries as his worldview from the identity of the place, which he considers for that specific location as well as other identities considered in the design process such as the identity of the users and the identity of the institution (the building itself). Naturally, identities may only be subdivided in a theoretical attempt to get insights into the complexity of their aspects. In fact, these identities are all part of the architect's interpretation of the world, the site and the users. Therefore, a design often shows ambiguous characteristics with ambiguous meaning which represent more than one kind of identity. Ando argues, "I create enclosed spaces mainly by means of thick walls. The primary reason is to create a place for the individual, a zone for oneself within the society. When the external factors of a city environment required the wall to be without openings, the interior must be especially full and satisfying" [biography on the Pritzker Prize website]. One can say that here he reinforces the idea of belonging of the dweller (the user) by creating a place protected from the city environment.

The spirit of the wabi in Ando's position refers to a resistance towards what could be called the lost of Walter Benjamin's Erfahrung and the homelessness of the modern man. Frampton argues, "Ando's insistence on the 'homelessness' of modern man, reflects […] his affinity for negative thought of the Krausian circle". This negativity, Frampton says, is represented in Ando's designs by "the monotonality of his architecture" and a "sense of nihilistic muteness" reminiscent of Adolf Loos. If I recall Loos' principles, I can link this to Loos' principle of the Mask that is represented in his architecture by the reinforced separation between private and public; by windows meant to bring light to the house interior and not for an overview; the almost obsession with having no ornaments; and indeed, monotonality (at least in what concerns the façade). In Ando's architecture the muteness is also achieved by the relation between walls and pillars as well as the play between translucence and opacity; creating spaces which are penetrated through a ceremonial route (the labyrinth) marked by sequential elements and a play with natural light.

Frampton links Ando to phenomenology by calling him a builder who, despite his minimalism, aims to provide a dwelling; a builder who is also the farmer occupied not only with the cultivation of land but the cultivation of the species and who understands that "the topos of the site only comes into being with being". It is unavoidable to speak about "place" without bringing Noberg-Schulz's "The phenomenon of place" and his description of the structure of the place recalling elements and aspects which "come only into being" through perception. According to Frampton, Tadao Ando is also a builder in the sense of "evocation of a resistant prebourgeois, pre-renaissance set of values", a builder also due his ontological and material presence of tectonic form.

Ando uses Japanese traditional architecture, Le Corbusier[5] and Louis Kahn's architecture as precedents. It goes without saying that his use of such precedents refers to his interpretation and recombination of the principles underlying each precedent. It is not about copying the morphology in a historicist fashion, but their essential operations (the "how" question). The use and recombination of these principles in Ando's work is meant to give gestalt to his own interpretation of the world.

4.2 Tadao Ando's design approach to Langen Foundation

The Museum Langen Foundation was built in Neuss, Germany in 2004. It was built at a special site within the former Hombroich Missile Base which was transformed by Karl-Heinrich Müller into a synthesis of architecture and art. Visitors stroll around in the park where they encounter pieces of art that belong to diverse periods and diverse styles without a rigid chronological order. On sunny days, the doors of the buildings in this park are kept open so that one may stroll from nature into a building and from there once more into nature.

The Missile Base is a protected site cut off from the outside world which justifies the use of the sparkling glass envelope which composes part of Ando's museum. Ando guides the visitor though a gateway into a promenade architecturale. This gateway clearly refers to Chinese and Japanese traditional gardens. However, it is not a moon gate on a flat wall; instead you find a rectangular entrance cut into a semi-circle concrete wall. This wall sets a boundary to the place beyond and at the same time invites the visitor to pass through it by providing them with a pictorial view of the building. The path that penetrates the gate invites the visitors to approach the building via the cherry trees and the artificial pond. Indeed it is not necessary to reinforce the character of the entrance. The path, the cherry trees, the pond, the glass envelope all guide the visitor toward its flush entrance. Air, water, wind and light are part of the experience of the visitor, making them fully awaked to and integrated with the nature around. Inside the glass envelope there is an exhibition space enclosed by thick concrete walls. The translucency of the glass envelope, where one feels integrated with the nature outside, is juxtaposed with the opacity of the concrete box.

The glass envelope is interlocked with a second part of the complex, with a rectangular volume at an angle of 45 degrees which is cut by a staircase through its longitudinal side dividing the interior spaces into two wings. This rectangular volume stands 3.45 meters above ground level, and extends 6 meters underground. The visitors enter this rectangular volume from the glass envelope, making their way onto a balcony. The underground exhibition spaces are reached via a ramp linking the

[5] Ando says about a book he acquired on the work of Le Corbusier: "I traced the drawings of his early period so many times that all the pages turned black. In my mind, I quite often wonder how Le Corbusier would have thought about this project or that."[Pritzker Prize website]

balcony with the left wing or via a staircase which is part of an interlocked volume penetrating both the balcony and the right wing. From the right wing visitors can make their way out of the building. The natural light in these exhibition wings and inside the concrete box within the glass envelope comes mostly from the ceiling.

5. Conclusion: Tadao Ando's Langen Foundation and the modes of identity

Ando seems to have paid lots of attention to the identity of the place and in this sense provides an exploratory journey for the user. He provides a boundary with the position of the semi-circular wall and with the gateway creates the perception of being inside or outside. Also, with the thin and transparent glass envelope he sets a slight boundary between inside and outside, between man and nature, integrating them more than separating them. The concrete wall seems to be more to provide a contrasting experience and to protect the art collection from environmental changes than to protect man from modern society, since the Langen Foundation is located in a place within a place (former Hombroich Missile Base). Also, it seems that in order to integrate the building in the park and minimalize its impact, Ando built the second volume mostly underground.

From the design description one can see how complex it is to discern one kind of identity from the other. Only by the fact that the building is located in Germany, one can understand that the abstract or defamiliarized elements of Japanese traditional architecture of his designs are not really used to prick the mind of the local people. Just like Le Corbusier's promenade architecturale, Japanese traditional architecture is used as a precedent which is defamiliarized and recombined to represent Ando's worldview.

One may say that this says more about the architect's identity that belongs to the autonomous moment of the architect than about a his original resistance position such as the one against the homelessness in the Japanese metropolis (a concern about the identity of the user). In fact, this building would probably have a more symbolic meaning for Japanese people due to its reference to their tradition and it could be called a critical architecture in the sense of the critical regionalists if built in Japan.

It seems that the use of Ando's precedents grew out a concern toward the local cultural potential (identity of the place and of the users) and became part of his worldview (the identity of the architect). It is quite possible that the use of Japanese traditional architecture, the confrontation with (abstract) nature, and the mystic use of light was meant – in a defamiliarized fashion and in unexpected recombination – to prick the mind of his Japanese contemporaries and that these are sources of the identity of the user as interpreted by Ando. This is at least what Ando's statement on the Pritzker Prize website seems to suggest: "I was born and raised in Japan; I do my work here [in Japan]." But it became part of his vocabulary.

This all shows the dynamics of the identities involved in Ando's design process where issues that were on one occasion circumstantial become part of the body of knowledge and of the poetics of an architect. This shift in his design process turns Ando not less creative, but it distances his work from the critical regionalism.

Finally, after this brief description of Ando's project, we hope to have made it clear that this dynamics may be a source of complication and in need of research for those trying to model the concept of identity for programmatic purposes.

References

Castells, Manuel. 2004. The Power of Identity. In: *The Information Age, Economy, Society, and Culture*. Volume II.

Frampton, Kenneth. 1987. "The Work of Tadao Ando". In: GA Architect 8, *Tadao Ando*. Edited by Yukio Futagawa. Tokyo, Japan: A.D.A. EDITA

Heynen, Hilda. 1999. *Architecture and Modernity, a critique*. Cambridge, Massachusets: The MIT Press

Jodidio, Philip. 2006. *Tadao Ando, Complete Works*. Taschen

Moraes Zarzar, K. 2004. "Design Precedents and Identity". Procedures GA2004

Tzonis, A., and Lefaivre, L. (co-author). 1990. "Why Critical Regionalism Today?" A & U. no.5 (236). May 1990. pp. 23-33

Tzonis, Alexander and Liane Lefaivre. 2001. "Chapter 1: Tropical Critical Regionalism: Introductory Comments". In: 2001. *Tropical Architecture: Critical Regionalism in the Age of Globalization*. Edited by: Alexander Tzonis, Liane Lefaivre and Bruno Stagno. Wiley-Academy.

Tzonis, Alexander and Liane Lefaivre. 2003. *Critical Regionalism, Architecture and Identity in a Globalized World*. Munich; Berlin; London; New York: Prestel.

Theory of Complexity

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Abstract

Dice throwing and similar techniques are valuable tools for moving the creative process out of a rut or for suggesting previously overlooked directions. Random number generators are often used in generative processes to produce variety.

Yet randomness and complexity have different meanings to different communities. Sometimes the term “random” is used to mean “of high complexity”, sometimes “of unrecognisable structure”. To discuss “unrecognisable” in a concrete manner we must discuss human perception and cognition, subjects which aren’t well understood. Meanwhile, highly complex artifacts can emerge from simple rules, adding to the confusion. Informal experiential notions of randomness and complexity differ in important ways from formal definitions derived from Information Science. These approaches are contrasted in an attempt to arrive at a shared model of complexity.

While randomness can be used as a creative trigger, its use in generative processes can impede the progress towards a desired solution. Therefore it is important to understand what a random number generator is providing. Since generative processes encode considerable structure and complexity into artifacts, we show that surprising variety can emerge without the need of random number generators. Complexity, surprise and variety are all possible without randomness.

1. The Role of Surprise

In many creative disciplines, chance is used to further the creative process. This can provide new insight and new solutions may appear. One famous manifestation of this is Brian Eno and Peter Schmidt’s Oblique Strategies [1], a deck of cards with cryptic remarks which one chooses for inspiration.

In music, the use of chance can be traced back to the 18th and early 19th century Musikalisches Würfelspiel (musical dice game) [2], one example of which is attributed to Mozart [3]. In modern dance, Merce Cunningham uses dice throwing just prior to a performance to determine the order of the choreography, costumes, lighting, décor, and music [4]. The mid-1900’s saw the establishment of aleatoric (or ‘chance’) music, defined as “music in which some element of the composition is left to chance or some primary element of a composed work's realization is left to the determination of its performer(s)” [2].

As a technique for unblocking creative potential, the use of randomness is clearly valuable. However in aleatoric music, chance is taken one step further and purposely removes some decision and control on the part of the composer (e.g. through the throwing of dice), although often within a limited number of possibilities. In so doing the composer hasn’t simply written one single piece of music, but rather a family of music, being all the combinations of the elements combined.

In modern terms, aleatoric music consists of a process by which a random number is used to select combinations from within a predetermined set of elements. It follows an algorithm, and is thus an early example of generative art.

More recently, John Cage used various elaborate approaches to the application of chance in composition and performance [5]. His techniques were more sophisticated than simply throwing dice. For example in one, the performer must interpret the ‘musical meaning’ of lines on a sheet of paper. In another he leaves instructions to the players on how to turn the volume and tuning knobs on a set of radios (which would play whatever happened to be broadcast at that time). We could thus consider his algorithms to be more complex.

2. Approaches to Complexity

But what do we mean by structure, by complexity? These subjects can be tricky to discuss because one often ends up discussing the *apparent* complexity of an artifact. This could be the subtle layering of a piece of music, the sophisticated composition of a painting, or the intricate details of a sculpture.

The problem is that these are all qualitative notions of complexity. Understanding them with more precision requires understanding perception and cognition. Our senses reduce and encode information prior to processing by our cognitive centers [6], so a comprehensive theory on pattern and complexity likely must take those encodings into account. Then the cultural context and knowledge of the individual must be factored in. Our lack of precision in understanding these areas leads us to conundrums like whether Fractals [7] are complex or not. Most would state that they are visually complex. Yet Fractals are derived from a very compact algorithm with no randomness. They are actually quite simple! Which is correct?

In math and computer science, there's a relatively recent definition of complexity. Kolmogorov complexity [8] defines the *algorithmic information content* of a string as being the smallest Turing machine[6] capable of producing that string. In simple terms, it's the smallest program that can produce that output.

For example, the following string is quite long, so seems to have lots of information content: "123123123123123123123123123123"

The clever reader will notice though that this is simply the string "123" repeated 5 times. Another reader might disagree with that encoding and state instead that its "123123" repeated 5 times. Or its "123123123123123" repeated 2 times. Those are all true. But which is *more* true from an information content point of view?

1. '123123123123123123123123123123'
2. '123123123123123' repeated 2x
3. '123123' repeated 5x
4. '123' repeated 10x

Intuitively we see that (4) is the shortest[7], and we're pretty confident that there's no shorter way of expressing it. If I wanted to transmit the string to you, I could send you all 30 digits, but it's faster just to say, "'123' repeated 10 times". That's its information

[6] A Turing machine is a simple theoretical computer that reads a tape of symbols which it interprets as instructions. Every real software program has an equivalent Turing machine, and every Turing machine can be realized as a real program.

[7] While these aren't Turing machines, they are like pseudo code programs and for the sake of this discussion are sufficiently representative of the complexity of the required Turing machine.

content, "'123' repeated 10 times". You now know everything there is to know about the string.

Rather than a subjective measure of complexity ("hmm, that looks complicated"), Kolmogorov complexity provides an objective, algorithmic measure of complexity ("hmm, that turned out to be easy to do"). It provides a theoretical, well constructed, quantitative definition of complexity: the information content of an artifact is measured by the complexity of the program that produces it[8]. It's irrelevant if the thing *looks* complicated, it only matters how hard it is to *make* it.

3. What it Means to be Random

The term "random" gets bantered about quite a bit. It, even more than complexity, requires more precision in our use. The mathematical definition is, "being or relating to a set or to an element of a set each of whose elements has equal probability of occurrence" [9]. Simply, anything could've happened, one outcome no more likely than the other. This is the classic dice throwing sense of randomness. Sometimes though we use it in the sense of "lacking a definite plan, purpose, or pattern" [9]. This is a kind of perceived randomness, as in "I couldn't predict the outcome".

Thus we have two approaches to randomness[9], one concerning the results, and the second concerning the behaviour.

4. Random Number Generators aren't Random

Ironically, random number generators aren't really random at all. They are referred to as "pseudo-random". Their outcome is somewhat random in the probabilistic sense above; the digits conform to an acceptable probabilistic distribution. But their behavior certainly isn't. Given the same seed, they will produce exactly the same sequence.

[8] The bad news is that for any arbitrary string, we can't know if we've in fact found the smallest Turing machine, there may always be a smaller one we just haven't been clever enough to come up with. Thus the theory is of limited practical benefit but is a powerful conceptual model.

[9] Kolmogorov complexity defines randomness as a string whose smallest Turing machine is, in fact, the string itself. That is, there is no algorithm which reveals hidden structure, which compresses it; the shortest way to encode the string is to just remember all the digits.

Thus when you reach for your random number generator, you aren't actually producing anything random, you're just producing an outcome which is very difficult to predict, with no recognizable pattern, whose values are well distributed probabilistically. There is in fact a pattern, you just can't spot it.

But pseudo random number generators tend to be relatively small programs. Thus the outcome is always of relatively low algorithmic information content: small Turing machine = low algorithmic information content. Their outcome could be considered simple, in fact.

Random number generators produce simple results.

5. Random Number Generators Considered Harmful

As discussed, randomness can be a valuable tool for permitting the artist or designer to cede control. However, when faced with set of design criteria, this randomness can do more harm than good. This is because without parameterisation and guidance of the randomness, results can just as easily move you further from your goal than closer to it. This is why approaches such as Genetic Algorithms [10] which use randomness to cross breed and for mutation require fitness functions to increase the probability of producing superior solutions. The randomness must be controlled.

Thus its not a matter of simply ceding control, but of ceding the *right* control, so that one can still achieve one's creative goals. To do so, one must guide the system to the desired solution. This task can be difficult once a random number generator has been introduced because it reduces predictability, yet predictability is required for us to navigate the space of possibilities. If you are unable to drive the system to the desired goal, then all you can do is chose from the results, hoping one matches. When control is lost, so too is subjectivity, and with it, access to one's cultural and aesthetical references [11]. One's role is relegated to that of a shopper [12].

Therefore it would be better if we could avoid the use of random number generators. But can we do so without sacrificing our desire for variety, for complexity, for surprise?

6. Complexity without Randomness

Lets us examine a simple L-System[10] [13] with the following grammar:

S=F

F=F[-F]F[+F]F

Figure 1 shows the tree expanded to depth 4.

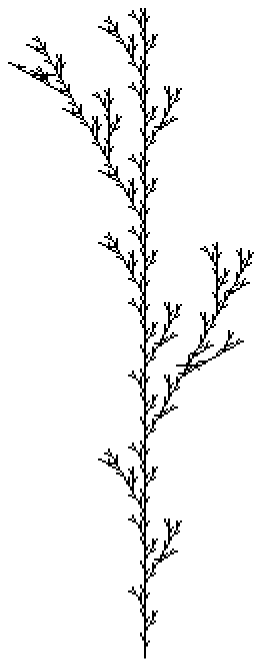

Figure 1 - Single rule

A lot of self-similarity and regularity are present. To add a bit of variety, lets add two more rules with LHS 'F', as shown in the discussion on Stochastic L-Systems in [13].

S=F

F=F[+F]F[-F]F

F=F[+F] F

[10] L-Systems are rewriting graph grammars capable of producing branching, organic shapes. The grammar consists of a set of rules, each with a left hand side, an assignment (in our case, "="), and a right hand side. Starting with the start symbol S, the RHS is expanded as follows: for each symbol, find a rule with LHS that matches that symbol and replace the symbol with that rule's RHS. This expansion continues for several recursions. Finally, the resulting string is interpreted, in this case as turtle drawing commands (e.g. "F" is "draw a line forward N steps").

F=F[-F] F

During expansion only one of these three ‘F’ rules can be applied, therefore we require a way of choosing which one to apply at any given time.

6.1 Random results

The obvious choice is to use a random number generator, with each rule having equal weight of being chosen. Figure 2 shows three randomly generated trees.

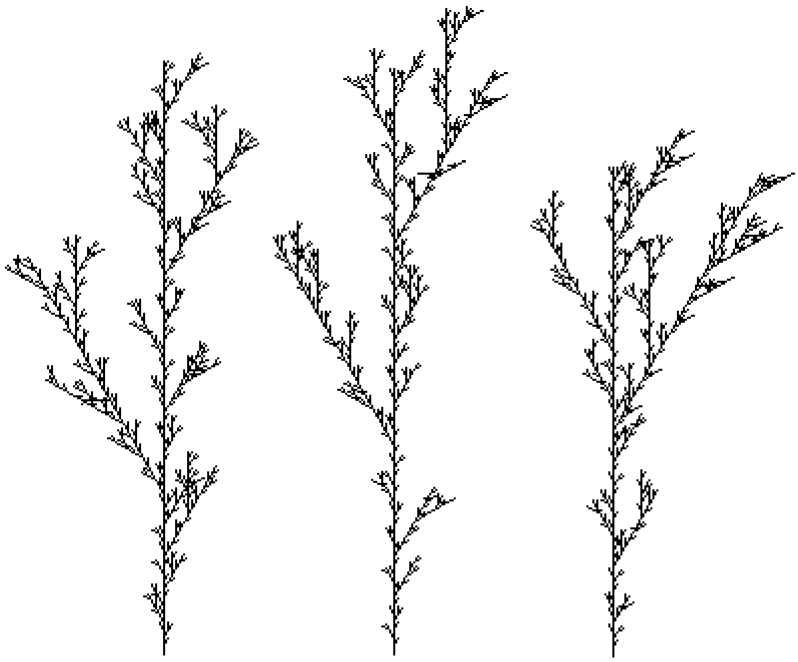

Figure 2 -Three random trees

These clearly exhibit more variation than Figure 1. Yet one could claim they are more alike than different. This is because the L-System itself, through the recursive application of a small set of rules, defines the topology. The random number generator just provides varieties. These look like they could be the same plant species, just grown under different conditions.

6.2 Sequential results

But was a random number generator really required? What if instead one did the simplest thing one could think of, which is that every time a rule must be chosen, the system just chose the next one in order? That is, first time it picked F=F[+F]F[-F]F, next time F=F[+F] F, next F=F[-F] F, then back to the first again.

This can be represented with the sequence {1, 2, 3}, signifying which rule to pick. When the sequence is exhausted, the system starts over at the start (i.e. with ‘1’). There are six combinations of sequences of three digits, thus six possible results. Figure 3 shows three of them. They exhibit a surprising degree of variety.

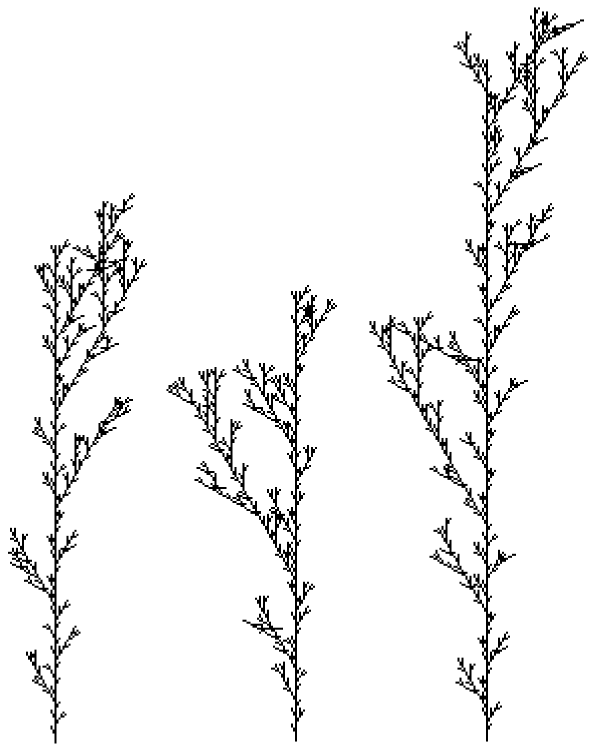

Figure 3 - The three variations of sequential rule selection

In fact, subjectively its difficult to guess that there was no random number generator involved. Yet there is very little information added above the existence of the three rules, just the simplest notion of a selection algorithm (i.e. “pick each in turn”).

6.3 Longer sequence

More algorithmic information, and thus variety, can be achieved by encoding more structure in the sequence. In Figure 4, on the left is the result of the sequence {3, 3, 2, 2, 1, 1, 2, 2, 3, 3}, and on the right is the author’s phone number. The results are rich though it's not evident that they exhibit any more visual complexity than the previous examples.

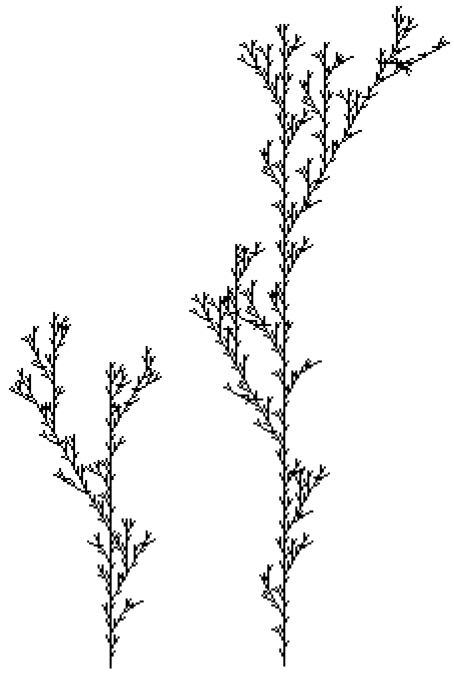

Figure 4 - Longer sequences

6.4 Discussion

This exercise could continue with more and more sophisticated sequences. A legitimate (and fun) area of exploration is the relationship between changes in the sequence and changes in the resulting picture. Patterns of digits, reflecting the sequence, etc., gradually adds more information to the sequence, which is then realized as visual complexity in the picture. Yet even the simplest algorithm for choosing the rules results in pictures with surprising variety. This suggests that the generative system itself is the primary source of the visual complexity. Similar rich results from generative systems that don't use random number generators have been shown in [14,15].

While random number generators provide a well distributed set of values, to achieve variety, a simple algorithm will do. Random number generators are overkill. Worse, they obscure the inherent rich complexity and variety of the generative process.

Each sequence above can be considered a computable function. There are an infinite number of computable functions. Most are not random number generators. Thus, there's a huge space of possible functions waiting to be explored.

7. Conclusion

Informal notions of complexity and randomness lead to ambiguity and misunderstanding in the generative community. One reason is that subjective complexity is experiential. To understand it, one must understand perception and cognition. Information theory provides a concise and quantitative definition of complexity in terms of the smallest program capable of producing the result. This allows us to think of complexity differently, not solely as a visual experience, but also in terms of the sophistication of the process which produced it.

We've shown that a considerable amount of visual complexity can result from the simple addition of alternative rules to a generative system. We've also shown that while random number generators produce well distributed values, visually rich and "random looking" results can be achieved through much simpler processes.

Throwing dice, picking cards from a deck, are valuable techniques for breaking one's thought processes out of a rut. However, the use of random number generators in generative processes makes it difficult to guide that process in the desired direction. If one's goal is to produce complexity, then one should look to the process, since it contains all the algorithmic information content. If one's goal is to produce variety, than a random number generator is likely unnecessary if the generative process itself is sufficiently rich.

When looking for a function to produce variety, there are infinite available. Rather than reaching for the random number generator, pick a different one!

8. References

[1] Oblique Strategies. http://www.rtqe.net/ObliqueStrategies/

[2] Wikipedia. http://en.wikipedia.org/wiki/Chance_music

[3] University of Vienna. http://sunsite.univie.ac.at/Mozart/dice/

[4] NAC/CAN. http://www.nac-cna.ca/en/nacnews/viewnews.cfm?ID=1113

[5] Cage, John. "Indeterminacy", in his Silence: Lectures and Writings, 35–40. Middletown, Conn. Wesleyan University Press, 1961.

[6] Resnikoff, HL. Illusion of Reality. Springer-Verlag New York, Inc. New York, NY, USA, 1989. ISBN 0-3879-6398-7

[7] Mandelbrot, B. B.. The Fractal Geometry of Nature. W. H. Freeman and Company, 1982. ISBN 0-7167-1186-9

[8] Li, Ming and Vitányi, Paul. An Introduction to Kolmogorov Complexity and Its Applications, Springer,1997.

[9] Merrian-Webster. http://www.webster.com/dictionary

[10] Goldberg, DE. Genetic Algorithms in Search, Optimization and Machine Learning, Addison-Wesley Longman Publishing Co., Inc. Boston, MA, USA, 1989.

[11] Soddu, Celestino. “Generative Design. A swimmer in a natural sea frame”, *9th Generative Art Conference*, Milan, 2006.

[12] Soddu, Celestino. Remarks made during presentation of [Soddu] as remembered by the author, *9th Generative Art Conference*, Milan, 2006.

[13] Prusinkiewicz, Przemyslaw, and Aristid Lindenmayer. The Algorithmic Beauty of Plants. New York: Springer-Verlag, 1990.

[14] McGuire, Kevin. “Controlling Chaos: a Simple Deterministic Program for Drawing Complex Organic Shapes”, *3rd International Conference on Generative Art*, Milan, 2000.

[15] McGuire, Kevin. “ArpEgg: a Rewriting Grammar for Complex Arpeggios”, *9th Generative Art Conference*, Milan, 2006.

A New Kind of Art: The Robotic Action Painter

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In the context of robotics RAP [Robotic Action Painter] demonstrates that machine creativity can be achieved by means of randomness, stigmergy and chromotaxis.
RAP's action painting is based on two distinct behavior modes, the first being essential random and the second reactive or of positive feedback. The initial random color spots functions as a seed for the reactive mode emergent composition. In this sense the paintings are always distinct and unique.
Mode activation is based on local information gather by the robot itself. RAP uses a set of nine RGB sensors turned to the painting plan in order to determine the presence, shape and intensity of color. If color – with considerable expression (threshold) – is found, RAP changes from Random to Reactive Mode and proceeds to final composition arrangements. In this mode the robot is both attracted by color (chromotaxis) and responds to it (stigmergy).
The nine RGB sensors disposed in a grid of 3x3 make also possible for the robot to decide when the painting is finished. The fact that RAP can read not just single color spots but also local patterns, permits to generate a kind of "sense of rightness" and let the robot determine by itself the end of the process.
RAP is also able to sign its works.
Although thresholds are used, essentially for variation of color sensibility, no use is made of any kind of fitness, other predetermined behavior loops (except for the signature), composition or aesthetical targets. RAP was conceived for the largest robot autonomy and consequently the less human intervention as possible.
RAP's paintings are fairly original to be considered the product of machine creativity. Sensors allow for an effective incorporation of new and non predetermined data which is the base of the creative process. Hence, these artworks are founded on the machine own interpretation of the world and not on its human description.

Machine creativity

Based on ants and other social insect's studies [1], I have tried to reproduce artificially a similar emergent behavior in a robot swarm. These insects communicate among themselves through chemical messages, the pheromones, based on which they produce certain patterns of collective behavior, like follow a trail, clean up, repair and build nests, defense, attack or territory conquest. Despite pheromone not being the exclusive way of communication among these insects – the touch of antennas in ants or the dance in bees are equally important –, pheromonal language produces complex cognition via bottom-up procedures. Pheromone expression is dynamic, making use of increments and decrements, positive and negative feedbacks. Messages are amplified when pheromone is reinforced, and lose "meaning" when breeze disperses it. It is also an indirect communication, coined stigmergy by Grassé [2], from the Greek stigma/sign and ergon/action. Between the individual who places the message and the one who is stimulated by it, there is no proximity or direct

relation.
Following these principles, I have replaced pheromone by color in my first ant-robots (2001). The marks left by one robot triggers a pictorial action on other robots. Through this apparent random mechanism abstract paintings are generated, which reveal well defined shapes and patterns. These robots create abstract paintings that seem at first sight just random doodles, but after some reflexive observation color clusters and patterns become patent. Through the recognition of the color marks left by a robot, the others react to it reinforcing certain color spots. The process is thus everything but arbitrary, stemming from a creative technique analogue to millions of years of evolution. As far as I know, ArtSBot (Art Swarm Robots) [3] was the first project to use emergent organization for developing robot creativity. Every previous experiment focused exclusively on randomness or sometimes on target strategies leading the machines to fulfill a pre-determined program created by the human artist. On the contrary, ArtSBot was ment to put into practice the utmost possible machine autonomy, aimed at producing original paintings. In operational terms, ArtSBot consists of a series of small "turtle" type robots, equipped with two felt pens and a pair of RGB sensors pointing to the painting plan. With these "eyes" the robots seek color (chromotaxis), determine if it is hot or cold, choose the corresponding pen and strengthen it by a constant or variable trace. To begin the process, when the canvas is still blank, the robots leave here and there a small spot of color randomly. Based on these simple rules, unique paintings are produced: from a random background stands out a well defined composition with intense shapes of color. In other words, initial randomness generates “order". The process is emergent and based on the properties of stigmergy.

1. A robot of the ArtSBot swarm

The artistic product of these robots is entirely original. In the same way that somebody who writes a book cannot be considered as a mere instrument of his primary school teacher, robots cannot be seen as simple instruments of the artist that conceived and programmed them. There is an effective incorporation of new and non predetermined information in the process. And that cannot be called anything but creativity. It is true that consciousness is lacking to this creativity. But if

we look at the history of modern art, it is obvious that, for example, surrealism tried to produce art works exactly in these same terms. The "pure psychic automatism", the quintessential definition of the movement itself, appeared as a spontaneous, non-conscious and without any aesthetic or moral intention technique. In the first Surrealist Manifesto André Breton (1924) defined the concept in this way: “Pure psychic automatism by which it is intended to express, either verbally or in writing, the true function of thought. Thought dictated in the absence of all control exerted by reason, and outside all aesthetic or moral preoccupations.” [4]. In the field of the visual arts, Pollock it is who better fulfills this intention by splashing ink onto the canvas with the purpose of representing nothing but the action itself. This was coined Action Painting, as it is well-known. Perhaps, because of that, the first paintings from my robots are, aesthetically, so similar to the ones of Pollock or André Masson, another important automatism based painter. In his surrealist period, this artist tried frequently to prompt a low conscious state by going hungry, not sleeping or taking drugs, so that he could release himself from any rational control and therefore letting emerge what at the time, in the path of Freud, was called the subconscious. The absence of conscience, external control or pre-determination, allow these painting robots to engender creativity in its pure state, without any representational, aesthetic or moral intention.
RAP (Robotic Action Painter), created in 2006 for the Museum of Natural History in New York, is an individualist artist and not a swarm, but makes use of the same composition methods based on stigmergy and emergence. This robot is additionally able to determine, by its own means, the moment in which the painting is finished. Previous versions didn't have this capacity being conditioned by battery discharge or my will to stop the process. RAP's decision is taken based on the information that it gathers directly from the painting, what produces a considerable variation of time and form, since RAP can decide that the work is complete after a relatively short while (entailing accordingly a low pictorial expression) or can extend the picture construction for a quite long period, making it much more dense and complex. The "secret" of this behavior is in the significant change of the sensors, which passed from two to nine "eyes", allowing now the reading of local patterns, in addition to color spots. RAP is also my first robot to sign its works.
ISU, the poet robot also created in 2006, has the ability to write letters and words producing poems and emergent compositions based on the letter, quite similarly to the Lettrism style, artistic movement that followed Surrealism.
These references to 20th century art movements do not seek any kind of historical legitimacy, but are intended simply to show how certain morphogenesis processes produce similar results in human as well as non-human artists. My painting robots generate artworks based on emergence. The essential of those creations is based on the machine own interpretation of the world and not on its human description. No previous plan, fitness, aesthetical taste or artistic model is induced. These robots are machines dedicated to their art. Creativity is not an exclusive ability of human culture and it can be acknowledge in the same way in the physical, biological and artificial world.

RAP’s behavior

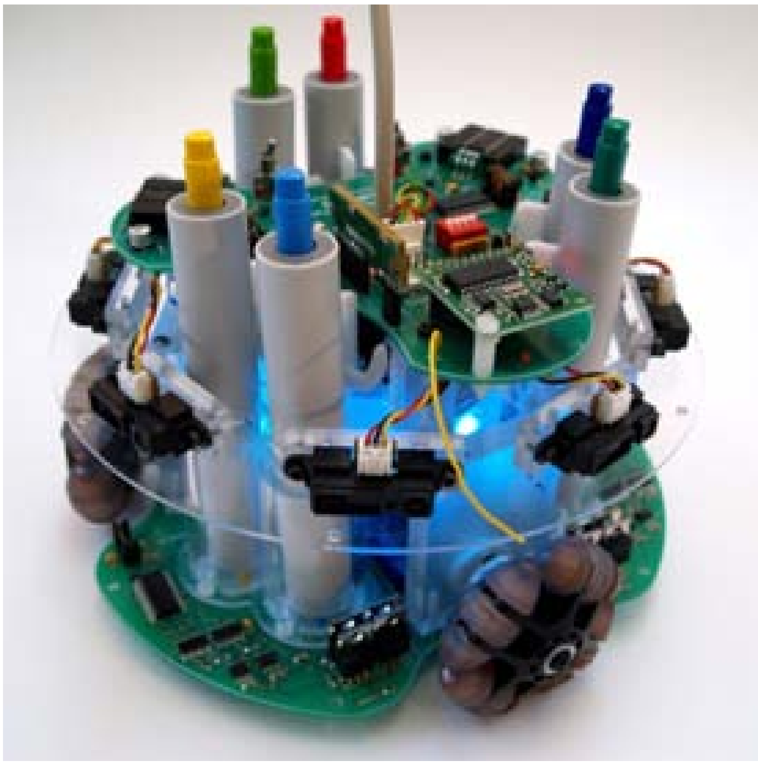
RAP is equipped with a grid of 3x3 color detection sensors, eight obstacle avoidance sensors, a compass, a microcontroller and a set of actuators for locomotion and pen manipulation. The microcontroller is an onboard chip, to which the program that contains the basic rules is uploaded through a PC serial interface.

The algorithm that underlies the program uploaded into RAP's microcontroller induces basically two kinds of behavior: the random behavior that initializes the process by activating a pen, based on a small probability, whenever the color sensors read white; and the positive feedback behavior that reinforces the color detected by the sensors, activating the matching color pen. These two distinct behaviors are described as modes, the Random Mode and the Color Mode. In the random mode RAP searches for color (chromotaxis). Until a sufficient amount is not found (threshold) RAP activates here and there, randomly, a pen stroke choosing also randomly the color and the line configuration. The shape, orientation and extent of these initial lines are determined by the robot based on a random seed acquire from its relative position in the space. This is done with the data retrieved by the onboard compass. In this way RAP's random generator can be described as real random and not pseudorandom.

When a certain amount of color is detected the robot stops the random behavior and changes to color mode. In this phase RAP only reacts to the spots where a certain amount of color is found, reinforcing it with the same tone.

After a while a discrete pattern emerges, where from a general random background a well defined composition can be recognized.

In order to determine when the painting is finished RAP makes use of a grid of 3x3 RGB sensors. If a certain pattern is found the robot "considers" the work to be done, moves to the down right corner and signs.



2. RAP (Robotic Action Painter)

RAP creates artworks based on its own assessment of the world [5]. At any given moment the robot “knows” its situation and acts accordingly. It scans constantly the canvas for data retrieving. It uses its relative position in the space as a real random generator. It builds gradually a composition based on emergent properties. It decides what to do and when to do it. It finishes the process using its particular sense of rightness.
Although the human contribution in building the machine and feeding it with some basic rules is still significant, the essential aspects of RAP’s creativity stems from the information that the robot gathers by its own means from the environment. In this sense RAP’s art must be seen as an original creation independent of the human artist that was at the origin of the process.

A new kind of art

RAP and the other of my painting robots were created to paint. Not my paintings but their own paintings. Such an objective addresses some of the most critical ideas on art, robotics and artificial intelligence.

Today we understand intelligence as a basic feedback mechanism. If a system, any system, is able to respond to a certain stimulus in a way that it changes itself or its environment we can say that some sort of intelligence is present. ‘Sheer’ intelligence is therefore something that doesn’t need to refer to any kind of purpose, target or quantification. It may plainly be an interactive mechanism of any kind, with no other objective than to process information and to react in accordance to available output capabilities.

Yet this is not what we usually observe in most of the artificial intelligence undertakings. For one part because human intelligence is still seen as the key model to be followed and by which all the experiments should be measured and evaluate. Artificial intelligence is in general a shadow of what we believe to be the human mind and behavior. As opposed to this, my painting robots were built without any previous intelligence model, human or other. Although the starting point was bioinspiration, in particular modeling social insect’s emergent behavior, the idea was to construct machines able to generate a new kind of art with a minimum of fitness constraints, optimization parameters or real life simulation. It is the simple mechanism of feedback and stigmergy that is at work here.

RAP is a singular species, with a particular form of intelligence and a kind of life of its own. It does art works as other species build nests, change habitats or create social affiliations.

3. A painting by RAP

If robots would appreciate art RAP's paintings would probably be the ones they like most. As these artworks expresses true machine creativity. But since we, humans, are for the time being the only pensive observers, the relation between machine art and human aesthetics principles is here the central issue. Many people like the robot paintings, probably because we seem to gladly embrace fractal and chaotic structures. But, more than shapes and colors, what some of us really appreciate in this idea and its associated process, is the fact that it questions some of our most strong cultural convictions. Actually it was supposed art to be an exclusive matter of mankind. In this sense, the robot paintings are a provocative conceptual art that problematizes the boundaries of art as we know it.

References

[1] Wilson, Edward O. (2006) *Nature Revealed, Selected Writings 1949-2006*, The Johns Hopkins University Press, Baltimore
[2] Grassé, P. P. (1959) *La réconstruction du nid et les coordinations inter-individuelles chez bellicositermes natalienses et cubitermes sp*. La théorie de la stigmergie: Essai d'interpretation des termites constructeurs, Insectes Sociaux, 6, pp. 41-48

[3] Moura, L. and Pereira, H.G. (2004) *Man and robots: Symbiotic Art*, Institut d'Art Contemporain, Villeurbanne

[4] Breton, André (1969) *Manifestoes of Surrealism*, University of Michigan Press
[5] Brooks, R. A. (1991) *Intelligence without Reason*, Ed. Morgan Kauffmann, San Mateo, California

An Agent System Based Tool to Help Designers for Free-Form Shape Generation in Digital Media

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Abstract

Architects have to search their design solutions back and forth through several abstraction levels to create the final design. But sometimes designers have to take one more step further in order to achieve the resemblance between the intended result and the end product in the domain of free-form design. Visual simulation models in digital environments of the designs are important tools for architectural process, but without any proof about whether the design could be built or not, these models are not enough to determine the design's feasibility. Therefore, designers need a tool that would work with them to determine if the design could be build or not and how could they improve their design solutions.

The aim of this paper is to find answers to the "how an agent system based tool can help designers for free-form shape generation in digital media?" question. The main issue about this problem is defining the main areas that agent based tool will be used to help designers. These areas should be determined by examining the difficulties within the domain of free-form design. Although there are several difficulties within the domain of free-form design, such as difficulties concerning the structural characteristics, materials and the form-finding process; this research only focuses on the form finding process regarding free-form design.

Form finding process of the free-form design is mainly depended on the distribution of the forces. How the forces distributed along the structural system and whether the design meets the structural stability or not, are the critical questions that define the form finding process of the free-form design. There are not many practical ways to determine if the design is capable of baring these forces or not. One of the most practical among the approaches is using the rain-flow analysis method to test the performance of the design solution under these forces.

In order to do that, design should be modelled in some suitable modelling software. After the design solution imported into the modelling environment, the design should be analyzed with the rain–flow analysis method. After the simulation and analysis is finished, the agent (in our case one of the completed agents) searches through the design and suggests alternative design solutions or points out the problem areas within the design according to the results of the rain- flow analysis.

Keywords: Agent systems; free-form shape generation; rain-flow analysis; simulation models; performance analysis.

1. Introduction

We are not entirely unfamiliar with the use of computer as architects for a long time. Architecture and industrial design firms have been using computers aided design programs for more than a decade and that technology is advancing aggressively since then. However unconventional use of dynamic modelling software and animation applications in architecture and industrial design is a rather recent event compared to the time we spent using computers just for their drafting abilities.

Architects like Ben Van Berkel and designers like Karim Rashid have placed themselves in another plane, completely different from the rest of the practitioners with their novel choice of using software which was intended for making of special effects and computer game development in the first place, to represent their designs in unique ways beyond the potential of traditional CAD software. Computer has been taking a bigger part in the design profession because of its ability to enhance efficiency in the process and for its remarkable flexibility as an artistic instrument in design. We can see computers' growing effect on architectural design with Greg Lynn's statement in which he has explicitly admitted this increasingly symbiotic relationship between designer and computer during an interview in 1998. Greg Lynn stated that "If it comes down to it, I would have to give the software 51 percent of the credit for the design of my buildings." [1].

Free-Form Architectural design could be mainly described by designs of different international design groups and firms like Gehry Partners, Asymptote, Decoi, Eisenman Architects, Greg Lynn Form, NOX, Mecanoo, UN Studio, Oosterhuis NL, VVKH Architects, Foreign Office Architects and many more. These firms have made remarkable contribution to the creation and illustration of the new architectural morphologies, different design strategies, documentation and explanation of the processes with their both constructed buildings and yet to be realized designs. After the construction of Gehry's 20th century Guggenheim Museum in Bilbao, there has been a tremendous change in the perception of architecture, it evolved into something completely unique by means of novel geometric and digital approaches in architectural design. Moreover, domain of free-form architecture has found its place and architectural form which was only produced digitally before, began to appear more frequently not just on the screen as impossible designs which would never be built, but also on built environment with the help of new computerized techniques that Guggenheim introduced.

Publications in the field are highlighting the principles, theories and methods concerning the subject on individual cases. They provide a solid foundation for the up and coming design content and have a large impact on the design theory. Nonetheless there is not enough number of researches about dynamics of the design process of free-form architecture and its limitations. Any designer who has limited or no knowledge about the limitations which gives the design artefact its final shape, like limitations about material, structure etc., bound to spend considerable amount of time while deciding the form of the building and might have to compromise some elements that are crucial in the context of their design just to make their design feasible to realized. Therefore, exploring the possible limitations concerning this emerging field and developing a tool to help designers to successfully solve problems that occur because of these limitations and optimize the design is crucial and the focus point of this research.

The main motivation to start this research has been to develop a model and a prearranged framework, which is capable of outlining the knowledge about the design and production phases, and some difficulties in this domain. The reason behind developing such a framework is to have it as a foundation of the future work related to the design tool we propose. By successfully and clearly outlining and describing the problems in the design process of the artefacts which belongs in the free-form design domain, making necessary additions to the existing design tool in the future would be possible and a lot less time consuming. Thus, we focused on pointing out the possible problem areas within free-form design domain while developing the tool capable of dealing with at least one of these difficulties. This research aims to be the next step of this exiting evolution and try to set out the principles of the design tool, which would act as a colleague to the designer by interacting him/her with the means of sharing of ideas and pointing out the problems.

In the research the main technique used to determine whether the geometry of the free-form design is feasible or not is the rain-flow analysis which is simulated in computer environment. Rain-flow analysis is used for searching the relationship of form and force in (irregular) curved surfaces. This idea was borrowed from a research made by Andrew Borgart, March de Leuw and Pierre Hoogenboom. Bogart, de Leuw and Hoogenboom stated that, “Like a rain flow loads will flow along curves with the steepest ascent on the shell surface to its supports.”[2]. This hypothesis for the flow of forces in shell structures was used to determine the feasibility of the free-form surfaces according to three design flaws:

Loads on the free-edges

Bending moments

Drain curves (valleys)

2. Free-Form Design

Architects have always been wanted to achieve to an aesthetic state, which can be explained by the irregular curves that used to describe free-form architecture and the unusual geometric approach, which was used in the process of producing these -almost liquid- forms, throughout the architectural history. This disposition can easily be seen in the examples of different architectural eras, such as; decorative, flowerlike forms of Art-Nouveau, nested/immersed style of Baroque architecture and the organic design repositories of twentieth century. In addition there is a new generation of architects, whom does not afraid of ever being tentative, emerged with not so different themes and forms that 1960’s neo-avant-garde dealt with, almost thirty years after the generation of Archigram had introduced their unlimited capacity of imagination to the world of architecture with their walking cities and utopian environment scenarios [3].

By means of recent developments in the computers and their ascending use in architectural design, there have been serious innovations in the domain of architecture: digital free-form architecture had become seen frequently than ever before and the construction techniques have increasingly become products of computerized procedures with the benefit of recent use of digital computer technology. Nowadays computers are not just used as drawing tools like t-square in the design process as they used to be, they have taken place in almost every phase of the construction process. They had found novel ways of usage in the design process concerning form, structure and planning. Computers can also assist the designers in construction phase. As a result of that most of the contemporary designs are computer generated or about to emerge as a result of the implementations of latest computer hardware and software. Nevertheless, architectural form has reached a fascinating state with the rising number of applications that computers have found in the design process with new techniques such as CAD (computer aided design), CAE (computer aided engineering), CAM (computer aided manufacturing) and CNC (computer numerical control). With the aid of computer animation software, designers can master complicated forms which consist of irregular curves that they ever dreamed of.

Working methods in designing free-form buildings can easily observed by examining the works of the pioneers in the domain. As common knowledge, Frank O. Gehry designs his shapes manually working on mock-ups of the buildings than produces a 3D model with the use of scanning the final shape with 3D scanner. On the other hand, Greg Lynn and some others entirely depend on software during the design process.

In our approach we propose “tool” – in the sense of a program component - consists of an agent system embedded within the software to analyze the feasibility of the form of the design.

3. Agent Systems

Agent-based computing started in the 1970s, and in the last years the notion of agents has become important by their intensive usage in the internet applications, drawing ideas from Artificial Intelligence and Artificial Life. Although there is no universal definition of the term agent, in the context of computer science, agents can be defined as intentional systems operate independently and rationally, seeking to achieve goals by interacting with their environment [4]. Agents have goals and beliefs and execute actions based on those goals and beliefs [5]. These features set apart a rational agent from the computational agents that perform actions based on predefined events, like search agents on the web.

Agent systems mainly have a usage in the field of architecture as intertwined with the implementations of virtual worlds. When searching through the literature to find the documentations and examples of usage of the agent systems related to the architecture, one definitely came across the rich body of work about; agent approach to sharing and synchronising building model data among CAD and virtual world systems, agent models for 3D virtual worlds, design agents for 3D virtual worlds , situated agents, creativity in design, situated computing, multidisciplinary design in virtual worlds by mostly done by Mary Lou Maher[6-7], John S. Gero[8], M. Rosenman [9] and R. Sosa [10].

Another usage of agents in the architectural design is in the field of decision making. Designers use modelling and generative tools to produce a model of the designed artefact which other tools simulate the behaviour of the model within the same shared representation. Such design environments are typically described as multi-agent decision making environments.

Aly has investigated enhancements to the design of computational assistants in multi-agent design environments that use shared representation schemes. He proposed expanding the notion of agency to the design objects; these agents than interact with other agents in the execution of design tasks relating to the objects. This approach called objects-as-agents approach, where objects are selectively activated to participate in decision making sessions to execute tasks regarding their immediate design states [11].

An object-agent (OA) is a design object that is activated to perform tasks. In an OA-based design environment, domain applications are global problem solving nodes, OAs are local coordination and management nodes, and, collectively, the designer(s) act as a coordinator and final judge. The designer orchestrates this fine-grained agent environment through incremental interactions until the model arrives as an acceptable design state [12].

We share same the point of view with Krishnamurti and Aly regarding multi agent decision making environments. The agents we use in our tool have object-agent behaviours. They separately activated to perform certain tasks in the model; in the model we propose one of the object-agents only deals with the rain-flow analysis on the form and another one is responsible of the visualisation of these results.

4. DigiTool

This research tries to explain “how an agent system based tool can help designers for free-form shape generation in digital media?” The main issue about “developing an agent based tool to help designers for free – form shape generation” is defining the main areas that agent based tool will be used to help designers. These areas should be determined by examining the difficulties within the domain of free – form design. Although there are several difficulties within the that domain, like difficulties concerning the structural characteristics, materials and the form – finding process, this research only focuses on the form – finding process .

The form finding process of the free - form design mainly depended on the distribution of the forces. How the forces distributed along the structural system and whether the design meets the structural requirements or not, are the questions that define the form finding process. There are not many practical ways to determine if the design capable of baring these forces or not. One of the approaches to determine whether the geometry of the free-form building is feasible or not, is using the rain flow analysis to test the building’s performance under these forces. Rain-flow analysis is used for searching the relationship of form and force in (irregular) curved surfaces. The idea borrowed from a research made by Andrew Borgart, March de Leuw and Pierre Hoogenboom. Bogart, de Leuw and Hoogenboom stated, “Like a rain flow loads will flow along curves with the steepest ascent on the shell surface to its supports.” [2]. This hypothesis for the flow of forces in shell structures was used to determine the feasibility of the free-form surfaces according to these three design flaws.

One of the main objectives of this research is to develop an agent based tool to help designers in free – form shape generation which used the rain flow analysis to determine the feasibility of the form and suggest different design alternatives which meet the requirements or help designer to revise their design according to the these results. In order to do that, design should be modelled in some suitable modelling software. Designers could use any surface, which modelled in a compatible modelling program to run rain-flow analysis. After the import or modelling phase, original surface should be duplicated and placed above the initial surface to use as a source in which particles emit from. After defining the gravity and amount of resilience of the particles, particle type, line and tail widths which could be modified within the program in order to enhance the visibility of the particles during the simulation. These groundwork phases before the actual simulation could be taken a lot of time if someone tries to do it by hand. In order to control the whole simulation and the variables, a script that actually does all these actions is written. In the later versions of the tool, designer would be able to change some of the key parameters with a user interface. After the simulation / analysis is finished, the agent (in our case one of the completed agents) searches through the modelled form and suggests design alternatives or points out the problem areas of the design according to the results of the rain flow analysis (Fig.1.).

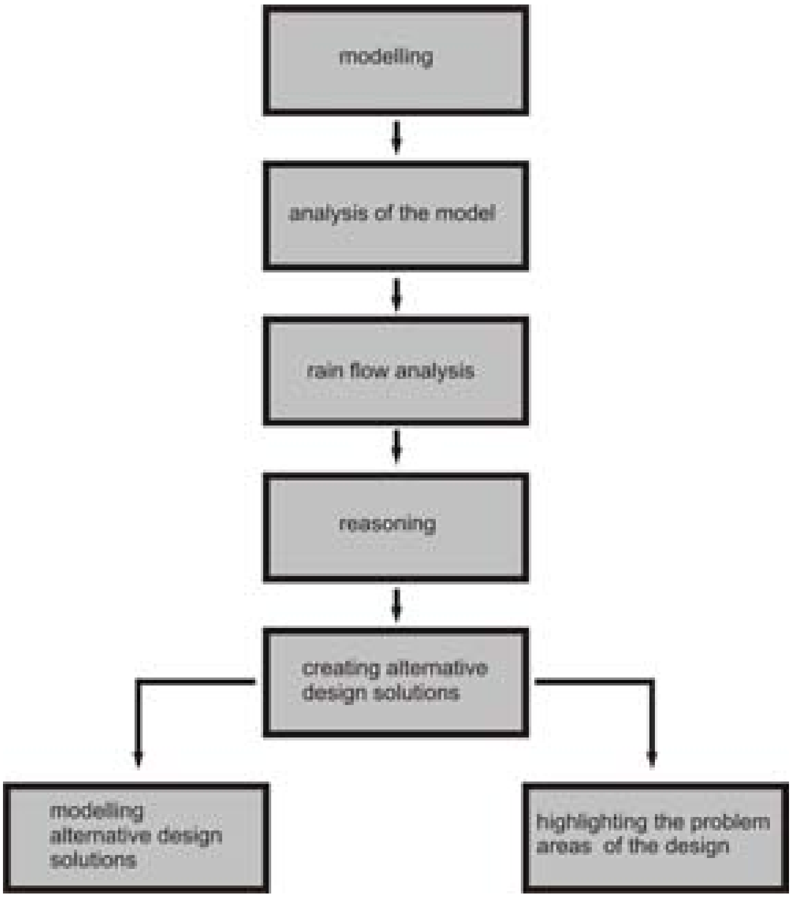


Fig 1. Workflow diagram of the tool.

Different types of agents considered to develop at the later parts of the research. All of these agents would be planned to be act as an individual tool that helps designer to develop their design in the domain of free – form design. Each agent would be specialized in the different problem domains. These agents differ from each other by their behaviour types. Analysing agents analyse the model before the rain flow analysis and recognize the objects in the model by their attributes, and names. Some kind of standardization in modelling process should be made in order to analysis agents could work properly (using predefined colours and names for some objects in the model). Reasoning agents work on creating alternative design solutions according to the results of the rain flow analysis (these results could be made understandable for agents by using colour). They could define the problem areas of the design and reasoning about how these problems should be solved. Suggestive agents could help designers by suggesting alternative design solutions according to the result of analysis. Modelling agents could help designers by visualising the alternative design solutions, that reasoning agents provide, based on the initial design. Computation agents could help the designer by converting their initial surface element into the means of parametric design and providing alternative surface component solutions based on the material of the component or the shape of the component. One or two agents with various behaviour types planned to be developed for during the research.

In order to test the tools reliability, some selected building examples tested out according to previously mentioned design flaws regarding to free-form surfaces.

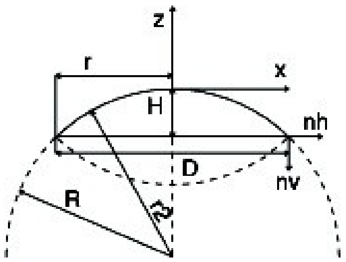
4.1 Case studies

Eero Saarinen's Kresge Auditorium in MIT campus is chosen as one of the case studies to test the reliability of the tool we proposed (Fig.2).The reason that we chose the Kresge Auditorium to be one of the examples that tool would be tested is that Kresge Auditorium is not considered as one of the successful examples of the shell structures. Because of its geometry the forces on the surface could not entirely distributed along the surface, and it resulted with the cracks on the surface. Because of these faults, Kresge Auditorium does not look like as it designed in the first place – thin white a concrete shell. Instead it was coated with lead panels to cover its concrete surface.

The Kresge auditorium defined by a thin shell structure, one eight of a square approximately height of 50 feet (15.24 meters) and divided by translucent glass walls so that only three points of the shell structure touches the ground [13].

Fig.2 Retrieved from http://en.structurae.de

Dimensions of the Kresge Auditorium are calculated by a mathematical equation (Fig.3). Then the auditorium is drawn in a drawing program to check these calculations (Fig.4).



$R = H/2 + r^2/2H$

Fig.3

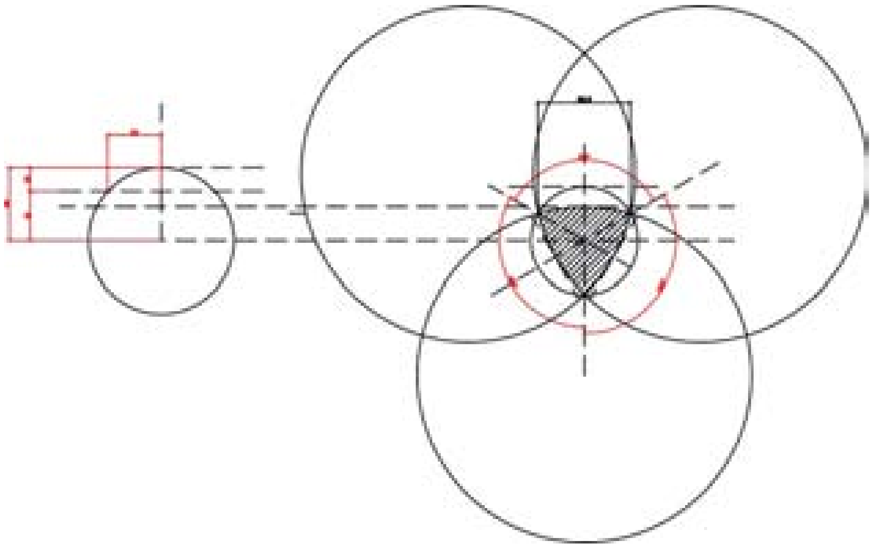


Fig.4

Kresge Auditorium is modelled in modelling program after the completion of the drawing of the Kresge Auditorium in an architectural drawing program. The modelling of the auditorium is made by Boolean operations like substraction and intersection. At first step, a sphere with a 46 feet radius is created, then seven/eight of this sphere is cut and sliced away from the rest. Then three intersected cylinders created in order to have the shape of the auditorium. After each one of the cylinder's and one eight of the sphere's intersection is taken, the final shape of the Kresge Auditorium was completed in the modelling program (Fig 5-7).

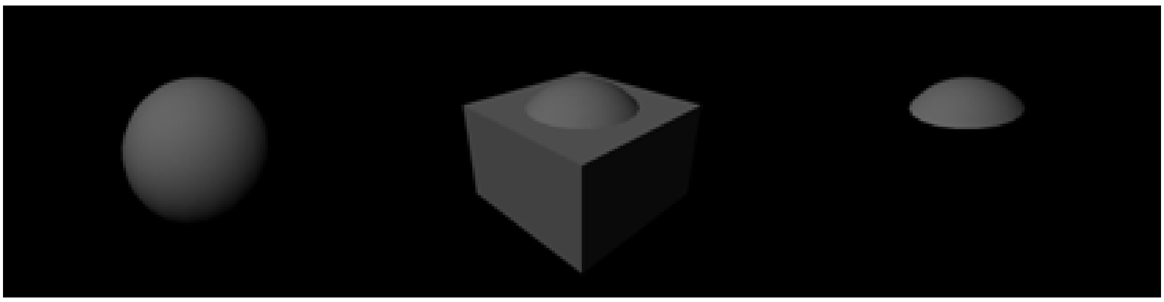


Fig.5

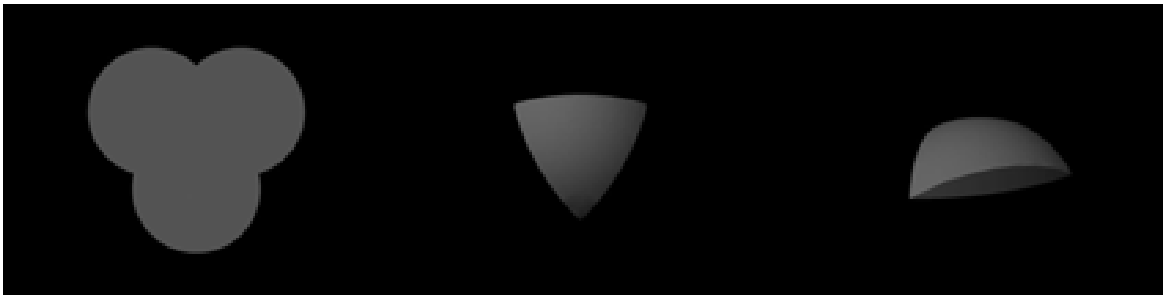


Fig.6

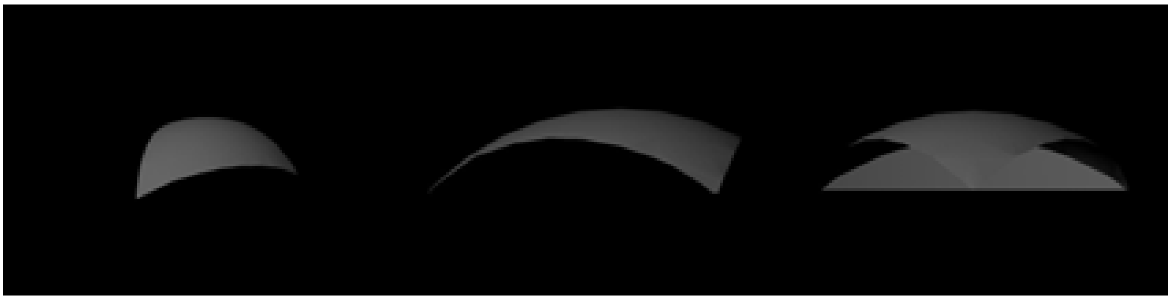


Fig.7

After Kresge Auditorium was transferred into the environment, rain-flow analysis was run with the model of the auditorium. Because of the scripting of the tool was in development process at the time, only the results of the rain-flow analysis could be presented (Fig.8).

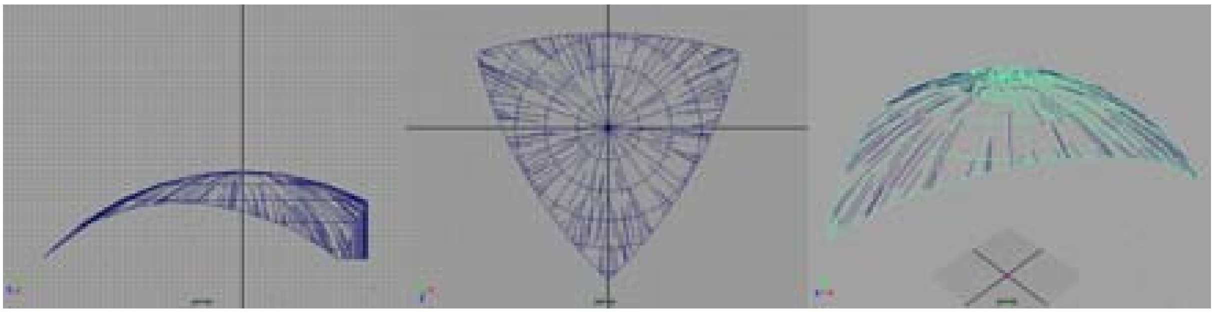


Fig.8

The hypothesis has been tested on the Kresge Auditorium, and the flow of the forces on the surface can be as seen in the results of the rain-flow analysis. On both left and the right sides of the surface, loads run through the edges instead of along the supports. This state leads to an undesirable position.

5. Conclusions

The digital tool we proposed in this paper shows how an agent system based tool can help designers for free-form shape generation in digital media. Results of this research can result in a novel way to determine the feasibility of the form of the free-form architectural designs. We suggest that with carefully describing and documenting the difficulties regarding the design stage of free-form designs like structural characteristics, material and form finding related issues; the core elements of free-form design, which play a great part in altering the design, can be captured so that we can examine and identify alternative design solutions regarding our design repository within the domain of free-form design. In the future, we aim to develop other agents which would deal with other issues related to the design process of free-form architectural designs; like analysing the form according to the choice of materials or computing the optimal size of the divisions on the surface. This way the tool would gives us a clear and through insight regarding designs.

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References

[1]Stille, Alexander, (July/August 1998). Invisible Cities, Lingua Franca, 40-48 Retrieved October,2007 from the www http://www.jya.com/inci.htm

[2]Borgart, A., de Leuw, M., Hoogenboom, P., (2005). The relationship of form and force in (irregular) curved surfaces, Proceedings of the 5th International Conference on Computation of Shell and Spatial Structures.

[3]Zellner, P. (ed.) (1999). Hybrid Space: New Forms in Digital Architecture, Thames and Hudson, London.

[4]Wooldridge, M. and Jennings, N. R. (1995). Intelligent agents: Theory and Practice, Knowledge Engineering Review 10(2): 115-152

[5]Wooldridge, M.,(2000). Reasoning About Rational Agents, MIT Press, Cambridge, MA.

[6] Maher, M.L., Smith, G. and Gero, J.S. (2003). Design Agents in 3D Virtual Worlds, in R Sun (ed), IJCAI03 Workshop on Cognitive Modeling of Agents and Multi-Agent Interaction, IJCAI, Acapulco. pp 92-100.

[7] Maher, M.L. and Merrick, L. (2005). Agent Models for Dynamic 3D Virtual Worlds, in T. Kunii, S.H. Soon, and A. Sourin (eds) CYBERWORLDS 2005, California: IEEE, pp 27-34.

[8] Saunders, Rob and Gero, John S. (2001). Designing for Interest and Novelty. Motivating Design Agents, Proceedings of the Ninth International Conference on Computer Aided Architectural Design Futures [ISBN 0-7923-7023-6] Eindhoven, 8-11 July 2001, pp. 725-738

[9]Rosenman M A, Smith G, Ding L, Marchant D and Maher M L (2005). Multidisciplinary Design in Virtual Worlds, In B Martens and A Brown (eds) Computer Aided Architectural Design Futures 2005, Springer, Dordrecht, Netherlands, pp.433-442.

[10] Gero, J.S. and Sosa, R. (2002). Creative Design Situations: Artificial Creativity in Communities of Design Agents, CAADRIA 2002 [Proceedings of the 7th International Conference on Computer Aided Architectural Design Research in Asia / ISBN 983-2473-42-X] Cyberjaya (Malaysia) 18–20 April 2002, pp. 191-198 http://cumincad.scix.net/cgi-bin/works/Show?b98f

[11]Aly, S., (2000). A Framework for Interaction and Task Decomposition for Objects Emulating Agency Behaviour, Phd. Dissertation, Carnegie Mellon University, Pittsburg, PA.

[12] Aly, Safwan and Krishnamurti, Ramesh, Can Doors and Windows Become Design Team Players?, Gero JS and Brazier FMT (eds).(2002) Agents in Design 2002. Key Centre of Design Computing and Cognition, University of Sydney, pp. 3-22

[13]Retrieved October,2007 from the www http://libraries.mit.edu/archives/exhibits/saarinen/

The Generative Powers of Textiles

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Abstract
The paper addresses an applied research approach to the generative powers of textiles and their global diachronic cultural and aesthetic influence on Art and Design. The author attempts to reveal the powers of Hellenic and North-East Mediterranean textiles on Art and Design development, based on evidence collected from a wide geographical and temporal expanse. Over the centuries diverse textile artefacts have been spreading throughout Europe, inspiring new designs, ceramics, furniture, decorations, founding local design heritages as well as cultivating national ones. The oldest forms of textile art, consisted of geometric figures, formed a common design background around the Mediterranean littoral, becoming the basis for the spread of intellectual and technical skills, providing inspiration to sophisticated artefacts, contributing to Art and Design evolution. The research team investigated the possibility for innovative design ideas and product-design development that results from the thorough study of textiles' culture and heritage in the context of the living memories and identity that is still present, both theoretically and practically. The approach has been in the applied research direction, and investigates the practical and academic value of an extensive knowledge of textiles among those working in the applied arts. The author guided the new designers towards this starting point for design works that are inspired by local textiles, through using the new perspectives of technical developments, with the idea of combining historic data, culture and innovation. Designers are gradually obliged to increase the quality and innovation of their design products in order to be competitive. Thus, the demand for original innovative designs with identity formulated the starting point of the research. Examples will be presented from the research work, the case study, the teaching programs and the product development. The theoretical and practical results of the total work offer good reason for further investigation on the contribution of textiles to the emerging industrial design culture, as well as to the practice of textile design and the active textile-education field. The total research and design development wish to bring new approaches to all fields of multidisciplinary education.

1. Introduction
The aim of the project was to develop an understanding of the values of antique and modern textiles, of their overall generative powers, of textile-design research methodologies. *The objectives* were to investigate pathways for innovative artefacts that result from the combined research on cultural textiles and today's accelerating electronic technology and to explore the role of research, technology and of the processes that lead to innovative artefacts with cultural identity. The project was

targeting to create new opportunities, visions, skills, directions and media for textile design students, professional designers and producers.
Cloth accesses an astonishingly broad range of human experiences. It is the raw material from which things are made, and has various associations: sensual, somatic, decorative, functional and ritual. Textiles are part of our everyday lives, their very familiarity and accessibility invites a range of speculations about their personal, social and cultural meanings. Textiles cover our body and our surrounding in thousands of variations, by hiding, protecting, warming, connecting, separating, enchasing and exposing. They follow our life from birth to death. They are materials of enormous importance, prime necessity, great variety and demand. It is actually this opulent variety of textiles that make them an incomparable human creation.
Clothing is made from textiles, which are themselves among the first composite materials engineered by humans. Everyone is wearing clothing. It conveys a sense of the wearer's identity, provides protection from the environment, and supplies a convenient way to carry all the paraphernalia of daily life. Textiles and clothing are also of great importance to the survival of the human race, playing key role in society, too. They are weather protections of the body, interrelated to sex and social rank, expressing characteristics and ways of living and thinking, of groups and individuals, of time periods and societies, projecting differences and similarities, capturing human nature. Textiles transcend boundaries, as they unite and divide mankind. The mode of dress differentiates friend from foe and peasant from prince. Changes in the appearance and types of textiles and garments through the ages are a significant indicator of social, economic and chronological changes.

2. Textiles

Clothes began from the efforts of people to cover the human body by the skin of an animal, to be replaced later by a rectangle piece of loomed cloth wrapped around the body, inevitably forming folds, embracing it in a variety of elaborate ways, creating garments that are often distinguished by their quality and simplicity [1]. Closely connected with the practical need of humans to be clothed is the desire for beautification of the imperative clothing with colours and patterns. From a historical point of view, dyeing is as old as the textile industry itself. According to Greek mythology Ariadne, the goddess of spinning and weaving, was the daughter of Idon, the dyer. This is an interesting chronological coincidence that shows how intimately the art of dyeing was connected with sister arts. Spinning and weaving goes back to the dawn of civilization to at least 8000 years ago, with the first materials probably woven like a basket, without loom [29]. Textile production around the Mediterranean littoral from antiquity was, and still is, mainly a woman's work and to this they devote more time than in their other pursuits. Clothing was usually homemade by the ladies of the house and the female slaves [20]. Quite often the task was considered a religious duty and an honour for women, as it was the case with the *'peplos'* of the statue of goddess Athena. Weaving was an occupation of the ladies of the highest status. In the *Iliad* Homer mentions that goddess Athena wears dresses she wove herself; in the *Odyssey* he states that queen Arete has offered to Odysseus clothes she had made with her female-slaves' help, while Penelope is described to weave and re-weave a piece of cloth to postpone second marriage [30]. Textiles and clothing have been also a great attraction of the travellers of antiquity since the Egyptian and Hellenic Bronze era. It is evident that travelling was quite limited at that time to few intellectuals with curiosity [26]. Democritos, Herodotus, Plato, Aristotle,

Ptolemy were some of the well-known travellers of the ancient world and via those travellers curiosity, fabulous hand made rare textiles moved from India and China to Egypt, Greece, Rome and the Black Sea littoral, inspiring and transplanting diverse local cultures, founding local heritages and cultivating national ones.
During recent years, the textile design industry has highlighted the strong position of hand made items and natural fibres. The "*traditional*" fabrics have come back with the use of various techniques of mechanical and chemical finishing. Clothing industries and producers of home textiles had turned back towards natural materials such as linen, cotton and wool into their collections. Natural fibres are applied in a whole assortment of products from clothing, bedclothes and upholstery to window decorations, carpets and fitted carpets. After a period of fascination with plastics, the conviction that natural fibres are especially precious materials is becoming more and more popular. They are ecological and have very good application and aesthetic qualities.

3. Textiles and Cultural Heritage

Designing textiles is a conscious process, carried out by synthesizing visual, aesthetical and applied means, which can be expressed in forms and creations. It is also a subconscious process expressing the designers' inner world, marked by their identity. The evolution of an idea into an innovative form of clothing has always been a challenge for any designer, unknown or a famous, exercising his or her imagination and reason. The form always emerges from many factors as a result of the original concept, though it is considerably modified during the process of creation. It expresses the artist's vision and culture, as far as this is possible, within the limitations of materials and techniques. Social groups express their cultural values through their demands, ideologies and preferences, and their aesthetic values have been improved through the distribution of various man-made products, and via their positive or negative appreciation of them. Industries are fully aware of that, and want to influence popular aesthetic values in order to flood the market with products, which are based on their selected standards. It is these very aesthetic standards, which are used by the producers to manipulate consumer demands not only in textile products but also in textile art.
The art of design/textile design stands in intimate relationship with materials, purposes, forms and styles. In many instances, depending on the form of the objects, it is also influenced by the materials in use, the manner in which the natural objects are presented, the purposes for which an object is created, as well as by the nature and the culture of the different people involved at different times, reflecting the spirit of the times, the political or religious ideas of the people, and the effects of foreign cultures. The styles so formed are the truthful expression and presentation of the character of the people of a certain area in a certain historic epoch, and constitute part of their cultural heritage [25]. Design is the product of its epoch rather than of a single person, and local heritage is the catalyst that enables the expression of the same designs seen in nature and which are inspired by the same fauna and flora in a different fashion, according to the culture in which it exists. The use of particular designs is linked to traditions, reflecting unchanged believes, customs and hierarchies, often with spiritual meanings. There is a complex relationship between textile design and identity, connected to aspects as culture, heritage, religion, social status and caste.

Culture and heritage have made a great contribution to textile development. The oldest forms of textile designs consisted of geometric figures such as circles, bands, straight and curved lines, which were drawn in categorical regularity, according to a certain rhythm, and conforming to the structure of the objects they adorned. They formed the common design background throughout the Mediterranean littoral, were the basis for the spread of intellectual and technical skills and provided the inspiration the Europeans needed to create more sophisticated designs. Local cultures remain one of the outstanding inner strengths of Europe and via history they have long contributed to textile design evolution. Across the centuries, Europe and European intellectuals have preserved their attachment to their heritage. The values of European cultural heritage are appreciated again, enriched with experience, new ways of thinking and techniques.

Reconsidering textile art and design from a new viewpoint and with new media is a real design work, because during the process of designing, the artist views things without preconception. It is also a human-centred approach, in the very broad meaning of the term, since textiles and culture are fundamental parts of human nature. Of course if one is unfamiliar with the real textile culture, the attempt to recreate or unite it with industrial products can destroy both the form and the artist's intention. The revival of textile culture and heritage through industrial design doesn't mean mere imitation of old designs. Actually they need to be fully understood and a renewed appreciation of traditional culture should be gained. It is vital to develop cultural originality and distinctiveness, and to design textiles and products that reflect cultural background in ways that establish one's identity and originality. When this distinctiveness is reinterpreted in terms of form, image and symbolism, and is compounded into products local industrial competitive powers will be definitely strengthened. Education is a very important factor in forming cultural-consciousness and the increasing opportunities offered by multimedia and the Internet help us to get closer to the values of textiles and cultural heritage [21].

4. Textile Design Research

The research team and the working group faced the fundamental question if textile design is a valid research area and technique - to be proved a valuable one. Design research by definition changes the state-of-the-world through the introduction of novel artefacts, which is the motto of the present case study. Design research is distinguished from design by the production of interesting to a community new knowledge. Design is distinguished from design research within its community of interest by the intellectual risk, the number of unknowns in the proposed design which, when successfully surmounted, provide the new information that makes the effort research and assures its value. Creativity is essential to any design effort. All design disciplines, including textiles, have a long history of building their knowledge base through the construction of artefacts and via the evaluation of artefact performance that follows the construction. Textiles are a strongly construction-oriented discipline, with a history extending over thousands of years to the pre-historic era.

Research in textiles has developed, expanded to technical textiles, while is still maintaining activity in important traditional textiles. Projects integrate textile design with technology and the study of the aesthetic concepts associated with the incorporation of shape and materials. Research is carried out also in the

textile/clothing interface, in methods for measurement of textile aesthetics, for fabric mechanics, computer-aided 3D modelling and visualisation techniques, linked to human body, and in face modelling developed to simulate garment drape. Electronic textiles, also referred to as smart fabrics, Intelligent textiles and Nanotextiles are quite fashionable right now, prooving that textiles are more than just cloths and curtains. Fabrics can catch bullets, fight infection, light up, warm, cool, and even react at the blink of an eye. Whether used as life-saving device or for sheer novelty factor, the latest innovations in textile effects are opening ways for textile developing beyond conventional limits. Their close relationship with the field of computer wearables gives many diverging research directions. On one end of the spectrum, there are pragmatic applications such as military research into interactive camouflage or textiles that can heal wounded soldiers. On the other end of the spectrum, work is being done by artists and designers in the area of reactive clothes: "second skins" that can adapt to the environment and to the individual. Fashion, health, and telecommunication industries are also pursuing the vision of clothing that can express aspects of people's personalities, needs, and desires.
Conductive yarns and fibers are used for power delivery, communication, and networking. These textiles are created using traditional textile manufacturing techniques: spinning conductive yarns, weaving, knitting, embroidering, sewing, and printing with inks. Leading apparel companies are successfully commercialising clothing with added functionalities, revolutionasing fabrics and high fashion markets in the years to come. Textile effects are created with the most exciting technologies of tommorow, like the shock-absorbent or breathable fabrics. One of the greatest challenges in the fabric enchancement are the Nanotextiles. Improoving the quality and value of textiles without impacting texture at all has been very difficult, but scientits have discovered that this can be achived by modifing fibers and fabrics at the nano scale. Groundbreaking enterprices are making commercial applications using nanofibres and nano-scale membranes and coatings. A system called Robotic Fibber Assembly and Control can mold a non-woven fabric of melt-blown nanofibres onto a mannequin, manufacturing a garment without cutting and sewing, shaping them into lightweight, high-performance protective clothing. Further research is underway to incorporate electro-spinning technology with the system, to reduce garment weights while increasing protection. This technology is available for soldiers and fire fighters to protect themselves from almost anything.
Textile design research can contribute to better theories and practices: the methodological construction of textiles and textile products/artefacts. The phase of textiles research on which reflection and analysis focuses and the level of abstraction to which the reflection and analysis generalize, determine precisely what is obtained from a textile design research effort. The construction phase of a textile design research effort can be an experimental proof of a method, or an experimental exploration of a method, or both. The problem statement is subject to revision as the design research effort proceeds. Evaluation takes place continuously in any design/textile design process, research or otherwise, since a large number of “micro-evaluations” take place at every textiles decision. Each decision is followed by a “thought experiment” in which that part of the textile design is mentally exercised by the designer. Research in the area of textile education is also vital in order to ensure that academics are at the forefront of textile and clothing industry developments, to ensure that the teaching is always up to date, and to prepare the graduates in an appropriate way for the world of work.

5. The Generative Powers of Hellenic Textiles

The earliest Hellenic civilizations thrived 4,000 years ago, but their culture still impacts arts, philosophy, science, literature, politics, and even fashion. Ancient Greek clothing is of increasing interest to scholars in many fields, including archaeology, anthropology, art and design. Unfortunately Greek mild climate is one of the worst to preserve archaeological textiles, since only extremely dry climates are ideal for preserving almost any type of fabric. Clothing in ancient Greece was plentiful, of a relatively high standard in terms of materials, construction and design, centred in an aesthetic that idealized the human body, rather then attempting to conceal its natural shape [22]. The Hellenes were always keen on fashion, fine cloths and fabulous decorative furniture fabrics, with evident increasing preoccupation with clothing during the Minoan/Mycenaean, Classical and Hellenistic periods [18]. There is plenty of evidence of very early blooming textile ‘factories’, from the 3rd millennium BC to the Roman era. Spinning, weaving and tailoring techniques were already known in Neolithic times and documentations of woven goods date back to 2000 B.C [3, 5].

Greeks were among the finest to portray fashion and costume with meticulous care and precision. There are untold numbers of frescoes, statues and carvings in pottery, which are revealing their textiles and fashions [9]. There are also great writers such as Homer and the Greek historian Herodotus who has given explicit details and descriptions of clothing and textiles [13, 14]. Though there are no surviving textiles of the Hellenic Bronze age, except a few scraps of cloth, the well-known impressions of the Aegean islands of Crete and Sandorini display the complex richness of clothing shapes and designs of the era [4, 27]. During the Hellenic Bronze Age the most widely used fibre was flax along with wool, goat’s hair and other animal fibres [7]. Minoan and Mycenaean textiles displayed distinctive colours and dyes characteristic of their art and culture [28]. The belief that classical Greek clothing was plain and not ornamented and that Greeks did not know how to make pattered cloths was an archaeological presumption [11, 12]. It is opposed by the discovered textile fragments, the numerous historical descriptions of heavily pattered and highly elaborate hiton (tunic) and peploi (veils), and their artistic representations, painted on thousands of classical vases, spread around the word’s Museums, showing men and women wearing garments covered with figured friezes and all-over elaborate patterns [6, 10]. The Ancient classical Greek costume, which belongs to the draped and wrapped convention, is one of the oldest forms of dress to be found, surviving to the present day in many traditional – and Greek - costumes [2] and in haute couture.Ancient Greek dress was more voluminous then that of the Egyptians, and was most often made of fine woollens, although it is thought that the Greeks also had regular access to linen, hemp cloth and silk [23, 24]. Although the Greek costumes had read no form, they managed to stay the same for many generations [8]. They were mostly made up of rectangles of cloth of various shapes and sizes but basically all stayed the same shape for men and women. Like Egyptian dress, The Greeks made many clothing decisions based on this aesthetic that were less then practical choices [19].

Though no ancient Greek dress has survived, modern designers have interpreted the Hellenic fundamental dress forms, as they are displayed on statues, in countless ways and versions [17]. Pleads light and shade continued to follow their path in history and at other latitudes and longitudes [15, 16]. From the so-called neoclassical dresses of the Directory period to the highly experimental investigations of the designers of the 20th century, classical cloth has influenced fashion design in different diverse ways, becoming a power of evolution in the hands of intelligent creators. The endless complex beauties of the simple draped and pleated clothing according to Greco-Roman style caught the eyes of artists of every sort, painters, sculptors and poets, for their delicate artfulness. Over the years styles changed, but the source of interest remained as a perpetual challenge and inspiration to all artists. The drapery in representations of Classical date grafted their aesthetics on to the garments over the years. The return of classical ideal to form in 19th century and early 20th dresses and Cashmere shawls recall the Greek hiton and himation, and the Roman toga.

Modern designers have interpreted Hellenic fundamental dress forms, in countless ways and versions. Madeleine Vionnet's, whose name is closely bound with the ancient draped cloth, evening gowns in shades of white, recall ancient Greek dresses. Her brilliant creation *The Living Statue* of 1931, implying all the concepts of the aesthetic culture of classical Hellenic clothing, revived the statue of Victory with wings (figure 1, a). Issey Miyake (figure 1, c), who is one of the most highly recognized Japanese designers, gained his esteem with a series of ethereal works of pleads and folds according to the ancient Greek manner, combining advanced technology with precise drawing and ethereal simplicity. Mariano Fortuny created the gossamer dress "Delphos' inspired by Isadora Duncan's dancers and the silk scarf "Knossos", inspired by the Minoan Lady with the scarf, of the 2nd millennium BC. The crystallised pleats of Desses (figure 1, d), Fath, Dior, Balenciaga captured a frozen moment of movement of the pleated cloth. The endlessly beauties of Hellenic draped and pleated clothing remained over the centuries a perpetual challenge and inspiration to designers. The culture of Hellenic Textiles are flourishing around the world, moving beyond the traditional Western sphere of influence, as designers explore their cultural, structural and thematic beauty, playing important role in many diverse design disciplines.

a

b

c

d

Figure 1. Real works of art, all inspired by the beauty of the Hellenic cloth. a: Madeleine Vionnet's "Living Statue", 1931; b: Rei Kawakubo dress, 1984; c:

Issey Miyake Waterfall body, 1984; d: Jean Desses robes-manteaux, 1960.

6. Teaching and Learning Methodologies in Textile Design

An important issue for the research team was to identify and adopt a teaching-learning methodology. Textile Design education is multidisciplinary, offering a range of textile design specialisms including print, weave, knit and mixed media. It is open and flexible, enabling to cross boundaries from one discipline to another and to direct work towards fashion, interior, craft or gallery outcome. There is a strong emphasis on visual research and drawing for design and concept development. Projects encourage self-motivation and generate personal creative languages. The education of textile designers is by its very nature the education of theory and practice. One cannot separate one from the other without irreconcilably corrupting the historic and process-based links that exist between them. Theory as an agent upon design process/practice, and design process/practice as an agent upon theory, create a symbiosis that are intimately and undeniably bound together. This bond exists both in practice and in teaching processes.

Textile Art/Design students are more accustomed to learning through teamwork, collaborative activities and peer assessment. Some Applied Arts disciplines, such as History of Art, offer a more traditional, academic approach to study. Textile learners prefer a more practical, visual, approach. Design learners are 'visual thinkers'. They appreciate materials, which are well conceived visually, but they can be critical or dismissive of those, which may not meet their aesthetic preferences. Textile artists and designers respond well to materials or activities that provide them with the stimulus to create something. The occurrence of dyslexia in art and design does not affect the design study. Many gifted students who use the new, visually oriented technologies are dyslexic or have other academic learning difficulties. Currently, art and design students are learning to use a range of tools, among which, the most popular are web and e-mail services. In the textile design field the greatest part of learning is independent learning. That does not degrade the role of the instructor. On the contrary, instructors help learning to take place by providing learners with resource materials and chances to test their learning, by giving them feedback on their progress and by helping them to make sense of what they have learned. Textile learning is resource-based. Design learning resources take many forms, including human resources (tutors, fellow-students) and information-type resources (books, databases, on-line databanks, learning packages, lecture notes, manuals). Nowadays, the range of media available to support textile art and design learning is extended due to many technological developments and important learning outcomes can also be achieved through games, simulations and role-play exercises. The research team adopted the independent resource-based and the teamwork learning approach, focusing on the learning side of the teaching-learning equation.

The adapted teaching methodology was composed of the following actions: *The first action* of the research team was to point all the participating students in the direction of exploring and studding selected periods of textile art and design. The study, by the participants, of the morphology of antique textiles resulted to innovative products. The *Investigating part* included collection of photographic data, sketches and drawings together with impressions, feelings and ideas, presentation, analysis and evaluation of the selected data, within special design teaching projects. It was comprised of three actions: *Field and desk research*, for an academic semester, of a selected cultural area of textiles. The working team created a flexible learning pathway among the different periods of the history of textiles for the participating students, offering them an optimum learning experience from the design data, and greater incentive to benefit from collaborative approaches to their subject. *Collection of textile designs* from the selected period. The participants had to outline what method of research had been used to obtain the information, what references and information had been sourced and could be utilized, and how the collected data had been organized and filed. *Study* of cultural textile designs, organized according to historic periods, within special lectures on the History of Textiles.

The second action was the design teaching projects. The students explored, as sensitively as possible, the developing possibilities of cultural textiles, acknowledging the constituent elements of 21st century and the contemporary way of thinking. The teaching projects involved design students trained to the same level in design/textile design. For all the participants the academic and practical work took place at the Textile Design Studio of TEI of Athens. *The Creation part* that followed included the development of the selected designs into new textiles and products by the participants, following the principle that the conformation of a design should be in keeping within its form and structure but not in complete subordination to it. The designs were treated with emphasis on their cultural values and identity. The total work aimed to create designs that fulfil the demands of the modern consumer and can be produced with traditional and computerized means of production. *Creation of new products*, accompanied with examples of the possibilities of their use, of applications and adaptations. The final products in many cases were developed by hand and via computer programmes, thus offering to participating students work interest, versatility and variety of possibilities and applications (Figure 2). All were created during the educational sessions and via special design teaching projects. A parallel market research was required, too.

a **b** **c**

Figure 2. Both the jewellery design, c, and the lamb-shade decorations, a, are inspired and follow the motifs of the traditional cloth, b.

The students' creative minds developed techniques and applications, which led to artistic production of innovative forms for personal or decorative use. In accordance to the research work and inspired by the various presentations of female Minoan dresses from the Santorini frescoes, the students of the Textile and Industrial Design Studios of TEI of Athens developed innovative forms for new industrial products, proposing innovative toothbrushes, designed totally according to the figure lines of the Minoan female fashion, and also a lamp shade (Figure 2, a,) and a silver jewellery set (Figure 2, c), both inspired by a traditional embroidery of 19th century (Figure 2, b).

7. Conclusion

There were many learning outcomes from the project. The research team realized that research methods need complex referencing for the discovery of relevant information. The identification of sources of information concerning Hellenic and Aegean fashion and textile design was important facet of this discovery process. Analysis of the materials and techniques of textile production in the Aegean, Classical and Roman eras was another element of this important agenda.

Textile and fashion design development is multifaceted and operates on many different levels and across subject areas. In this regard it is also essential to analyse the materials and techniques of fashion and textile production in the modern European Industry. The project assisted in determining the value of providing case study material for the student to develop an understanding of value of deep knowledge of design/textile design history in the active product design process. It is expected that this initiative will provide a working model for developing future projects on culture, textiles and design.

The work of the participants was, directly or indirectly, technologically assisted, so the influence of communication technologies on the designer's sensibility and creativity was employed as criterion of the final evaluation. However, it was found that this influence was to a great extent less evident than expected and it did not limit the artistic freedom in creation. In the time of cultural changes, elements such as sensibility, creativity, personality and cultural heritage are still playing a very important, almost ethical, role in students' aesthetics, generating the power of design with or without the aid of technical processes.

The hope is that this approach to textiles will highlight new frontiers in design production, generate new opportunities for young designers and introduce new approaches to all fields of design education. This proposal aims to stimulate further research for design projects, which will result from historical/cultural data, have identity and inspire unique modern products. Simultaneously, the present work intends to open up new horizons for young textile designers with a spirit for innovation based on respect for their history of design. Thus, the educational work is not limited to the field of textile design; neither does it focus only on Greek textiles or design production. In fact, it aspires to motivate and strengthen European and international intercultural transactions.

8. References

1. Abrams, H. (1993), *Textiles 5,000 Years: An International History and Illustrated Survey,* Harris, Jennifer, Inc., Publishers, pp. 161-165, New York.
2. Abrahams, E. (1908), *Greek Dress,* London.

3. Barber, E.J.W. (1990), *Prehistoric Textiles,* Prinston University Press, New Jersey, USA.
4. Beckwith, J. (1954), Textile Fragments from Classical Antiquity, *Illustrated London News*, no. 224, London.
5. Benson, A. & Warburton, N. (1986), *Looms and Weaving*, Shire Publications, London.
6. Burnham, H. (1964), The World's Oldest Textiles, *Journal of the Royal Ontario Museum* 1, pp. 105-108.
7. Carington, S. (1975), Spinning, Weaving, and Textile Manufacture in Prehistoric Crete, PhD Thesis, University of Tasmania.
8. Creekmore, A. & Pokornowski, I. (1982), *Textile History,* University Press of America, Washington.
9. Doumas, C. (1992), *The Frescoes of Santorini,* Thira Foundation, Athens.
10. Furtwangler, A. (1904 & 1932), *Greek Vases* vol. 1 & 3, Munich, National Library of Athens.
11. Gertsiger, D. (1973), *Antique Textiles in the Hermitage,* pp. 71-100.
12. Granger-Taylor, H. & Wild, J. (1981), Some Ancient Silk From the Crimea in the British Museum, *Antiquaries Journal,* no. 61, pp. 302-306.
13. Homer, in Greek Ὅμηρος/Hómēros, (9th or 8th century BC) *Iliad,* (Greek Ιλιάς), Greek original edition, Athens University.
14. Homer, (9th or 8th century BC), *Odyssey* (Greek Οδύσσεια)*,* Greek original edition, Athens University.
15. Hope, T. (1986), *Costumes of Greeks and Romans*, Dover Publications, Minneola.
16. Huston, M. (2003), *Ancient Greek, Roman and Byzantine Costume*, Dover Publications, Minneola.
17. Karouzou, S. (1980), *National Museum Illustrated Guide*, National Museum, Athens.
18. *Manufacture of Wool, Silk, Cotton and Flax, Ancient and Modern*, United States Democratic Review, 1846, Posted October 1, 2004.
19. Norris, H. (2000), *Ancient European Costume and Fashion,* Dover Publications, Minneola.
20. Ovidius, Publius Naso, (1st century BC), *Heroides, Penelope,* original Latin text, University of Athens.
21. Perivoliotis, M. C. (2005), *The Role of Textile History in Design Innovation,* textiles History Journal, May/2005.
22. Richter, G. M. A. (1929), Silk in Greece*, American Journal of Archeology* no. 33, pp. 27-33.
23. Roccos, L. J. (2002), *Ancient Greek Costume*, College of Staten Island Library, New York.

24. Smith, J. M. (1882), *Ancient Greek female costume,* Sampson Low, Marston, Searle, & Rivington, London.
25. Speltz, A. (1994), *Styles of ornament*, Gramercy Books, New York, pp. 1-7.
26. *Textile Analysis: Early Techniques in Egypt and the Near East,* (1950) The Textile Museum, Workshop Notes, USA.
27. Tzachili, I. (1982), *Τα ποικίλα Θηραϊκά Ιμάτια*, Αρχαιολογικά Ανάλεκτα εξ Αθηνών 14, (*Ta poikila Thiraika Imatia*, Arheologika Analekta es Athinon), pp.251-64
28. Tzachili, I. (2004), Egyptian, Minoan and Greek dress: Differences and similarities *Pleats and Folds conference proceedings,* Beneki Museum, Athens, Greece.
29. Wild, J. (1988), *Textiles in Archaeology*, Shire Publications, Aylesbury.
30. Wylde, C. H. (1907), The History of Tapestry *Burlington Magazine for Connoisseurs*, Vol. 11, No. 51/1907, pp. 171-172.

Automatic Generation of Aesthetic Images for Computer-Assisted Virtual Fashion Design

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Abstract

The paper presents both a theoretical framework and software developments for the creation of aesthetic images in the context of virtual fashion design. Image generation involves different approaches such as iterated fractal systems (IFS) and nonlinear trajectory models. Both model parameters and colour space exploration is performed through a simple user interface. Interactive mapping of the generated images is realized on virtual clothes, and realistic rendering techniques are used for 3D visualisation. The results contribute to promote both computer assistance and mass customisation for fashion design.

1. Introduction

There is a multitude of domains in which aesthetic component plays an important role. For example to estimate the interest of solutions proposed in architecture, product design, interior decoration, or in the field of fashion design. Automatic or computer assisted generation of solutions is a promising domain. However, we are confronted with the difficult problem of the formalization of aesthetic criteria. Moreover, the aesthetic interest of a solution generated by a computer lies in the way the human perceived it.

In the context of fashion design, Virtual Reality (VR) techniques provide a very efficient way of visualizing clothes with different texture images on virtual mannequins in both static and dynamic situations (catwalks). However, fashion design VR applications allow only to show 3D clothes models with predefined texture images. We believe that the integration of "on-line" creation modules may stimulate creativity of the designers or customers and reduce the number of physical prototypes. Indeed, such modules could propose some efficient functionalities for automatic generation of digital patterns with aesthetic qualities. Aesthetic may be defined here by some geometrical properties such as symmetries or regularities in scale.

In this paper, we present mathematical models that allow automatic generation of aesthetic images in the context of fashion design. Our current approach involves both iterated fractal systems (IFS) and nonlinear trajectory models. In section 2, we describe the proposed methodology and analyze two of the most interesting mathematical models we use. In section 3, we present two software applications that allow easy creation of aesthetic textures images and 3D mapping onto the clothes of a virtual mannequin. The paper ends by a conclusion and gives some tracks for future work.

2. Methodology and models

The contribution of this work is multiple and involves three complementary steps:

1 - the identification or development of mathematical models showing some potentialities for generating complex patterns with aesthetic qualities,

2 - the implementation of the identified or developed mathematical models for computer-aided exploration of their potentialities,

3 - the integration of the mathematical models in a flexible software platform offering multiple interactive capabilities for virtual fashion design.

2.1 Methodology

The developed methodological approach is illustrated in Figure1. This approach is based on two modules:

- The exploration module allows the user for fast exploration of the mathematical models parameters.

- The visualization module allows visualizing the generated images onto clothes of a virtual mannequin. The generated images may be correctly placed and/or scaled directly on the clothes. The user is also allowed to rotate and zoom on the mannequin using the computer mouse. In this way, he/she could get better appreciation of the final result.

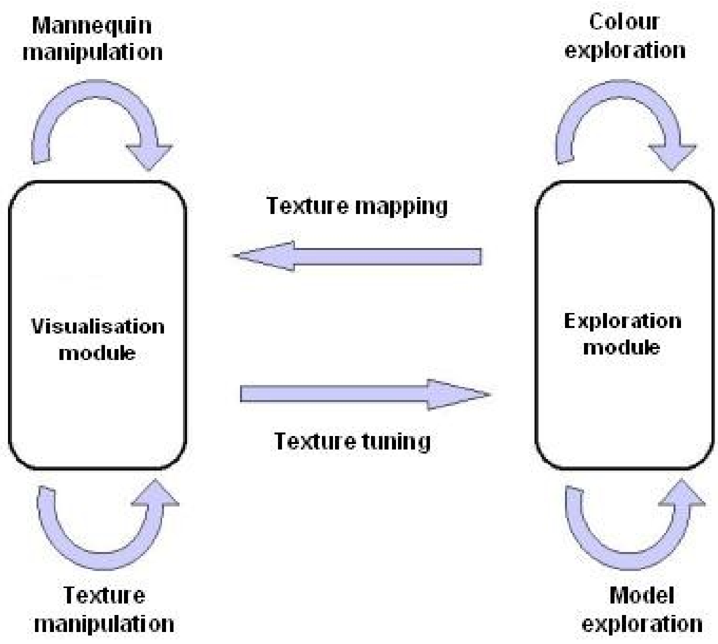


Fig.1: Methodological approach for the design of texture images for fashion design

2.2 Iterated fractal systems

Iterated fractal systems (IFS) are formed by systems of functions which are iterated to converge to fractal attractors. They have been introduced in the context of fractal geometry as models to construct fractal patterns. In the context of image processing, they have found applications for image synthesis and image compression [1-4]. IFS contain rich potentialities to be explored, particularly in the context of fashion design. Indeed, automatic generation of fractal image could stimulate creativity and allow fast exploration of solutions space of a given IFS. Here, we describe and analyze a basic model of IFS and address the issue of fast generation of the fractal images they generate. We consider the set I of two-dimensional images gray-level $s(x,y) \in$ IR with spatial coordinates (x,y) defined over the support S = [0,1[x [0,1[. A transformation T is introduced which maps an initial image of I into a final image of I [5,6]. The final image is obtained as the union of 4 sub-images defined over the 4 quarters of support S, i.e. [0,1/2[x [0,1/2[= S_1, [1/2,1[x [0,1/2[= S_2, [0,1/2[x [1/2,1[= S_3, and [1/2,1[x [1/2,1[= S_4, over which each sub-image is a contracted version of the initial image with affinely transformed gray levels. Explicitly, the union of the four sub-transformations defines transformation T as:

$$S \times \mathrm{IR} \rightarrow S_1 \times \mathrm{IR}$$

$$((x,y), s(x,y)) \rightarrow ((\frac{x}{2},\frac{y}{2}), a_1 s(x,y)+b_1 +c_1 x+d_1 y) \quad (1)$$

$$S \times \mathrm{IR} \rightarrow S_2 \times \mathrm{IR}$$

$$((x;y); s(x;y)) \rightarrow ((\frac{1}{2}+\frac{x}{2},\frac{y}{2}), a_2 s(x,y)+b_2+c_2 x+d_2 y) \quad (2)$$

$$S \times \mathrm{IR} \rightarrow S_3 \times \mathrm{IR}$$

$$((x,y),\ s(x,y)) \rightarrow \left(\left(\frac{x}{2}, \frac{1}{2} + \frac{y}{2}\right),\ a_3 s(x,y)+b_3+c_3x+d_3y\right) \qquad (3)$$

and

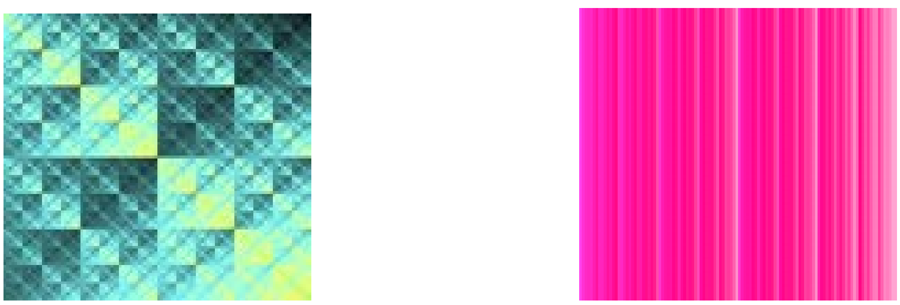
$$\mathrm{S} \times \mathrm{IR} \rightarrow \mathrm{S}_4 \times \mathrm{IR}$$

$$((x,y),\ s(x,y)) \rightarrow \left(\left(\frac{1}{2}+\frac{x}{2}, \frac{1}{2}+\frac{y}{2}\right),\ a_4 s(x,y) + b_4+c_4x+d_4y\right) \qquad (4)$$

with real coefficients a_j, b_j, c_j and d_j verifying $0 < |a_j| < 1$, for j = 1 to 4, so as to have contractive mappings.

The transformation T defined by Eqs.(1)–(4) implements on both the spatial coordinates (x,y) and the gray level $s(x,y)$, contractive affine transforms. Consequently, the mapping $s(x,y) \rightarrow T[s(x,y)]$ is also a contractive affine transform. It results [2] that $s(x,y) \rightarrow T[s(x,y)]$ admits one single fixed point, i.e. an image $\sigma(x,y)$ verifying $T[\sigma(x,y)] = \sigma(x,y)$ also called the attractor of transformation T. Starting from any initial image $s_0(x,y) \in I$, iterative application of the transformation T defined by Eqs. (1)–(4) realizes an IFS. The process converges to a unique attractor $\sigma(x,y)$ that is completely determined by the set of 16 parameters $\{(a_j,b_j, c_j,d_j), j =1...4\}$.

The attractor, solution of the fixed-point equation $T[\sigma(x,y)] = \sigma(x,y)$, is endowed with a self transformability property which confers to it a self-affine or fractal character. This translates into complicated shapes for $\sigma(x,y)$, with structures or details occurring at all scales, as visible on the image of $\sigma(x,y)$ shown in Figure 2a.
Depending on the parameters, the generated images can display more or less prominently their inherent fractal structure. For instance the apparent homogeneity of the image shown in Figure 2b produces a relatively poor visual traduction of the fractal structure. By contrast, Figure 2a provides a very vivid traduction of this fractal structure. This shows that certain sets of parameters are more suited than others for a prominent traduction of the fractal structure. The achievement with fractals of aesthetic criteria and the exploration of the solutions thus rest on the capacity to control in a precise way the parameters of the IFS.



(a) **(b)**

Fig. 2 : Examples of attractors $\sigma(x,y)$ of the IFS of Eqs. (1)–(4) obtained with a given set of parameters $\{(a_j,b_j,c_j,d_j), j = 1 ... 4\}$.

Determining how to choose the parameters *{(*a_j, b_j, c_j, d_j*), j =1...4}* of the IFS in order to impose prescribed properties onto its attractor is a very difficult problem which would require to explicitly solve the fixed-point equation $T[\sigma(x,y)] = \sigma(x,y)$ in a parametric form. Another possibility is to start with a given set of parameters *{(*a_j, b_j, c_j, d_j*), j =1...4}* and to iterate Eqs. (1)–(4) to converge so as to exhibit the resulting attractor. It is this constructive approach, based on manual exploration of the parameters space via a user interface, that we currently investigate.

2.3 Nonlinear trajectory models

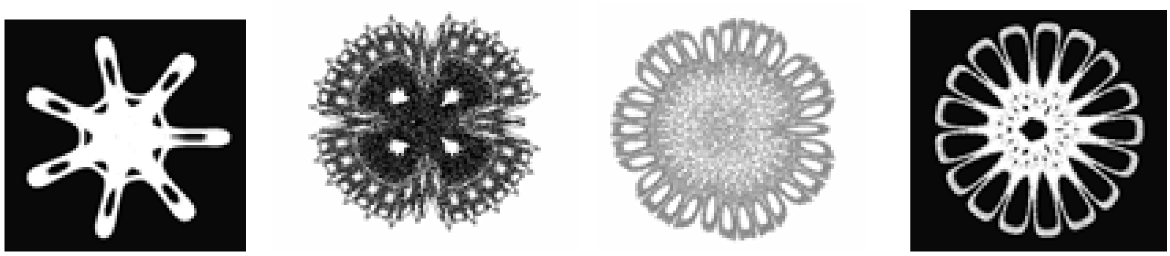
Different nonlinear mathematical models which exhibit rich and complex properties exist in the literature. Some of them may reveal some aesthetic potentialities and are therefore interesting to study in the context of this work [7-8]. Among these models, one of the most interesting is the Mira-Gumowski model (Eq. 6) [9]. Iterations defined by Eq. 7 produce different kind of cellular patterns such as illustrated in Figure 3.

The Mira-Gumowsky model has been introduced for modeling and study accelerated particles trajectories at CERN in 1980. More recently, their aesthetic quality has been identified.

$$F(X) = AX + \frac{2(1-A)X^2}{1+X^2}$$
(6)

$$X_{n+1} = BY_n + F(X_n)$$

$$Y_{n+1} = -X_n + F(Y_n)$$
(7)



A = 0.79, B=1 **A = 0.43, B=1** **A = 0.22, B=1** **A = 0.39, B=1**

Fig. 3 : Examples of patterns obtained using the Mira-Gumowski model.

3. Automatic generation and 3D visualisation

Automatic generation of images and their 3D mapping on virtual clothes are achieved using the software applications illustrated in Figures 4 and 6. The monitor screen is divided in two parts: (1) a left part (visualization module) containing the 3D layout and (2) a right part (exploration module) containing both the generated images and a control interface. The visualization module, developed in C language, is common to the two software applications. It allows to load any 3D model in .3DS format.

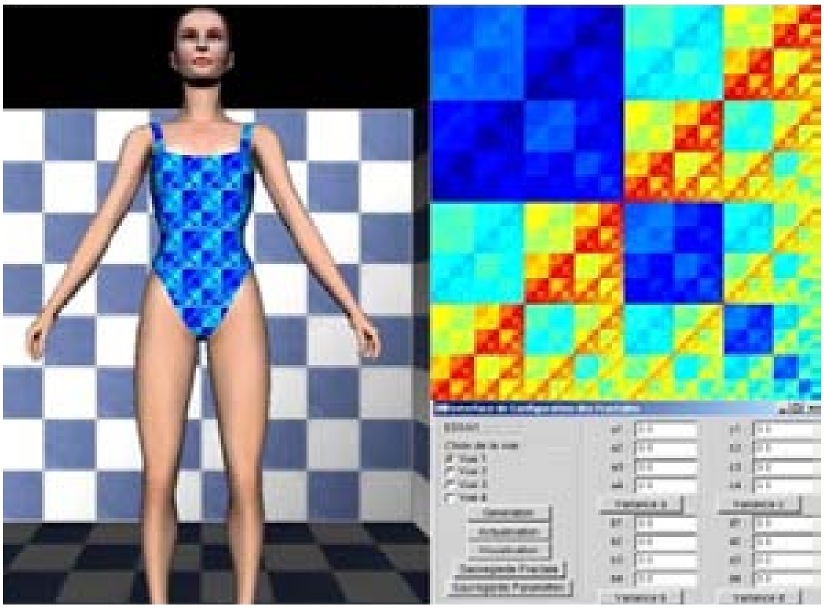
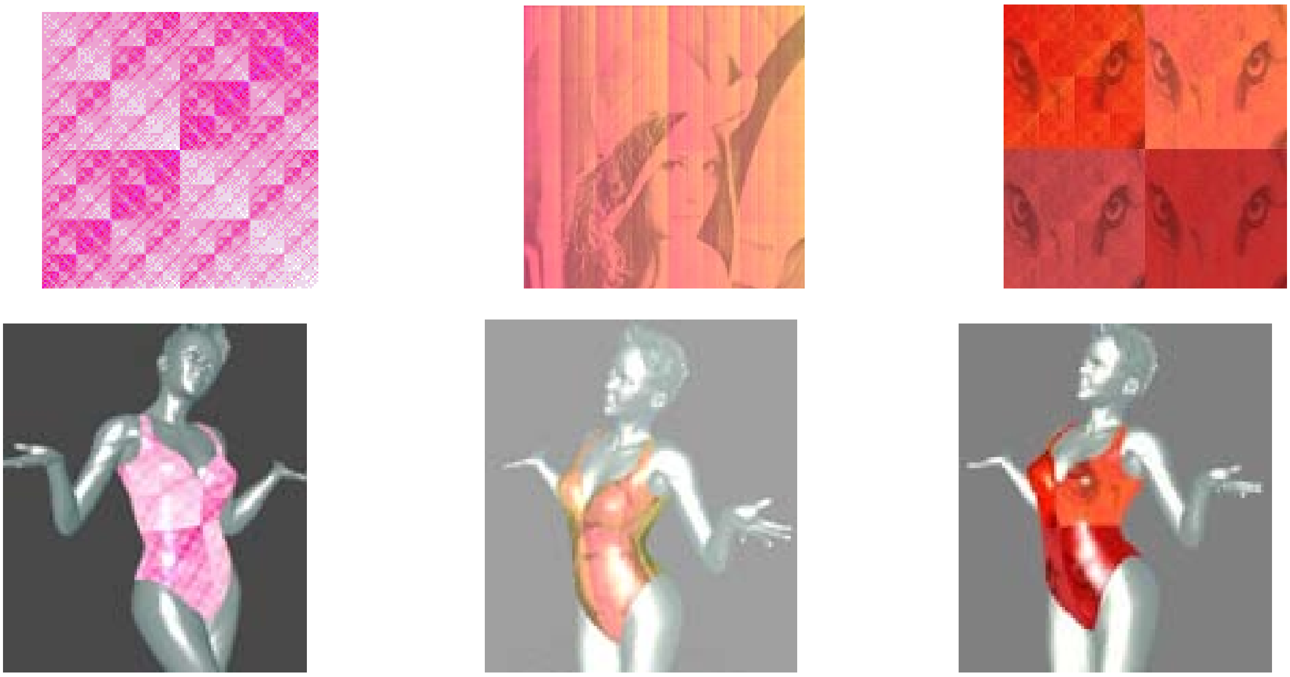


Fig. 4 : Screen shot of the software prototype developed for automatic generation of IFS images based on the attractor $\sigma(x,y)$ of the IFS of Eqs. (1)–(4).

3.1 Generation of IFS images

The control interface allows the user to select one out of four predefined sets of parameters by clicking on given “motif” buttons. A button provides an easy way to configure any color pallet. These pallets may be made from two to four different colors.

A colour configuration interface can be launched from the main control interface. The user may also launch another window that allows individual tuning of the 16 IFS parameters through scrolling buttons. This window also displays the numerical values of these parameters. An example of IFS image and its mapping on a virtual swimming suit is given in Figure 5a. In order to increase customisation of the generated images, we add the possibility to mix any image or picture with an IFS image. Some examples are given in Figures 5b and 5c.



(a) (b) (c)

Fig. 5 : Examples of images based on $\sigma(x,y)$ and their 3D mapping: raw IFS image (a), grayscale Lena picture mixed with an IFS image (b), composite image based on a grayscale lion picture mixed with an IFS image (c).

3.2 Generation of Mira-Gumowski images

The generation of texture images based on the Mira-Gumowski model and some other non-linear models is achieved using a software application illustrated in Figure 6. This application, developed in C# language, allows to generate both centred-pattern images and multi-pattern images such as the one illustrated in Figure 6. As shown on the bottom right part of the Figure 6, other nonlinear models such as Pickover or De Jonc ones may be chosen by the user. For all selected models, colour space is automatically explored, based on random or pre-selected colours. In both cases, a given colour is associated to a given number of iterations, this number being specified by the user. As illustrated in Figure 7, generated images may contain a single centred pattern, or be made of different patterns from the same or from a different model.

Fig. 6 : Screen shot of the software user interface developed for automatic generation of images based on nonlinear trajectory models.

(a) (b) (c)

Fig. 7 : Texture images based on the Mira-Gumowsky model, mapped on a virtual dress.

4. Conclusion

We present both a theoretical framework and software developments for the creation of aesthetic texture images in the context of virtual fashion design. The developed image generation techniques involve different approaches based on iterated function systems (IFS) and on non-linear models. Both models parameters and colour space exploration is realized through a simple user interface. Interactive mapping of the generated images is realized on virtual clothes, and realistic rendering techniques are used for 3D visualisation. The results contribute to promote both computer assistance and mass customisation for fashion design. Concerning the presented IFS, our objective is to try to progressively increase the aesthetic performances of the generated images. We plan to automatically explore model parameters space by seeking to optimize the value of quantitative criteria measuring the aesthetic qualities of the images.

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REFERENCES

[1] Peitgen H., and Richter P., (1986). *The Beauty of Fractals*. Springer-Verlag, Berlin.

[2] Barnsley M. F., (1993). *Fractals Everywhere*. Academic Press, New York.

[3] Lu, N. (1997). *Fractal Imaging*. Academic Press, New York.

[4] Turner M. J., Andrews P. R, Blackledge, J. M. (1998). *Fractal Geometry in Digital Imaging*. Academic Press, New York.

[5] Portefaix C., Cavaro-Ménard C., Chapeau-Blondeau F., (2002). *Identification and modelling of fractal signals with iterated function systems*. pp.185–188. Proceedings of the 11th European Signal Processing Conference, Toulouse, France.

[6] Portefaix C., Cavaro-Ménard C., Chapeau-Blondeau F., (2003). *Modelling of fractal images with iterated function systems: moment matching, continuity of attractors*. pp. 113–116. Proceedings of the 3rd International Symposium on Physics in Signal and Image Processing, Grenoble, France.

[7] Pickover, C. "A Note on Rendering 3-D Strange-Attractors." *Comput. & Graphics* 12, 263, 1988.

[8] http://local.wasp.uwa.edu.au/~pbourke/fractals/peterdejong/

[9] Gumowski I, and Mira L. (1980) Recurrences and Discrete Dynamical Systems, Lecture Notes in Mathematics No. 809, (Springer-Verlag), New York

How does the analog “talk” to the digital?
The Art of Penny Feuerstein

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Abstract:

My paintings are a product of the dialogue between the analog and the digital. I express this in three basic ways: by painting, using the computer, and printing. In the same way that Fernand Leger’s work was a product of the industrial revolution at the turn of the twentieth century, I feel compelled to make art about the “digital revolution.”

Myself. Found objects. Paint. Canvas. My printer. These all represent the analog world, matter made of atoms.

Using the computer, I mimic the digital revolution as I integrate, generate and replicate sections of scanned images taken from multiple analog sources: my paintings, drawings, photographs, and found objects.

This process of using bits to create my collage-paintings mirrors both the computational speeds of our digital age, and an evolving technology of generation and replication that we see in specific areas of science and engineering, i.e. nano technology and bio-medicine.

I bridge these worlds of analog and digital by scanning and printing. Scanning inputs from the analog into the digital. Printing outputs my images from the computer, even as it deliberately communicates how dramatically printing has transformed—from 1440 when Johannes Gutenberg invented the first printing press to our current digital revolution with such innovations as MIT’s “nano-printing” techniques.

The computational speed of working with the computer creates a direct path between how I think, feel and visualize. Our digital world creates a centripetal force in my life that becomes a super integration of what’s on my mind, and what I experience interacting with the rest of the world. For me, reality is not an occurrence of separate events but a state of “continuous flux” where disparate thoughts, feelings and appearances create integrated layers of reality. My collage-paintings are equally layered ideas pulled together by a layered process of painting, computing, and printing, which, together, becomes a superintegration reflective of living within the digital revolution as I create my artwork.

Two questions drive my work:
How does the analog talk to the digital?
And… how does the bit give voice to the atom?

While paint lives in the analog world of matter and atoms, the computer calls the digital world its home. My work is a dialogue between these two worlds.

The paint in my work represents the analog world. Nothing goes on or off, or changes from one state to another, without going through a transition. The tangible, kinesthetic experience of holding a paintbrush in my hands, feeling the movement between brush, oil paint and canvas traveling up my hand, arm, and into my body is totally different from manipulating images with a mouse, on a screen, then clicking a button that tells a machine to print. Paint is thick and juicy. A print is flat and smooth. There is no getting around the visceral differences.

But the digital world holds equally compelling experiences. When I'm manipulating the computer to generate, replicate and integrate my images I am mimicking the "digital revolution" both in process and experience.

Working with the computer enhances my experience of viewing life from a subatomic perspective. By converting my paintings to bits after scanning them into the computer I think about how Nature occurs in bits and pieces interacting and integrating to create infinite possibilities and opportunities within a single moment. The analog and digital world collide and swirl in my mind and on the monitor screen.

Conceptually, the computer mirrors our minds in the sense of working within a continuous state of flux where the only constant is constant change.

How does the analog talk to the digital, the bit give voice to the atom? I often compare the generation of digital DNA to our biological DNA, which is the essence of analog life itself.

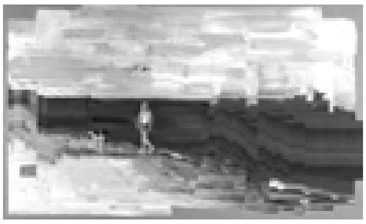
Living in the "digital revolution"-with better and faster versions of the internet, laptops, cell phones, blackberries and multimedia –correlates with my experience of existence as a flow of evolving protons, neutrons and electrons. The natural outcome is that I compose my work from integrating, generating and replicating multiple sources and visually "speaking" the unique vocabulary of "copy, paste, copy, paste, copy, that runs throughout my collage paintings and the digital age of our time.

In Leger's 1921 painting "Le Petit Dejeuner," he uses geometric shapes to portray the onset of the industrial revolution of his time.

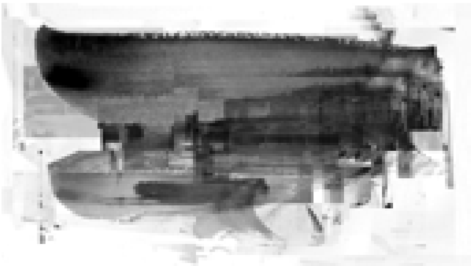
I use the essential ingredients of generation, replication and integration to portray the onset of the digital revolution of my time. I generate and replicate by choosing sections from my paintings, scanned objects, and photographs. Then I use copy/paste tools to replicate the generated selections.

"Field", "Lina and Jenna", and "Working in the Garden"
are examples of work where I generated and layered specific sections to create the final

image before printing.

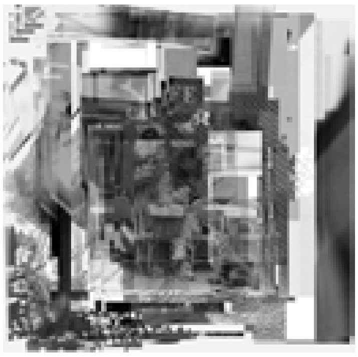

I play with integration because it portrays both the macroscopic view of a globalized world, and the microscopic lens of our evolving human awareness that the mental, physical, emotional and spiritual aspects of our lives are, in fact integrated. I integrate by using linking tools and layers. I use the transparency tool of the computer to further work with the idea of integration. In blue brush stroke I used the transparency tools, masks and copy paste to combine photograph and paint.



In “Waiter with Red Coat” and “Portrait” I used the transparency tools to form geometric shapes, which also reflect levels of awareness, conscious or not.


My work emerges from an on going “state of collage,” a dynamic collection of disparate experience flowing between my state of mind and how I experience the world around me.

In Café, the final work is a collage comprised of layered ideas. A woman sits with a china dish, rocks, paper and scissors, each one a symbolic manifestation of her thoughts. This work portrays her physical appearance, as well as her thoughts and feelings, at the same time. In many respects, I am that woman; her thoughts are my thoughts as I paint, scan, store, retrieve, print and paint again.



Essential to my process is the act of printing. At the most basic level printing outputs my work from the computer. And it is an intentional comment about the importance of printing in our “digital revolution, ” and how dramatically printing has transformed since 1440 when Johannes Gutenberg invented the first printing press, to our current digital revolution.

In an article from the MIT Deshpande Center for Technological Innovation (MIT University, Cambridge Mass) you can see how printing, as it does in my art, facilitates a graphic interface between our digital and analog worlds: “Just as the printing press revolutionized the creation of reading matter, a “nano-printing” technique developed at MIT could enable the mass production of nano-devices currently built one at a time. Professor Francesco Stellacci and graduate student Arum Amy Yu, both in the Department of Materials Science and Engineering, have developed a printing method that is unmatched in both information content per printing cycle and resolution. They achieved the latter using what Yu calls “nature’s most efficient printing technique: the DNA/RNA information transfer. In the new printing method, called Supramolecular Nano-Stamping, single strands of DNA essentially self-assemble upon a surface to duplicate a nano-scale pattern made of their complementary DNA strands. The duplicates are identical to the master and can thus be used as masters themselves. This increases print output exponentially while enabling the reproduction of very complex nano –scale patterns.” [1]

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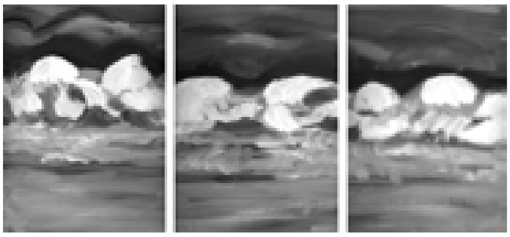
Painting, Scanning, Digital imaging, Printing, Painting

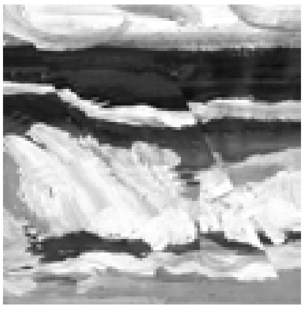
Let’s take a closer look at my process, which consists of scanning my paintings or drawings into digital format and manipulating them in the computer, much as a painter pushes paint around, printing them back onto canvas and finally applying paint on the print.

Here are two works: waves july 3, and waves july1, Each work is 2 panels consisting of oil on giclee print on canvas. In waves july 3, each panel is 50 x 68 inches. In waves july 1, each panel is 40 x 40 inches. I begin in the analog world, taking photographs and making small sketches of waves at the beach.

Later, I took the photographs and paint sketches to my studio where I painted a small oil of beach waves—all the time aware that nothing in the analog world goes on or off, or changes from one state to another, without going through a transition.

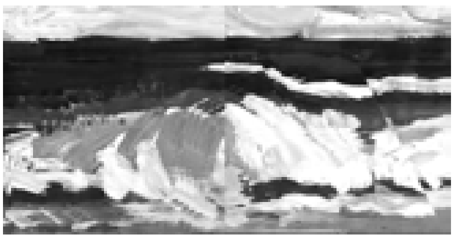


When the small oil painting dried, I scanned it into the computer and begin manipulating the resulting digital image with masks, copy/paste, and cut/paste.
Working as fast as my mind could think, I generated a flow of material by using the computer's DNA of information – bits – to create multiple layers.



Before I know it, my monitor is covered in versions of the manipulated beach waves, a collage conversation where the analog and digital are talking to each other.

I view the computer as a resource where information can be retrieved at computational speed for integrating, generating and replicating. For 2 weeks I worked, overlapping and enlarging, reducing various pieces to achieve the final versions: waves july 1, and waves july 3.

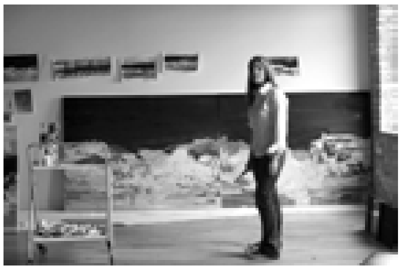


This creative process mirrors both the computational speeds of our digital age, which integrates unparalleled amounts of information, and the evolving technology of generation and replication that we see in nanomachines, genetic algorithms, biology stem cell research and cloning.

In the next stage, I send the work from my computer to a rip station, which prepares the piece for printing on a 5' x 5' format giclee printer.

This Giclee print becomes another layer of the digital world, which I use as a source of primary material, not as a reproduction. It takes 2 50 x 68-inch pieces nearly 2.5 hours to print out.

Then I coat and uv varnish the final print, and stretch it for the final phase of oil painting.



This time, as is often the case, I sat and studied the printed piece for a long time, for up to this point I usually have no idea what I am going to paint. Once I start, my strokes alternate between a haphazard approach, to mimic my free will, and a very organized application to mimic digital computation.

I applied thick layers of paint as a deliberate contrast to the smoothness of the giclee print. It was amusing to include analog paint drips in some areas, and digital paint drips in other areas.

Cool Globes, "Hot Ideas For A Cooler Planet"

In the Fall of 2006 I used the concepts of generation, replication and integration to portray nanotechnology as a solution to global warming for a public art exhibition in Chicago.

100 Artists were selected to paint their own, 5-foot fiberglass “Cool Globe,” each one reflecting that artist’s solution to global warming. Many globes were sponsored by various companies. My globe was sponsored by the Motorola Corporation.

As I began researching global warming solutions, I discovered nanotechnology, the science and technology of precisely controlling the structure of matter at the molecular level. I was amazed at the parallels between what Northwestern University, called “the next Industrial Revolution,” nanotechnology, and my creative process. [2]

The phrase -- “the next Industrial Revolution” -- invoked a 20th century artist who had always inspired and fascinated me, Fernand Léger, whose work rose straight out of the Industrial Revolution. It was clear that I had found the right direction for my Cool Globe.

Like nanotechnology, I move between the two worlds of analog and digital, by first scanning a variety of painted surfaces and every-day objects from the macro, analog world, and then manipulating these in the micro, digital world of the computer. Afterward, I print my work from the digital world onto the analog world of canvass or paper.

Nanotechnology also moves between the macro and micro worlds by transferring the assembly production of ‘real world’ factories to a microscopic, molecular-sized universe. And, surprisingly, nanotechnology uses a form of printing: ultra violet lithography and nano imprint lithography can, for example, “print” efficient and durable solar cells. [3]

But the axis parallel between my work and nanotechnology is how we both use replication and generation to achieve a final object. I often refer to my work as “generative art in an Age of Replication” because, like nanotechnology, I take a ‘bite’ out of the DNA of my materials and generate multiple replications to create works of art. Nanotechnology uses molecular machine systems to replicate and build multiple products; and in the process saves energy, reduces waste, eliminates toxic residues, and dramatically lowers production costs. [4, 5]

My challenge was identifying images that integrated art, technology, and the “next Industrial Revolution.” My version of Léger’s 1924 painting, Femme Au Bouquet, signaled Mother Earth, knowledge, and nature. Water molecules, equations, and landscapes connected environment with technology, and the Légeresque Woman with Microscope completed the cycles of art, science, and our natural world.

It seems that the 2 questions that drive my work:
How does analog talk to digital?
And… how does the bit give voice to the atom?

…are also the driving questions behind the science and the time we live in.

References

1. MIT Deshpande Center for Technological Innovation "MIT's Nano-printing technique could enable the mass production of nano devices currently built one at a time" http://nanotechwire.com/news.asp?nid=2021, 2005
2. International Institute For Nanotechnology, " Nanotechnology is widely viewed as the most significant technological frontier currently being explored.", (www.iinano.org/), 2007
3. Nanosolar, "Semiconductor Printing", (www.nanosolar.com/printsemi.htm), 2008
4. Center For Responsible Nanotechnology, "General Purpose Technology", (www.crnano.org/whatis.htm) 2006
5. Discover Nano, "Nanotec Applications" (www.discodvernano.northwestern.edu/affect/affect/applications_content/environment/renewable)

Database Design for Represent Genetic Information and Environment Impression in Architectural Design

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Abstract

One of the way to access many types of design is combination of three types of design in generative design, such as parametric, genetic algorithm and shape grammar in a database with many fields as genes that can related with other database (as chromosomes or environment agents) .The main fields are Primary shapes (two or three dimensional shape),Transformation language field as verbs, nouns, adjectives the architect used [1] can represent with transformation matrix, Spatial relationship field (*bounded polyline shapes* in a groups of shapes or subshapes[2]) so can represent with transformation matrix , a memo field for transformation sequence stores the shape grammar and is a genotype for objects ,that is made in program process ,many fields for many fitness value that compute in program process and finally a total fitness value field that can used with weighting for each fitness value[3].

The phenotype with a script file can represent in CAD or other graphic tools. With mutation in gene or chromosomes as deletion, insertion, duplication, inversion , translocation (of fields) and crossover in one ,two and so point, only with exchange the fields value we can able to generate many shapes and objects. With append one or many fields of database information to another we able to complicate the genetic information of creatures. We can relate databases with key field and change the values of fields with program. This simple programs can able the users to access many records for next use.

1. Introduction

In view of system definition, collection of related elements or things for accessing an aim is propounded, with recognition and analysis of the elements, relationship between them and aims can find another approaches and so can able to change, improve and develop the aims. However possibility of receive to objects will be more if identification of more parameters, coefficients, constants, functions, relationships and finally condition of act is well explained. Just as Frazer was said '….Evolutionary Architecture is formulate architecture…." , but formulizing don't mean a frame or deterministic function ,because exploring the effective agents ,will open the new aspects and directions for expansion. Thus evaluate and analyze important agents of each entity such as architectural design will evaluate fitness function of it. In this paper we propose linear function to interfere sub function.

Fitness value of an architectural design could studied with evaluate and analyze aspects of aesthetic, behavior in space, climatic design and technical details in performance. These attributes refer to attributes of material, surface and space of solid object .Material property includes appearance and structural properties of solid shape, surface includes main surface and subsurface and last of all shape contains direct or indirect connection of surface. These attribute are columns of total fitness function in a matrix with rows include four aspect of architectural design evaluation.

2. Evaluation of Architectural Design

Four aspect of evaluation are related to solid shape properties include material, surface and space, each of these properties effect on many type of evaluation that is described.

2.1 Evaluation in aspect of Aesthetic

In Sensory Aesthetic the appearance of material property in solid shape is important.

In Formal Aesthetic function appearance and structural properties of material, main surface and subsurface, direct and indirect connection of surfaces are considered.

In Expression and associative Aesthetic function (Symbolic Aesthetic) appearance and structural properties of material, subsurface, direct and indirect connection of surfaces have to concentrate.

2.2 Evaluation in aspect of Behaviors in Space

In evaluation of Main behaviour places properties deals with direct and indirect connection of surfaces and so is true for connective behaviour places.

2.3 Evaluation in aspect of Climatic Design

Natural Light, Natural Ventilation and Natural cooling and heating must be evaluated with refer to main surface, direct and indirect connection of surfaces for all type of this evaluation.

2.4 Evaluation in aspect of Technical details in performance

In this evaluation Material Selection for Different Surfaces are related to structural property of material and Joint & Neighbourhood of Different Surfaces are referred to structural property of material, main surface and direct connection of surfaces properties in solid shape.

Thus we define fitness function in matrix that the rows are fitness function in aspect of aesthetic, behaviour in space , climatic design and technical details in performance and the columns are properties of solid shape. For example in evaluate the minimum rate of surface to volume for each shape in population within climatic design ,we need minimum of SVR for prevent waste of energy ,so user must define fitness function in this way and sorted the results till selection of individual is occurred. Total fitness function can defined as following :

$$F(x) = Max(\sum_{i=1}^{6}\sum_{j=1}^{6} w_{ij} \cdot f(x_{ij})) \quad \text{where} \quad \sum_{i=1}^{6}\sum_{j=1}^{6} w_{ij} \le 1 \qquad (1)$$

I for four aspect of evaluation in architectural design
J for properties of material , surface and space
w_{ij} for weighting to each fitness function in total fitness function .

3. Database Design

Database table is the physical implementation of an entity with related attributes; this is where the actual data is stored as student, lesson, teacher or whatever. Each table consists of one or more columns .Columns of a table is the physical equivalence to an attribute or field, all important things about an entity describe with attributes / fields. Database design is the process of producing a detailed data model of a database, correct design due to fast access to the correct classified and sorted data. Importance of shapes and materials in solids because of evaluating an architectural design duo to suggest databases with related fields named key fields. Process by acting the fields ,calculate and evaluate values are stored in other fields of another database .

Combination of three types of generative design in database design in following steps of model is described . First must have a value for recognize better or best solutions, this performs with fitness function as field or fields in a solid shape.

Thus fault of parametric design by comparison of fitness value are released in waste time after each changing parameter values, andso have many type of species .
shape grammar is rules for construct a shape, therefore must define with a field and perform as genotype.

This field needs is defined by text thus a memo field in database is suitable . Containing text with statements of CAD can express steps of construction , text must be named as script file untile can able to load in CAD . we can display physical property of shape as phenotype in Cad or other graphical tools . some field for perform deformations such as rotate ,move ,mirror and enter deformation matrix as genes of shape deform the primary shapes,therfore can able to change attributes with mutation ,crossover and recombination , also can explain development and growth in this model and are formed a Lindenmayer system with such statement of CAD mcopy ,or first slice and next mcopy ,and then define a path for locating the copy of whole or part of solid object .

In genetic algorithm design we generate with a few data in gene pool and with processing such as mutation ,crossover ,recombination,much more individuals (design) . And then with natural selection, best solution maintain and have existance chance due to reproduct .In case a gene is deleted from gene pool in any generation but we need it, have to enter the lost gene in artifical synthesis to population .

Existence chance in population due to fitness value and external condition such as environment impression ,therefore a weak gene for existence may maintain in gene pool and has positive effect for existence chance .(e.g.There is malaria disease in meditreranean climate,but individual with talassemia disease gene in this climate have more existance chance because the malaria agent doesn't affect him.) Also there are methods to prevent this effect,but is not concideraterd here.

In this paper is proposed sorting the combination of fitness fields or total fitness field in main database and then append the best record to another database ,In this way individuals selection are kept as next generation parents. Bentley do this with introduce two population ,internal population that must evaluate and translate to external population have possibility for reproduction.[5]

Shape grammar in each individual of database as is said before keep in a memo field that explain the construction of shape from primary shape with rules from left to right to deform it.

3.1 Structure of Database

For database design we define many database one for primary shape with unique code for identify each individual ,another database for deform the shape with a unique code ,a database for parameters of shapes , a database for material properties, a database for 2D shape for making spatial relationship in location of individuals to move there, thus a database for deform 2D shapes.

3.2 Programs

Some program for execute mutation, crossover, recombination and selection must prepare as follows:

3.2.1 A program for create new creature with chromosome mutation:

Some Cad statement for create combination of shape (subtract, union, intersect) is used in design ,this program ,with randomly selection of two parents from primary shape and randomly run (subtract ,union, intersect) on them ,due to create a new shape then the result save with unique code for it .Some attributes such as volume, centroid , moments of inertia ,… after displaying in CAD is produced with "massprop" statement and maintain on a text file with .mpr extension , copy this file in a memo field and separate different attribute in text file and replacing with fields in new shape ,the values of fields in new shape is filled and get ready for next evaluating.

3.2.2 A program for create new creature with gene mutation:

Such attribute is suitable to play the role of gene in shape as (3dmove ,3drotate , 3dmirror, scale) statement , with manipulate the sequence and with insertion ,deletion , duplication ,inversion ,translocation of one of the steps, mutation is happened.

3.2.3 A program for crossover :

With exchange the sequence of attribute such as (3dmove,3drotate,3dmirror) in a shape, we have gained new shape ,this event might happened for two or three exchange ,the condition of program for more exchange must not include in first point exchange.

3.2.4 A program for recombination:

This effect similar to the parametric design with a randomly change in the parameters , duo to generate new creature of same species each time .

3.2.5 A program for environment impression:

Some statement in CAD such as (slice ,thicken, also scale ,copy) or with a deformation matrix we can operate shape ,new produced shape is not able to maintain this changes in gene pool .

3.2.6 A program for development and growth:

Some statement in CAD such as (mcopy, scale) can cause the growth and development of shape or part of shape (if slice statement is used) and with definition a path for location the copy objects, we can simulate Lindenmayer system in development.

3.3. Examples

Some example for parametric design with change the parameters of multiple box and spatial relationship as rotation and transition in x ,y ,z direction, are shown, indeed they could simply designed in this way ,but never means this are designed so.

Figure 1: Durham ,Nasher Art Museum , Rafael Viñoly (left)

Figure2 : Cincinnati ,Contemporary Art Center , Zaha Hadid (right)

Figure 3 : Culver City ,Offices and 606 Parking Garage , Eric Owen Moss (left)

Figure 4 : Tokyo ,K-Museum , Makoto Watanabe (right)

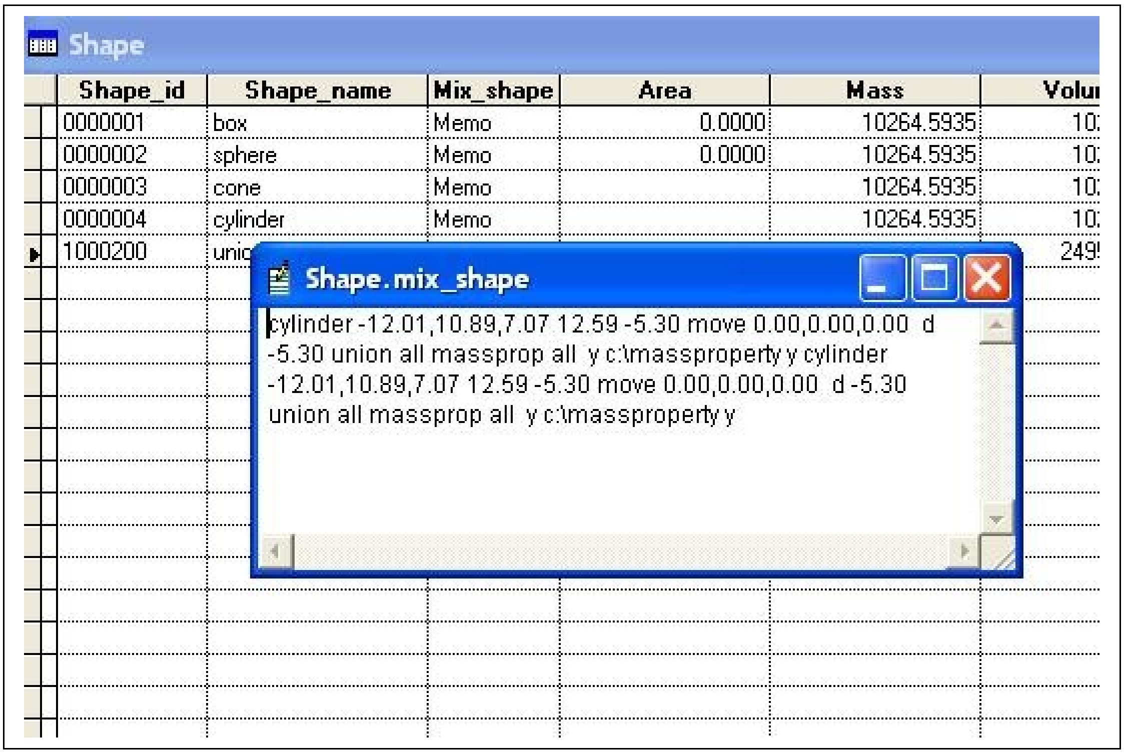

Figure 5 : Memo field contains of shape grammar for construct shape from script file in CAD

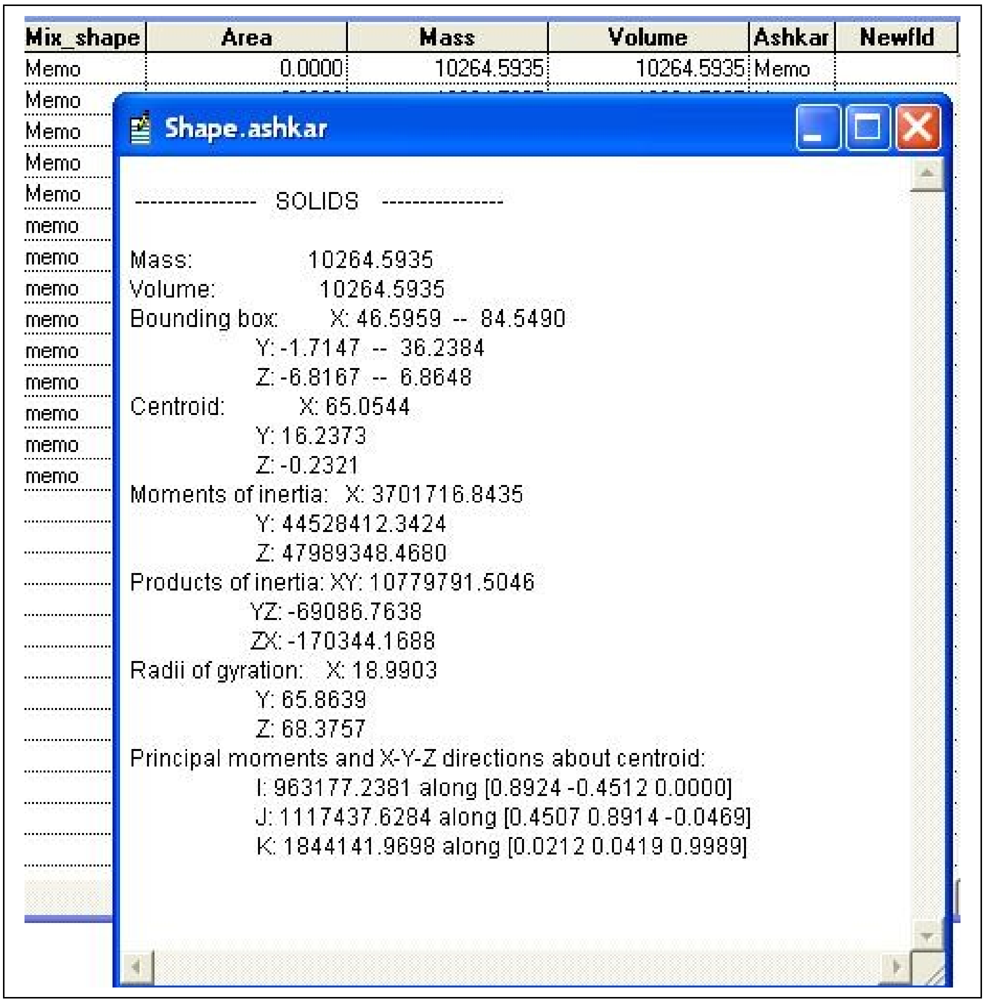

Figure 6 :Memo field contains of Massproperty field for evaluate fitness

5. Conclusion

Association programming in graphic tools is caused to produce complicated design with simple programming.

Acknowledgements

In this paper,I wish to acknowledge encouragement by Dr. Hossain Soltanzadeh for insistence in selection new proposal in Architecture Department in Islamic Azad university of Qazvin and his trial in Iranian symbolic aesthetics in his courses ,also acknowledge insights from discussions with Dr.Noruzian and inspiration of SWOT decision model for evaluate fitness value .Next by consultant professors in my proposal, Dr.Parvin Ghaemmaghami and Dr. Ebadzadeh . With thanks a lot from Saeed Vahdatipour for past experiences .

References

[1] O'Raily U. , Ramachandro G. : 1995 , A preliminary Investigation of Evolution as a Form Design Strategy, Paper ,M.I.T ,paper

[2] Cha M. , Gero J. :2006,Style Learning : Inductive Generalisation of Architectural Shape Patterns , Paper

[3, 5] Bentley P. : 1996, PHD Thesis ,Generic Evolutionary Design of Solid Objects using a Genetic Algorithm

[4] Lang ,J.: 1987 , Creating Architectural Theory

[6] Frazer .H.J. : 1995 ,Evolutionary Architecture

[7] Prusinkiewicz et . al. : , Visual models of plant Development ,paper

[8]Rowbottom A.: 1993,1994,1995 , FORM software

Figure and table References

Figure 1 : Explored from arcspace.com

Figure 2 : Explored from arcspace.com

Figure 3 : Explored from Eric owen moss architects site

Figure 4 : Explored from makatovatanabe.com

Figure [5 ,6] :Display part of database in programming as prototype.

(1) This formula is my proposition to evaluate architectural design.

A Shape Grammar Study: Form Generation with Geometric Islamic Patterns

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Abstract

The aim of this research is to present the features of geometric patterns in Islam, to use rules-sets for two and three dimensional form generation and to indicate the potential of mathematics of symmetry and geometry. The study focused on parametrically defined shape grammars of Islamic patterns to generate three dimensional forms in CAAD. The information offered in this paper can be used to generate innovative depictions and to add fresh perspective to architecture. Throughout the history, some simple repetitive patterns were used as a starting point for architectural layouts, landscape designs or urban planning. In this research, Islamic patterns are used as a basis for three dimensional form generation explorations. This study can be accepted as a preliminary step of more complicated forward studies for innovative designs with historical patterns.

Keywords: Islamic patterns, form generation, shape grammars.

1. Introduction

Geometric patterns have been used by different cultures throughout the history. These patterns were used mostly as decoration elements for interior or exterior design of surfaces. When Turks chose Islam, they had developed entirely innovative and unique art field. Geometry is the origin of every art and discipline. Every society has used patterns in different forms. The octagonal interlacing patterns had significant function in Karahanli architectural ornaments. Afterwards, these patterns had been improved with original ideas in Gazneli, Big Seljuk, Anatolian Seljuk and Ottoman cultures.

For almost 30 years, shape grammars are used as a foundation for art and architecture such as Chinese lattice designs [1], window designs of Frank Lloyd Wright [2], traditional Turkish houses [3], ornaments on ancient Greek potteries [4], chair designs of Hepplewhite [5] and paintings of Richard Diebenkorn [6], Georges Vantongerloo and Fritz Glarner [7]. These series of examples point out that shape grammars can be used to produce innovative models on the basis of historical styles. Today, there are various significant research connected to Islamic ornaments and geometric origins of Islamic patterns [8-11].

Roots of Islamic patterns are differentiating in time, according to historic periods and cultures. Two and three-dimensional creative expressions can be seen in Islamic art. Islamic art has three main objectives, which are calligraphy, floral ornaments and geometric ornaments. In general, combinations of these elements are used on the same object. Geometric and floral patterns are the most important ornamental design components of Islamic art, because any depictions of human and human related subjects are forbidden. Art and need of expression lead people to another solution, which is based on geometry and mathematics. Although the main aim of these geometric or floral patterns is decoration, they depict a variety of Euclidean rules and geometric structures. These patterns are used on different kind of materials such as tiling, glass, paper, wood, plaster, metal, stone and brick. Usually, Islamic patterns can be seen on *mihrap*, minbar, window and door shutters, sultan’s lodge, fountain fences, tile, stalactites, *rahle*, ceiling and walls.

Architects should try to explore new tools for being able to design in a different and more efficient technique than a conservative approach. The patterns can be spatial elements and be used as a base for architectural, interior or urban designs. This paper is focused on one of the fundamental patterns in geometric Islamic ornamentation; eight-pointed star and innovative form generation explorations with this pattern.

2. Islamic Patterns

According to Stiny, design is calculating with shapes and rules, and shape grammars are mathematics. They let us calculate in algebras of shapes [12]. Geometry is the basis of everything. From the beginning, Islamic patterns were considered as three dimensional and used in different buildings as basis for the domes, plans for minarets, tombs etc. Especially, in the mosques of Architect Sinan, simple patterns are used as underlayers of his design of the mosques [10].

The complexity of shapes is retrospective. It is an artefact of the rules that depends on how they are actually applied. Without rules, there is no complexity. And with rules, complexity varies – up and down- [12]. Shape grammars are the algorithmic systems used to analyze existing designs or create new ones. In spite of using text or symbols to express conceptual representations, shape grammars help to generate innovative designs through computational effort with shapes and rules. Stiny indicates that design is calculating when you do not know what you are going to see and do next. What a shape is depends on what rules are used, and when and how. This can vary for different rules, and, in fact, it changes every time any rule is tried [12]. Numerous probabilities of rule selection and application of these rules may cause emergent design solutions. This research aims to present the characteristics and shape grammar rules of geometric patterns in Islam and to indicate the potential of mathematics of symmetry and geometry. The study focused on parametrically defined shape grammars of Islamic ornaments for form generation in CAAD. The information offered in this paper can be used to generate innovative depictions and to add fresh perspective to architecture.

Islamic art was derived from Greek math that based on pure geometry. According to Pythagoras, everything in the universe can be defined by mathematics. Each number has certain meanings. Cube and square represent world, pyramid and triangle represent fire, and dodecahedron represents the universe. Two-dimensional geometric patterns in Islamic art are compositions of closed polygons. In Islamic art, geometric and floral patterns are generated by some basic geometry rules such as isometric transformations and Boolean operations. Translation, rotation, reflection, repetition are the isometric transformations (also called as Euclidean transformations). Boolean operations are operations like union, intersection, subtraction etc.

Repetition is the most useful and fundamental feature of Islamic patterns. There are few basic shapes in Islamic art, but interlocking design of these basic shapes generate different and complex patterns. Islamic patterns are usually produced by the repetition of triangle, square and pentagon. Star is an important shape in Islamic art. In almost every culture, the star represents the eternity. Each arm of a star has the same distance from its center. Circle does not have starting or ending points. In Islamic art, the circle and the center of the circle represent the creator (*Allah*) and Mecca - the center of Islam. That's why circle is one of the key shapes in Islamic art and architecture. Another important feature of Islamic patterns is *symmetry*. Symmetry, or the series of ways in which a single *motif* can be repeated an exact number of times within a circle, is the most fundamental manifest aspect of Islamic geometric art [11]. It is the main operation in derivation of geometric and floral patterns. Symmetry is used for generating compositions and tessellations. Stylized rose pattern - *gülçe* (rosette) and stellar patterns are the most frequent Islamic ornaments and they are generated with these simple features. Figure-background relationship is another important aspect in Islamic art. Different parts of the patterns can be dominated by figure-background relationship. Colors are essential for figure-background relationship and visual perception, particularly in tiling and engraving. Sometimes, different materials or colors can be combined with others to increase the visual perception.

3. Form Generation with Islamic Patterns

This study is focused on one of the fundamental patterns in geometric Islamic ornamentation; eight-pointed star. The square represents the *earth*, or the physical elements such as earth, air, fire and water. If a square overlaps another, with the second square pointing upwards, eight-pointed star is formed. The eight-pointed star is related to the symbolism of the *eight bearers of the throne*, from Koran and certain cosmological subjects [11]. Different rule-sets are applied to the pattern and these generative rules are based on shape grammar and fractal geometries [13]. Afterwards, the resultant patterns are used as a basis for generating three dimensional forms. Rectangular array (Figure 1) and polar array (Figure 2-10) are applied to the eight-pointed star. Then, each star is extruded to a specific height; in most of the cases, the height of each star is increased from outside to the center of the pattern.

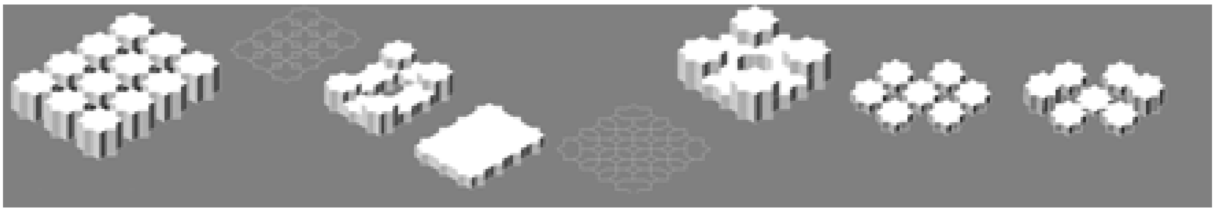

Figure 1. Rectangular array with eight-pointed star.

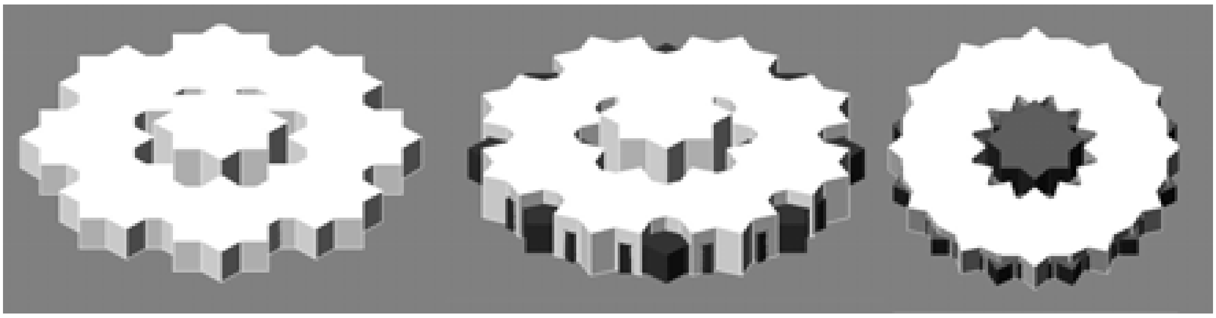

Figure 2. 3D representation of the polar array with 8, 16 and 32 stars.

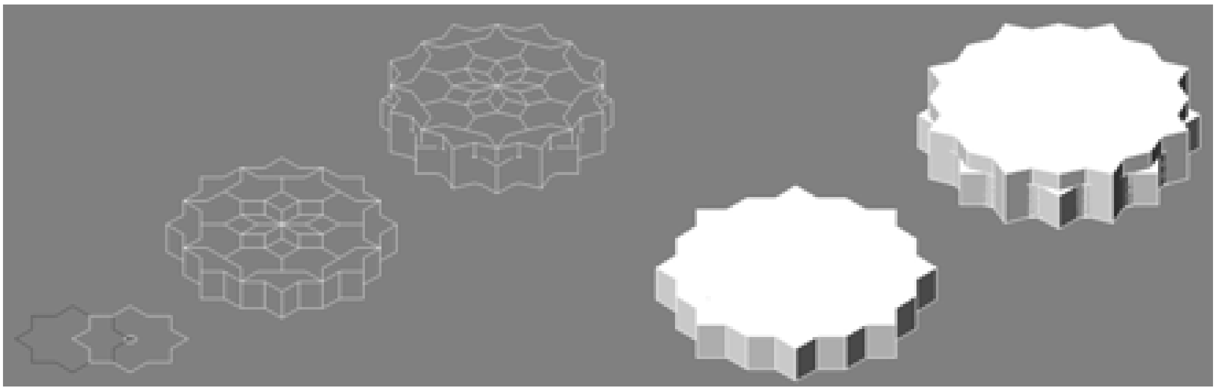

Figure 3. Initial shape and 3D representation of the polar array with 8 and 16 stars.

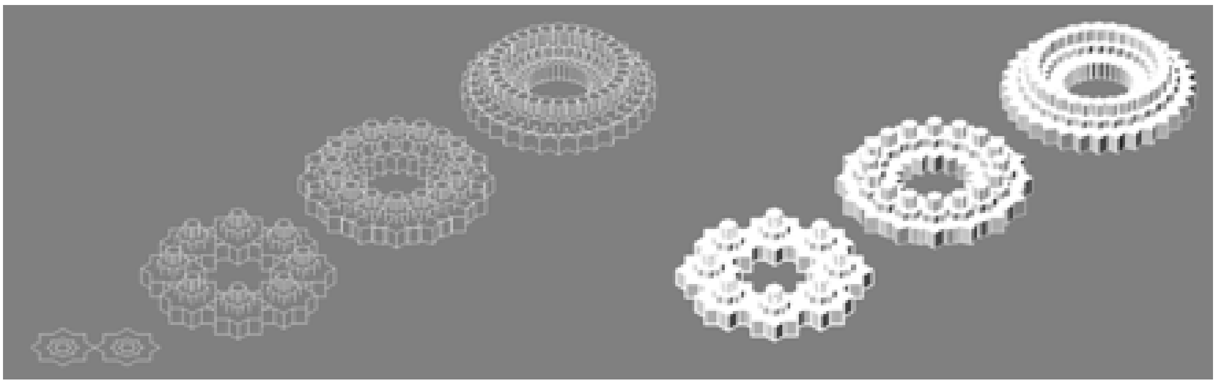

Figure 4. Initial shape and 3D representation of the polar array with 8, 16 and 32 stars.

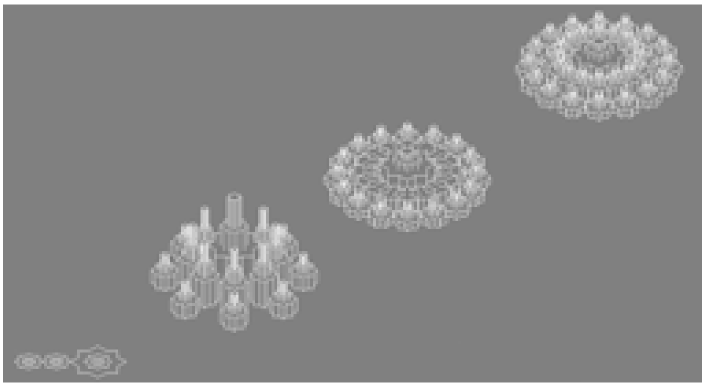

Figure 5. Initial shape and 3D representation of the polar array with 8, 16 and 32 stars.

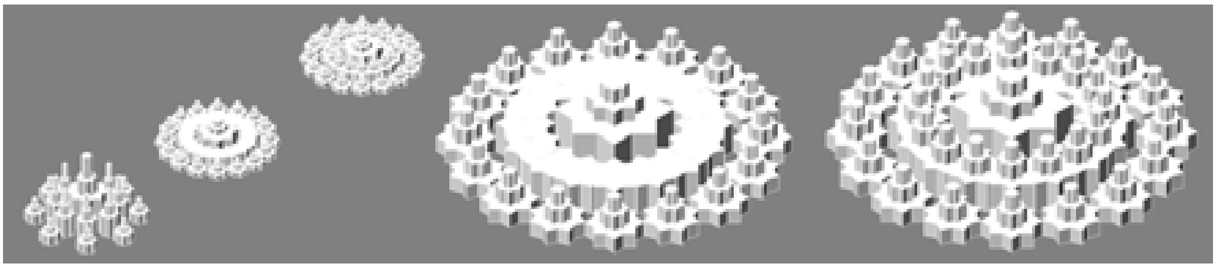

Figure 6. 3D representation of the polar array with 16 and 32 stars.

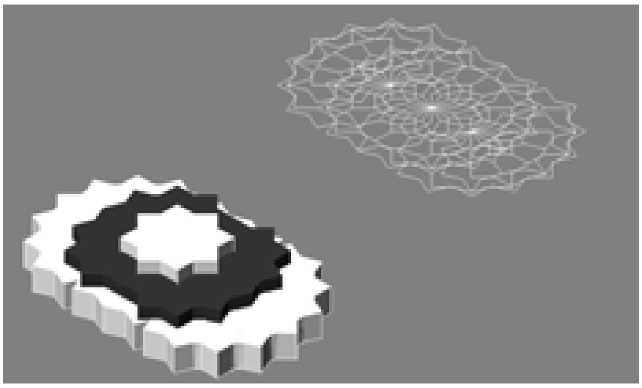

Figure 7. 3D representation and the base pattern.

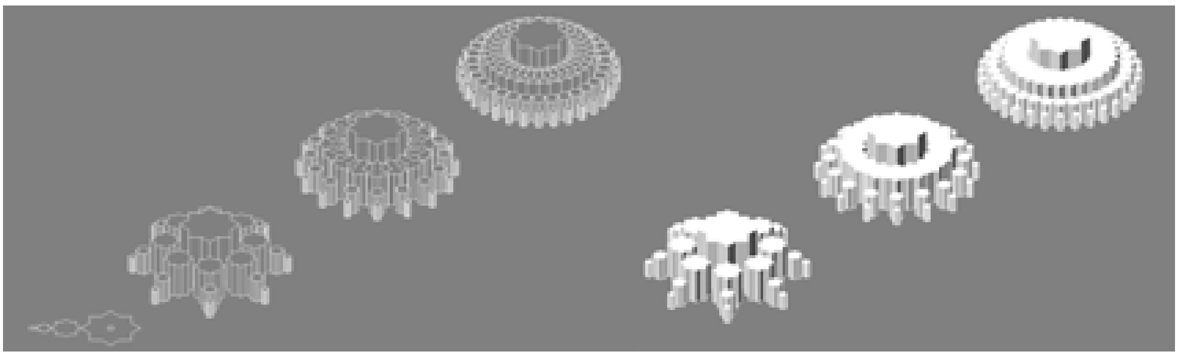

Figure 8. Initial shape and 3D representation of the polar array with 8, 16 and 32 stars.

One of the patterns is generated with scripts (Figure 9). In the near future, the main aim is to improve and transfer all of the rule-sets and the measurements to a programming language and generate a computer implementation to study further design innovations with different patterns and rule-sets in two and three dimensions.

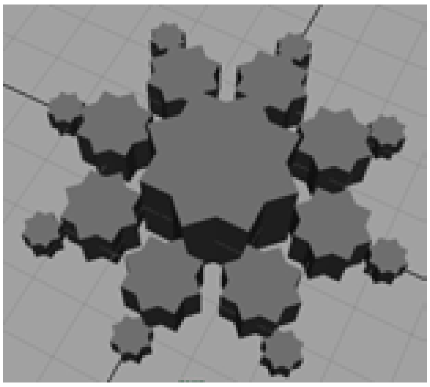

Figure 9. Script-based generated form.

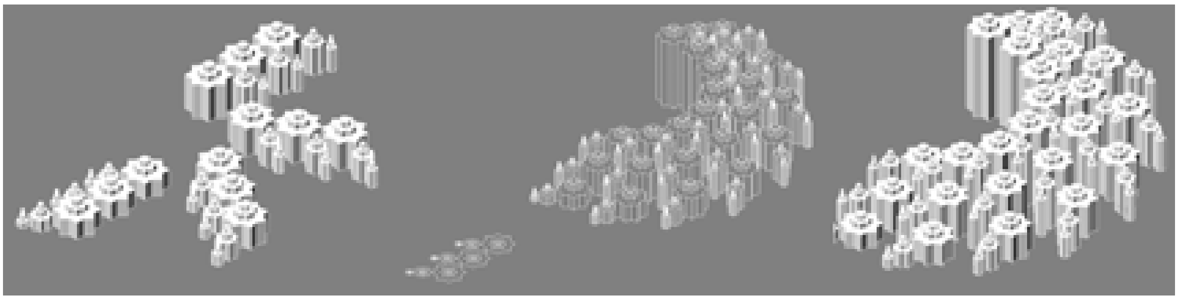

Figure 10. 3d representation of partially polar array with 4 and 8 stars.

Throughout the history, some simple repetitive patterns were used as a starting point for architectural layouts, landscape designs or urban planning. In this research, generic patterns from previous study used as a basis for three dimensional form generation explorations [13]. In the future, structural aspects, columns - beams and interior spatial organizations are going to be considered and resultant forms are going to be improved to respond to these necessities.

4. Conclusion

In Islamic art, there are both floral and geometric patterns. In this study, the grammar rules for geometric Islamic patterns are used as a basis for form generation methods. These geometric patterns are the origin of Islamic art. The stylistic features are correlated with structural framework and social, material, and individual forces. Today, there are CAD programs to help designers to explore innovative design potentials. The resultant forms from this study can be used in the conceptual phase of the designs of restaurants, hospitals, libraries, art galleries, hotels, houses and religious buildings, landscape designs and even in urban planning layouts. This is a preliminary study to design three dimensional forms with pattern grammars and Islamic patterns. The resultant forms are simple, but very inspirational. In the near future, the main aim is to improve and transfer all the rule-sets and the measurements to a programming language and generate a computer implementation to study further design innovations with different patterns and rule-sets in two and three dimensions. This study can be a starting point of more complicated forward studies for innovative designs with historical patterns.

References

[1] Stiny, G.: 1977, Ice-ray: a note on the generation of Chinese lattice designs, Environment and Planning B, 4, pp. 89-98.

[2] Rollo, J.: 1995, Triangle and t-square: the windows of Frank Lloyd Wright, Environment and Planning B: Planning and Design, 22, pp. 75-92.

[3] Cagdas, G.: 1996, A shape grammar: the language of traditional Turkish houses, Environment and Planning B: Planning and Design, 23, pp. 443-464.

[4] Knight, T. W.: 1986, Transformations of the Meander Motif on Greek Geometric Pottery, Design Computing 1, pp. 29-67.

[5] Knight, T. W.: 1980, The Generation of Hepplewhite-style chair back designs, Environment and Planning B: Planning and Design, 7, pp. 227-238.

[6] Kirsch, J. L. and Kirsch, R. A.: 1986, The structure of paintings: formal grammars and design, Environment and Planning B: Planning and Design, 13, pp. 163-176.

[7] Knight, T. W.: 1989, Transformations of De Stijl art: the paintings of Georges Vantongerloo and Fritz Glarner, Environment and Planning B: Planning and Design, 16, pp. 51-98.

[8] Moustapha, H. and Krishnamurti, R.: 2001, “Arabic Calligraphy: A Computational Exploration”, Mathematics and Design 2001, Third International Conference, Geelong, Australia.

[9] Kaplan, C. S.: 2000. “Computer Generated Islamic Star Patterns”, in R. Sarhangi (ed), Bridges 2000 Proceedings.

[10] Ozsariyildiz, S.: 1991, Conceptual Design by means of Islamic-Geometric-Patterns within a CAAD-Environment, PhD Thesis, TU Delft, Netherlands.

[11] Critchlow, K.: 1976, Islamic Patterns: An Analytical and Cosmological Approach, Thames and Hudson.

[12] Stiny, G.: 2006, Shape: Talking about Seeing and Doing, MIT Press, U.S.A.

[13] Cenani, S. and Cagdas, G.: 2006. “Shape Grammar of Geometric Islamic Ornaments”, in V. Bourdakis, D. Charitos (eds.), Proceedings of the 24th eCAADe 2006, Communicating Space(s), Volos, Greece, September 6-9, 2006, pp. 290-297.

Growing a City: Individuals, Interactions, and Emergent Behaviour

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Abstract

Individuals and interactions between individuals are key to the evolvement of complex systems. This work harvests the power of individuals and interactions to create a responsive environment, which emulates the growth of Tainan City. Through the study of urban patterns (armatures, enclaves and heterotopias) and their evolutions, a set of individuals and interactions are formulated to represent elements of a city as well as compositional rules for urban patterns. These individuals and interactions are designed into a cellular automation machine to explore their emergent behaviours. The resulting system is a virtual world where a city evolves with the growth and decay of city blocks. This virtual world is presented in a physical space where a video is installed to monitor the changes in this space. Significant changes in the physical space are interpreted as external forces (natural or political events) that trigger massive changes in the virtual world. This system is used by the second- and third-year architectural students to study the growth of cities (the emergent behaviours) by tweaking the individuals (building blocks of the city) and the interactions (generative rules).

1. Introduction

The nature, ant colonies, beehives, human societies, urban developments... are emergent systems where a collection of individuals interact without central control yet achieve an integral whole []. In a smaller scale of living organisms, they are formed by a collection of DNAs that interact with proteins to maintain the development and functioning of living organisms. Individuals and interactions between individuals are key to the evolvement of complex systems. This work harvests the power of individuals and interactions to create a responsive environment, which emulates the growth of Tainan City, the most ancient city in Taiwan.

The purpose of this work is not to develop a generative design system, but to train students of computational design thinking. This is part of a research aims to create a new curriculum to train the new architectural designers to all be competent digital designers.

2. City as a complex system

Cities are one of the finest examples of complex systems. Cities display many traits common to complex systems in the biological, physical, and chemical worlds. Experiments with fractal geometry and feedback mechanisms in cellular automata have proposed various cellular models of urban theory [].

Central to the physics of complex systems is emergence. Emergence refers to the way complex systems and patterns arise out of a multiplicity of relatively simple interactions [,]. An emergent behaviour or emergent property can appear when a number of simple entities (individuals) operate in an environment, forming more complex behaviours as a collective. Such emergent behaviour is usually hard to predict because the number of interactions between components of a system increases combinatorially with the number of components, thus potentially allowing for many new and subtle types of behaviour to emerge. Emergent structures appear at many different levels of organization or as spontaneous order. Emergent self-organization appears frequently in cities where no planning or zoning entity predetermines the layout of the city.

The process of genetic recombination allows for change in actors and their responses to altered circumstances, explaining the mutation of traits from one generation to another and the natural selection process. Recombinant DNA technology genetically engineers DNA by cutting up DNA molecules and splicing together specific DNA fragments usually from more than one species of organism. These DNA spiral code is analogous to some sequencing apparatus in the city and architecture. Processes of sorting, layering, overlapping, and combining of disparate elements involved in the recombinant DNA is analogous to the similar process in the field of architecture.

Recombinant Urbanism [] is a new approach to contemporary practice that proposes urban modelling with enclave, armature, and heterotopias as three DNA elements in the urban context. Enclaves are self-organizing, self-centring and self-regulating systems created by urban actors, and are often governed by a rigid hierarchy with set boundary. Armatures are linear systems for sorting sub-elements in the city and arrange them in sequence. Each armature forms a recognizable topological module aligned in distinct poles. Heterotopias as switching devices control and direct urban growth in times of crisis, like genetic switches that control growth form, size and direction using simple, recombinant codes and sequences... urban actors act as catalysts in this situation, shaping the codes.

Taking the recombinant urbanism approach, at the smallest scale, buildings (individuals) can be considered basic the component of the city as a complex system. Enclaves and armatures are emergent behaviours. At a larger scale, enclaves and armatures are also components of the city, and heterotopias are emergent behaviours. Heterotopias, in turn, become another type of components to interact with enclaves and armatures thus create further emergent behaviours. The work in this paper takes the approach to study the growth of cities through emergence.

3. An analysis of Tainan City

3.1 The history of the city

Tainan, located in the southwestern shore of the Formosa Island [], is the most ancient city in Taiwan with a history over 300 years.

In the early 17th century, Dutch East India Company built Fort Zeelandia (1624) and Fort Provintia (1654) and established a Dutch colony [,]. It is the site of Fort Provintia that gives rise to the Chinese city of Tainan in the following two century. The Dutch town, occupied areas around the between these two forts, did not have fences and its streets were arranged in a chessboard pattern []. The Dutch ruled this area for about forty years until the Ming loyalist Koxinga (Cheng Cheng-kung) took over.

Figure 5. An oil painting of Fort Zeelandia area (source:[])

Koxinga encouraged Chinese settlers to move away from the coast into wilderness inland areas to reclaim new land []. The settled area was divided into four sections but no city walls were built. Nevertheless, religious temples were built following traditions from the Mainland Chinese []. In 1680s Manchu Ching (Qing) dynasty established official control of Taiwan. Many more military, government, religious and school buildings were built. In 1720s, bamboo city walls and seven city gates were first built. City walls and gates were rebuilt using clay and bricks in late 1780s and early 1790s []. In 1820s, floods caused silts altering waterways and shorelines and greatly affected the urban development of Tainan city. In the latter part of the 19th century, the city took shape as a typical Chinese settlement [,].

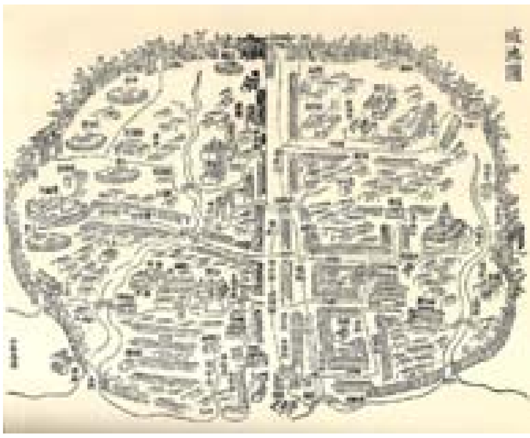


Figure 6. An 18th century map of Tainan

Taiwan was conceded to Japan in 1895. Japanese transplanted the Western models learned abroad to Taiwan. The Japanese plans for the new city completely disregard the pattern of the original city []. Old city walls were torn down and gates demolished; new grid roads were built. After World War II up to present day, the city grew according to the Japanese plans even though the Japanese had left.

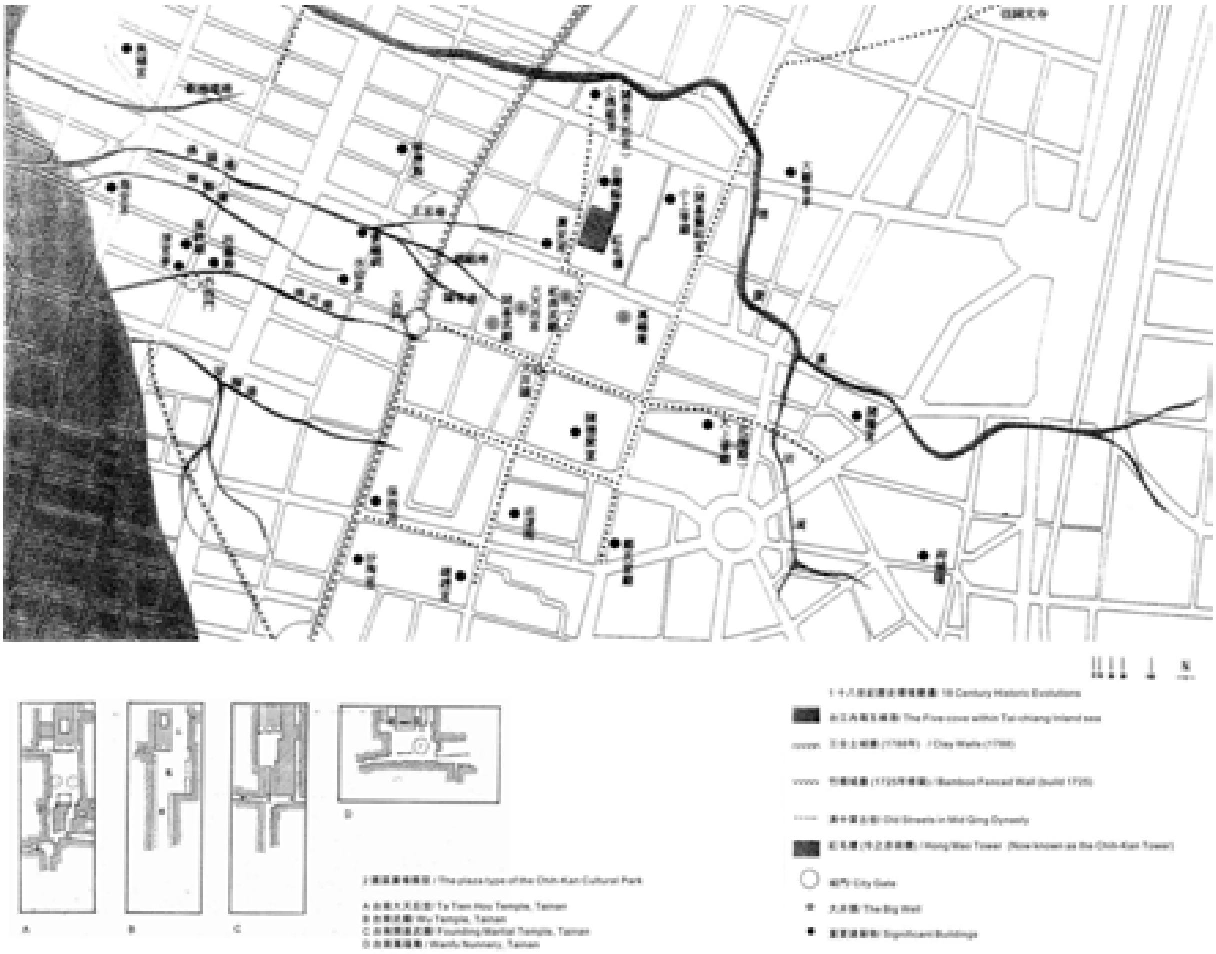


Figure 7. Historic patterns in Tainan (source:[])

3.2 The evolution of the urban patterns

The development of Tainan City is reviewed based on the urban growth model by Shane []. Several urban patterns (armatures, enclaves and heterotopias) are identified throughout the past and present Tainan City.

The very early settlements were established along waterways and formed patterns of armatures. The Dutch colony introduced enclaves of forts and town area in a distinct order. The Chinese immigrants established more enclaves of temples in yet another distinct (heavenly) order. In addition, Chinese military formed enclaves of camps. Chinese farm houses formed yet another type of enclaves. Between these enclaves, armatures formed along natural pathways. The Japanese regime imposed a new order onto the original pattern and thus created heterotopias. Later expansions of the city were heterotopias of armatures and enclaves established on the pre-existing urban context.

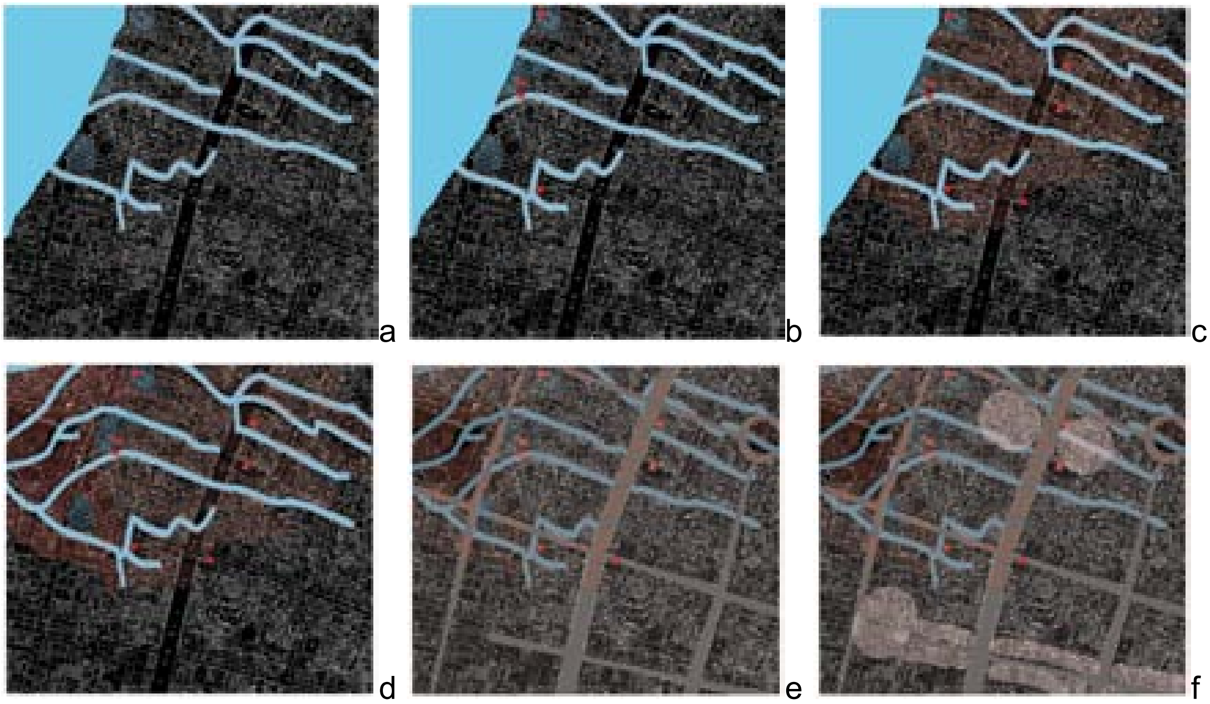


Figure 8. The evolution of urban patterns.
(a) armatures: settlements along waterways; (b) enclaves: temples of heavenly order;
(c) armatures and enclaves: increasing expansion; (d) natural changes;
(e) heterotopias: Japanese city plan; (f) modern expansion

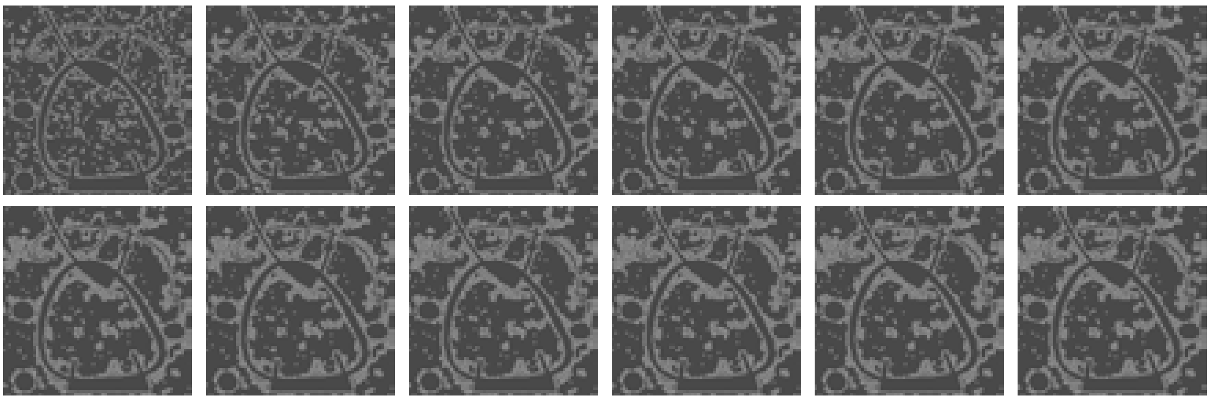
4. Explorations of virtual cities

Through the study of urban patterns and their evolutions, a set of individuals and interactions are formulated to represent elements of a city as well as compositional rules for urban patterns. These individuals and interactions are designed into a cellular automation machine to explore their emergent behaviours. The system of cellular automation machine based on Conway's Game of Life [] is implemented in Processing []. In it, an individual is a computational representation of city blocks, which is realized as graphical elements on the display screen. Each individual contains a set of compositional rules to react to another individual to generate new forms, a set of rules to react to environmental stresses, and a set of rules to respond to external forces. The environmental stresses are represented as colours or shades of grey, while the external forces are pre-coded into the machine or data taken from input devices such as video camera. The virtual city is a simulated graphical layout presented on a display screen or projected on a vertical or horizontal surface.

A group of second- and third-year architectural students, after studied the history and the urban patterns of Tainan city, begin to explore the growth of virtual cities through various types of interaction rules. The first exploration focuses on the urban pattern of armatures. The set of interaction rules is formulated based on the infant years of Tainan, where settlers gather along waterways. These rules are as the following:

1. Loneliness: any individual with fewer than two live neighbours moves away (basic Game of Life rule);
2. Overcrowding: any individual with more than three live neighbours moves away (basic Game of Life rule);
3. Unchanged: any individual with two or three live neighbours stays (modified Game of Life rule);
4. Move in: any empty city block with exactly three live neighbours has an individual moved in (modified Game of Life rule); and
5. Uninhabitable: any individual situated on the water moves away.

Students use a painting by Miró [] as the virtual landscape, where colour “black” is interpreted as water. The virtual city is presented in two colours: white as building block and grey as vacant land. This exploration shows that armatures become prevalent in less than 60 generations. As the generation continues, the settlements developed into clusters.



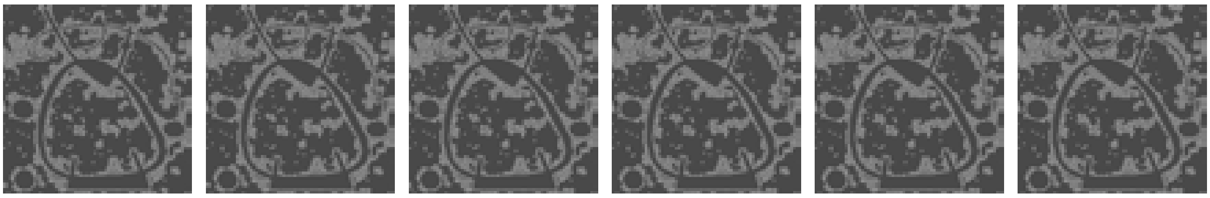
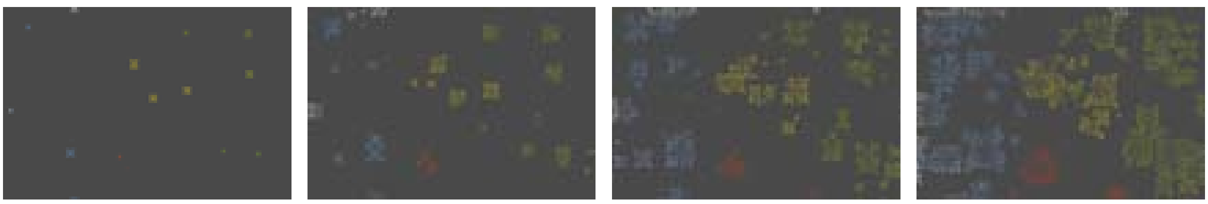


Figure 9. An exploration of armatures.

The second exploration focuses on the urban pattern of enclaves. The set of interaction rules is formulated based on the development in the 18th century of Tainan, where settlers built temples, which are organized according to heavenly orders, of enclaves. These rules are as the following:

1. Settling: an individual picks a suitable land to settle;
2. Decaying: an individual with no neighbours or with more than four neighbours decays gradually and dies in four generations;
3. Clustering: a strong individual attracts another individual to settle in the neighbouring land (probability: 0.4);
4. Longevity: an individual within a cluster of more than five individuals stays; and
5. External Force: an individual dies when its occupied land becomes unsuitable.

In this exploration, the landscape of the virtual city is directly taken from the image captured through a webcam. On the video image, the landscape, the colour lightness (value) of 0.5 or above is interpreted as suitable land. Significant changes in the physical space (captured through the webcam) are interpreted as external forces (natural or political events) to trigger massive changes in the virtual city. This exploration shows that enclaves become prevalent in 10 generations. As the generation continues, the enclaves disintegrate and lose the distinct patterns. External forces trigger the re-generation of enclaves.



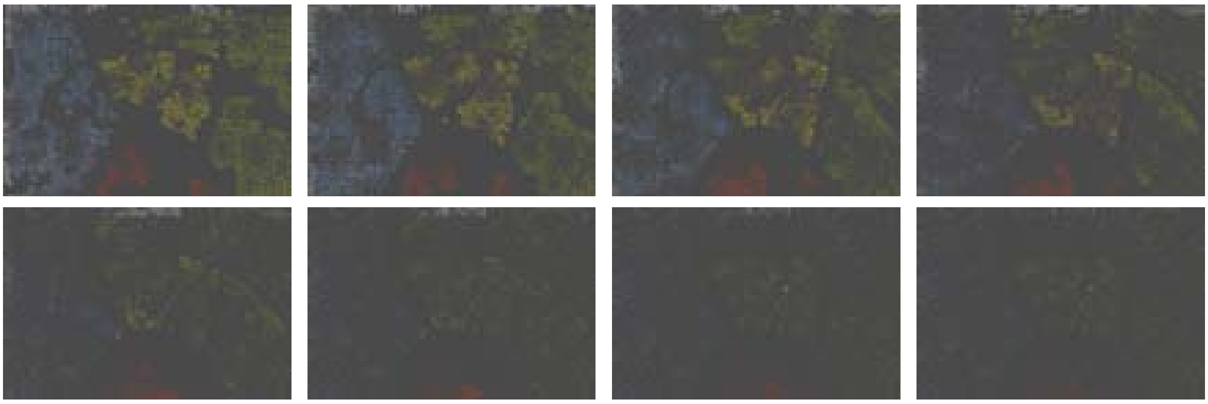


Figure 10. An exploration of enclaves.

The third exploration focuses on the urban pattern of heterotopias. The set of interaction rules is formulated based on the development of Tainan during Japanese occupation, where the western urban plan was imposed on the pre-existing context. Again, a webcam is used and changes in the webcam image are interpreted as natural or political powers, which interrupt the development and created new armatures and enclaves.

Figure 11. An exploration of heterotopias.

The fourth exploration tries to emphasize on the modern heterotopias of vertical armatures (flows in elevation) and enclaves. The set of interaction rules is formulated based not on the historical records of Taiwan but on the urban modelling technique of Shane []. These rules are as the following:

1. Loneliness: any individual with fewer than two live neighbours moves away (basic Game of Life rule);

2. Overcrowding: any individual with more than three live neighbours moves away (basic Game of Life rule);

3. Raising: any individual with two or three live neighbours raises one more level (modified Game of Life rule);

4. Move in: any empty city block with exactly three live neighbours has an individual moved in (modified Game of Life rule); and

5. External forces: an individual moves away when its occupied land becomes unsuitable.

In this exploration, the landscape of the virtual city is directly taken from the image captured through a webcam. On the video image, the landscape, the colour lightness (value) of 0.5 or above is interpreted as suitable land. Significant changes in the physical space (captured through the webcam) are interpreted as external forces (natural or political events) to trigger massive changes in the virtual city. After 100 generations, the virtual city becomes forest-like, where pockets of low-rise enclaves spread among high-rise armatures.

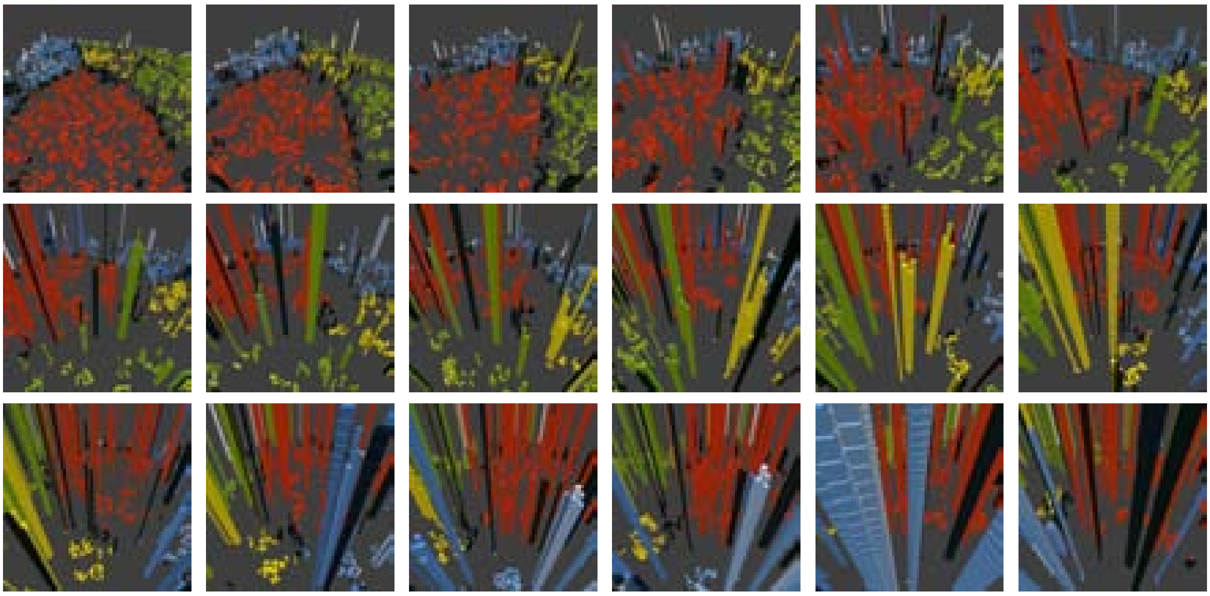


Figure 12. A further exploration of heterotopias.

These explorations create virtual worlds where a city evolves with the growth and decay of city blocks. These student works were exhibited in a workshop where each virtual world was presented, as an installation, in a physical space with a webcam installed to monitor the changes in this space. Significant changes in the physical space are interpreted as external forces (natural or political events) that trigger massive changes in the virtual world. These installations promoted discussions among students, as well as the architecture faculty members, regarding the role of computation in design.

5. Discussions

The works presented in this paper are parts of an on-going effort to train “digital designers” in the field of architecture in Taiwan. Many related works and research projects provided foundations to the trials illustrated in this paper, especially those presented in the past Generative Art conferences, such as [,,]. Digital computational tools have become necessary in architectural design and development processes. These tools, in particular three-dimensional modelling tools, have become very sophisticated and provided users a wide spectrum of operations to create complex three-dimensional models. Using these tools, designers can create a three-dimensional model through direct manipulations on surfaces as if working with digital clay. Furthermore, these tools provide scripting/programming interfaces so that designers may generate models through computer programs. A “competent” designer, therefore, should be able to understand the full spectrum of operations provided by these tools.

I believe the key to a competent designer is “computational design” thinking. My early efforts focused on teaching graduate-level architectural students to write computer programs and recursive computational mechanisms with naïve and unrealistic applications in architectural domain. More recent efforts focused also on training graduate-level architectural students to employ generative methods for conceptual designs [].

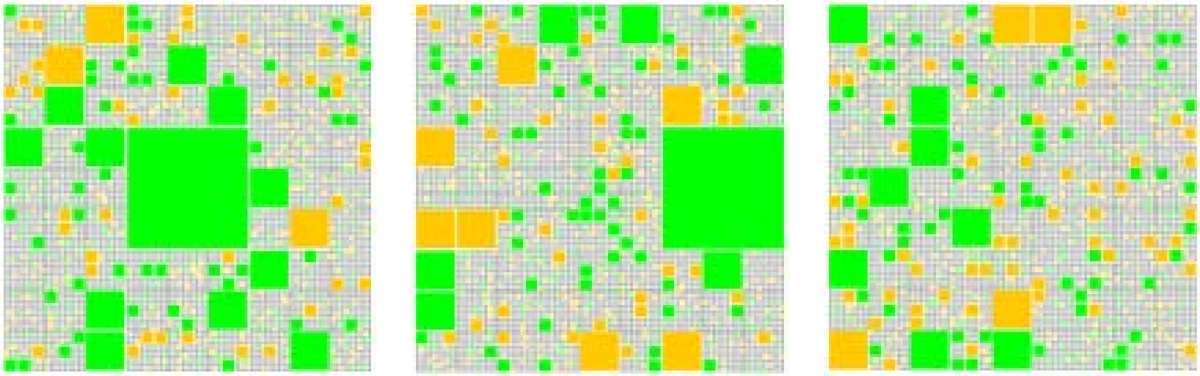


Figure 13. Employing fractal dusts algorithm to generate urban zoning plans

Among various generative mechanisms the ones based on optimization and heuristics (e.g., expert systems, shape grammars) are easily understood by students yet difficult to be implemented and applied by students. The theories of chaos and complex systems explaining emergent behaviours through simple individuals and interactions between individuals are difficult for students to understand yet can be easily implemented and tested by students. This paper shows that second- and third-year students could begin to grasp and appreciate the power of computation through hands-on exercises. A new digital design curriculum is under planning to integrate these generative mechanisms into the undergraduate architectural curriculum.

Acknowledgement

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References

1. Hofstadter, D.R. (1979), *Gödel, Escher, Bach: an Eternal Golden Braid*, Harvester Press.
2. Batty, M. (2005), *Cities and Complexity: Understanding Cities with Cellular Automata, Agent-Based Models, and Fractals*, The MIT Press.

3. Johnson, S. (2001), *Emergence: The Connected Lives of Ants, Brains, Cities, and Software*, Scribner.
4. Shane, D.G. (2005), *Recombinant Urbanism: Conceptual Modeling in Architecture, Urban Design and City Theory*, Wiley.
5. Thomson, J. (1873), Notes of a Journey in Southern Formosa, *Journal of the Royal Geographical Society of London* **43**: 97-107.
6. Rubinstein, M.A., ed. (1999), *Taiwan: A New History*, M.E. Sharpe.
7. Fu, C.-H. (2003), City and architectural transformation in Tainan, *Dialogue Magazine* **072** (2003 Aug), Taipei Taiwan.
8. Sun, C.-w. (2003), Chih-Kan cultural part plan, *Dialogue Magazine* **072** (2003 Aug), Taipei Taiwan.
9. Gardner, M. (1970), Mathematical Games: The fantastic combinations of John Conway's new solitaire game “Life”, *Scientific American* **223**: 120–123.
10. Reas, C. and Fry, B. (2007), *Processing: A Programming Handbook for Visual Designers and Artists*, The MIT Press.
11. Miró, J. (1968), *The Birth of Days*, Oil on canvas, Pierre Matisse Gallery, New York.
12. Frazer J.H. (1998), Macrogenesis: generative design at the urban scale, *Generative Art 1998*, Milan Italy.
13. Ceccato, C. (1999), Parametric urbanism: explorations in generative urban design, *Generative Art 1999*, Milan Italy.
14. Frazer, J.H. (2001), The cybernetics of architecture, *Kybernetes* **30**(5/6): 641-651.
15. Chen, C.-C. and Chien, S.-F. (2005), *A Being :{ boids }*, top 40 design projects, FEIDAD 2005, URL: http://course.ad.ntust.edu.tw/teacher/nik/FEIDAD2005/index.htm.

Section as Form Generator under Digital Environment

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Abstract

Given the development of digital design concepts and technologies, architects are confronting a new territory of architectural form generation. Two significant themes have emerged. One has to do "post-generation systems" dealing with the analysis of existing precedents and the derivation of new instances. The other has to do with "dynamic forces" dealing with form abstraction based on process and movement. This paper examines how section may be used as form generator under digital environment. Two sets of design experiments are developed and conducted to explore the aforementioned two themes. The concept and logic underlying the methodology of the two design experiments are discussed. The processes and the products are presented. The attributes characterizing dynamic forms are also identified on the basis of the findings acquired from the experiments.

1. Approaches to Form Generation

Many scientific approaches to the problem of form generation in architectural design have progressed greatly since the second half of the 20th century. Along the progression, two significant themes have emerged. One has to do "post-generation systems" which deals with the analysis of existing precedents and the derivation of new instances. Noteworthy among them is the shape grammar formalism initiated by George Stiny and James Gips. [6] Many known architectural precedents are employed as subjects for study such as Andrea Palladio [7], Frank Lloyd Wright [3], and Giuseppe Terragni [8]. The other has to do with "dynamic forces" which deals with form abstraction based on process and movement. Noteworthy among them is the animate form proposed by Greg Lynn. [5] The purpose of this paper is to explore how section may be used as form generator under digital environment. Two sets of design experiments are developed and conducted in response to the aforementioned two themes. Experiment I places emphasis on the design from known to new and Experiment II on the dynamic form making.

2. Experiment 1: Design from Known to New

2.1 The process of analysis and generation

The first set of experiment addresses the theme of design from known to new. A method for analysing the morphological structure of an existing building and generating the new form is developed on the basis of “structural section.” The process of analysis and generation consists of three sequential steps: the derivations of the basic form, the composite form, and the plastic form.

Step 1: The Basic Form
The derivation of the basic form is based on the analysis of a historic sawmill building. An interesting structural difference is found in the longitudinal cross section. The idea of “Difference” is extended to establish the form generation mechanism. (Recall Derrida’s use of “Différance” for the discussion on time and space.) An operation called “Differential Generation” is applied to generate the basic form as shown in Figure 1.

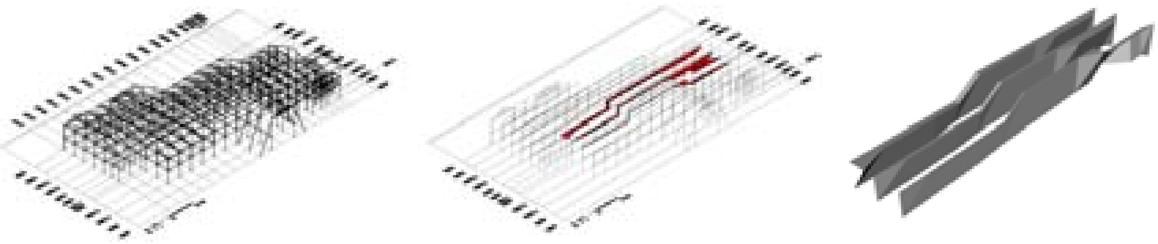


Figure 1. Basic Form Generation

Step 2: The Composite Form
The basic form is placed within the framework of another existing building (a small sawmill attached to the historic one). Their spatial and inter-relations are created through the application of an operation called “Constructive Linkage.” The composite form is generated as shown in Figure 2.

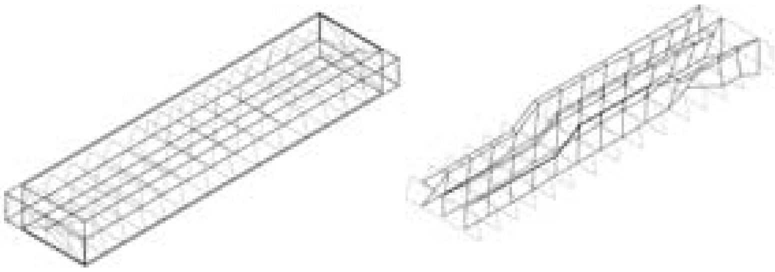
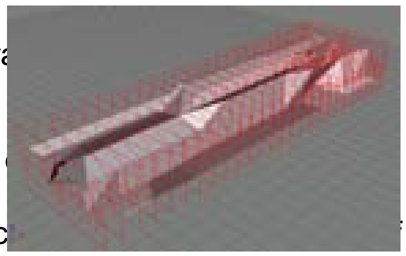


Figure 2. Composite Form Genera



Step 3: The Plastic Form
As shown in Figure 3, the composite form is made up
section frame is in turn made up of a number of straight
of the section frames need to be modified for further proc
the straight lines are transformed into curved lines through the application of B-spline. As shown in Figure 4, the final form is generated through the application of the operation called “Plastic Integration.” Note that each section in the final form consists of four basic spaces and one to three overlaps in-between.

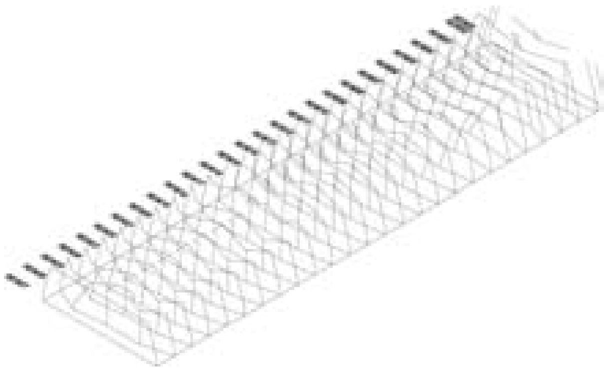
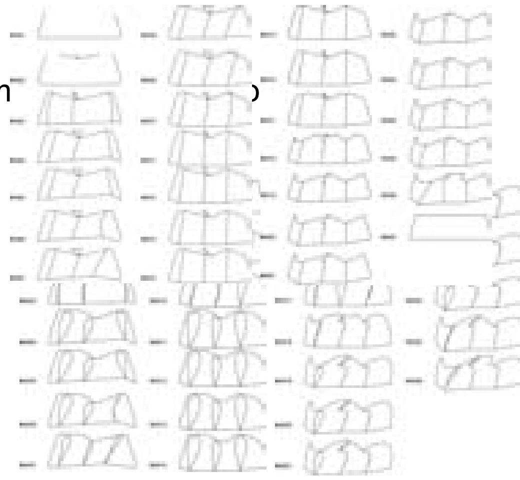


Figure 3. The Composite Form



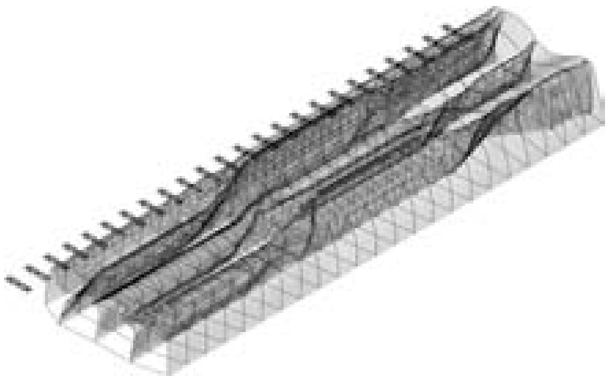


Figure 4. The Final Plastic Form and Its Sections

2.2 Formal Attributes

The final plastic form is characterized by the overlaps in section. The formation and the shapes of the four basic types of the overlaps are shown in Figure 5.

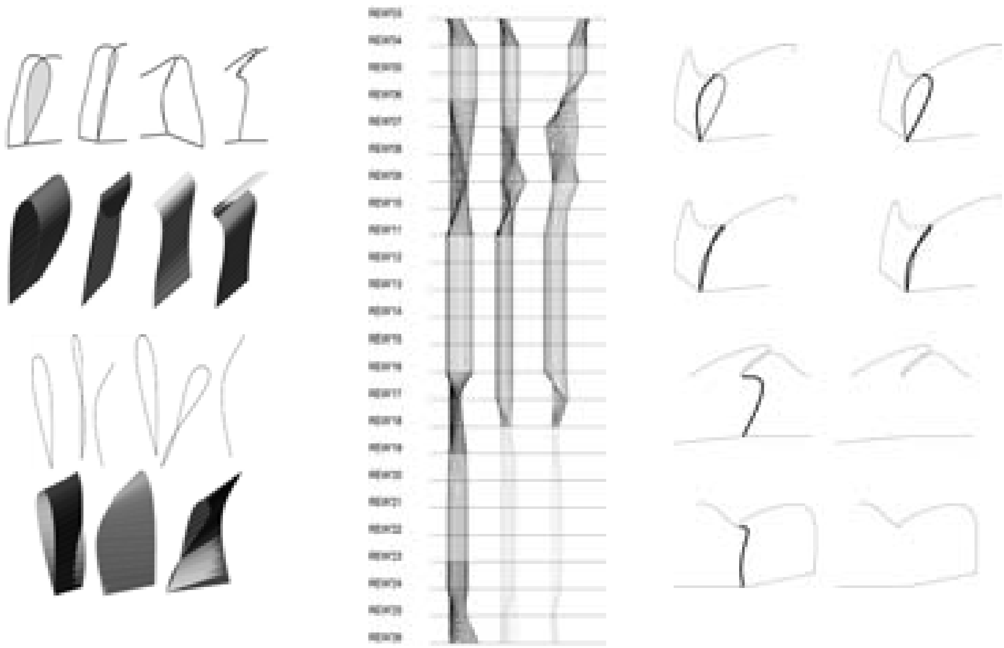


Figure 5. Basic Types of Spatial Overlaps in Section

Moreover, the combination of the basic types of overlaps provides the sections with a wide variety of spatial morphology as shown in Figure 6.

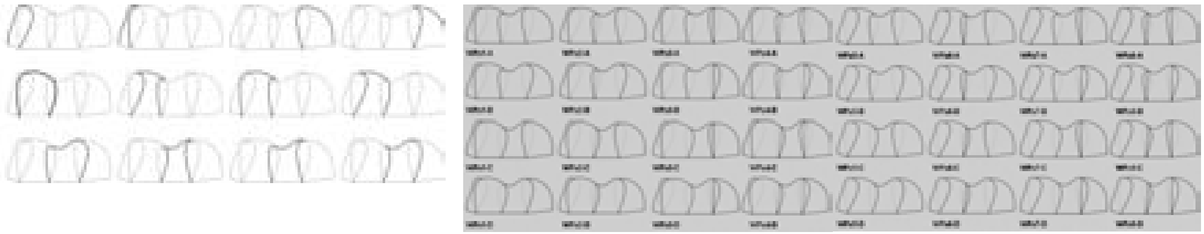


Figure 6. Sections of the Final Plastic Form

3. Dynamic Form Making

3.1 The process of analysis and generation

The second set of design experiment addresses the theme of dynamic form making. The idea of section is employed as an archetype for abstracting the ostensibly complicated shapes derived through human body movement. In the following experiment, basketball playing is used as the subject for study. As shown in Figure 7, the experiment captures the movement of dribble and represents it in a series of frames of frozen states. Each frame shows that the gesture of the body occupies space in a particular time. The contour shapes of the body gesture are abstracted and superimposed in Figure 8. The overall dynamic form is generated from the accumulation of the application of NURBS on the ever changing shapes of the section through a period of time, as shown in Figure 9.

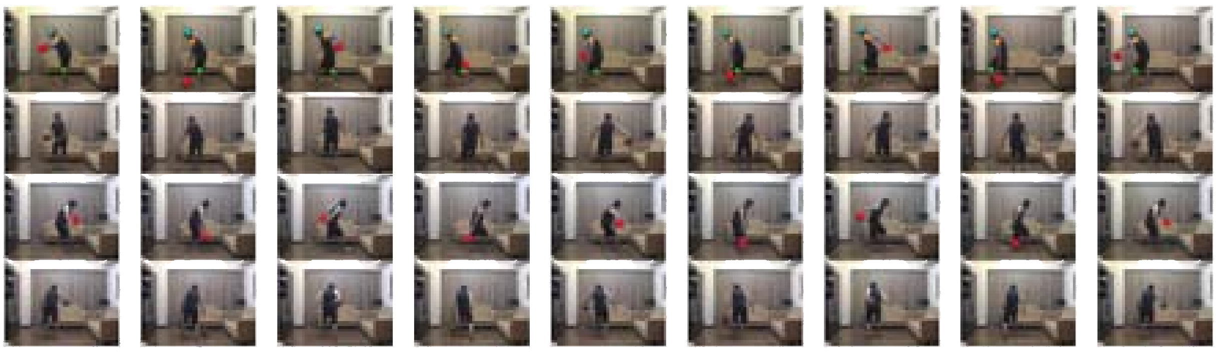
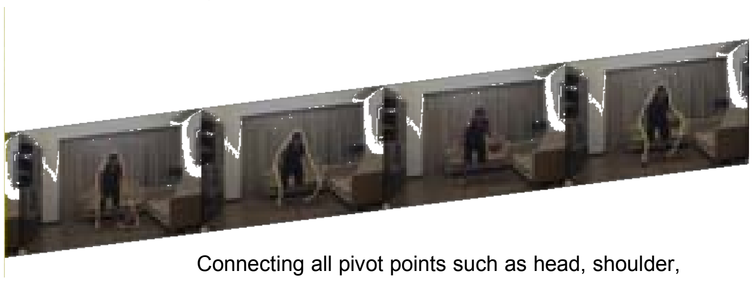


Figure 7. The Frames Captured in the Movement of Dribble



Connecting all pivot points such as head, shoulder, elbow, wrist, knee, and ball using PLINE in CAD.

Figure 8. The Abstraction and Superimposition of the Shapes Derived from Body Movement

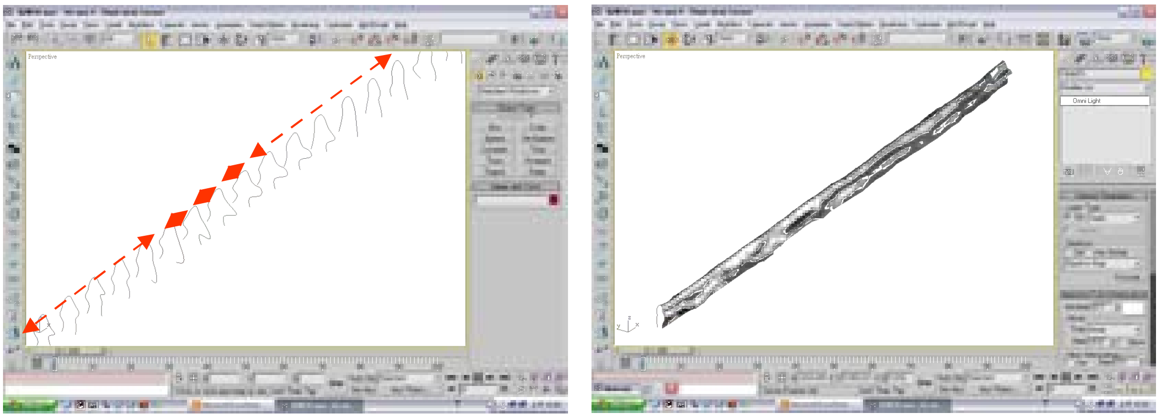


Figure 9. The Application of NURBS on the Ever Changing Shapes of the Section

3.2 Sectional Spaces in the Dynamic Form

Five basic dribble movements are recorded and analyzed respectively according to the aforementioned process. Finally five dynamic forms are generated. The sectional spaces in one of the dynamic forms are shown in Figure 10.

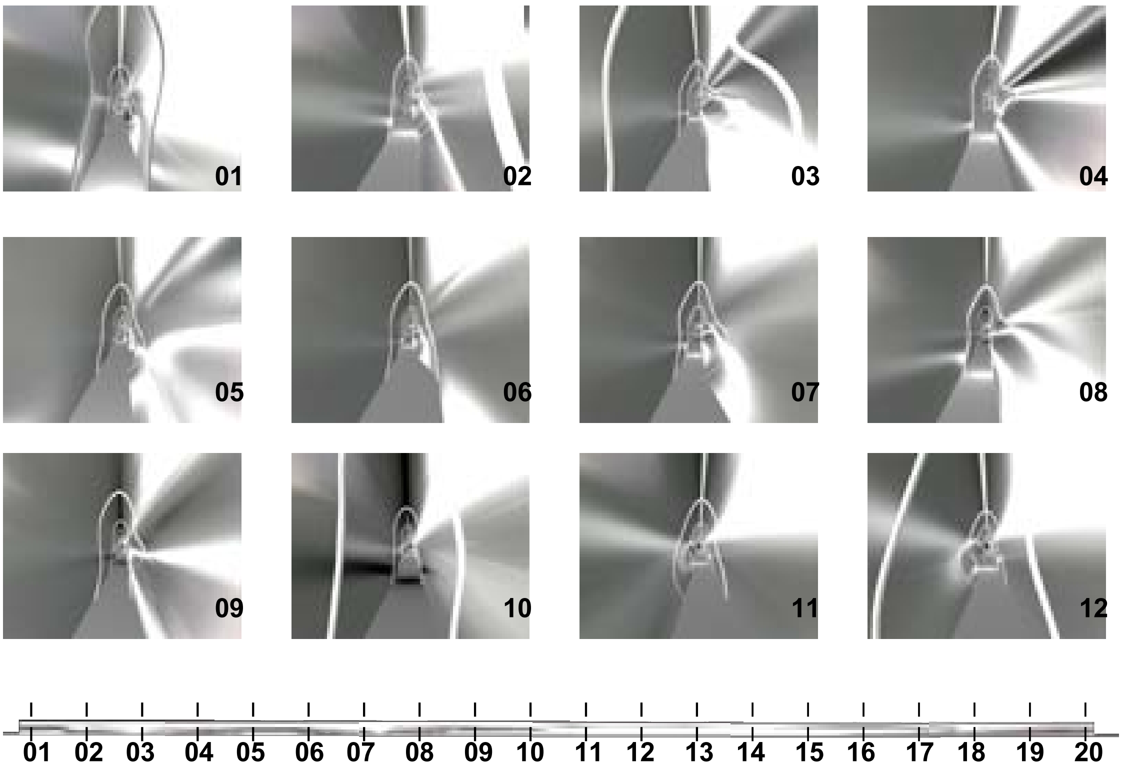


Figure 10. The Sectional Spaces at Different Locations of a Dynamic Form

3.3 Formal Attributes

Each of the dynamic forms appears as a longitudinal, curvilinear form with various degrees of folds on surface. In contrast to the traditional geometric form, the dynamic form is characterized by its apparent complexity and continuity. A closer examination reveals that the visual effect of complexity and continuity may result from the following formal attributes.

With respect to complexity, the findings show that the sections of the dynamic form have no recognizable basic shapes such as square, circle, and triangle. They instead are irregular in shape. In addition, the composition of the sections normally lacks of a clear orientation. The ambiguity in orientation is due to the multiple axes underlying the composition's multiple directions. Moreover, the layers of composition are interweaving. The alternation of the concave and convex surfaces also increases the effect of unbalance. In summary, the complexity of the dynamic form is characterized by the formal attributes like irregular shapes, multiple axes, interweaving layers, and unbalanced composition. (See Figure 11.)

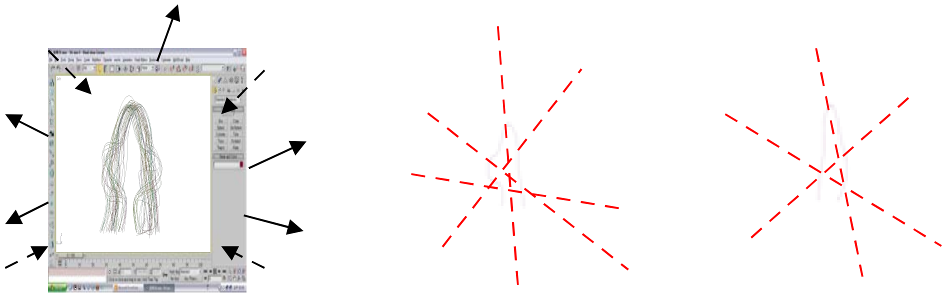


Figure 11. Complexity: Irregular Shapes, Multiple Axes, Interweaving Layers, and Unbalance

With respect to continuity, foldness and smoothness are the two key issues. There are various kinds of folds on the exterior and interior surfaces. Nevertheless, all the folds are determined by size and angle. Smoothness can be realized as the continuous changes of folds within a limited period of time and space. The changes of folds in different depths produce the density of folds on the surfaces of the dynamic form.

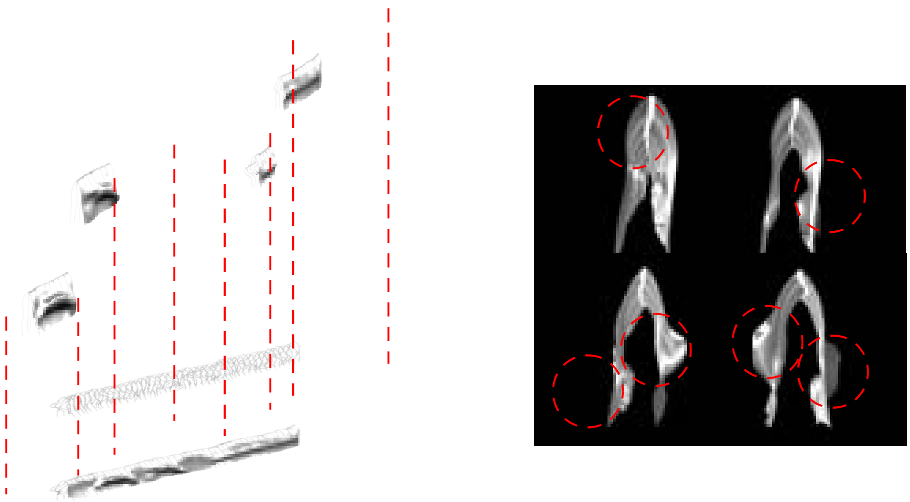


Figure 12. Continuity: Foldness and Smoothness

4. Discussion and Conclusions

The two design experiments using section as form generator under digital environment are presented above. The first experiment deals with the design from known to new. The idea of "differential generation" is employed for the analysis of the architectural precedent. The "structural section" is applied throughout the three steps of form generation. It is found that the structural section constitutes a good mechanism for understanding the existing spatial structure and, on the basis of the understanding, for creating a new form. The final plastic form is characterized by the four basic types of the overlaps in section. The combination of the basic types also provides the sections with a wide variety of spatial morphology.

The second experiment deals with the making of dynamic form. The idea of "section" is employed as an archetype for abstracting the ostensibly complicated shapes derived through human body movement. The contour shapes of the moving body are captured, abstracted, and represented in a series of frozen sections. The final dynamic form appears as a longitudinal, curvilinear form with various degrees of folds on surface. It is characterized by its apparent complexity and continuity. The problem of complexity can be addressed by the formal attributes like irregular shapes, multiple axes, interweaving layers, and unbalanced composition. The problem of continuity can be addressed by the issues of foldness and smoothness. Smoothness can be realized as the continuous changes of folds within a limited period of time and space.

It's difficult to use the formal principles such as proportion, geometry, axis, symmetry, rhythm, and hierarchy, as applied in classical or modern architecture, to address the problems of the digital-generated free form such as the plastic form in experiment I and the dynamic form in experiment II in this paper. From the above discussion, it is clear that some more adequate terminology (e.g. Greg Lynn's use of blob) is required. A general framework for describing, understanding, and interpreting the properties of these new forms also needs to be established in the discipline of architecture.

In contrast to section, plan as the generator for new architecture was ever advocated eloquently by Le Corbusier. In his Towards a New Architecture, Le Corbusier stated: "*The Plan is the generator. Without a plan, you have lack of order, and willfulness. The Plan holds in itself the essence of sensation. The great problems of to-morrow, dictated by collective necessities, put the question of 'plan' in a new form. Modern life demands, and is waiting for, a new kind of plan, both for the house and for the city.*" Indeed by tradition architectural research has paid much less attention to section than plan; however, as reflected in this paper, it can be argued that "the essence of sensation," "the great problems of tomorrow" may exist in Section. It's about time to call for the development of a new discourse on section as form generator in the new digital era.

5. Acknowledgement

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6. References

[1] Chao, C.-B., The Architectural From Operation Based on the Framing Pattern of Animation in the Digital Environment. Taichung: Tunghai Univ., 2007.
[2] Flemming, U., "The Secret of the Casa Giuliani Frigerio." Environment and Planning B 8, 1981, pp. 87-96.
[3] Knight, T., "The Transformation of Frank Lloyd Wright's Prairie Houses into His Usonian Houses." Transformations of Designs, University of California, Los Angeles, Doctoral Dissertation, 1986, pp. 338-377.
[4] Liou, S.R., "Design from Known to New – Issues of Generative Architecture under Digital Environment." Proceedings of the 5th International Conference on Generative Art, pp. 31-38, 2002.
[5] Lynn, G., Animate Form, New York: Princeton, 1999.
[6] Stiny, G. and J. Gips, “Shape Grammars and the Generative Specification of Painting and Sculpture.” Information Processing 71, Freiman, C. (ed. Amsterdam: North Holland, 1972, pp.1460-1465.
[7] Stiny, G. and W. Mitchell, "The Palladian Grammar." Environment and Planning B 5, 1978, pp. 5-18.
[8] Vollers, K., Twist & Build: Creating Non-Orthogonal Architecture. Rotterdam: 010 Pub., 2001.
[9] Wang, C.-K., Form Generation through Digital Tools on the Basis of Existing Architectural Structure-Elements. Taichung: Tunghai Univ., 2002.
[10] Zellner, P., Hybrid Space: New Forms in Digital Architecture. London: T & H., 1999.

From Clay Cones to Tesserae:
the Generative Art of Mosaic Making

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Abstract

The story of mosaics began over 5000 years ago in Mesopotamia when tiny baked-clay cones were first used as a strong finishing material for mud-brick structures. The head of these cones were sometimes colored in black, white or red, and a pattern was achieved by inserting them into the mud plaster on the walls; this was the earliest form of mosaic which has been discovered to date. Since then, many variations have been generated in many parts of the world.

After Mesopotamia the art of mosaic-making in the region, which is now called Turkey, developed in the Hellenistic era, flourished during the Roman Empire continued in the Byzantine period, stagnated during the Ottoman Sultanate and revived in modern times as a decorative finishing material. Over the centuries mosaics have been produced with different material and techniques, textures and colours, motifs and patterns, icons and themes, and on different surfaces and objects; for different reasons and beliefs, the most important reason being to provide a lasting, meaningful and aesthetical finish to the surface it is being applied on.

A study was conducted to trace the development of mosaics in Turkey from the point of view of the types of material and tesserae used, the techniques employed, the colours, motifs, scenes and themes developed in these mosaics. This paper presents the salient features of this transformation through a period of almost two thousand years. The journey starts in Antioch (Antakya), continues in Constantinople (Istanbul) and ends in the Turkish capital, Ankara. Photographs of historical mosaics in Antakya and in Istanbul were taken to collect pertinent visual data; and historical facts were obtained from a survey of literature. Information on modern mosaic-making techniques was gathered during visits to two mosaic workshops in Ankara. Both of these workshops produce mosaics by first fashioning tesserae out of left-over or faulty material, and then using the recycled tesserae to create handmade borders and panels with modern techniques. One workshop dealt with stone, marble and ceramic tiles and the other with glass off-cuts or recycled broken glass.

1. Introduction

The first evidence of mosaic-making in Turkey is attributed to the discovery of baked clay cones in the rubble of ancient mud-brick houses of the Sumerian period (3100 -3000 B.C.). These cones were similar to those used in the mosaics of the 1st Ur dynasty in Iraq (2600 B.C.). Ancient cone-mosaics were followed by the black and white pebble-mosaics of the Greeks in Delphi (600 B.C.). Although, classical Greek mosaics were being executed with small cube shaped stone tesserae (450 to 350 B.C.), coloured marble was used for the first time in 300 B.C. During this period, geometrical motifs, animal forms and also human figures were being used in the mosaic panels; however, the use of cut stones instead of pebbles in pavement-mosaics started much later, in 200 B.C. Finally, colored glass tesserae started to be used for domestic mosaics in around 150 B.C. [1]

The finest examples of early mosaics unearthed in Turkey belong to the Roman era in Antioch (Antakya) and the Hellenistic era in Zeugma. These mosaics were prepared with stone and glass tesserae embedded in lime plaster; and were executed on a grand scale with excellent techniques and naturalistic effects [2]. The mosaics uncovered in Antioch are representative of the iconographic and stylistic changes in Roman art history over a period of four centuries -- from 2nd to 6th century C.E. -- in the Mediterranean region and its environs. [3]

Mosaics are the most splendorous form of architectural decoration and mosaic-making became an art form during the Ptolemaic period in Egypt, from where it spread to the near and far east as well as the Roman provinces [2]. The art of mosaic-making developed by copying old paintings; especially, during the period from 150 B.C. to 200 C.E. When Christianity spread in the Roman Empire and became the official religion during the 4th century C.E. mosaics became recognized as a Christian art and became a medium for large-scale wall decoration in the form of religious murals [1]. These mosaics or stone paintings had superlative permanence and splendor of color compared to frescoes; their grandeur was enhanced when gold started to be used with colored glass tesserae for mosaics in palaces and churches. Examples of such mosaics, which belonged to the Byzantine Empire, can be seen in the churches of Chora and St. Sophia in Istanbul. Gold foil was combined with glass in a special technique to produce the golden tesserae; these were then inserted at a slight angle to catch and reflect the dim light in church interiors, especially the walls and vaults. Figure 1 shows a mosaic from Hagia Sophia, which was built in the 6th century and its mosaics were executed from the 6th to 11th century C.E.

Figure 1. Byzantine mosaic on the vault of Hagia Sophia in Istanbul, Turkey.

Mosaics lost popularity with the coming of Renaissance when paintings became more fashionable; especially since mosaics were more expensive to execute and could not be transported like paintings[1]. On the other hand, Constantinople (Istanbul) had been taken over by the Ottomans who preferred tiling as a decorative art and an architectural finish. Nevertheless, examples of pebble-mosaic pavements can be seen in the 15th century. Ottoman Palace of Topkapi in Istanbul which is remarkably similar to the 1st century mosaic in Russi, Italy (Figure 2). The palace also has a marble mosaic in the Opus Sectile technique next to the swimming pool. After almost 5 centuries of neglect the art of mosaics finally revived in the first half of the 20th century and gained popularity towards the second half [4].


(a)

(b) photo by S. King [4].

Figure 2. The black and white pebble-mosaic pavement of Topkapi Palace in Istanbul (a), executed in the 15th century, resembles the 1st century mosaic in Russi, Italy (b).

With the passage of time, the technology of designing and producing mosaics underwent a change, which was not always progressive. The most important aspects in determining the techniques of production of a mosaic were the availability of material to be used as tesserae and the surface it was to be applied on; while the design depended upon the colour, texture and size of the tesserae, as well as the intention, importance and social relevance of the mosaic. Some of the techniques, motifs, and themes have continued over time while others have been abandoned. Although hand-drawn and hand-crafted mosaics maintain their originality and allure, modern mass-produced mosaics are being fashioned with the help of CAD CAM technologies.

2. Generating mosaics

Mosaics are created by inserting small pieces of stony material in a bed of plaster; these pieces are called tesserae, which are available in many shapes, sizes, materials and colors. The transition from pebbles to cube tesserae was not abrupt but a refining process [1]; and the evolution of tesserae from clay to recycled material occurred in the following chronology: clay cones (3000 B.C.) to limestone and shells (2600 B.C.) to pebbles (600 B.C.); to cut stone (200 B.C.) and marble (450 to 350 B.C.) and then glass (150 B.C.); and finally ceramics, metals, and recycled material such as broken pottery, tiles and mirrors (1900 C.E). . As the variety in material increased, so did the variety in colour and texture. Colours of older pavements are restricted to the colours of marble and stone available in the region. However, with the spread of glass tesserae the colour palette was extended and enriched. For example the mosaics in Hagia Sophia have been executed in 23 colors, including gold.

Modern mosaics are produced with many different materials used in conjunction, such as: glass, ceramics, marble, stone, metals, shells, pebbles, *etc*. Ceramic tiles are cut into regular shapes; squares or rectangles of desired size, the smallest being 1cm x 1cm; with the help of cutting machines or broken into irregular pieces in-situ (Fig. 3). Marble / glass tesserae are produced from thin marble slabs / glass sheets in the same way as ceramic ones are with the help of machines and special tools. Conversely, they are fashioned from off-cuts or waste pieces of marble or glass. Sometimes, glass or ceramic tesserae are factory produced in the desired colors, shapes and sizes; the glass tesserae in the workshop surveyed are produced from recycled glass.

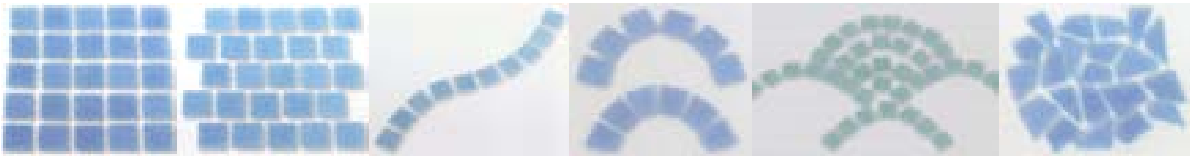
Figure 3. Preparing tesserae in a workshop in Ankara, Turkey.

Along with the transition in materials there also existed a continual transition in the themes, motifs and techniques. For example, in Antioch the educated elite preferred to commission literary scenes in their homes, such as ‘the judgement of Paris’; while some themes were of a moral value, such as ‘the drinking competition’. Superstition was another theme in residential mosaics, such as warding off ‘the evil eye’. Labelling is found from 3rd century C.E. onwards where abstract concepts were portrayed, while lengthy inscriptions were used to immortalise quotes or biblical verses.

2.1 Designing mosaics

The first mosaics consisted of simple geometric patterns such as bands, grids, zigzags, triangles etc; as in the Temple of A-anni-padda belonging to the 1st dynasty of Ur. These geometric patterns evolved into more complicated designs which were later combined with panels of stylized scenes, as in the Hellenistic and Roman mosaics. On the other hand, imagery in mosaics changed from pagan gods to literary scenes and then to religious ones with the spread of Christianity in the Roman Empire [1].

Mosaic patterns can be classified according to the shapes and order or disorder of the mosaic tesserae [4]. For instance, when cubic tesserae are fixed in a rectangular geometrical grid the pattern is called *Opus Regulatum*. However, if the rows in the grid are offset to resemble the common brick bond it is called *Opus Tesselatum,* which is mostly used for mosaic infill or background. On the other hand, if the tesserae are inserted in a worm-like winding pattern, which is often used for outlining or emphasizing a shape for pictorial effects, it is called the *Opus Vermiculatum*; and when this style of fixing tesserae is used to cover entire vaults or walls, as in the early Christian mural mosaics, it is called *Opus Musivum*. Finally, if the cubic tesserae are fixed in the key-stoning curves and a repeated fan-shaped pattern is achieved, it is called *Opus Circumactum.* To execute a mosaic in an *Opus Sectile* pattern, the tesserae are cut to fit the contours of the design, as in the 15th century C.E marble marquetry of the water channel in Topkapi Palace in Istanbul, belonging to Ottoman times (figure). Conversely, if the tesserae are not only randomly shaped but also laid in a random manner the pattern is referred to as *Opus Palladianum*; this style of executing mosaics has become very popular in contemporary times and the most remarkable examples can be cited as Gaudi's Parc Guell in Barcelona.

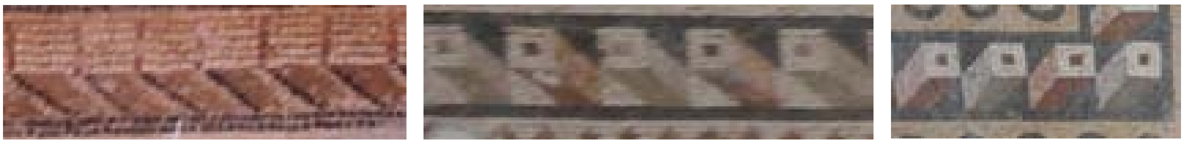


Regulatum Tesselatum Vermiculatum Musivum Circumactum Palladianum

Figure 4. Mosaic patterns are classified according to the shapes and order or disorder of the mosaic tesserae [4].

The *Opus Regulatum* is used to create the meander borders and the stepped pyramid shape; the latter then generated the stepped diamond pattern. The diamond was transformed into the lozenge, which in turn generated the dentil and solid borders (Fig. 5). The solids were used in varying configurations to create smaller emblemata (Fig. 6).

meander borders stepped pyramid stepped diamond lozenges



Dentil border solid borders

Figure 5. Opus regulatum used to generate various shapes and border designs

Figure 6. Solid box motif used to generate various emblemata.

The *Opus Vermiculatum* is used to create the wave-crest and folded ribbon borders; the latter was transformed into a twisted ribbon by creating a three dimensional effect with bands of colors ranging from dark to light to give it the feeling of depth (Fig. 7). This style is also used to create the guilloche borders which become more and more complicated with the addition of strands (Fig. 8). The guilloche, which is a pattern of interlacing bands forming a plait, is also a forerunner of the gradually complicated knot emblemata (Fig. 9).

Figure 7. Opus vermiculatum used to generate various shapes and border designs

Figure 8. Opus vermiculatum generating 2, 3, 4 strand- and loop- guilloche borders

Figure 9. Generating emblemata from meander to knots and loops

Traditional techniques:

The mosaic school of Eastern Arts extended beyond the workshops of Antioch. In these workshops there used to be teams of mosaicists consisting of a designer and the apprentice workers just like the team consisting of a figure specialist, an ornament painter and a plasterer for producing murals. Mosaicists traveled to far off places to practice their trade which is why the style and iconography of mosaics produced in the workshops of Antioch can be seen in places like Cyprus and Israel [3].

The mosaics had depth and three dimensional effects similar to paintings, which is why they were often called stone paintings. The mosaicists were known for the sophisticated handling of foreshortening, shading and lighting that produced these effects. Their style was a continuation of the Hellenistic artistic tradition in the selection of Greek themes and patterns, and illusionistic treatments in painting style. The iconography in these mosaics had messages of social and moral nature [2].

The three dimensional effect was created with various techniques shown below, such as: coffered panels; lozenges and a square to give the solid box and a square within the square to give an open box effect; meander pattern in isometric; empty cubes; inscribed boxes; folded ribbon, etc.

Figure 10. Generating three dimensional patterns from meanders and solid boxes.

The basic composition of a mosaic consisted of square or rectangular panels of geometric patterns or scenes from religious or literary stories. The panels were encircled with geometric borders or rinceau, which were wide borders of vines, leaves and flowers interlaced with birds and masks. The geometric borders were composed of plaits, solids, row of dentils, guilloche (2, 3 or 4 strand or looped-), stepped pyramids, meanders, tangent diamonds, wave-crests, twisted ribbon, folded ribbon, trellis, or bead and reel. Sometimes a panel would contain a rectangular, circular or octagonal emblema instead of a scene. It was also possible to create a panel with semis of florets, crosses, rose-buds, stars, diamonds, etc. The smaller emblemata would contain rosettes, simple knots, zigzag bands or a Solomon’s knot.

Modern techniques:

Computer programmes such as AutoCAD or CorelDraw are used to generate the pattern, which is either provided by the client’s architect or chosen from ready made ones in the mosaic catalogue If a photograph is used then it is scanned and imported into a CAD programme, where it is subdivided into manageable panels. The panels are numbered sequentially and printouts are produced; these printouts serve as the stencil for the mosaic panel. A 160 square meter swimming pool was finished with glass tesserae mosaic by first enlarging the chosen pattern and then dividing it into 30x30cm tiles. These tiles were produced using the direct mesh method and numbered according to their sequence in the pattern. They were brought together on site and installed in their designated places to assemble the pattern (Fig. 11).

 **(a)**  **(b)** 
(c)

Figure 11. Transforming design into mosaic tiles and panels: (a) post card to mosaic (b) wall-paper panel (c) wall paper pattern executed as mosaic for swimming pool

2.2 Production Techniques

There are mainly two ways in which a mosaic can be produced: in-situ or in a workshop. When a mosaic is executed in-situ, the outline of the pattern is drawn directly on to the surface on which it is to be applied; mortar or adhesive is then spread over small sections of the pattern and tesserae are inserted into it piecemeal; once the pattern emerges the background is filled in. Since the pattern is stenciled in directly this technique is called the ‘direct method’. The direct method can also be used in workshops to produce panels of mosaics on a solid base that can be transported to the site and fixed in place. Although, in-situ mosaic production was common in the past and although it is still used to produce smaller objects, it is no longer practical to execute mosaics for architectural decoration purposes using this technique. Due to time and space constraints, it is more convenient to install made-to-order mosaics, which have been prepared in workshops.

Mosaics created in workshops, to be applied on walls or floors elsewhere, can be prepared using one of the following three techniques: the mesh, reverse-stencil or template-tray. In the mesh technique the tesserae are glued on to a glass-fibre mesh according to the pattern drawn on a paper stencil placed under the mesh. Since the pattern is drawn normally on the stencil and since the tesserae are fixed face up it is considered to be a direct method. On the other hand, the reverse-stencil and the template-tray techniques are considered to be indirect methods.

In the reverse-stencil technique, the pattern is sketched in reverse on paper and tesserae are fixed face-down onto the pattern with a temporary adhesive. When panels so prepared are inserted on to a layer of fresh plaster or stucco the paper is peeled off to reveal the mosaic and the gaps between the tesserae are filled in with grout. In the template-tray technique, the mosaic is prepared in modular plastic trays which have the pattern molded in like a template. The tesserae are placed face-down on the template-trays and glue is applied to their backs with a roller; the mesh is then stuck to the tesserae and once the glue dries it is possible to lift off the mosaic from the template-tray and store it in boxes to be transported to the installation site. At times these mosaic tiles are part of a very large pattern or scene which is assembled on site and inserted in the proper sequence.

Figure 12. Glass tesserae and template trays used to produce mosaic tiles and panels.

Traditional techniques:

Early mosaics were always executed in-situ; plaster was laid on a foundation coat of cement on which the principle features of the design were drawn and coloured. This plaster was removed bit by bit and replaced with binding cement and tesserae. Sometimes the design was scratched into the base plaster with the colour of the larger areas indicated on it. The design was thought out by the master mosaicist who also laid out the contours of the design and the main panels; the rest was filled in by his assistants. The grout that would be applied to fill in the spaces between the tesserae was sometimes coloured; e.g. the grout used in the Hagia Sophia mosaics was deep red so as to bring out the splendour of the gold tesserae [1].

The surface to be decorated was covered with a thick plaster of powdered marble lime mixed with pozzulana (volcanic rock), to make it smooth. The mosaic pieces were inserted into a second layer of stronger plaster that was applied in sections small enough to allow the work to progress before the plaster had time to dry out. The tesserae were not absolutely regular in shape, ranging from 0.4 cm to 1.8 cm; smaller ones were used for detailed work and larger ones for the background. The tesserae were never set flush but at slight angles, with the darker coloured ones set deeper to give an illusion of three dimensions [1].

In Antioch mosaics, the glass, marble or stone tesserae were set in a lime plaster. Each mosaic was designed by improvising on a standard theme composed of borders and a scene or emblema within [2]. The direct technique was also used in Roman times to prepare portable panels, called emblemata, in the mosaic workshops and carried to the site to be inserted in the pavement; the rest of the panel and borders were laid in-situ [3]. It is believed that the complicated and main figures as well as the emblemata were prepared by the masters and the minor work such as filling in the background of the mosaic or its simple border was done by the apprentices [4].

Modern techniques:

A black and white photocopy of an old pattern is obtained from a scanned picture which is enlarged to the desired size; or a life-size printout of the design is obtained of the computerized pattern to be used as a stencil for the mosaic. The print-out is laid out flat on the ground or a worktop. A nylon or plastic sheet is fixed to the stencil to protect the paper and to prevent it from sticking to the back of the mosaic. A nylon- or glass- fibre netting/mesh is fixed temporarily to the plastic sheet to stick the tesserae on to. White water-soluble PVA glue is applied over bits of the pattern area visible through the nylon. The tesserae are glued to define the outline of the pattern first and then the rest of the pattern is filled by sticking the rest of the tesserae according to the colour copy of the pattern being produced.

Depending upon the complexity of design and the size of the tesserae, it can take anytime from one day to one whole month to finish one square meter of mosaic; for example a copy of an ancient mosaic is produced in 25 to 30 days by one skilled mosaicist. When the panel is finished, it is lifted off the paper stencil along with the nylon sheet and put into boxes to be transported to the building it will be installed in. Mosaic panels produced in workshops are applied to the surface (floor or wall) with a thin mortar and, when dry, cement grout is spread on it liberally to fill in the spaces between the tesserae. The surface is then wiped to remove the excess grout and reveal the mosaic pattern.

3. Concluding remarks

Visual information presented in this paper demonstrates clearly that there exists a very strong relationship between tradition and the innovative generative approach. Simple shapes were used to generate compound motifs, which were then used to further generate borders and emblemata of increasing complexity; nonetheless maintaining the quality achieved.

Throughout the ages, some motifs and themes have been transformed, some changed and some remain all time favorites. For example the superstitious evil-eye theme in the Antioch is continued in modern Turkish mosaics as well, albeit, with different motifs; while the meander and guilloche borders are still being used in modern designs. Due to the ease of producing and controlling the transformation of the design idea into reality with computer aided tools and modern equipment, the techniques have changed for the individually crafted mosaics to mass produced ones.

Acknowledgement

The authors would like to thank the personnel of the two mosaic workshops in Ankara, for their cooperation in this study. Thanks are also due to Natasha, Zara and Furhaan Saleem who helped with the photography in Istanbul.

References

[1] E. W. Anthony, “A History of Mosaics”, Hacker Art Books, New York, 1968.

[2] L. Becker and C. Kondoleon, “The Arts of Antioch: art historical and scientific approaches to Roman mosaics and a catalogue of the Worcester Art Museum Antioch collection”, Worcester Art Museum, Massachusetts, 2005.

[3] F. Cimok (Ed.), “A Corpus: Antioch Mosaics”, Tourism Publications, Istanbul, 2000.

[4] S. King, “Mosaic Techniques and Traditions: Projects and designs from around the world”, Stirling Publishing Co. Inc., New York, 2003.

Hidden in the Urban Fabric:
Art + Architecture – a Case Study of Collaboration in interdisciplinary Contexts

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Abstract
This paper relates to the Conference's theme of the Exploration of possible (interdisciplinary) worlds, where collaboration flows naturally and partnering delivers benefits for all participants. It contributes to the ongoing debate about installations / interventions in an urban context, and the potential that such new collaborative experiences and interdisciplinary models can present. It discusses the potential that partnering between architects and artists has for creative interaction with a city's cultural (often derelict) fabric through 'informal urban design'. It introduces and examines a selection of site-specific installation works in Brisbane (Australia) and Berlin (Germany), which were the results of collaborative practices initiated by the author. These temporary works provoke our comfortable notions of life in cities as well as challenge our understanding of the roles of architecture and art, and their modus operandi.
Each presented installation involved the collaboration of at least one artist and one architect. The paper provides insight concerning the organisational process and the interaction of the organisations involved and the behind the scenes activity as to how the curator was able to get the different groups involved, to work together and focus on the project. While working together with a common goal opens up new arenas for artistic exploration, where do the boundaries between art (electronic media art, etc) and architecture / urban design begin and end? Addressing this question of discipline boundary is an essential element in an educational context of interdisciplinary pedagogy, a context in which both projects were initially set.
The exhibitions involved teams of established and emerging artists, and students of architecture, visual arts, landscape architecture and urban design. The resulting dialogues and contemporary crossovers between the disciplines have led to new, informal forms of collaborations and ways to understand the urban context. It has also promoted a fresh perspective on the design process, demonstrating the potential of such reciprocal relationships.
How do media artists draw inspiration from architecture and vice-versa (e.g. intuition versus analytical approach)? How can disciplinary boundaries best be challenged and transgressed in order to critically re-assess them? How might architects and artists work together in Design+Build Studios and temporary urban interventions in public space, in an interdisciplinary future?

Keywords

Collaborative design-build Studio, site-specific installations, interdisciplinary crossover, partnering between artists and architects, reciprocal relationship, urban public space.

1. Introduction: Testing Different Models of Collaboration

The architectural world is continually looking elsewhere — outside itself — for reference points. The current debate about public art and interdisciplinarity indicates that there is a huge potential for collaboration between architects and artists in interacting with the cultural fabric of the city. In this context, temporary installation works can provoke our comfortable notions of life in cities as well as challenge our understanding of the roles of architecture and art, and their *modus operandi*. [1] Obviously, as architects we need to be able to operate in several domains at the same time, or as Wouter Davidts has put it: 'Disciplinary borders should be challenged and transgressed in order to critically reassess them.' [2]
In response to our current times of rapid change, we have become increasingly aware of the need to look beyond conventional models of organisation, and to develop more appropriate cross-disciplinary studio models in teaching architecture. [3] Such collaborative studios differ from the traditional design studios in that they are cross-disciplined and, at the same time, embed a leadership role for the architecture discipline. Of course, there are many precedents for such interdisciplinary approaches. I found the advantage of running collaborative studios is that they produce students who are highly motivated, and who are more rigorous in their thinking.

2. Ways of Sharing Criteria

But where does the discipline of art begin and that of architecture end? The reciprocal relationship between architecture and sculpture has been an intriguing artistic phenomenon for a long time. It's challenging to uncover these methodological differences, through the act of making. Our recent investigations revealed interesting crossover practices, where contemporary artists produced *architectural* objects and space-engaging installations, while artistic tendencies such as Constructivism, Pop Art or Minimalism were quickly adapted by the architecture students.
The idea behind the two exhibitions *Rethinking: Space, Time, Architecture* in Berlin (2002), and *Art+Arch infinite* in downtown Brisbane (2004), was to bring together the disciplines by engaging artists and architects / landscape architects in a collaborative and exploratory discourse with each other. Therefore, the exhibition projects involved teams of both established and emerging artists, and students of architecture and art. Collaboration thrives on difference as much as similarities and the resulting dialogues between the disciplines has led to interesting new forms of collaborations and innovative ways to understand urban context, demonstrating the potential of such reciprocal relationships. Working together with a common goal has opened up new arenas of artistic exploration.
Today, more than ever, making architecture is an interdisciplinary adventure without clear boundaries. Space, proportion, material, colour, surface: architects share with artists a whole range of criteria in their work, as well as some central elements of

theory, planning and delivery. Both disciplines are concerned with the construction of space. Consequently, the influence of works by artists such as Richard Serra, Donald Judd or Gordon Matta-Clark on architects and urban designers is often evident, despite the radical alienation from architecture by these artists. [4] [5] The area between the two poles is charged with a tension that can release artistic energies, witness the case of Matta-Clark, who introduced radically new ideas into the artist-architect relationship, and who is known for his dissections of buildings. ‘Why hang things on a wall,’ he asked, ‘when the wall itself is so much more a challenging medium?’ [6] His installations transformed the notion of sculpture into bisected pieces of walk-in architecture. Thus, art and architecture can meet and define each other’s respective domains on many levels, in a healthy cross-fertilisation.

3. Site-Specific Installations in Public Space: How Context becomes the Content

Probably for too long, artists and architects have performed in their separate communities. Prior to the two mentioned exhibitions, the interaction between practising artists and architects in Brisbane was limited or, rather, accidental, in Berlin it was limited to a small group. In order to improve this situation, the exhibition projects were conceived to realise site-specific installations at different locations in the city — outside, not inside a museum or gallery. [7] For the potential of interdisciplinary crossovers and new forms of partnering, the notion of ‘working conceptually’ is crucial, since this method relates directly to working methods in architecture as well as in visual arts. Through the collaborative process, architecture and the arts willingly or unwillingly become ‘accomplices’ in working together in the construction of space.

However, it seems that collaboration frequently means different things to architects and artists. While the roles played by architects and artists certainly vary from project to project, and while it is impossible to generalise about their relationship, old stereotypes were challenged and new forms of partnering explored.

Most of the teams in Berlin and Brisbane were quick in selecting their sites; the contextual characteristics re-emerge as content – something Rorimer had pointed out. [8] The preparation period was sometimes hampered by the difficulties of liaising between overpowered architects and egocentric artists, where observations and concepts where at constant risk of being compromised. Soon it became clear that there is no ‘ideal’ way artists or architects should perform, and there were some expectable differences between what was supposed to happen, and what really did happen. Surprisingly, most of the artists acted more like architects, whereas the architects started to approach the design task suddenly in the way as expected by the artists. This phase revealed the varying levels to which individuals were able to work across discourses and accommodate different perspectives. As noted by Nicolescu, ‘interdisciplinarity concerns the transfer of methods from one discipline to another’, similar to the borrowing of techniques or values. [9] Such teaming-up, of course, is generally not so new for the architectural disciplines which have, for a long time, recognised and responded to situations in practice where collaborations with consultants from various disciplines have become a common standard. Unfortunately, in the past, this has too often been piecemeal and not explicitly informed by theory, substance or method.

The discussions between architects and artists involved in these innovative collaborations required changing roles in terms of agreements, disagreements and resolutions. Furthermore, it seems that the architect is frequently unable to experiment, with the same degree of freedom as the artist. It often seems that ‘the question of assumed disciplinarian rights, namely that of form-giver and space-maker, bothers architects more than it bothers artists.’ [10] As Philip Drew rightly remarks, ‘the artist frequently appears to be at liberty to develop a new means quickly and inexpensively with an ease that the architect can only envy’. In this regard, the collaboration between architect Peter Eisenman and sculptor Richard Serra is worth a closer look. [11] Some lessons could be learnt from such projects.

4. Strategies for Art Interventions in Public Spaces: Case Studies in Transferring Techniques

How have the teams of visual artists and architects dealt with the complexity and diversity of their urban surroundings, and how have they transformed their various environments? And, in turn, do these installations alter our perception of the city, e.g. in the sense of a ‘Creative City’ context [12]?
The earlier exhibition in Berlin led to a wider understanding of contemporary art and its appropriate venues, and even to an advancement of architectural knowledge. In some way, the Brisbane project developed from the experience with the Berlin exhibition, and was a continuation of these aspects. Importantly, the method of working ensured that art was always a part of the whole, not simply a later application. Thus these types of projects have the potential to open up a much broader discourse about public space. In both cities, the selected participating teams used prominent places and locations for their interventions, such as city gardens, city squares, inner city parks, busy thoroughfares, as well as little known spaces such as laneways and alleyways off the central business district, under-croft spaces along the river, and less-known corners of the city precinct. Typically, such often-overlooked spaces evade description or have outlived their former usefulness, but are ideal for those ‘informal urban design interventions’. The following shows a selection of four works from Berlin and Brisbane:

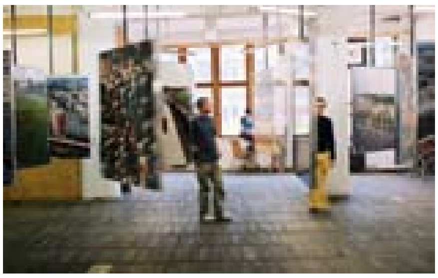

Fig. 1: ‘Where is Bolk?’, Berlin 2002. Art: Florian Bolk. Arch: Philip Wehage. The installation comprised of turning panels with photos of macro and micro views.

Fig. 2: ‘Marking Time and Territory’, Berlin 2002. Art: Colin Ardley. Arch: Hermann Scheidt. A large, object-like ramp was inserted into a ruin of a church by K.F. Schinkel.

Fig. 3 : ‘Surveillance’, Brisbane 2004. Art: Cida de Aragon. Arch: Phil Heywood. Sound: C.McCombe. Large eyes and whispering voices indicate a climate of fear: post 9/11 paranoia, security systems and control of space. Too much control diminishes the public realm.

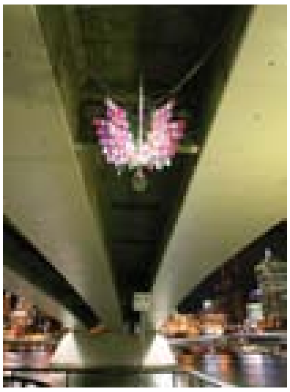

Fig. 4: ‘Dining Room’, Brisbane 2004. Art: Simone Eisler. Arch: Alex Steen. A large chandelier is suspended from underneath a bridge, playing with the irony of opulence, and offering a dining room to the homeless.

5. Some Concluding Remarks: An Evolving Network between Artists and Architects

The involvement of students from different disciplines in the presented exhibition projects created a pedagogical model that resulted in a particular type of learning situation. I would like to suggest that the applied collaborative model was successful in engendering an interdisciplinary attitude, as well as achieving creative energy and new awareness of public space. In this respect, the collaborative exhibition projects were used as the theoretical basis for the further development of an interest in cross-discipline design+build studios for architecture students, dealing with the revitalisation of the city centre.
Architecture is constantly used as a vehicle to fundamentally rethink the way artworks are displayed on both the micro and the macro level. Today, each museum of contemporary art would like to transform itself from a static repository and institutional space into a ‘dynamic workshop’ engaged directly with the city and the artist’s ever changing strategies of production and presentation. [13] Thus, it seems reasonable to conclude that the public, outdoor and temporal nature of both

presented projects has allowed for works unlikely to result from permanent works or to conceive of in the 'white cube' of an art gallery. Here, contemporary and ephemeral art and architecture indulges in the truly public domain by being, literally, in public space. Most of the time, convincing art is temporary, not permanent. The culture of temporary use and temporary installation is an important urban resource that can generate and encourage new activities and make a significant contribution to city life. [14] Interestingly, such interventions can be small scale and do not need to be of large scale and budget.
The exhibition projects have clearly improved and triggered more collaboration between the artists and architects in both cities. The next exhibition project entitled 'Back to the City' is organised for the city of Newcastle, in 2008 (see: www.backtothecity.com.au) The architecture students involved in the project were highly motivated to test this new ground, and most of them confirmed afterwards that they wanted to do more work with artists in the future. A vibrant and active network has been evolving out of the projects. These collaborative programs offer a useful model for other architecture / art programs to adapt. All the works explored the uniqueness and the scope of topics that are brought together within the fields of art and architecture, and the contradictions inherent in the relationship of architecture, as an art form in itself, to the forms of life that it serves.

References

[1] Lehmann, Steffen (2002/2004). In Berlin: The collaborative exhibition project *Rethinking: Space, Time, Architecture* (July 2002) was part of the UIA 2002 World Congress, exhibiting 80 site-specific installations in Berlin's centre, published in the book: Lehmann, S. (Ed.), *Rethinking: Space, Time, Architecture. A dialogue between Art and Architecture*, Jovis Verlag. In Brisbane: The collaborative exhibition *Art+Arch infinite* in September 2004 was part of the Brisbane Festival, exhibiting 15 site-specific installations in Brisbane's centre, published in the book: Lehmann, S. (Ed.) (2005). *Absolutely Public. Crossover: Art and Architecture*, Images Publishing Group, Melbourne, 12-21. See also: www.slab.com.au and www.backtothecity.com.au
[2] Davidts, W. (Febr. 2005). Discussion at the conference on 'Art and Architecture' at Ghent University.
[3] Franz, Jill, & Lehmann, Steffen (2004). *Side-by-side: A pedagogical basis for (design) transdisciplinarity*, in *IDEA Journal 2004*, published by the Interior Architecture Educators Association, Brisbane, 9-29.
[4] Krauss, Rosalind (1983). Sculpture in the Expanded Field. In Hal Foster (Ed.), The Anti-Aesthetic: Essays on Postmodern Culture, Bay Press, Seattle.
[5] Helsel, Sand (2004). Architecture in the Expanded Field: Lessons from Land Art, 38-41. In S. Lehmann (Ed.), Absolutely Public, Images, Melbourne.
[6] Matta-Clark, Gordon (1975). *Days End*. In Exhibition Catalogue, Museum of Contemporary Art Chicago (1985), *Gordon Matta-Clark: a Retrospective*. Quoted according to: Anne Rorimer (2001), *New Art in the 60s and 70s. Redefining Reality*; Thames & Hudson, London, 229ff.
[7] In this regard, refer to: Malraux, Andre (1965), and his concept of *Museum Without Walls.* Paris
[8] Rorimer, Anne (2001). *New Art in the 60s and 70s. Redefining Reality*; Thames & Hudson, London, 229ff.
[9] Nicolescu, B. (1997). *The transdisciplinary evolution of the university condition for*

sustainable development, Melbourne.
[10] Drew, Philip (1986). Site-specific installations, exhibition catalogue, RMIT, Melbourne. Of course, both are disciplines with a long and profound historical and theoretical background of their own.
[11] Eisenman, Peter (2005). *The Holocaust Memorial in Berlin.* This recently completed project (inaugurated May 2005) offers an interesting case in our exploration: Initially, the American sculptor Richard Serra collaborated with architect Peter Eisenman. However, Serra could not accept any required changes to the winning proposal and therefore walked-out from the partnership. Eisenman accepted the changing requirements from the user groups and government bodies, kept adapting the scheme over three years and finally completed the memorial himself. Refer to the interview between Eisenman and Serra, where Serra argues that 'one reason architects consume and use traditional sculpture is to control and domesticate art'; in: Serra, R. (1994). *Writings and Interviews*, University of Chicago Press, Chicago/London, 142.
[12] Florida, Richard (2002). *The Rise of the Creative Class*, Basic Books, New York. In his concept of the 'Creative City', Florida argues that the values most favoured by creative people, such as artists and architects, are: progressive and free-thinking, tolerance, diversity, and a cosmopolitan lifestyle.
[13] Refer in this regard to the debate at Arts@Work Public Art Conference (2005). *Claiming Ground*, Hobart, Tasmania (August 2005). See: www.artsatwork.com.au/claiming_ground
[14] Kwon, M. (2002). One place after another. Site-specific public art. MIT Press, Cambridge, 112.

Light Play

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Abstract

The paper focuses on understanding the quality of user experience during the whole period of engagement with the product-in this case a lamp. One of the characteristics of modern society is its life under artificial light. What is light but an interactiona multi-sensorial interaction? It is cultural; it is emotion and sensation together. Emotions are memory, place, people, light, touch, and aroma all together. We are rooted in the continuity of time, and it is the task of the designer to facilitate this experience. Light is regarded as metaphor of truth. The new lighting should “penetrate the surfaces of popular tastes and values”. The new light should emerge from our memories, imaginations and dreams; it should re-sensitize architecture and invite sensory intimacy. The lighting designer today should sculpt stories with light.
And build a “new sensibility that can turn the relative immateriality and weightlessness of recent technological innovations into a positive experience of space, place and meaning”.

The projects are a search of “light” rather than a “lamp”. The idea is not “constant” but “variable”. There is a clear indication of changing modes of consumption in consumers today; the semantic issue takes precedence in people’s minds over technical ones. There is a need for uniqueness and individual environmental expression. Borrowing from the traditional oriental spaces and of course taking inspiration from light play one sees in nature, it is challenging to create something that is beyond servicing practical or a functional role but has the power to appeal directly to the human spirit. Through series of real projects carried out by the author and his students the attempt is to see how light can play an emotive and more encompassing role within an environment. In the resulting light in space, the observers are free to perceive what they see in their own way and with their own association to the experience.

Will the sun rise again?
Will our old friend the dawn come again?
Will the power of darkness be conquered by the God of Light?
(From an Indian Veda ca 1500 BC)

In India, sun is generous, it is the god of life, and millions of Hindus even today sing their worship to sun god “Surya”. A symbol of “Surya” and “Agni”, the lamp plays a very important role in Hindu life. . The sanskrit term ‘Aloka’ alludes to quality of ‘shining’, to glow. It also means cosmos; light and radiance are its attributes, an entity which has the capacity to emit light and illuminate the ‘loka’, or the world. If you have been to city of Banaras or Varanasi, “there is little in the world to compare with the splendour of Banaras seen from the river at dawn. The rays of the early morning sun spread across the river and strike the high banked face of this city, which hundreds call Kashi- the luminous, the city of light. Kashi is light, they say. The city illuminates truth and reveal reality.”

Travellers who have been to city of Agra, and visited the Agra fort, would have seen the Shish Mahal or the Glass Palace. This was constructed by Emperor Shah Jehan in 1631-40. The name is derived from the fact that its ceilings and walls are covered with innumerable pieces of mirror set in the plaster. Minimum openings were kept to necessitate the use of artificial light, which was essential to obtain the picturesque effect of the glass work. The Shish Mahal comprises of two large chambers, light penetrated only through two doors and a ventilator in the southern wall near the ceiling. Each chamber had a marble reservoir for water. Water coming through an inlet fell into the tank sunk in the wall like a continuous sheet. From here through another channel the water fell into another tank. Two series of candle niches were also provided. Candles burning behind the falling water created a gorgeous effect. From the tank in the inner hall the water then flowed through a long canal into the tank in the outer hall. Both these tanks had fountains, which added to the mysterious effect of light. *Light play was understood by architects even in those days.*

“The great festival of “Diwali” or “Deepavali” meaning a row of lights is celebrated with enthusiasm in all parts of India. This is the day all wait for the goddess of fortune to their homes and their workplaces. As evening approaches, each household puts out its rows of lights, lining the rooftops and window sills with the small single wick oil lamps for which this festival is famous. Even the poorest household will have a lamp or two, and the richest may replace the simple oil-lamps with festive, even garish, strands of electric lights. In this way the darkest night of the month is made brilliant, to welcome “Lakshmi” for another year”. *The light play in this festival weaves magic.*

As a child I saw my grandmother light a lamp every morning and pray to “Surya” and “Agni”. She would do her “Aarati” holding the lamp in both her hands and waved repetitively in front of the image of the gods. *This was my first conscious experience of light play.* When I went to a temple with her, I would see elaborately fashioned lamp structure with multiple cavities being used by the priest for performing the ritual of aarti. *The light play, became more elaborate, as many lamps together were being waved repetitively*

As a young boy, I would eagerly wait for “Diwali” festival so that I could play with light. *We were allowed to play with light.* I spend much of my time alone engrossed in an imaginary world. During the nights, I would very often look up into the sky. The moon fascinated me. When I was thirteen I discovered the world of Van Gogh, and one of my favourite painting was “The Sun of Arles. Whenever I was sad I would go to the riverbank, and sit there gazing at the light play on moving water.

My first job as a professional designer was to design light fixtures or lamps at Philips. The task of designing lamps was not as simple as I initially thought it would be, “for it is not easy to bring light where it is needed. Because for that it is necessary to make a large irritating gadget which is rather fragile even though it only has to bear its own weight- and it has to hang there, whether it is in use or not.”
I designed many light fixtures…more solid forms, all were manufactured and sold well…. They used hardy, industrial materials metal, plastics….there was only play of form. Light was always constant. Electric Light is always constant. *I had forgotten the light play in my search for good form.*

The new lighting landscape must be brought into harmony with the rhythm of the seasons, of sunrise and sunset, day and night and restore the balance between us and our environment. The oriental disciplines of sensibilities grew out of the feeling that men lived fully by opening themselves to the universal rhythm of nature
An order and simplicity underlies all natural phenomenons.

Natural light is constantly weaving a magic of colours. Moonlight is cosmic, cold and frail. Moonlight is a soft light. At twilight there is no glare and no shadows. There is a soft, emotional atmosphere. Sunlight is like a billion watt bulb. A single electric bulb in an Indian home is a replica of the sun. *Electric light within built space is always constant; it weakens the experience of time.* Lighting has to be an integral part of our life, a thing dynamic, not static, it lives, it changes, it expresses- it brings inert spaces to life by relating them to human spirit.

What is light but an interaction- a multi-sensorial interaction? It is cultural; it is emotion and sensation together. Emotions are memory, place, people, light, touch, and aroma all together. We are rooted in the continuity of time, and it is the task of the designer to facilitate this experience. Light is regarded as metaphor of truth. The new lighting should “penetrate the surfaces of popular tastes and values”. The new light should emerge from our memories, imaginations and dreams; it should re-sensitize architecture and invite sensory intimacy. The lighting designer today should sculpt stories with light. And build a “new sensibility that can turn the relative immateriality and weightlessness of recent technological innovations into a positive experience of space, place and meaning”.

Student’s projects

The next generation of interactive design will employ embedded computational power in various environments’ in our home, public spaces or in the lamps themselves. There is a huge potential for the future of what we do in terms of building and designing of lights that we use for enhancing our living environments and enhance our experiences of these spaces. Following are the student’s projects that were chosen for presentation here based on their clear understanding of using light to enhance the experience of time.

Project 1: Projected Reflections
Student: Thomas George

In *'Isha'* Upanishad, one of the most famous Upanishads, we have a description of something that moves and at the same moves not: '*Tad ejati tan naijati'-"That moves and that moves not. That is far and that is near. That is within and without." The sun god is also the god of flight, and he performs his task like a beautiful bird. Time and space are covered by the wings of the sun god.*

The use of reflective surfaces such as mirror paper of various colours and a chrome plated sheet to project reflections on a screen or wall were attempted. The paper was placed on the table and either one or two spotlights were used to produce the reflections, the angles of light incident on the reflective surfaces were manipulated to produce the clearest reflection on the screen. The projected reflections off the undulated chrome plated sheet produced an almost three dimensional quality that is remarkably similar to computer simulations of an organic form folding in on itself.
A series of coloured reflective paper was used in sequence moving horizontally along the table surface towards the light source. The effect produced by the projected reflection is that of an animated column of light that continually changes hues as the frames advance. A primitive simulation of the aurora, the spectacular natural phenomenon that has few parallels in terms of sheer beauty, was achieved.

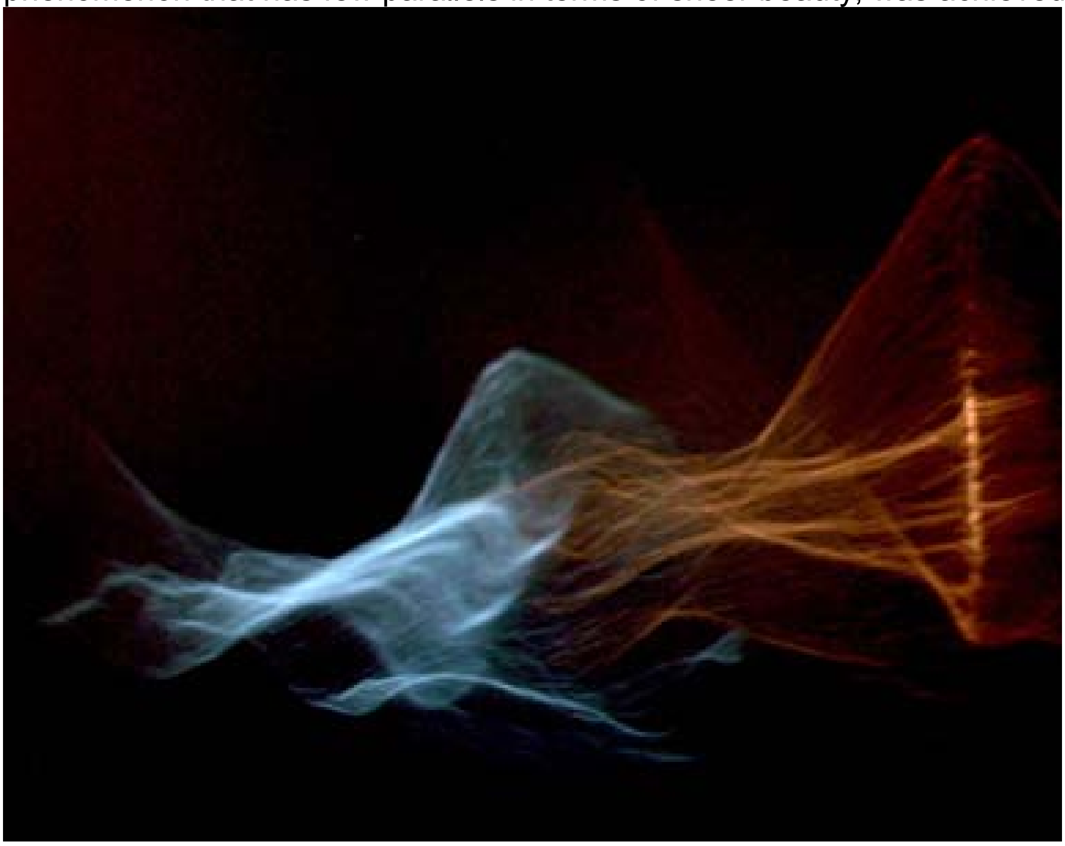

Fig 1: Reflected Effects

Project 2: Reflections inspired by "City of light –Banaras"
Student: Gauri Tiwari

Water is the foundation of the whole world, from the waters arose all plants, all life.

Banaras or ‘Kashi’ is the city of light, city of death and liberation. The concept was based on reflections on water and was also linked to sustainability, to reuse, to the changing hues of colours on river “Ganga” from sunrise to sunset. The new lamp creates a mirage, the light becomes new aquatic realm, and the viewer finds a new way of enjoying the water. Image of water exists in this light.

Figure 2: ‘Kashi’ Lamp

Project 3: Natural –Artificial: Light Effects
Student: Sreeja Balachandran

Light is all around us. From dawn to dusk light is with us in varying intensities – the subtle day break bringing the feeling of life - the fresh morning light - the bright daylight - he harsh afternoon light - the intimate evening light - the cozy twilight - the sensuous moonlight. As light changes from cool early morning to bright white light at noon, to hazy yellow twilight, the way our surroundings appear seem to change too. Light plays a profound effect on the emotions of man. This is an important aspect to be considered while designing the lighting conditions in a particular space. Artificial lights generally tend to be uniform and steady throughout, giving a monotonous feeling. Today artificial lights are being designed to closely simulate the ambience of natural light. This special project is a part of an extensive research on lighting, where the focus is to understand the qualities of natural and artificial light, the effect of light on human emotions and how, with the use of different type of light sources and different materials, the artificial lighting can be made more active and effective to give the same richness as the natural light.

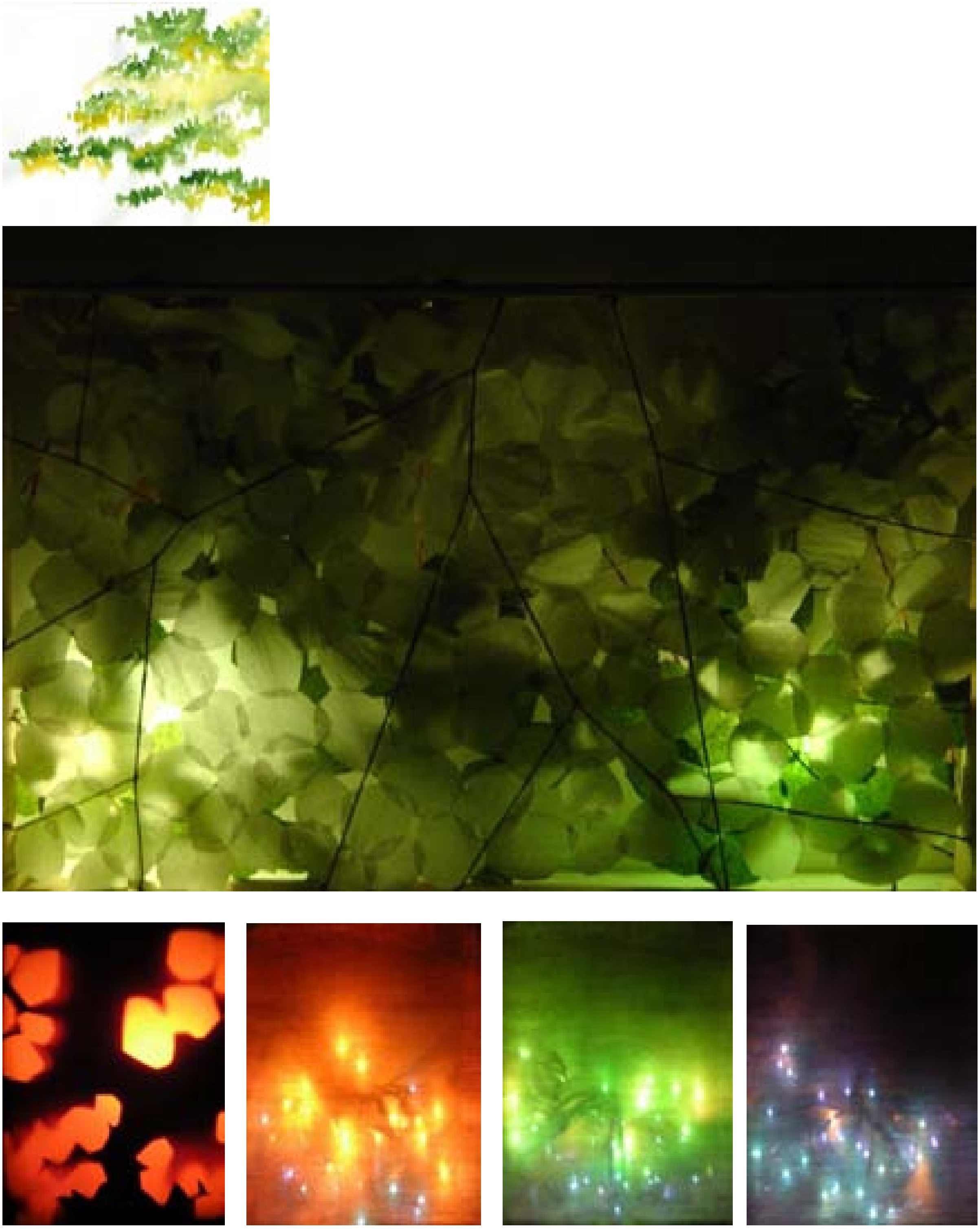

Figure 3: Light Effects: Light Filtering Through Foliage, Student: Sreeja Balachandran

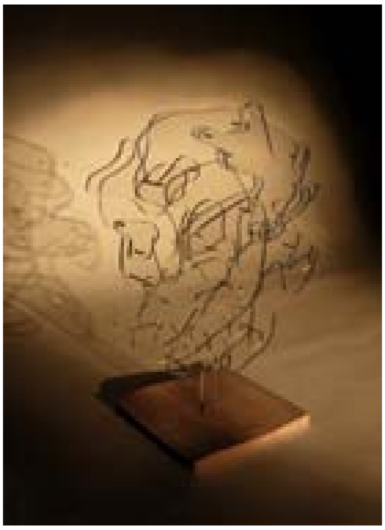

Figure 4: Concept Interactive Lamp 2007, Suresh Sethi

Bibliographical references:

Eck Diana L, (1993) Banaras City of Light, Penguin Books India

Pallasmaa Juhani, (2005) The Eyes of the Skin, Wiley-Academy, John Wiley & Sons Ltd. England.

Treasures of Dinkar Kelakar Museum, The Light: Lamps of the Temple and The House, Marg Publication, India

Calvino Italo, (1993) Six Memos for the next Millennium

Sethi Suresh (1982) Designof Luminaires for Miniature fluorescent lamps. Thesis National Institute of Design, India.

Sethi Suresh (2005) Blossoming Gap: The Role of Memory, Experience and Intuition in Design, DETM Conference, Ahmedabad, India, March 2-4

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I would like to thank my students without whom this adventure would have been incomplete, of discovering the soul of light, its lightness. I am especially grateful to Deepa Sam, Sreeja Balachandran, Thomas George, and Gauri Tiwari.

Biographical note:

Suresh Sethi began his Industrial design career as designer in Philips India in 1983, after graduating from the national Institute of Design, Ahmedabad. He went to pursue further studies choosing Milan, Italy, and did his Master's from the Domus Academy in 1985. In 1988, he left Philips and set up his own consulting company Circus Design Studio, in Bombay focusing on product design. Various assignments firmly consolidated his position among the successful designers in India. Suresh has been visiting professor and has led many workshops and seminars at top Design Institutes in India. In 2003 Sethi was a tenured professor at the Indian Institute of Technology Bombay. In 2005, Sethi joined Nanyang Technological University as Associate Professor in Art, Design and Media, and is the Associate Chair (Academic) and lead faculty of Product design.

Identity SA - an interactive swarm-based animation with a deformed reflection

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Abstract

Identity SA is an interactive and generative installation that combines a swarm-based simulation with real time camera based interaction. The agents' distributions are transformed into "painterly" images by employing a variety of different visualization techniques and styles, such as texture surfaces, short line segments, font glyphs, curved lines, etc. Camera based Interaction is based on a simple motion detection algorithm that affects the agents' movements as well as their coloring. Normally, an agent's color is solely determined by its orientation, but whenever the tracking system detects a visitor's motion, the agent's color is additionally affected by the corresponding pixel color in the camera frame. It acts as a visual and acoustic mirror, which distorts the continuity of the visitor's physical existence into ephemeral patterns and flowing motions.

Introduction

Humans are the only species that strives to achieve an understanding of its nature and purpose. Since ancient ages, we have struggled to find satisfactory answers since our capabilities of introspection are very limited. Often, we try to observe ourselves via a reflection through our social environment. Despite these efforts, our self-image always remains unclear, fuzzy, and ambiguous. We cannot even preclude that it might be an illusion.

Identity SA is a computer based interactive artwork that creates abstract reflections of the visitor's appearance. It acts as a visual and acoustic mirror, which distorts the continuity of the visitor's physical existence into ephemeral patterns and flowing motions. It reminds the visitor of the fragility of his/her own self-awareness and existence. The installation mimics an abstract painting whose moving brush strokes create a portrait of the visitor. The integrity of this portrait can only be preserved by the sustained activity of the visitor. Whenever he/she stops moving, the portrait becomes increasingly vague and fuzzy and eventually disappears entirely in a swirl of colors. This continuous struggle versus one's own disintegration metaphorically reflects our permanent exposure to the treat of losing ourselves through mental and physical decay. According to Buddhist teachings, sickness and aging together with birth and death form the group of four inescapable sufferings . The suffix in the title for this project stands for sickness and aging.

In our former works, Flocking Orchestra , MediaFlies , and Flocking Messengers , we have examined combinations of swarm simulation and camera-based visual feedback in order to realize pieces of generative art. Several other artists have chosen similar approaches in their works . These works employ tens or hundreds of agents moving in a virtual 3D space to play music and/or to draw images. In our newest work that is presented here, we increase the number of agents to thousands but reduce the dimensionality of the agent world to 2D. As the agents move through this flat canvas space, animated patterns are created based on their distributions rather than their movements.

In the subsequent sections, we describe the following technical features of the system: swarm simulation, drawing methods, camera-based interaction, sound synthesis, and choreographed transition of parameters. We conclude this paper by describing our observations during an experimental exhibition and outlining possible directions for future extension.

Swarm simulation

In Identity SA, visual and acoustic output is created via a swarm simulation. A swarm consists of a collection of mobile agents each of which behaves according to simple rules. These rules take only the interaction between neighboring agents and the local environment into account. Swarm simulations are mainly used as a computational model for group movement behaviors observed in nature such as for example in a school of fish, a flock of birds, a herd of herbivores, a colony of social insects, or a crowd of people. Simultaneously, it is successfully applied as an optimization technique for distributed systems such as in transportation scheduling and communication network routing . Similar to other models of complex systems, swarm simulations can be employed to create surprising results despite the fact that they are based on entirely deterministic algorithms. For these reasons, swarm simulations can be of interest for generative art.

Idendity SA implements agent behaviors that are based on the classical BOID's algorithm . Accordingly, each agent is controlled by a set of forces that causes the following behaviors:

1. collision avoidance between agents
    1. velocity alignment with neighboring agents
    2. flock cohesion by attraction towards the center of the neighboring agents
    3. collision avoidance with the boundaries of the agent world.

The repelling forces for collision avoidance are proportional to the inverse of the square of the distance between the agent and the obstacle. Based on the sum of all the forces that affect an agent, a goal angle and a goal speed are calculated. The agent tries to meet these goal values by modifying its current orientation and velocity within the allowed limitations of its steering angle and acceleration.

Similar to the implementation in our previous project "Flocking Orchestra", the agents are divided into two species. This approach leads to a richer variety in behaviors as compared to classical BOID's type of swarms. Each species has its own individual set of parameters that control both behavior and appearance. A single parameter globally controls the interaction among agents of the same and different species. This parameter ranges from −1 to 1. A negative parameter value causes agents of one species to treat agents of the other species as moving obstacles. In this situation, no alignment or cohesion behavior among agents of different species takes place. If the parameter value is positive, even agents of the same species treat each other as obstacles. A parameter value of zero causes agents to engage in normal BOID's type of behavior that ignores species differences. This single parameter therefore allows us to control the amount of mixing or separation among agents of the two species.

The swarm consists of more than 2,000 agents and covers the whole area of the screen surface. Agents are moving in a two dimensional Euclidean space that is bounded by the rectangular borders of the screen. Due to recent improvements in computational power, it became feasible to simulate such a large swarm in real time on a single personal computer. The system is currently implemented on an Intel-based 2 GHz Core 2 Duo CPU running MacOS X 10.4.

To calculate forces among agents, neighborhood relationships need to be determined. If we used an exhaustive algorithm to check the distance between every possible pair of agents, the computational time complexity would be proportional to square of the number of agents. To reduce this complexity, we introduced a method that divides the 2D space into a number of sub-areas. Each of these sub-areas maintains information about the agents contained within. For this reason, we can restrict distance calculations to agent pairs that reside within neighboring sub-areas.

Drawing methods

The agents' positions and movements are transformed into a "painting" by employing a variety of different visualization techniques and styles. The agents themselves can be drawn in one of the following five different styles.

1. a triangle pointing toward the agent's movement direction
2. a textured surface depicting a predefined pattern
3. spray spots that are randomly distributed around the agent's position
4. short line segments that are parallel to the agent's movement direction
5. a glyph that is selected from a predefined set of characters of Roman, Japanese and Chinese characters.

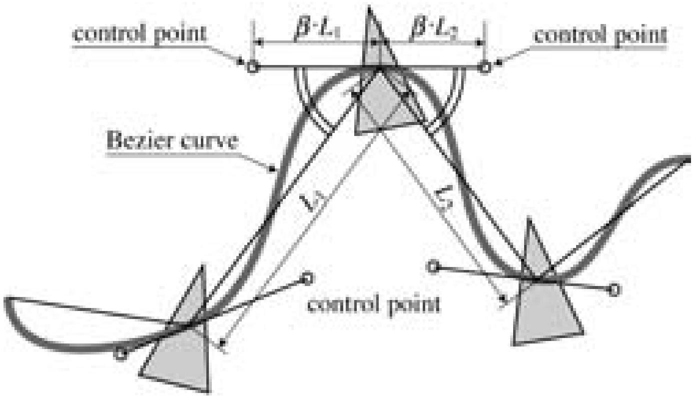
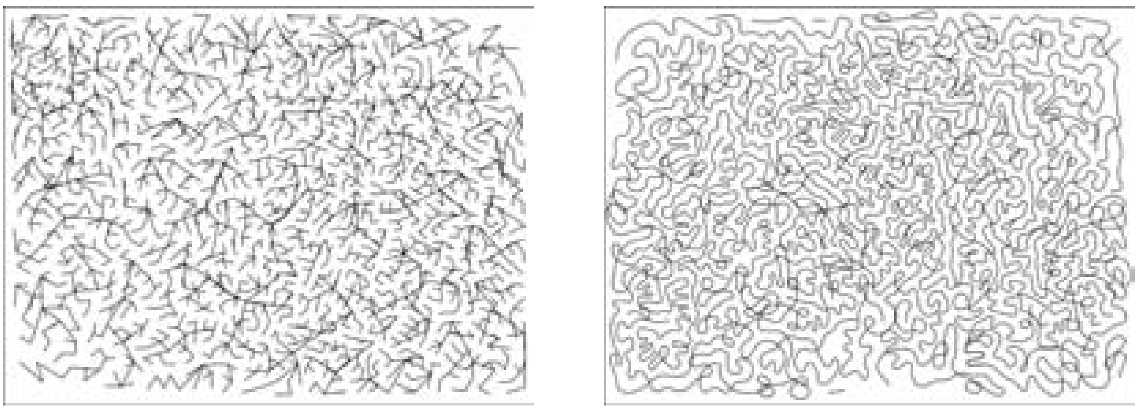


Figure 1. Illustration of Bezier curves to connect the positions of the agents smoothly.



A
B

Figure 2. Examples of drawing line segments that connect the positions of agents. Figure A depicts connections between nearest neighbors as straight line-segments. In figure B, these connections are depicted by curved lines. Line segments above a certain length threshold are not displayed

Each of the shapes listed above is drawn in a single color that is selected based on the agent's orientation angle. This mapping from angle to color depends on a parameter that can be changed via a scripting language (see section).

The connections between agent positions can be displayed in two different styles:

1. a set of straight lines that connect each agent to its nearest neighbor
2. a single curved line that forms a chain through all agents' positions.

The curved line is a sequence of cubic Bezier curves that smoothly connects the positions of agents. Figure 1 illustrates how the curved line is organized.

Because the computational time complexity to find the shortest path to chain the agents is very high, we employ an alternative algorithm for faster calculation. The algorithm theoretically needs a computational time that is proportional to an exponent of the number of agents in order to find the true shortest path. In the first step, it picks an agent as the start point of the line, finds the nearest agent, and connects the positions of these two agents by a line segment. Then it iterates the same calculation by finding the next position from the remaining agents. The algorithm continues to extend the line until all of the agents are chained. Fortunately, it is possible to reduce the time complexity of this algorithm by exploiting the benefits of our sub-area space partitioning structure to quickly find neighboring agents. Figure 2 depicts examples of these two types of drawing styles. Each line segment is drawn in a color that is determined by the orientation of the agent at the start point of the line segment.

Furthermore, post-processing effects such as blur and afterimage are also applicable. Combinations of these effects and different transparency settings allow the creation of a wide variety of aesthetically complex images.

Calculation speed is dependent not only on the number of agents but also on the chosen graphic styles and the display resolution. The 2 GHz machine is fast enough to produce frames at VGA (640 by 480 pixels) resolution. A 3 GHz quad-core machine with a high performance graphics processor unit is needed to produce visual output for high definition video displays which are increasingly becoming popular.

Camera-based interaction

Camera-based interaction is based on a simple motion detection algorithm that affects the agents' movements as well as their coloring. Basically, motion is detected by calculating the color difference between the previous and current frame for each pixel. To avoid errors in motion detection due to noise and light fluctuations, frames are cumulated into an image memory buffer by calculating a weighted sum between the memory buffer and a newly acquired frame. Expression (1) denotes the modification of each color component value *M* for each pixel in the memory buffer by combining it with the corresponding component *I* in the input frame.

$$M \leftarrow \gamma \cdot I + (1 - \gamma) \cdot M \qquad (1)$$

□ is a constant coefficient in the range (0, 1). The current implementation uses a □□ value of 0.1.

The next step in motion detection involves the calculation of the absolute scalar value of the pixel difference between subsequent frames. There exist several alternative methods to obtain a scalar value from the three color components (red, green, and blue) of a pixel. The current implementation selects the maximum value among the absolute differences of each color component as shown in the following equation.

$$m = \max\{|I_R - M_R|, |I_G - M_G|, |I_B - M_B|\} \qquad (2)$$

Thus, this algorithm results in the creation of a single channel image that encodes the amount of detected motion in each pixel. Each agent responds to motion by adding a force towards the center of detected motion that lies within its local neighborhood.

In the absence of interaction, an agent's color is solely determined by its orientation as described in the previous section 3, but whenever the tracking system detects a visitor's motion, the agent's color is additionally affected by the corresponding pixel color in the camera frame. The ratio of orientation and interaction based color change is proportional to the amount of detected motion. Therefore, the visitor's figure is reflected when he/she is moving, but it disappears when he/she stops moving.

Figure 3 depicts the example images of analysis and synthesis. The motion distribution at the top right of the figure is calculated from camera image at the top left, and the motion distribution affects the agents' distribution show at the bottom right. Then the final image at the bottom left is composed from the agent's distribution and the original camera image.

The computational cost of motion detection depends on the resolution of the camera image. We use two different camera frame resolutions for color selection and motion detection. Colors are obtained from a camera frame in QVGA (320 by 240 pixels) resolution. A smaller camera frame of 160 by 120 pixels serves as bases for detecting the visitor's motion. This lower resolution has proven to be sufficient for our purposes in previous experiments.

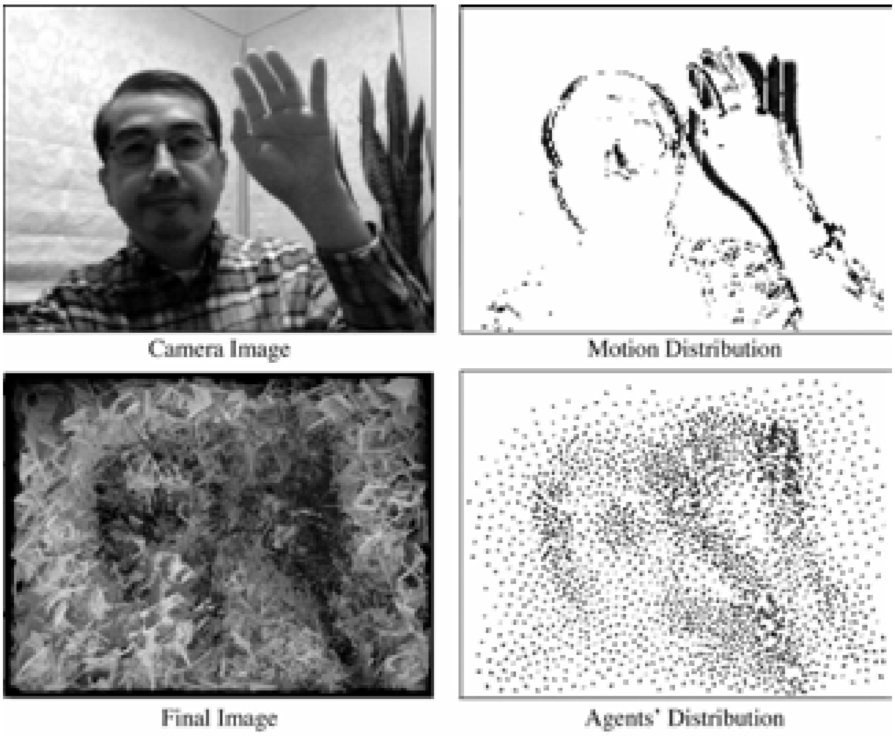


Figure 3. Camera-based interaction.

Sound synthesis

Sound synthesis also depends on the movement of agents and visitors. Only a subset of all agents is involved in the generation of sound. The probability that an agent creates a sound is proportional to the square of its angular velocity. Sound synthesis is controlled by several parameters such as frequency, amount of frequency fluctuation, mixing ratio of harmonic overtones and so on. All these parameters are controlled by the state of the agent. In addition, white noise is added to the overall audio output. The amount of white noise is proportional to the amount of visitor's motion.

Our current sound synthesis implementation doesn't rely on any synthesis libraries but is based on relatively simple routines that calculate samples at a fixed frame rate of 44.1 kHz. Agents that are allowed to generate sounds are organized in a queue of fixed length. In the current implementation, the queue can hold 12 agents. If a new agent is selected for sound synthesis and the queue is already full, the new agent replaces the agent that has been in the queue for the longest time.

The value of each sound sample s_t at time *t* is calculated according to the following equation:

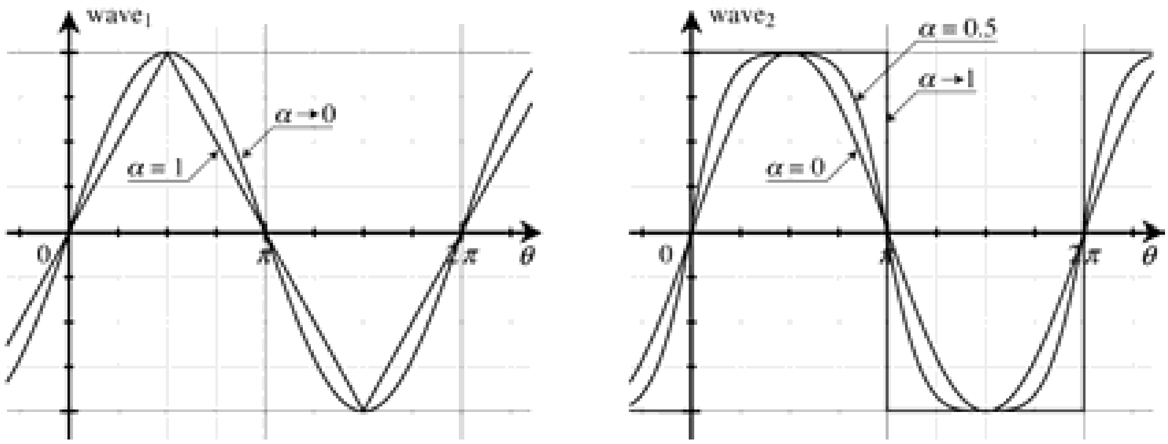


Figure 4. Functions for waveforms of sound generation.

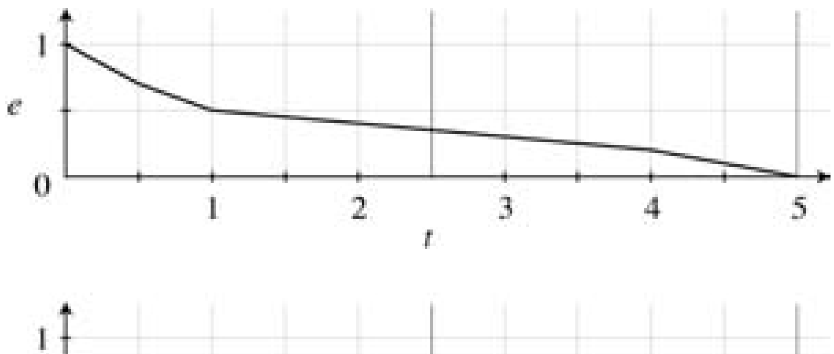


Figure 5. Shapes of two predefined envelopes.
The upper one possesses a strong attack, and the lower one starts

$$s_t = \mathrm{wave}(a_t + A \cdot \sin b_t) \cdot (1 - B \cdot (1 + \sin c_t)) \cdot e_t \qquad (3)$$

where $\mathrm{wave}(\theta_t)$ is a periodically oscillating function that accepts a phase angle as single input parameter and produces the main waveform. *A* and *B* are constants. a_t,

b_t, and c_t are angles rotating with frequencies f_a, f_b and f_c. e_t is a coefficient expressing the envelope. f_a is the frequency of main waveform, f_b is the frequency of phase fluctuation, and f_c is the frequency of volume oscillation. The values of these frequencies are determined from the states of the agent. $\log f_a$ is proportional to the vertical position *y*, $\log f_b$ is proportional to the absolute value of angular velocity, and $\log f_c$ is proportional to the velocity. The ranges are $40 < f_a < 1000$ (Hz), $2 < f_b < 10$ (Hz), and $100 < f_c < 1000$ (Hz). The constant *A* is 0.2□, and *B* is 0.2 in the current program.

We have created two types of "wave" functions and two types of envelopes from which each agent selects its own function and envelope. The variations of the "wave" function are:

$$\mathrm{wave}_1(\theta) = \frac{\mathrm{asin}(\alpha \cdot \sin\theta)}{\mathrm{asin}\,\alpha} \tag{4}$$

$$\mathrm{wave}_2(\theta) = \mathrm{sign}(\sin\theta) \cdot \left(1 - (1 - |\sin\theta|)^{1/(1-\alpha)}\right) \tag{5}$$

where □ is a parameter that varies from 0 to 1 and whose value is proportional to the square of velocity of the agent. Figure 4 depicts these functions for different value of □. Intuitively the generated sound becomes sharper with increasing □ since the number of higher harmonic overtones increases.

```
tell application "DT4"
  repeat
    set species to species1
    set drawing style to curves
    set cohesion to 40
    set species to species2
    set drawing style to
textures
    set avoidance to 20
    delay 10
    set species to species1
    set drawing style to
bristles
    set cohesion to 50
    set species to species2
    set drawing style to
branches
    set avoidance to 50
    delay 15
  end repeat
end tell
```

The first envelope possesses a strong and fast attack like for example the plucking of a guitar string, The second envelope has a slowly increasing attack section the resembles for example the bowed sound of a violin. Figure 5 depicts the shapes of these two envelopes.

In each case, the length of the sound is scaled so that it is inversely proportional to $1-F$ within the range of 0 to 0.9, where *F* represents an agent's the force of attraction towards detected motion. Accordingly, strongly attracted agents tend to produce short sounds whereas agents that don't respond to interaction create long sounds.

Finally, white noise is mixed together with the audible output. The volume of the noise is proportional to the amount of motion captured by the camera. The stereo panning of the noise is controlled by the position of the center of gravity of the detected motion.

Choreographed transition of parameters

The swarm simulation, its visualization and sound generation can be controlled via scriptable parameter changes. Scripting therefore offers an easy approach to create choreographed transitions in the swarm's visual and acoustic appearance. The implementation of the scripting functionality is fairly easy since our software's implementation is based on the Cocoa framework of MacOS X. The scripting functionality of our software is based on program modules for inter-process communication via AppleScript. AppleScript is an easy scripting language widely used in MacOS. For example, in order to change the agents' drawing method to triangles, the single line "set drawing style to triangles" needs to be inserted into the script. The number of scriptable parameters includes eleven parameters for visualization, eight parameters for behavior, and eight parameters for sounds. Both parameter changes and their timing can be freely chosen and therefore allow to create a wide variety of choreographed scenarios. Figure 6 is an example of the script code that iterates alternation of the shape of the agents and behavioral parameters.

A particularly interesting trasition is achieved by changing the parameter that controls the interaction among the two agent species. Depending in this parameter setting, ag ents from different species tend to mix uniformly or separate into distinct clusters. Fig ure 7 depicts an example of this visual transition.

Concluding remarks

We organized an experimental exhibition at Soka University during the campus festival on the 7th and 8th of October 2007. Figure 8 shows photographs taken from the exhibition space. Our software was running on a MacPro Quad Xeon 3 GHz to which a 32 inches LCD display, an iSight camera, and a pair of active speakers was connected. This computer's computation power is sufficient to simulate 2,000 agents at a rate of 25 frames per second and a resolution of 1024 by 768 pixels. Our observations of the visitor's reactions have been very encouraging. New visitors quickly understood the interaction possibilities of the system when they perceived how their reflected image emerged in the visual output. Some children and young persons then started to move their body more actively or even began to dance in front of the screen. Typical visitor comments were: "it is interesting" and "I never tire of this." On the other hand, one visitor wasn't particularly happy about the acoustic feedback and said: "I feel getting sick from hearing such a sound". From am artistic viewpoint, this comment is not that bad because it is evidence that the work made a strong impression on the visitor.

We would like to further extend the system. First of all, we would like to experiment with alternative mechanisms for generation of sound such as playing back

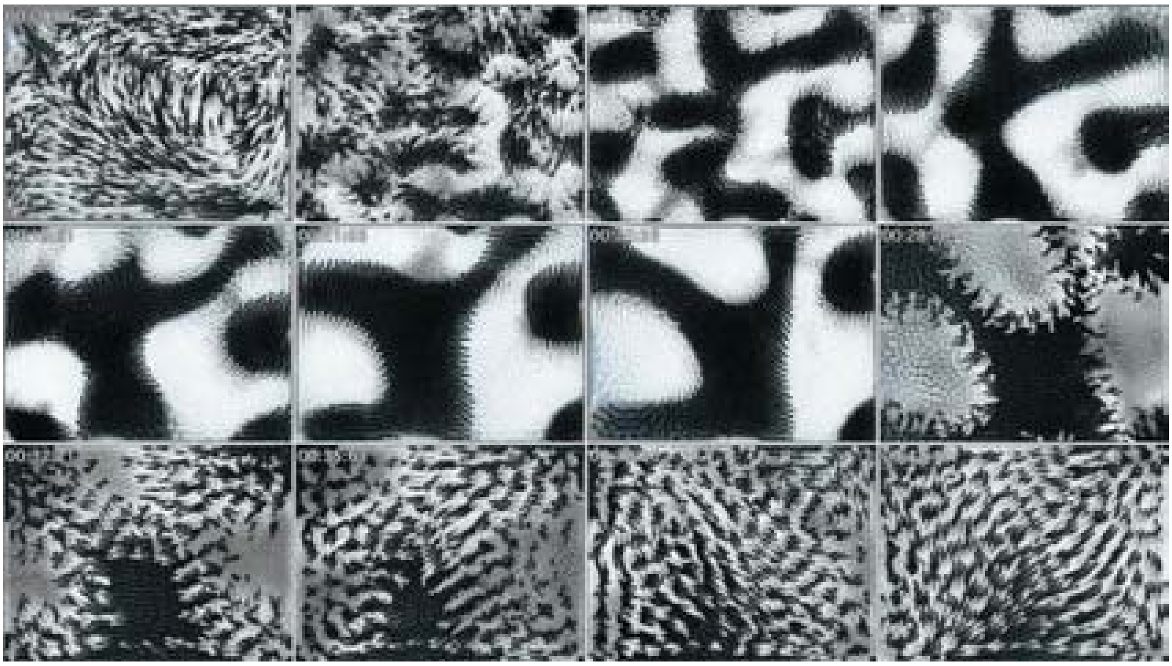


Figure 7. Example of visual transition by changing the parameter value of inter-species interaction.

prerecorded and life sampled sounds. Furthermore, we would like to setup the

Figure 8. Photographs taken from the exhibition room in the campus festival of Soka University on 8th October 2007.

installation in non-exhibition environments such as in public space or on stage where it could be combined with a dance performance.

To conclude, we hope that Identity SA creates an aesthetic experience that provokes visitors to reflect on issues of identity and transitoriness. The binary executable and sample scripts are downloadable from the link in the project web site:

http://www.intlab.soka.ac.jp/~unemi/1/DT4/

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References

[1] Daisaku Ikeda, The Living Buddha – an Interpretive Biography, trans. Burton Watson, Weatherhill, New York, p. 19, 1976.

[2] Tatsuo Unemi and Daniel Bisig, Playing Music by Conducting BOID Agents - A Style of Interaction in the Life with A-Life, in J. Pollack et al eds. Proceedings of the Ninth International Conference on the Simulation and Synthesis of Living Systems, MIT Press, Boston, MA, pp. 546-550, 2004.

[3] Tatsuo Unemi and Daniel Bisig, Flocking Orchestra – to play a type of generative music by interaction between human and flocking agents. in C. Soddu ed. Proceedings of the eighth Generative Art Conference, pp. 19-21, 2005.

[4] Daniel Bisig and Tatsuo Unemi, MediaFlies – A Video and Audio Remixing Multi Agent System. in C. Soddu ed. Proceedings of the 9th Generative Art Conference, pp. 63-74, 2006.

[5] Tatsuo Unemi and Daniel Bisig, Flocking Messengers, –, pp. 272-280, 2006.

[6] Christian Jacob, Gerald Hushlak, Jeffrey Boyd et al, SwarmArt: Interactive Art from Swarm Intelligence, *Leonardo*, Vol. 40, Issue 3, pp. 248-255, 2007.

[7] Gerardo Beni, From Swarm Intelligence to Swarm Robotics, in *Swarm Robotics*, Springer, LNCS 3342, pp. 1-9, 2005.

[8] Craig W. Reynolds, Flocks, herds, and schools: A distributed behavioral model, *Computer Graphics*, Vol. 21, No. 4, pp. 25-34, (SIGGRAPH ‘87 Conference Proceedings) 1987.

Using Organic and Curvaceous Forms as a Reference Point for New Product Development

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Abstract

Throughout history it is possible to map how the form of products has been influenced by particular styles and movements in art and design at that time. Previous styles have been adapted or re-interpreted and there is now a range of mixed styles used in contemporary product design. The overriding influence now may be that of brand and corporate style rather than fashion. In particular, Organic design is regaining interest and with integration of new technology and greater interaction with human emotional feelings, a closer link is being established with nature. An organic and curvaceous shape is the most recognisable and ubiquitous genetic shape found within natural life forms. From a historical perspective, this paper looks at the evolution of styles that have influenced the forms of man-made products and in particular organic designs that draw inspiration from the natural world. We have developed a methodology to establish the relationship between product forms and the aesthetic association and emotional feelings that can be evoked from perceiving these forms. This will contribute to establishing a product language system from the aspect of addressing product style. In this paper we have also showcased some of the designs of MP3 and CD players, completed by product design students at Southampton Solent University, with reference to the 'organic' and natural world.

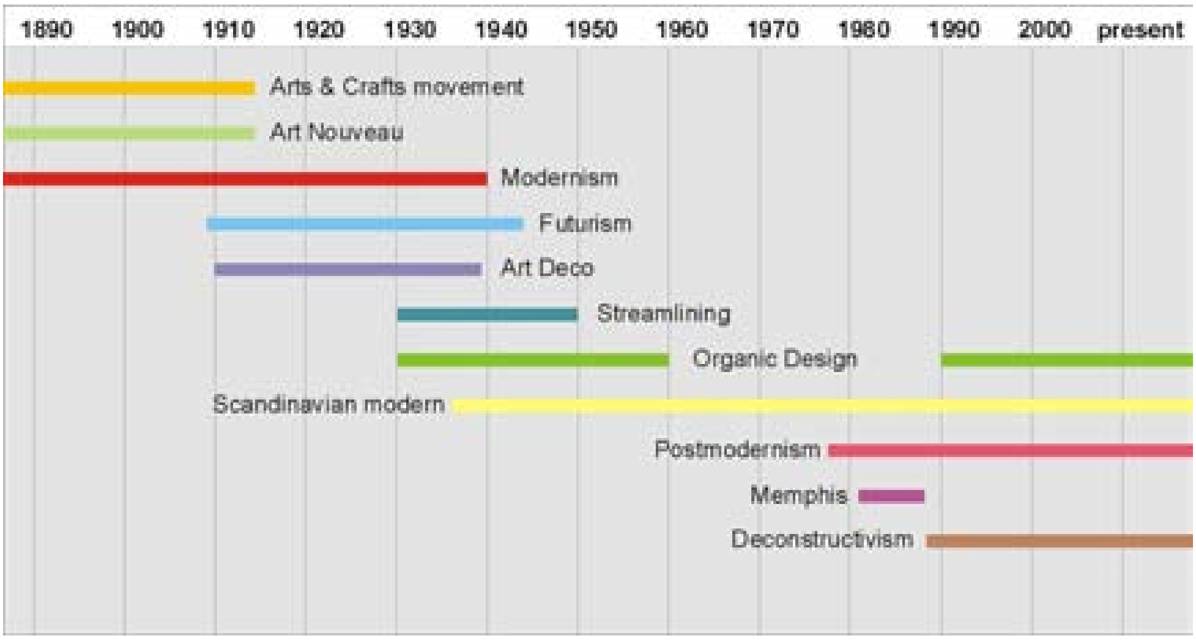
Keywords: form, shape, curvaceous, organic, emotions, nature, product design.

1. Evolution of the styles of product forms

Any artefact is formulated and recognised by its form. A product consists of a number of elements such as colour, shape, material, texture, proportion, size etc, all of which contribute to the overall form and perception of that product. The interrelationship of these key elements and the combination with the physical presentation affects how people perceive and respond to a product.

Historically, artists and designers have shown great ability to adapt and evolve the form of a product or artefact in line with the style/movement of that era. For instance, Modernism, Art Nouveau, Art Deco, Streamline, Organic design etc, see the illustration in Table 1. If we look at how style is originated, one of the differences between artists and designers lies in that, artists may create works according to their personal experience and passion; whilst designers, particularly industrial product designers of today, need to apply more rational thinking about the form of the product and style in relation with the product context, target market, manufacturing economics, and people's perception.

Table 1 Styles that have influenced the form of products over time
(Reference from [1], redrawn by author)



In general, a product or artefact that is created will not only reflect the style and influence imposed by any art and design movement of that time, together with other influences and ideological values, but will also reflect and be limited by the available technologies (for example, the material and processing technology).

Let's take radio design as an example, and give a brief overview of its form evolution influenced by the styles over time, illustrated in Figure 1.

Radio waves were discovered in 1888. Guglielmo Marconi was the first person to have the capability to apply radio waves in communication and propaganda in 1896. Since then, the radio design has evolved for more than a century. From the end of 19th century to the beginning of 20th century, the *Art and Crafts movement* and *Art Nouveau* peaked in popularity. The purpose of *Art and Craft movement* was to promote the ideals of traditional craft production and craftsmanship, advocated simplicity of form. It was featured by using simple, linear shapes with inspiration from natural plant and animal forms (either concrete or abstract) in line with the union of form, function and decoration. On the other hand, *Art Nouveau* is characterised by highly stylised, flowing, curvilinear designs often incorporating floral and other plant-inspired motifs. However, it was not until 1920s that radio had been put into commercial production. These two movements had passed by 1914, and had little influence on the design of radios at that time. Nevertheless, we can still slightly glimpse the marks of Art Nouveau style by looking at the second radio sample from the top of Figure 1.

Modernism, as the leading design movement in the twentieth century, emerged due to the growth in industrialisation that occurred from the 19th to the 20th century. With emphasis on function, modernistic design was usually seen in the form of simplicity such as geometrical shapes with straight lines, sharp edges and corners, cubic bodies. Although modernistic notion was afterwards questioned by *postmodernism* that germinated in1960s, the style of modernism had been extending all through to late 20th century. We can see that most of the radio samples in Figure 1 from 1930s through to 1980s took a regular geometrical shape.

Figure 1 Examples showing the evolution of radio design throughout history

Art Deco is an international decorative style, firstly emerged in France during the

1920s. It is featured by the use of geometric and stepped forms, however, usually with reflective surfaces, sharp edges, rounded corners and expensive materials. However, the style of Art Deco in radio design seems less obvious. As the trend for modernism evolved, the distinctive Art Deco style of the late 1920s was overtaken by *Streamline* Modern design. Sharp stepped sides of skyscrapers softened into curves, while ‘boxy’ trains and automobiles were replaced with sleek, fluid lines that created the illusion of speed and motion. Streamlining was a popular style from 1930s to 1950s and even became a symbol of technological progress. We can see two or three radios from 1930s to 1950s in Figure 1 that show such streamlining characteristics, although it was not over used. One of the advantages taken by streamlining was the Phenolic plastic, which later became a symbol of progress and modernity. The Streamline Modern style was perfectly suited to cast phenolic resins because the plastic easily flowed inside a curved mould, which facilitated shiny surfaces, curves, waterfall fronts etc. One of radios in Figure 1 has the facades that look like car grills. Streamline style lasted until World War II.

Organic design centres round the belief that individual elements such as a piece of furniture should connect in harmony with their surroundings (interior). Usually a product with organic style takes soft, flowing lines and sculptural forms. However, as organic design was initially rooted from the concept of organic architecture, it did not influence consumer product design to the same degree in the early stage. It is difficult to find examples of radios in Figure 1 that show this style. It is since the end of last century and now in 21st century that we can see many of modern radio designs emerging with this particular style.

It should be pointed out that, in parallel to changes in style, the function of the radio also evolved with the integration of additional functions since early 1980s. For example, Sony Walkman with the integration of radio and cassette was ever popular in 1980s and early 1990s. Today, the new digital technology and nanotechnology, smart technology has totally brought large innovation to radio design, with regard to colourful displays, subtle tactual materials and textures, miniaturisation of size, high resolution and quality of sound, and integration of radio into other digital devices such as MP3, MP4, computer and internets etc.

Today, it is noticeable that most of former styles are continually being revived, but with an injection of merits of contemporary features [2]. In particular, Organic design has returned with increasing frequency, being used across almost all design areas from architecture to furniture, interior to 3D product design. One of the most influential designers advocating organic design currently is Ross Lovegrove. Figure 2 shows some of his wonderful designs with so smooth and soft contours. Current trend seems to be the mixture of different historical styles with new technology to provide a fresh approach.

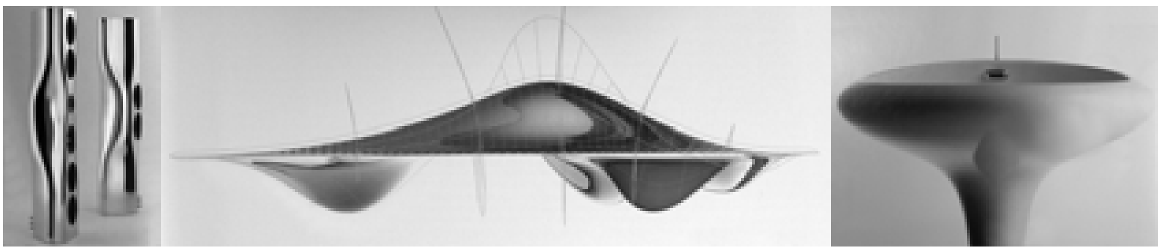


Figure 2 Organic designs by Ross Lovegrove

2. New organic design with inspiration from nature

It is easy to see that organic shapes are widely found within the natural world and objects, such as seashells, flower petals, water drops, flowing liquid, insects, animals, and humans per se – the human body. See figure 2.

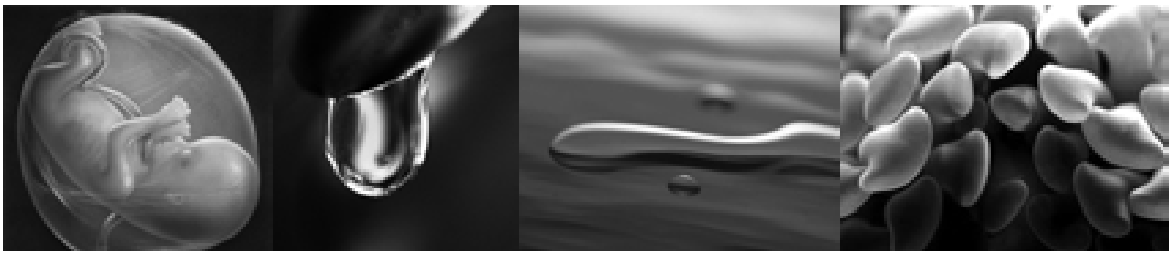


Figure 3 Organic/curvaceous forms found in human and nature

The human body is appealing with its curvaceous forms. The only obvious parts of the body with sharp shapes and edges are the teeth and nails. Nails and teeth can be regarded as the tools for protection (grabbing) and survival (chewing food). In addition, considering our senses, physiologically, we experience a soothing sensation when our eyes see round and curvaceous shapes; we feel comfortable when our hands touch smooth surfaces; we feel pleasure when we listen to melodic and harmonious sounds; we feel happy when we smell mild and fragrant flavours; and we experience delight when our tongue tastes delicate and delicious food etc. It would be difficult to imagine all of these positive feelings, regardless from which sensory channel, if they were connected with sharp and harsh forms. Cognitive psychologists have explored the processing facts of human brain to multi-sensory stimuli. Results show that, ‘in the brain at least, your hands are connected to your ears, which send signals to your mouth, which takes information from your nose, which depends upon your eyes to tell it what it’s sensing. A product that looks appealing doesn’t just seduce the eyes. It can make the mouth water and the hands expect’ [3].

What we advocate here is that we need to give sufficient concern in design to the natural, original design and intention of life forms, towards creating great harmony between human (including artefacts and activities) and our natural environment. We can learn from nature and obtain inspiration to look for the most natural, comfortable but also the most powerful forms and mechanisms for our man-made products, so-called biomimetic design. Biomimetics is the concept of taking ideas from nature and implementing them in another technology such as engineering, design, computing, etc [4]. The concept is an old one as humans have been learning from nature since the ancient. For example, the Chinese tried to make artificial silk 3 000 years ago. However, it is only now that biomimetic design has entered a new domain due to the following aspects:

1. It has not been until recent years that scientific research has facilitated a closer exploration into the details of nature and its translation into industrial and commercial application [5];
2. Advances in new materials and manufacturing technology now enables the various formal aesthetic features (such as shape, colour, texture, sound etc) to more closely resemble natural forms;
3. People are getting more aware of the importance of harmony with nature, and have an aspiration of belonging to a green and comfortable living environment;
4. The platform for enhancing collaboration between biologists, engineers and designers is being actively developed.

One of the greatest designers in our history, and renown for seeking inspiration from nature, is Luigi Colani. For Colani, the natural world particular the sea life, has been a continuing resource of inspiration. Over the years, Colani has cited flies, whales, and a wide variety of insects as the inspiration for his design works. Figure 4 shows a motorcycle model, an aircraft and tableware designed by Colani, which reflect his passion to the aerodynamics inspired by nature.

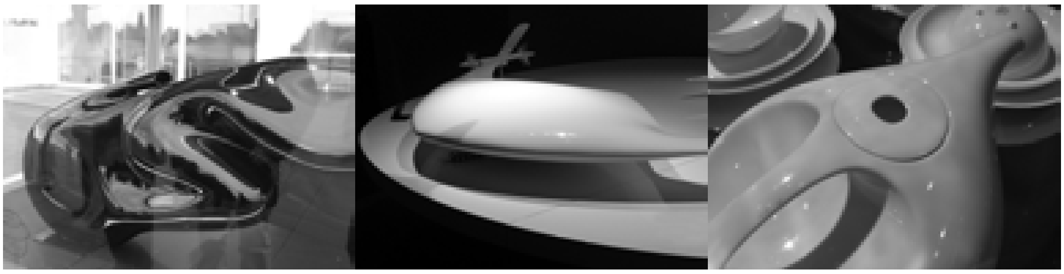


Figure 4 Colani's designs inspired by nature

3. What we are doing and what to do next

Design is no longer simply a matter of form and function, it is not only to deliver a physical service, but also brings to people an experience, either pleasure or displeasure, a sort of emotion and a process of interactive participation. On the whole, it is a language to communicate with people and our surroundings. It can be hypothesised that the language of human, the language of man-made products, and the language of nature can and should have something in common, which enables the smooth flowing of information during the dialogue between people, artefacts and environment, despite the dialogue might be mute.

We have been developing a methodology addressing the product language, which our design students are currently using to manipulate and evaluate a product form in line with particular aesthetic associations and application contexts. We have introduced a dual directional method.

Method 1: starting from a given group of verbal descriptors that are relevant to the design topic, students collect a number of visual images that can be perceived as an interpretation of the verbal description. Initial preliminary ideas are sketched together

with a selection of materials, colours and textures to align with the descriptors. Students then develop ideas into a final solution, which closely reflects the verbal description. (Perception process from verbal to images.)
Method 2: students gather a number of visual images that reflect the essence of a particular target group they are given. The images are shown to a group of people, who are asked to give verbal description of how they feel and perceive. Following this, they move ahead with the preliminary sketch ideas, choosing materials, colours and textures to closely match the descriptors. Chosen concepts are then developed into the final design. (Perception process from images to verbal.)

Both methods are about establishing the correlation between visual image and vocabulary (language), used to describe these images. The methods differ in that they operate in opposite directions. In order to examine the extent to which the designs have matched both the relevant visual images and the perceived description, evaluation of the completed designs have been conducted in both cases. Based on this information, we then categorise this vocabulary according to the topology of products, of contexts, and of topics in aesthetic association etc, which will contribute to establishing of a product language system, that will inform practice through identifying elements and features that will be necessary ingredients in formulating the product style.

As examples, we showcase here some of the student designs following both types of the methodology.

Method 1: verbal description → visual images → design
In this unit, students were asked to design a MP3 with speakers in line with particular topics of aesthetic associations, each topic being represented by a group of verbal descriptors. One of these groups is: *curvaceous*, *organic*, *fun*. The procedure is illustrated in Figure 5. After the designs were completed, we presented the models to a different group of students for evaluation with regard to whether the style and aesthetic perception of curvaceous-organic-fun has been successfully matched. Results show that an average percentage of 70% success was achieved in the form and aesthetics matched the topic. Therefore, method 1 is fairly effective in training students to manipulating a product form. Similar results have also been achieved for other style and aesthetic topics.

Figure 5 Illustration of the procedure of MP3 design following Method 1

Method 2: visual images → verbal description → design

In this unit, students were asked to design a CD player with speakers under two contexts: for 'an Alien species' and for 'Marine biologists'. They started by collecting a number of visual images that they perceived were relevant to the topics of Alien or Marine. These were presented in the form of a style board. Each student then conducted a survey by showing the style board to a minimum of 20 people for perception. People were asked to describe how they felt and verbal descriptors were recorded. The words that appeared with highest frequency were selected to help inform the development of design ideas through to the final form. The procedure is shown in Figure 6, which is for designing the CD player for a Marine Biologist. Figure 7 shows an example of a CD player designed for the Alien species. Evaluation of the designs with regard to whether the designs have matched the style and aesthetic topics (e.g., in the case shown in Figure 6, curvaceous-sleek-aquatic) is still undergoing by the time of writing this paper. Further results and comparison with those obtained in Method 1 will be reported at a later date.

Figure 6 Illustration of the procedure of designing a CD player for Marine Biologists following Method 2

In addition to developing a practical database of product language, i.e. the vocabulary according to the categorisation of product types, user information and contexts, etc, our next step requires a more detailed look at the features of natural life forms, shape, colour, textures etc. Following this, we intend to connect this information with three aspects in design: senses, forms, and emotions. We are going to explore the other sensory interaction such as touch. This will enable the methodology to go beyond deriving purely visual inspiration from nature. We also intend to look for material/finish techniques in relation to a natural surface textures.

Figure 7 Example of the CD player designed for Alien species also following Method 2

4. Conclusions

1. The form of man-made objects historically was subject to influences and overriding styles within that particular era. Most previous styles have since re-emerged and been fused into today's design practice, which features a diverse multitude of styles.
2. Organic design has particularly revived, along with the new domain of Biomimetic design due to new technology and human expectation of building harmony with and returning to nature.
3. A methodology is being developed to build a product formal language system and to educate young designers to manipulate form style to facilitate an effective communication between people and product, perhaps also between product and nature.

References

1. Lakshmi Bhaskaran, (2005), *Designs of the times: using key movements and styles for contemporary design*, published by Roto Vision SA. ISBN: 2-88046-816-7.
2. David Pearson, (2001), *New Organic Architecture*: *The Breaking Wave*. University of California Press, ISBN-10: 0520232895.
3. Tess Raine, (2007), Multisensory appeal, *Packaging News*, 02 May 2007.
4. http://www.bath.ac.uk/mech-eng/biomimetics/about.htm
5. Julian F V Vincent et al, (2006), *Biomimetics: its practice and theory*, J R Soc Interface, 3, p471-482.

A GENERATIVE MODEL FOR OBJECT DESIGN FROM LETTERS IN PLAYGROUND

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Abstract

In this paper, structure of a grammar model for design of a children's playground, involving playground objects evolved from letters of alphabet, is introduced. In the project the main idea is to think the letters as the main shapes for the shape grammar model. This computer aided design model makes use of boxes and arcs only, in accordance with the three main rules which are limiting the number of shapes that can be used at most, the number of shapes that can be used at least and how the shapes should be oriented. Following the main three rules and making use of a custom script with AutoDesk 3D Studio Max version 9.0, twelve different template shapes derived from the shapes of letters, are generated. Before starting the study of the design process for the project, two major points taken into account regarding the selection of an appropriate alphabet to be employed in the design, are explained. First task executed for the selection process has been the search for alphabets that would be suitable for the design, i.e., alphabets consisting of letters which are of elastic and soft figures. After the selection of a group of letters, an analysis was carried out in order to divide each of them into their basic geometrical constituents. Second part of the preliminary work, was the development of two different custom scripts to be used for the generation of each shape and the Guide User Interface (GUI). The first script generates shapes in sequence, without any modification of the original shapes, by letting the user to define the number of objects in a sequence and the distance between the objects. The second script, on the other hand, generates shapes with some modifications by using ordinary commands like taper, bend, squeeze and scale. During the creation of this shape grammar model, needs of a children playground were taken into consideration, bearing in mind that playfulness is an important feature of children's life. This generative model expresses how it can be possible to transfer the virtual world in a child's mind into a reality through basic rules in computer programming.

1. Introduction

After the advance of computer programming languages, virtual worlds started to interfere in variety of areas, such as generative arts. Not only computer programmers but also designers are capable of developing scripts to create imaginable environments by making use of different programs that working on 2D and 3D. In recent years, people have a desire to see technological products everywhere, especially children who are started to become central objects in the market of industrial products. '*As our design partners in developing new technologies, children can offer bluntly honest views of their world. They have their own likes, dislikes, and needs that are not the same as adults'* [1]. During the design process designers should be in collaboration with children in order to understand what playfulness means in their outdoor and indoor activities. *Playfulness is the capacity to draw satisfaction from the immediate intellectual development of a topic, irrespective of any ulterior motive.* [2] Playfulness is a source of amusement for children. All children, no matter where and in which conditions they live, are capable of creating a play area for themselves and during the play they can adopt a different identity.

What is the significance of play and playground and what are its effects on children? Researches shows that play have an important effect on a child's development. For this reason, international organizations like UNICEF and IPA are also dealing with rights of play and playgrounds. The basic statement of both organization regarding the children's play and playgrounds, is that children have the right to play and these rights must be guarantied by the adults.

Children should be provided with proper places where each element of the playground is designed and serviced in a different way to create sense of a space and to alert perception and motor improvement. Children must be in command of different concepts, such as in, on, under, outside, left, right, far, near, color and rapid of designs, to develop a sense of space. A playground enables the child to cognize, shapes, sizes, numbers, and relationships between pieces. In other words, playground is an educational environment which helps improvement of social, physical, sensual and cognitive behaviors of children. If children have this opportunity, they become more creative, and they can find more flexible solutions to problems, and also they can develop better and healthier relationships with other children.

To create design playground objects, shape grammar methods were examined and it was decided to use some alphabets resembling each other and consisting of not only letters but also symbols. As a consequence of a thorough research, alphabets of Russian, Greek and Sanskrit were chosen. One of the most important criteria in the choice of letters has been their possession of at least one common shape and their capability of being transformed into other shapes which are possessing elastic or soft forms. All letters which were selected to generate shapes are shown below. (Figure 1)

Ψ Ω β ф ю P O

Figure 1: Letters are chosen according to three different alphabets like

Russian, Greek and Sanskrit.

Following the forms of those seven main letters, twelve shapes were generated. One of the letters was taken directly to generate forms for playground's element as an initial shape, i.e., **"Ψ"** the other eleven are changed according to the base shapes and initial shapes.

2. Generating Shapes

Stiney's formalization of the shape grammar provides a semantic model with a compressed representation of architectural form (Stiney 1978 and 80). The discipline of space syntax, developed by Hillier provides analysis of spatial configurations with empirical data that could be developed into fitness criteria (Hillier et al., 1984, 93 and 96). [3] In this shape grammar model, principal letter at the beginning of the design process was kept fixed and an analysis of each principal letter to its sub-components was carried out at the beginning of the design. Below, it is illustrated how they are divided into basic constituting figures such as, box and line in two dimensional space, and the composition of these two basic figures in three dimensional space in such a way that the composition obeys three main rules which are,

1. All shapes are built by using at least an arc and a box.
2. All shapes may contain a maximum of two arcs and two boxes.
3. All boxes must be placed in the middle of the arcs or at the edge of the arcs.

Following these three main rules, four different variations of composition were created.(Figure 2)

Ψ Ω β ф ю Р О

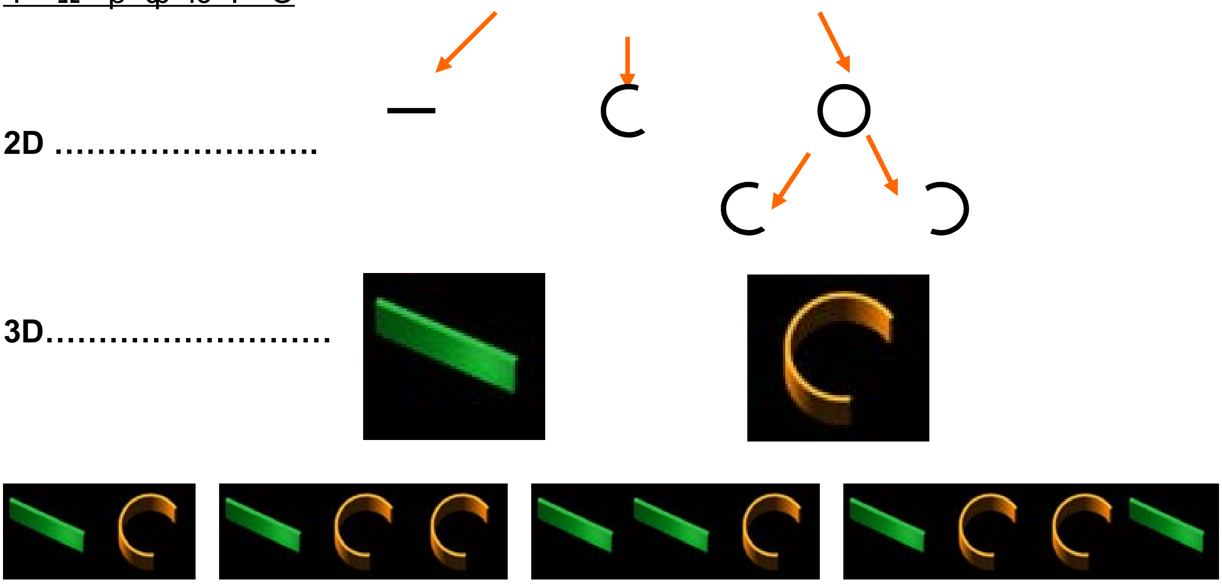


Figure 2; division of letters to the basic constituting figures and development of four different compositions for shapes.

2.1. Generating Sub-Shapes with using a custom script 1

Firstly, the initial letter was choosen and a custom script to generate the pieces of initial
Shape, i .e. box and arc, and guide user interface (GUI) was developed by using 3D Studio Max version 9.0. According to three main rules which is shown in Figure 2,

script 1 produces both twelve shapes and GUI. During the generation phase, there are two important steps: one of them, is to determine the size of the shapes that will be created; the next step is to decide the position of the object and the way it is connected to the others. After creating the initial objects that were derived from those boxes and arcs; a capability of movement about x-axis, y-axis and z-axis, was ascribed to them. Making use of this movement capability and repeating of those objects, 12 different shapes were generated by using Script 1. The twelve different shape rules are listed in the following figure (Figure 3). User Guide Interface is a useful tool for generating shapes in the direction of user's choices.(Figure 4).

Rule
Compenent - MODEL

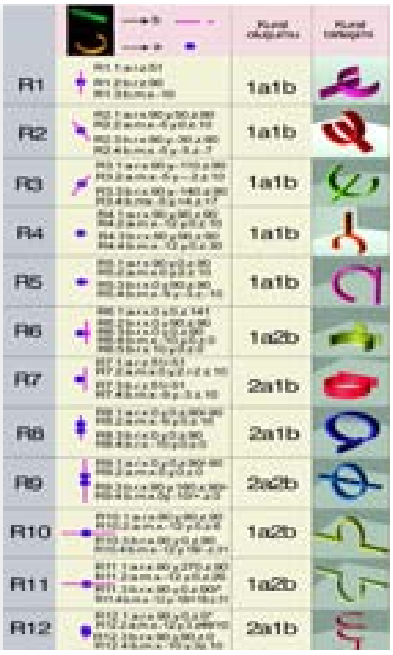


Figure 3; is shown that generated 12 shapes. Figure 4; GUI is written as a custom script.

When a user chooses any rule on the GUI and clicks on "make" button the custom shapes are created automatically according to the initial shape of the rule in this shape grammar. The user can define the number of shapes and distance between each of them, also can change the color of shapes with using GUI. Every rule generates one shape and if user clicks on the "make" button more than once; shapes are created at the same position. When users choose some rules and click on them, cumulative alternatives can be created for designing elements of playgrounds (Figure 5).

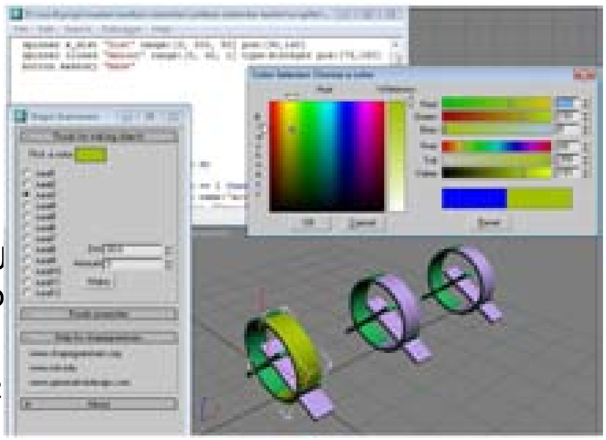


Figure4;indicatesflowchart.
flowchart.

2.1. a Generating Sub-Shapes 1(SS1)

All rules are generated in the same way. U
thought as consisting of two different compo

and rotate are determined. The properties of the arc shape, for instance, are written in the script as follows:
Arc is named as “myArc” that is:"arc" radius:9 from:277 to:161 and extrude of arc is 5.0
and the properties of the box shape are written as follows;
Box is named as “myBox” that is height: 5.0 length: 1.055 width: 20.5.

For generating rule 1, one arc and one box are used and their position is determined in advance, to be at the origin. In the tables below, two main shapes of arc and box are considered as composed of two different components and the movement and rotation in and about each axis are shown;

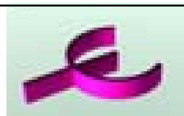
Rule 1		Rotate			Move			Model
arc	box	x-ax.	y-ax.	y-ax.	x-ax.	y-ax.	z-ax.	
→		0	0	51	0	0	0	
	→	0	0	90	-10	0	0	

Table 1; explanation of the model rule 1

Rule 1 is thought to be the initial shape and represents the origin of the others. (Table 1)

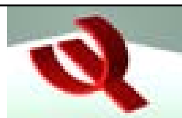
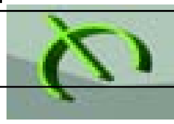
Rule 2		Rotate			Move			Model
arc	box	x-ax.	y-ax.	y-ax.	x-ax.	y-ax.	z-ax.	
→		90	-30	90	-5	0	10	
	→	90	-30	90	xof-5	-5	7	

Table 2; explanation of the model rule 2

Rule 2, is another version of Rule 1 (Table 2). It provides the production of playground elements with inclined angles, and as the angle changes it enables a variation in the activities such as jumping, passing through, swinging, etc. Taking the mirror of Rule 2, design of an element which allows swinging and passing through was realized (Figure 6). With the rotation of Rule 3 about y axis and mirroring that product a teeter totter is created (Figure 7).

Figure 6

Figure 7

Rule 3		Rotate			Move			Model
arc	box	x-ax.	y-ax.	y-ax.	x-ax.	y-ax.	z-ax.	
→		90	-140	90	-5	0	10	

		90	-140	90	xof-5	-5	7	

Table 3; explanation of the model rule 3

Applying the mirror command to Rule 3 (Table 3) which was derived from Rule 1, it is possible to create an element that allows children to pass through a hole and to sit inside that
vacancy and also it is possible to create a tunnel by repeating the element (Figure 8). Besides, when it is rotated 180 degrees closed/semi closed units serving for the same function can be developed (Figure 9).

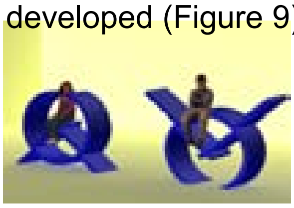


Figure 8

Figure 9

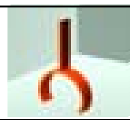
Rule 4		Rotate			Move			Model
arc	box	x-ax.	y-ax.	y-ax.	x-ax.	y-ax.	z-ax.	
		90	90	90	12.8	0.2	13	
		90	90	90	12.8	0.2	29.5	

Table 4; explanation of the model rule 4

Rule 4, is already stable without any distortion (Table 4). When used as a single component, it provides a passage and partition. By applying the mirror command to Rule 4 about z axis and repeating that product a tunnel and a bridge are generated below and above respectively (Figure 10).

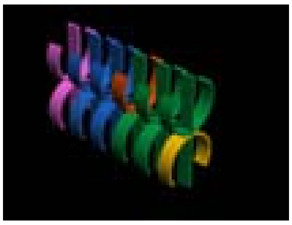


Figure 10

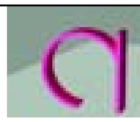
Rule 5		Rotate			Move			Model
arc	box	x-ax.	y-ax.	y-ax.	x-ax.	y-ax.	z-ax.	
		90	0	0	0	2	10	
		0	90	90	xof-9	-3	10	

Table 5; explanation of the model rule 5

Rule 5, serves as a door when used alone (Table 5). By applying the mirror command to Rule 5 about y axis and repeating the product curved passages providing connection between elements (Figure 11).

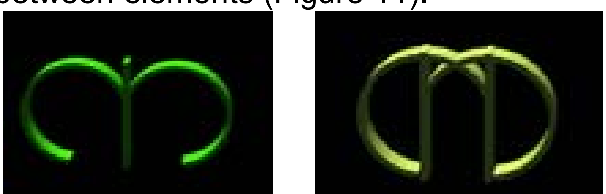


Figure 11

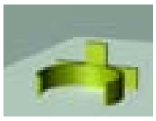
Rule 6		Rotate			Move			Model
arc	box	x-ax.	y-ax.	y-ax.	x-ax.	y-ax.	z-ax.	
		0	0	140	0	0	0	
		0	90	90	xf-10	-2.5	0	
		0	0	90	xf-10	0	0	

Table 6; explanation of the model rule 6

The most important feature of Rule 6, basically a semi-open shape, is its richness in providing alternatives by using two boxes and one arc (Table 6). Combining Rule 6 and Rule 5, rotating this combination 90 degrees about z axis and ultimately mirroring it about several axis, multifunctional elements, enabling such activities as climbing, jumping, passing over, are formed (Figure 12).

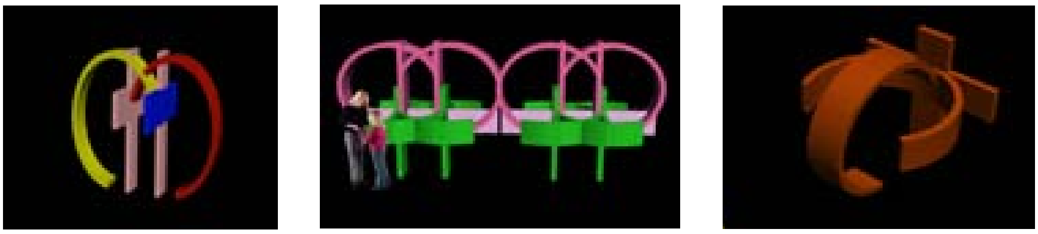


Figure 12

Rule 7		Rotate			Move			Model
arc	box	x-ax.	y-ax.	y-ax.	x-ax.	y-ax.	z-ax.	
		0	-0	-90	0	0	0	
		90	0	0	0	0	0	
		0	0	90	xf-10	0	0	

Table 7; explanation of the model rule 7

Rule 7 is highly suitable to be combined with other rules (Table 7). Even the circle, which is one of the components of the whole body and standing on the ground, itself, is a very commodious playground element. When repeated, it allows running through itself. Combining Rule 7 and Rule 1 and repeating the same application, a playground element with holes that make it possible for children to run through, is obtained (Figure 13). When Rule 7 is combined with Rule 1, Rule 5 and Rule 8, elements for climbing, jumping, and passing through area created (Figure 14). Rule 7, is very helpful for the design of many elements for many different purposes.

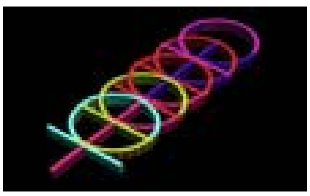


Figure 13

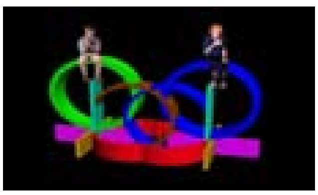


Figure 14

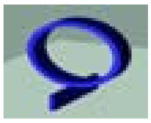
Rule 8		Rotate			Move			Model
arc	box	x-ax.	y-ax.	y-ax.	x-ax.	y-ax.	z-ax.	
→		0	90	90	-9	2	16	
→		0	-90	90	-9	2	16	
	→	0	0	90	xf-10	0	0	

Table 8; explanation of the model rule 8

Rule 8 is a hollow unit itself and provides connection between a variety of elements. It generates many other alternatives with other rules.

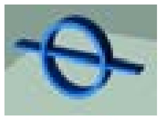
Rule 9		Rotate			Move			Model
arc	box	x-ax.	y-ax.	y-ax.	x-ax.	y-ax.	z-ax.	
→		90	90	90	0	0	0	
	→	90	180	90	0	-10	0	
	→	90	180	90	0	10	0	
→		90	-90	90	0	0	0	

Table 9; explanation of the model rule 9

Rule 9, shows the properties of a teeter totter (Table 9). However, when repeated in y and z axes, it forms a climbing element. Combination of Rule 9 with other rules; also, provide creation of a diversity of playground elements (Figure 15).

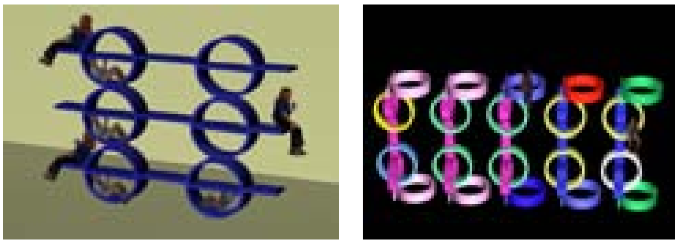


Figure 15

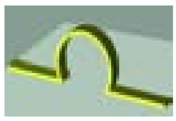
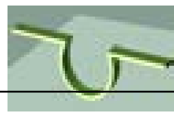
Rule 10		Rotate			Move			Model
arc	box	x-ax.	y-ax.	y-ax.	x-ax.	y-ax.	z-ax.	
→		90	0	90	90	90	90	
	→	90	-14	90	12	18	1	
	→	90	0	90	-12	-18	1	

Table 10; explanation of the model rule 10

Rule 10, provides a passage itself and generates spaces suitable for hiding.

Rule 11		Rotate			Move			Model
arc	box	x-ax.	y-ax.	y-ax.	x-ax.	y-ax.	z-ax.	
→		90	270	90	-12	0	25	
	→	90	0	90	-12	18	30	
	→							

		90	0	90	-12	-18	30	

Table 11; explanation of the model rule 11

Rule 11, is symmetrical to Rule 10 and provides bridge function (Table 11).

Rule 12		Rotate			Move			Model
arc	box	x-ax.	y-ax.	y-ax.	x-ax.	y-ax.	z-ax.	
- - — - - ►		90	0	0	-12	3	47	
- - — - - ►		90	0	0	-12	3	30	
	- - — - - ►	90	90	0	xf-10	3	10	

Table 12; explanation of the model rule 12

Rule 12, is designed as an element (Table 12) which provides several functions i.e., swinging, climbing, and supporting other elements, by making use of three shapes it possesses.

In Figure 16, some example shapes which were generated by using the first script are shown that can be used as objects in a playground and with the combinations of these rules it is possible to produce infinitely many .

Figure 16

2.1. Generating Sub-Shapes with using a custom script 2

All rules are generated in the same way. Script 2 is created by adding some transformation properties over he rules generated in Script 1. First script is taken without any change but some limitations are introduces for each rule. Here, already exist some limitations determined in advance- keeping in mind the needs for height, length, etc. - besides the features that are assigned by the computer randomly. 2nd script is a bit more advanced when compared with the 1st script, and can make use of transformations such as scale, squeeze, taper, etc.

R1 +

By the addition of Rule 1 in SS1, Twist modifier and Scale modifier are attached and some examples are generated (Figure 17). Some of them are used as semi- open spaces mixing the inner and outer space concepts, which are allowing to hide and slide together, also creating the idea of house-tent.

Figure 17

R2 +

By the addition of Rule 2 in SS1,Twist modifier and Scale modifier are attached and some examples are generated (Figure 18).These elements for playground design can be used as objects creating space-.... concept; tunnels can be built up by the repetition of the object, or may be used as a teeter totter or just as a seat.

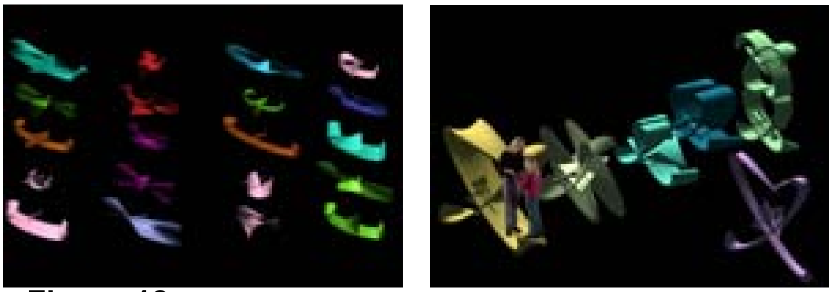


Figure 18

R3 +

By the addition of Rule 3 in SS1, Twist modifier and Bend modifier are attached and some examples are generated (Figure 19). It is aimed to create objects for children to sit in different levels, climb up and while climbing to recognize and understand different geometric shapes and to manage with their relation.

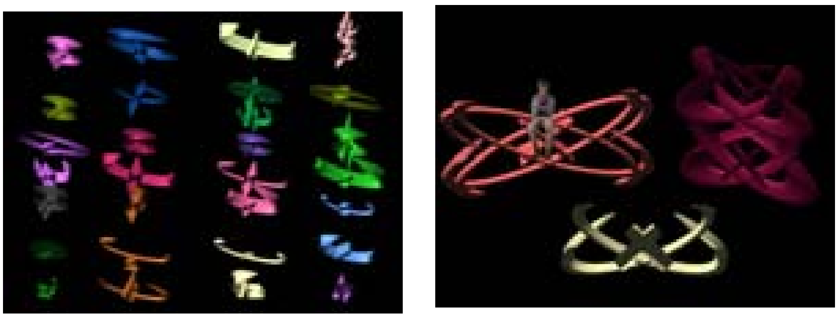


Figure 19

R4 +

By the addition of Rule 4 in SS1, Twist modifier and Mirror modifier are attached and some examples are generated (Figure 20). This is again an object for climbing. When applied in y axis, a climbing element with a seating unit below is obtained. When applied in x axis only a seating unit is obtained.

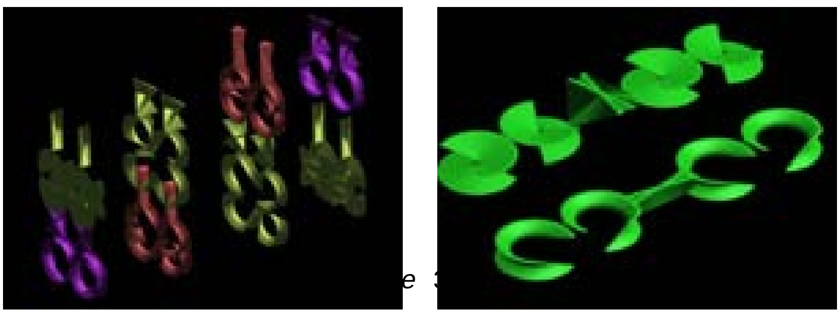


Figure 20

R5 +

By the addition of Rule 5 in SS1, Stretch modifier and Mirror modifier are attached and some examples are generated (Figure 21). The designs obtained can be used as seating units for adults, and teeter totter and slide for children. There will be enough space left for hanging the swing.

Figure 21

R6+

By the addition of Rule 6 in SS1, Twist modifier and Mirror modifier are attached and some examples are generated (Figure 22). Seating units, slides and elements for hiding can be produced.

Figure 22

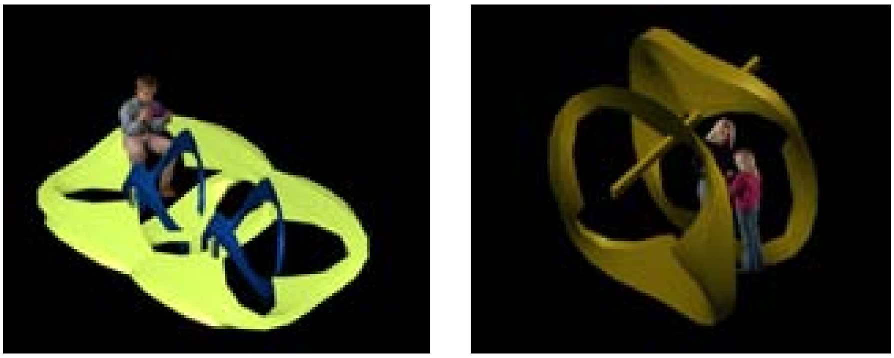
R7+

By the addition of Rule 7 in SS1, Stretch modifier, Ripple modifier and Taper modifier are attached and some examples are generated (Figure 23). It provides the production of a mini-amphi and a sand pool for children. At the same time, together with necessary additions, it is possible to create swing or cradle.

Figure 23

R8+

By the addition of Rule 8 in SS1, Stretch modifier and Ripple modifier are attached and some examples are generated (Figure 24). This is the rule for the creation of small lodges to be shared between children. It produces playground objects which favors adults to involve in children plays and provides elements for hanging.



R9+

By the addition of Rule 9 in SS1, Stretch modifier and Ripple modifier are attached and some examples are generated (Figure 25). It realizes objects that provide children to understand curved surfaces, enables them to swing and pass through and to sit in different elevations.

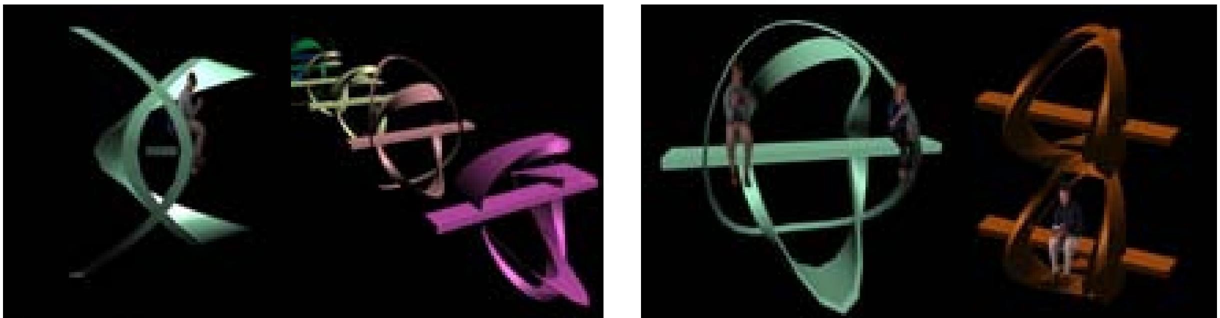


Figure 25

R10+

By the addition of Rule 1 in SS1, Twist modifier and Mirror modifier are attached and some examples are generated (Figure 26).An element which can be shared between children and adults. It serves as a seat for adults while providing passage for children. It can also be used as a teeter totter.

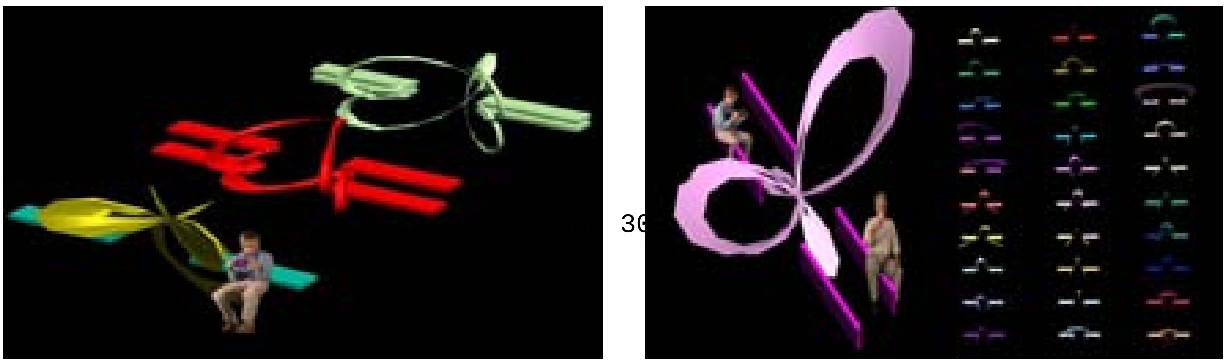


Figure 26

R11+
By the addition of Rule 11 in SS1,Stretch modifier, Ripple modifier and Twist modifier are attached and some examples are generated (Figure 27). It creates elements for climbing for children and creates seats for adults.

R12+
By the addition of Rule 12 in SS1, Stretch modifier and Mirror modifier are attached and some examples are generated (Figure 28). It creates elements which introduce organic forms to children while providing a tool to swing, climb and pass through all together.

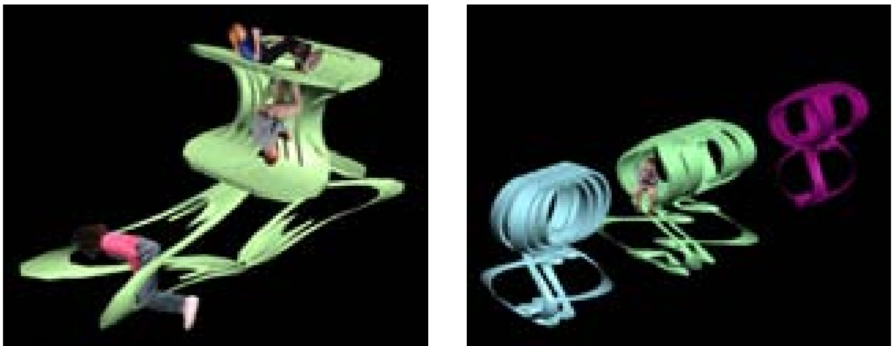


Figure 28

3. Conclusion

One of the most important problems in the design of children's playground elements is the fact that design process disregards the richness of the children's world. However, children who are at the very center of technological development prefer different designs which excite them. Colors are also highly effective, as the design itself, in the perception of space for children. Since the knowledge obtained through observing and experiencing the environment are direct and without any dictating agent, are much more long-lasting.

In this project, the main idea is to create elements to satisfy many demands of children at the same time and the basic figures are chosen to be with soft edges in order to prevent the injuries.

Regardless of which script is chosen during design process, the end products, the custom shapes themselves, have common specifications. They can all be useful and suitable objects if used in a playground.
To conclude, the program, built up with a simple and user friendly GUI and two custom scripts, offers a creative and funny way for generating custom shapes which can be used as objects in a playground, by using just letters as the origin.

References

[1] [1] *Durin, A., Bederson, B., Boltman. A.*, (1997), “Children as our Technology Design Partners”, Holland.

[2] [2] *Hoyles, C., Noss, R., (2000)*, “Playing with (and without) words”, Instute of Education, University of London

[3] [3] http://www.vterrain.org/Culture/shape_grammar.html

[4] Aldo, E., (2002), “The Playgrounds and the City”, ed. Liane Lefaivre, Ingeborg de Roode; text Rudi Fuchs, Amsterdam NAI Pubs.

[5] Anon (1998), T.C. Bayındırlık ve İskan Bakanlığı Teknik Araştırma ve Uygulama Genel Müdürlüğü, *Çocuk parkları oyun gereçleri* , Ankara.

[6] Hendrix, B. E, (2001), Designing for play, Aldershot: Ashgate.

[7] Günay, E., (2007), *A Generative Model for Object Design from Letters in Playground*, Term Project in Generative Systems in Architectural Design, Architectural Design Computing Graduate Program (instructor: G. Çağdaş).

[8] Senda, M., (1992), “Design of children's play environme nts”, New York : McGraw- Hill.

[9] Stiny G, 1982, "Spatial relations and grammars" Environment and Planning B: Planning and Design 9, 113–114.

[10] Theemes, T., (1999), Let's go outside!: designing the early childhood playground , Ypsilanti, Mich., High/Scope Press.

[11] http://yayim.meb.gov.tr/dergiler/158/yilmaz.htm

[12] http://yayim.meb.gov.tr/dergiler/151/tekkaya.htm

A GENERATIVE MODEL FOR ANATOLIAN MEDRESES BY ANALYZING OF PRECEDENT

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In this study, medreses, which are the educational buildings of a period in Anatolia, are analyzed. For this analysis Seljuks State medreses' with open courtyard and 1 storey type are chosen. By analyzing their topological and geometrical properties, parametric shape grammar rules are defined then new plan layouts are generated. In this study the translation from a set of design principles of medreses into a shape grammar has been done by hand. The future objective of the study is to implement it in a computer.

KEYWORDS: Shape Grammar; Medreses; analysing architectural precedents

INTRODUCTION

Stiny described shape grammars as a method for formal descriptions of designs. An alphabet of shapes, a strarting shape, and shape rules which defines spatial relations between shapes consititute shape grammars.

The power of shape grammar is obvious in design areas like painting, sculpture, especially in architectural design and in the study of historical architecture (some examples; Palladian Villas and Victorian windows, Frank Lloyd Wright Houses, Alvaro Siza's Malagueira houses, Traditional Turkish Houses). An architectural composition has some principles. These principles can be defined by a set of rules, and these rules form the language of the grammar.

Mark Tapia (1999) describes well the relationship between shape grammars and computer implementations:

Shape grammars naturally lend themselves to computer implementations: the computer handles the bookkeeping tasks (the representation and computation of shapes, rules, and grammars, and the presentation of correct design alternatives) and the designer specifies, explores, develops design languages, and selects alternatives.

People who develop shape grammars have had two choices: either simulate the shape grammar by hand or develop a program on a computer.

In this study the translation from a set of design principles of *medreses* into a shape grammar has been done by hand. With a bottom-up approach architectural language and a vocabulary of medreses are defined, then this vocabulary transformed into a shape grammar and finally a variety of medrese plan layouts are generated.

MEDRESES

Courtyard with eyvans plan layout is a common scheme, used in central Asia, Iran, and in other parts of the Muslim world. It functions equally and perfectly for different functions, as medrese, caravanserai, palace and mosque.

Medrese is a building type which has an important role in the development process of Turkish Islamic architecture and the cultural content of Middle Ages Anatolia. In *medrese*s experimental and religious sciences were educated freely. These educational buildings have their own specific, architectural characteristics. *Medrese*s consist of a big classroom and enough number of student rooms.


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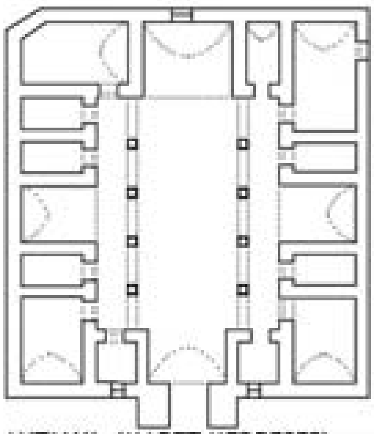

ANTALYA, IMARET MEDRESESI

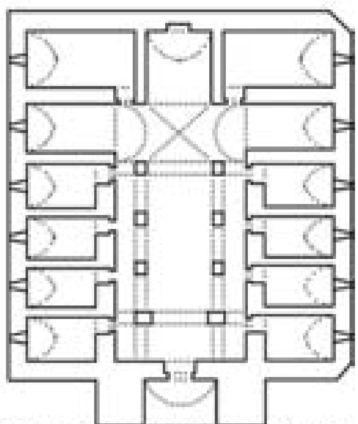

KAYSERİ, SERACEDDIN MEDRESESİ

Figure 4. Some photographs and plans of medereses

In Seljuk Anatolia's there were two types of *medrese*s; "*medrese* with open courtyard", and "*medrese* with vaulted central area".

On the entrance part there is a big chief doorway (main door). By passing from the main door through a vaulted passage you reach to the courtyard. There is a big *eyvan* on the opposite facade of entrance and courtyard, which is used as a common classroom.

Through the entrance and big *eyvan*'s right and left side there are student rooms. Generally in the middle of these rooms there is an *eyvan* and in front of them there are colonnades (*revak*). In these rooms students could study with their teachers in Private.

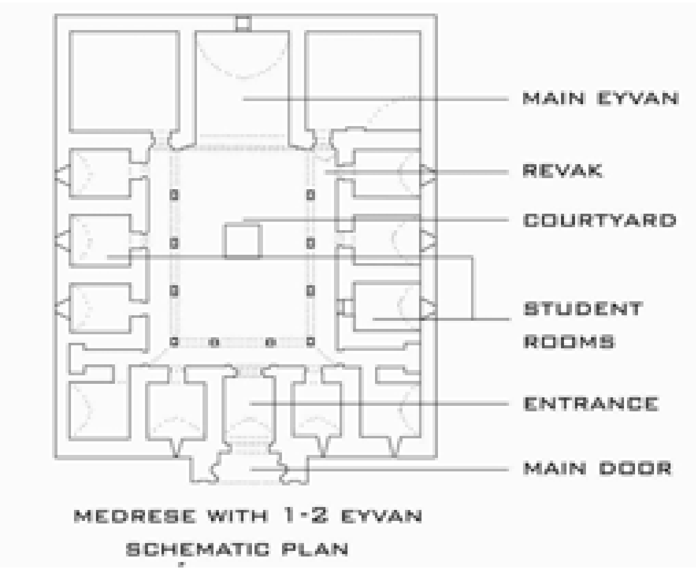


Figure 1. Schematic plan of medrese with 1-2 eyvan

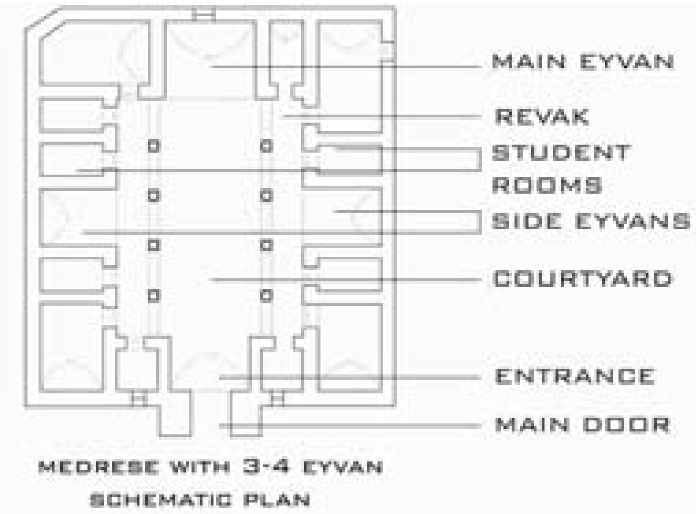


Figure 2. Schematic plan of medrese with 3-4 eyvan

THE GENERATION PROCESS

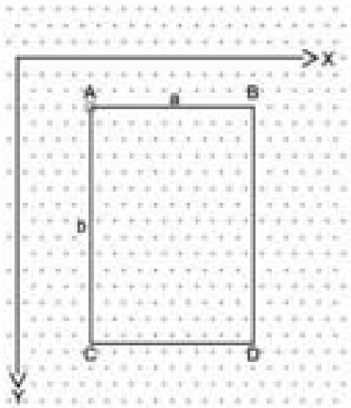
By analyzing different types of *medrese* plans, some general decisions have taken about building elements, dimensions, proportions and plan schemes. Geometrical and topological constrains are the followings:

- The entrance must be from the short façade;
- Axes of entrance and big *eyvan* must be on the same direction;
- If there are side *eyvan*s, they must be in the middle;
- If there are side *eyvan*s, they must be smaller than big one;
- There must be colonnade (*revak*) in front of student's rooms;
- Dimensions of the axes of colonnade and columns must be chosen from knowledge base.

The steps of generation:

- Defining general dimensions of layout;
- Placing main entrance and big (main) *eyvan*;
- Placing and measuring student cells, and (if there is) side *eyvan*s;
- Placing colonnades;

- Defining the place of chief doorway.



K1. DEFINING DIMENSIONS OF THE STARTING SHAPE

a: parallel to the x axis and $21<x<27$

b: parallel to the x axis and $26<y<43$

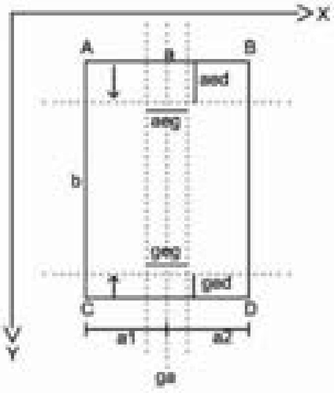
$a<b$ (must be)

proportion of a/b : $1<a/b< 1.6$

$a<b$ (must be)

DEFINITION: Main shape is generated by starting from point A.

Generally main shape is in a rectangular form.



K2. ENTRANCE AXIS

K2.1. WIDTH OF ENTRANCE AXIS

entrance axis(ga) must be just in the middle of short side

width of entrance eyvan (geg) : $3 < geg <7$

.entrance eyvan and main entrance (aeg) may be in the same dimensions

.but entrance eyvan's width cannot be more than main eyvan's width

K2.2 DEPTH OF ENTRANCE EYVAN

depth of entrance eyvan (ged): $3 < ged <7$

depth of entrance eyvan can be defined parallel to the |CD| direction, with measurements written above

K3. MAIN EYVAN

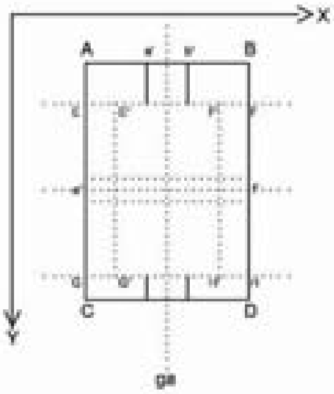
K3.1 WIDTH OF MAIN EYVAN

width of entrance eyvan (aeg) : $5 < aeg <10$

K3.2 DEPTH OF MAIN EYVAN

width of main eyvan (aed): $5 < aed < 10$

depth of entrance eyvan can be defined parallel to the |AB| direction, with measurements written above



K4. STUDENT ROOMS AND SIDE EYVANS

K4.1. IF THERE ARE SIDE EYVANS : ROOMS AND SIDE EYVANS

(After defining dimensions of entrance and main eyvan we get some helping points ; E,F,G,H)

K4.1. 1. WIDTH OF SIDE EYVAN

|EG|=|FH|

Mid point of |EG| and |FH| sides locates the axis of side eyvans : |e'f'|

.Width of side eyvan (yeg) $3<yeg<8$

.Side eyvan cannot be wider than main eyvan

$yeg<aeg$

Side eyvan width is defined by shifting equally |e'f'| side through |AB| and |CD| sides.

K4.1. 2. DEPTH OF SIDE EYVAN

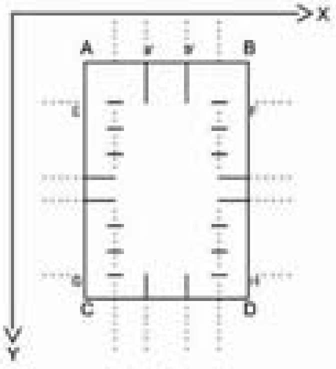
|EG|=|FH|

.Depth of side eyvan (yed) $3<yed<8$

.Side eyvan cannot be deeper than main eyvan :

$yeg<aeg$

Side eyvan depth is defined by shifting equally |EG| and |FH| sides through inside.



K4. STUDENT ROOMS AND SIDE EYVANS

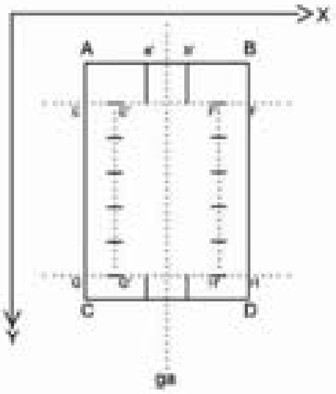
K4.1. 3. LOCATING STUDENT ROOMS

After defining side eyvans on |EG| ve |FH| sides, left pieces are divided equally to get student rooms.

Rooms can be behind or on the same line with side eyvans:

.Side eyvan depth (yed) 3<yed<8 —> room depth 3<bd<8

. Room width (hg) 2<hg<8 —> if the left piece is smaller than 2, then no division occurs and one room is located.



K4.2 ROOMS; IF THERE IS NOT SIDE EYVANS

(After defining dimensions of entrance and main eyvan we get some helping points ; E,F,G,H)

K4.2. 1. ROOM DEPTH

|EG|=|FH|

Room depth is defined by shifting |EG| and |FH| sides through inside

|E'G'| and |F'H'| are generated

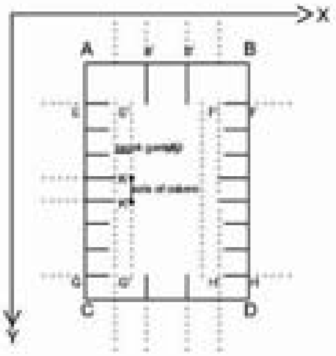
Room depth (hd) 2<hd<5

K4.2. 2. ROOM WIDTH

|E'G'|=|F'H'|

|E'G'| AND |F'H'| sides are divided according to the measurements written below

Room width: 2<hd<6



K5 REVAK

K5.1. IF THERE ARE SIDE EYVANS

K5.1. 2 LOCATING SIDE EYVANS

By shifting |E'G'| and |F'H'| axis, the places of comuns are defined.

Column measurements 0.6*0.6 m

Width of revak 13<rg<25

K5.1. 2 LOCATING THE COLUMNS

There are 3 choises for locating Revak columns through |AC| side:

can be on the axis of main eyvan's side walls.

can be on the axis ofentrance eyvan's side walls.

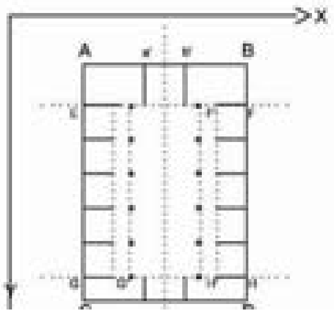
can be independent from both axis.

Column axis (ka) 20<ka<30

Firstly columns are placed through the wall of side eyvans.

Other columns are placed according to the measurements written below.

Column axis 20<ka<30



K4.2. 2. IF THER IS NOT SIDE EYVANS

|E'G'|=|F'H'|

|E'G'| and |F'H'| sides are divided equally accoeding to the measurements written below.

Column axis: 20<ka<30

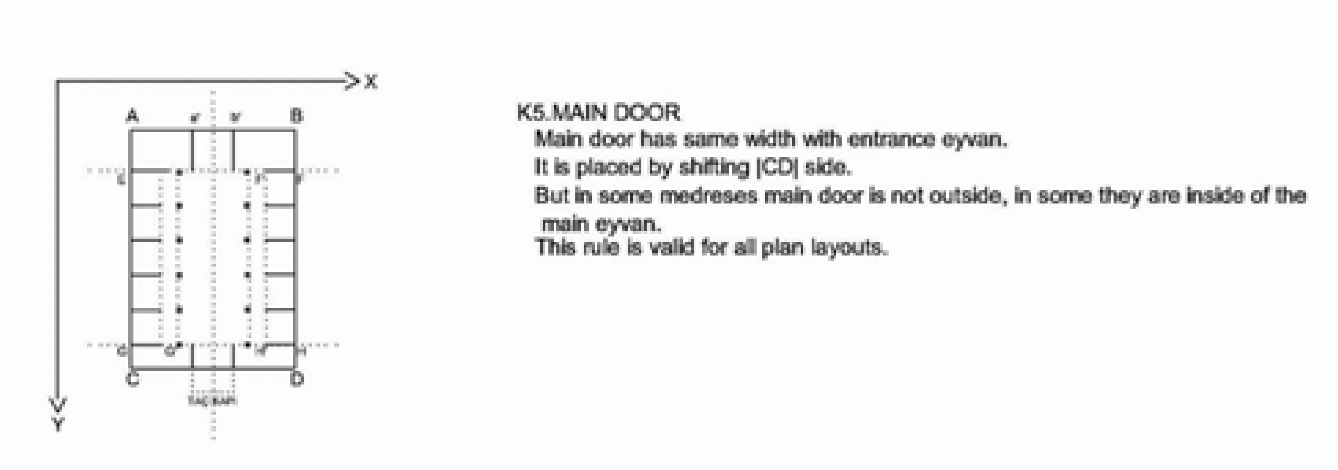


Figure 4. Steps of generation

At the end of this process two different kinds of layouts (one with side *eyvan*s, one without side *eyvan*s) and variations of them are generated.

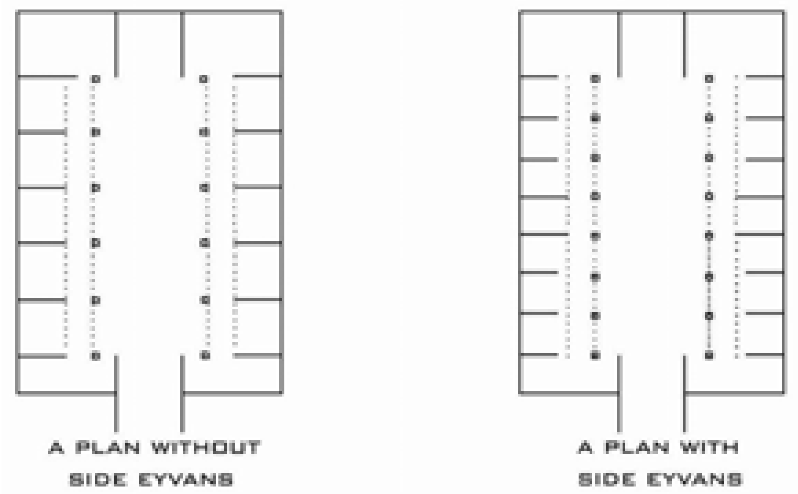


Figure 5. Examples of produced layouts

CONCLUSION

The main objective of this work is to analyze the precedent for producing architectural knowledge about Anatolian Seljuk's medreses. The most important part is to understand design process and architectural content of *medrese*s' and adapt this knowledge today's design. For this adaptation parametrical shape grammer rules and generation methods are used.

The educational value of the shape grammars is clear. The generation process of designs can be made explicit by specifying the shape rules. The shape grammar developed in this study helps to facilitate the students' understanding of the formal compositions of *Seljuk's medrese*s clearly.

REFERENCES

Sozen, M., 1970, Anadolu Medreseleri, İstanbul Teknik Üniversitesi Matbaası, İstanbul.

Stiny, G.: 1980, Introduction to shape and shape grammars, Environment and Planning B: Planning and Design 7, 343–351.

Tapia M A, 1999, "A visual implementation of a shape grammar system"

Environment and Planning B: Planning and Design 26, 59–73.
Yetkin, K. S., 1970, Türk Mimarisi, Bilgi Basımevi, Ankara.
http://www.dallog.com/index.html, 23.09.2007
http://www.shapegrammar.org, 23.09.2007
http://tr.wikipedia.org, 23.09.2007

Batik Fractal : Traditional Art to Modern Complexity

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Abstract
Fractal Dimension Analysis with Fourier Transformation for Batik shows the presence of fractal with range between 1 and 2. The Isen process (filling smaller motifs after the bigger motifs are done) is a significant factor which made the Self Affine,a fractal's characteristic, appear. Analysis of Variance/ ANOVA Test for Fractal Dimension classified several batiks that have similar value, according to their motifs and their place of origins. Furthermore, Fractal Dimension spreads almost symmetrically in every angle, except for banji motifs where the symmetry appears less. According to their place of origin, Yogya and Solo has similar Fractal Dimension with batik from Madura and Garut, but Madura and Garut themselves has different Fractal Dimensions.

The presence of fractal in batik indicates the presence of complexity in this traditional art. The complexity emerges because the effort to obey pakem rule (symbolic meanings, harmony, symmetry) and media limitations (canting, wax)

Keywords: batik, isen, fractal, Fractal Dimension, Self Affine, Fourier Transformation

1. Batik and Fractal Dimension: An Introduction

Batik is considered to be a textile art. The character of this particular art extents from ethnography, archaeology, anthropology, tribal art, primitive art, and traditional visual art. Basic technique in producing batik has been widely known, such as India (bandhana), China (miao), Japan (rokechi,katanori), Russia (bokhara), and Malay region (plangi, palekat).

Batik motifs itself evolves according to their place and time, such as keraton (solo, yogya, majapahit), India (patola and jlamprang), Islam (anti-anthromorphic, arabesque, flat forms), China (bright colour, floral, phoenix, lions and dragons) and even dutch influenced Indonesia.

Because batik has certain symbolic meaning, then each object which become batik

ornamentations has mythological meanings. Animal motifs use many bird objects due to its flight capability that can connect between heaven and earth. So does lotus motif, a water plant, as a manifestation of life since it grow upward to the sky from the depth of water.
There are two main topics in defining batik: as a process and as motif. Process is the technic in craftsmanship to produce batik by resist-dye technique. The motifs itself is the ornaments found in batik, which are classified as parang, geometry,banji, spreading plants, water plants, flowers and animal.
Batik is not an ordinary textile art. Inside we found functional value. This value creates different batik motifs. For example the motifs between peasant and noble, coastal and interior, everyday and ritual are not similar to represent the difference of each value.
In aesthetic side, the quality is not based on the judgment of being good or bad, but in its effort to obey the pakem rule. As a form of decorative art, the ornament or isen is not merely to fill the space left from the batik motifs, but rather as to give specific value. Indeed, to understand the batik motif it is not enough to disentangle the motifs to just merely dots, line, colour or shape, but also its meaning behind it.
In Complexity Theory, the emergent of Chaos are marked by the presence of fractal. Fractal stands between order and chaos, in which case are known as in Edge of Chaos. Fractal can be seen by its characteristic, which is Self-Similarity and Self-Affine. In Self-Similarity an object has geometrical form which resembles the object's detail in smaller scale. In Self Affine an object has detail which resembles the object, although not necessarily be similar in every aspect.
This paper examines the process of batik in producing batik motifs which has fractal characteristic. The initial Hypothesis of this research is that batik has fractional fractal dimension, which means that batik is Fractal. The hypothesis' background is the making of isen in batik motifs. Isen itself is the process of filling the space left by main motifs with ornamentations.
The measurement of fractal dimension itself is useful for analyzing in different fields. Such as heart failure detection (Teich et al), river flows (Szustalewicz et al), transportation (Dorfman), brain tumor detection (Marsh), fish's neuron in brain (Isaeva), retinal eye scan (Ewe et al).
The paper thus explores the possibility of creating batik through Generative Arts. If batik is indeed fractal, then it is appropriate to produce batik motifs using the same means. The algorithm is as follow:

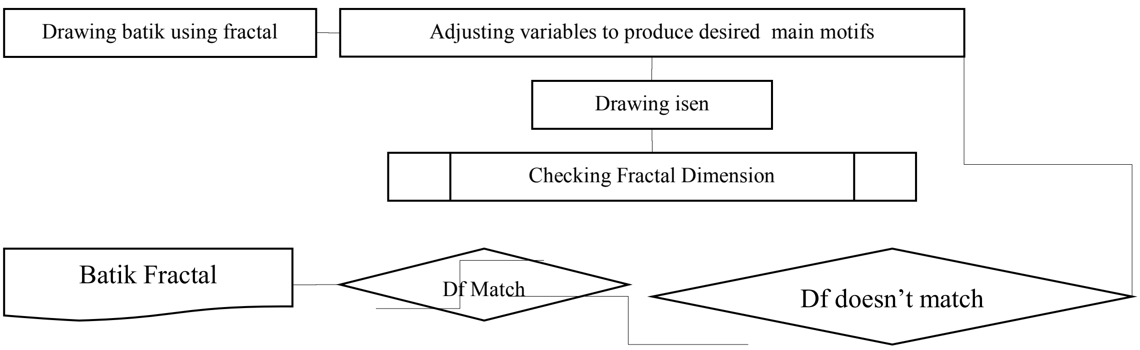

Figure 1, algorithm of creating batik using fractal as mean of Generative Art
The paper's systematic consists of Preface, Methodology, Analysis, Conclusion and Suggestion for Further Works.

2. Methodology

Fractal dimension are defined by this expression:

$$D = \lim_{\epsilon \to 0} \frac{\log N(\epsilon)}{\log \frac{1}{\epsilon}}$$

Suppose Z is a picture with M X N size, with value for each pixel is f(x,y), then:

$$X = [f(x,y)]$$

Indeed, the Fourier Transformation will be:

$$F(u,v) = \frac{1}{MN} \sum_{x=0}^{M} \sum_{y=0}^{N} f(x,y) e^{-j2\pi(ux/M+vy/N)}$$

$$G(u,v) = F(u,v) - \bar{F}, \bar{F} = \frac{1}{MN} \sum_{u=0}^{M} \sum_{v=0}^{N} f(u,v)$$

Value for each pixel is defined as G, whereas:

$$W = \|G(u,v)\|$$

Value for each W are grouped in angle parameter (with different m angle) and distance (different n length), with (x_c, y_c) reference, thus:

$$W(\theta_i, R_j) = \left\{ w_{uv} | \tan^{-1} \frac{v-y_c}{u-x_c} \in \theta_i, \sqrt{(u-x_c)^2 + (v-y_c)^2} \in R_j \right\}$$

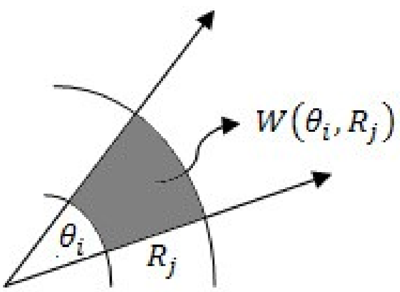

Figure 2, coordinate distribution

$$D_f(\theta_i) = \alpha_i, \psi_i = -\alpha_i R + \delta_i$$
$$\psi_i = \left\{ \frac{1}{\varpi_i} \sum W(\theta_i, R_j) | j = k, \cdots, n \right\}$$
$$R = \{R_j | j = k, \cdots, n\}$$
$$Df = \{Df(\theta_i) | i = 1, \cdots, m\}$$
$$DF = \frac{1}{m} \sum_{i=1}^{m} Df(\theta_i)$$

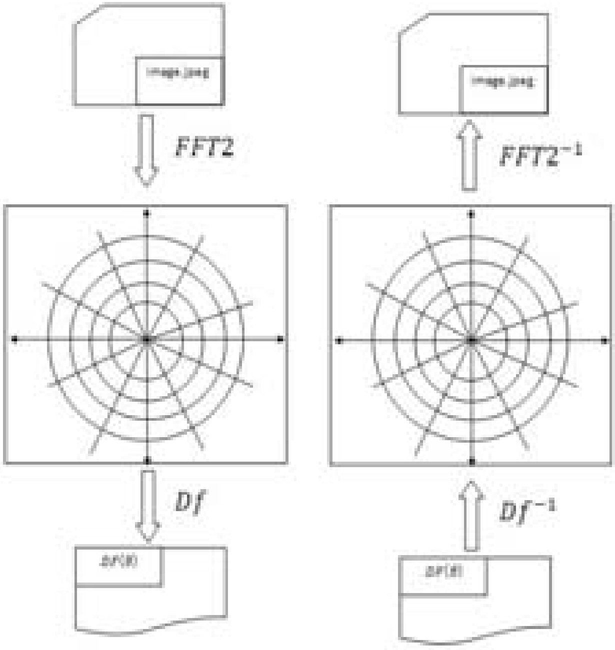

Figure 3, Df algorithm

3. Analysis

Data in this analysis are from several region that produces batik in Java from Batik Komar collection and Nian Djoemena. Picasso paintings (from 1989-1940) are included as comparative object to test the validity of Fractal Dimension analysis. Each picture in this analysis has 200 X 200 pixel size, with m = 24 and n = 30.
To further illustrate Fractal Dimension in objects, below are several picture along with the analysis of Fractal Dimension.

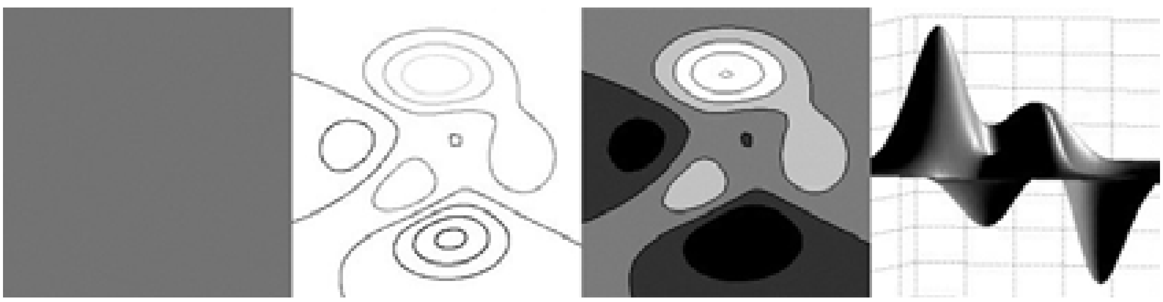

Figure 4,
Fractal Dimension in each object that does not has fractal characteristic; empty space (df=0), line contour (Df=1,099), plane contour (Df=2,011), and sphere (Df=3,040)

Based on Fractal Dimension Analysis trough Fourier Transformation, it is shown above each dimension is not natural numbers whereas they supposed to an integer of 1 or 2. The explanation is because the Analysis also calculates angle parameter and length from each point to centre point of picture. But in general the rounding off to nearest natural number show that Fourier Transformation is able to calculate the dimension from each picture. Object in picture 3 which depicts three dimensional forms from mathematical equations can even be calculated as three dimensional object although in two dimensional media. Then what would happen to object made by humans?

From Figure 4 it is shown that aspect of colour is important in analyzing Fractal Dimension. The change from 0 dimension (empty space) to 1 dimension (line) needs curve to fill the empty space. Furthermore the change from 1 dimension to 2 dimension (plane) needs colour to fill the space. And the change from 2 dimension to 3 dimension need certain colour gradation for giving the effect of 3 dimensional forms.

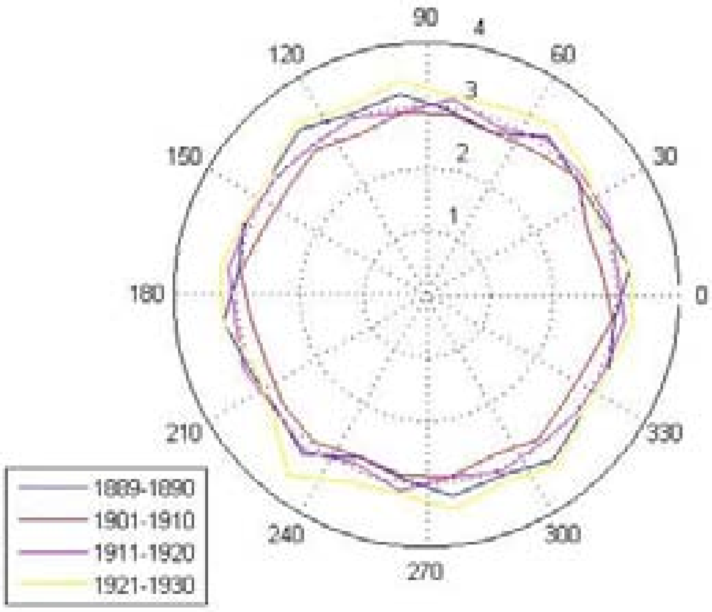

Figure 5

Fractal dimension of Picasso's work according to time period. The Fractal dimension for each period is near 3, which is conforms to the fact that Cubism depicts 3 dimensional object.

In Picasso's work, there are slight differences in Fractal Dimension in each period. Although it is still consistent with Cubism style which has ranges around 3, the 1921-2930 period has higher dimension. It means that the detailing level in that period is particularly high. But in general all of Picasso's work does not show the presence of fractal. What about batik?

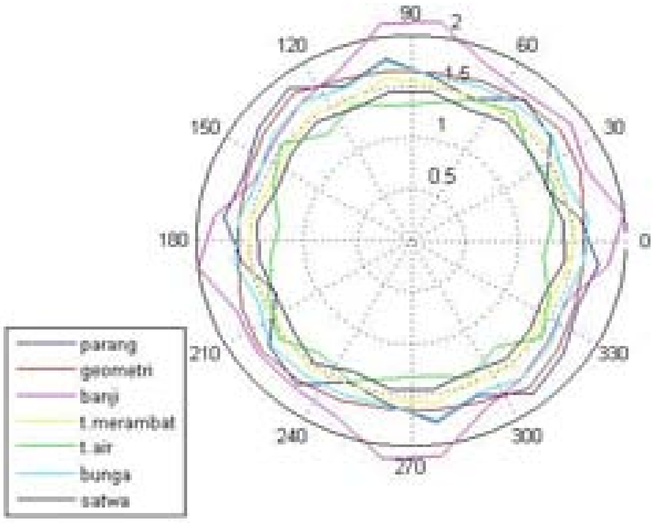

Figure 6a, motif

Batik is different than Picasso's painting. It is clearly evident by comparing the Figure 4 with Figure 5a. It is seen that batik motifs' Fractal Dimension ranges between 1 and 2, even though the object of the batik motifs is in 3. It shows that the pakem rule in making batik is to draw objects which has dimension between 1 and 2, specifically in the range of 1.5 In other words batik motifs appearance is between a curve and a plane.

The value of this particular dimension shows the presence of high detailing level in batik. This is because the "isen" process in batik making. In this process, the empty space left by the main motif are being filled by ornaments that fits the main motif. In batik, the isen is not just merely filling the empty space but also a way for perfecting the entire motifs and giving batik its meaning. From its symmetry by seeing the variance value (distribution of its average value), it shows that banji motifs (batik index no. 62-65 in appendix) are the most asymmetrical compared to other motifs, with highest variance level for Fractal Dimension of 0.0307. It can be seen by the fluctuation of Fractal Dimension in angle 0, 90, 180, and 270, which is close to dimension 2 (plane). It raises interesting topic about the meaning of banji motifs itself, which closely related to the tradition of weaving rattan to create planar forms.

motif	mean(Df)	var(Df)
parang	1.6623	0.0194
geometry	1.6912	0.0030
banji	1.8313	0.0307
Spreading plant	1.5095	0.0021
Water plant	1.3952	0.0094
flower	1.6358	0.0031
animal	1.4180	0.0017

Table 1,
Fractal dimension and the symmetry of each motifs

Besides banji motifs, according to Table 1 all motifs are symmetrical. In symbolic meaning the symmetry itself symbolizes harmony and balance. Even though the object in batik motifs, such as animals or plants are 3 dimensional forms, but the drawing style makes these object less than 2 dimensional and symmetrical. For example In Kupu Gandrung/ Butterfly in Love motifs (batik index 167) which shows the effort to present the symmetry of butterfly by depicting the form in spreaded wing. In Kawung motif (batik index 34-36). Or in Ceplokan flower motifs (batik index 121-126), the effort to create symmetry is being done by drawing batik motifs seen from above. Interestingly, the most symmetrical condition are being shown by animal motifs, which has lowest variance value in Fractal Dimension.ANOVA Test for Fractal Dimension in Figure 6b and 6c shows four categories of different Fractal Dimension of batik motifs.The first category is water plant and animal with Fractal Dimension of 1,4, second is spreading plant of 1,5, third is parang, geometry and flower of 1,65, fourth is banji of 1.8.

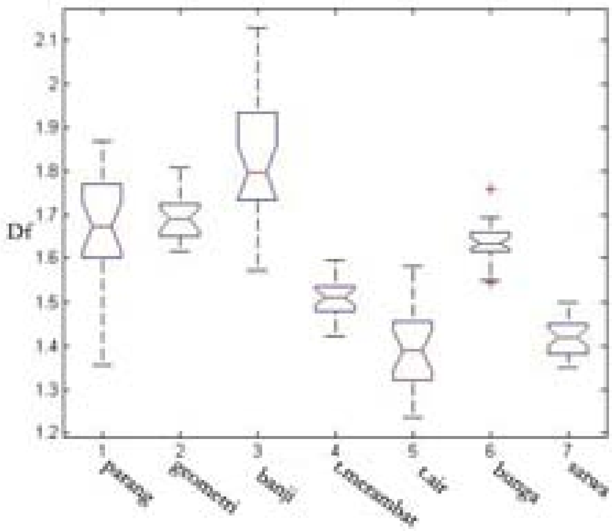

Figure 6b,
ANOVA Test for each motifs, which shows their proximity to other motifs

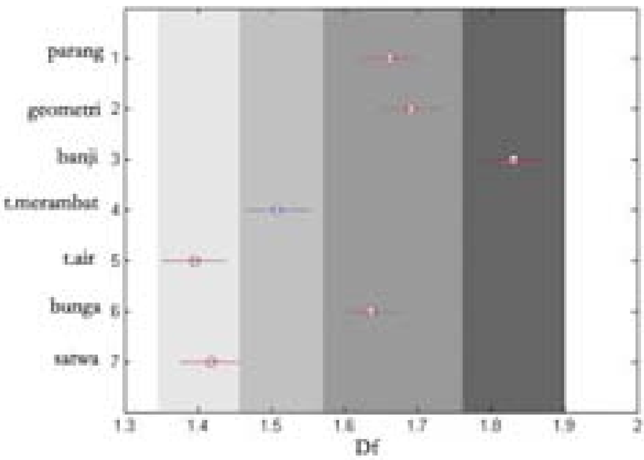

Figure 6c,
Anova Test which shows 4 categories with different Fractal Dimensions.confidence interval 95%

Batik motifs produces different Fractal Dimensions. But the difference is still consistent with batik motifs in general whereas batik is fractal with its dimension ranging from 1 to 2. The next examination would divide batik into groups according to their place of regions they produce. In everyday life, people often divide batik into their region it produces, such as Cirebon, Yogyakarta, Solo, Tasik, etc. How would these effect batik's Fractal Dimension?

Fractal Dimension of batik samples for each region with ANOVA Test shows that each regions has different dimensions. Anova analysis categorizes batik according to its Fractal Dimension. In first category with Fractal Dimension of 1.1 is only from Batik Cirebon as its member. In second category of 1.3 – 1,4 are from Batik Solo, Garut, Yogyakarta and Madura. In third category of 1.25 are from Madura, Yogya, Solo as its member. Fourth member of 1.4 are from Madura, Yogya, Solo. Fifth member of 1.6 are from Lasem and Tasik.

In second, third and fourth it shows that Fractal Dimension of Batik Madura and Garut has resemblance with Batik Yogya and Solo. However Batik Madura and Garut are different in their dimension. This means that Batik Yogya and Solo influenced Madura and Garut. In relation with its geographic place this analysis will prove interesting, since Solo and Yogya are situated in Central Java, whereas Madura is in the east, and Garut is in west.

The ANOVA Test also shows that Batik Cirebon has singular Fractal Dimension, contrary with other region. The result is in accordance with the fact that ornamentation of Batik Cirebon has different perspective in principal and expression.

Fractal Dimension Analysis of batik, be it in motifs or regions, shows the presence of Fractal. This resulted in interesting question: why does Batik has Fractal properties? To answer this, we first must examine the characteristics of Fractal. Self-Similarity and Self Affine of an object means that smaller scale in detail it exists geometry which resembles the object. The Isen Process gives significant contribution in detailing in smaller scales. Because the isen does not have to be necessarily the same with the motif, and Batik often has isen which resembles its main motifs but not in scale or angles, then Self-Affine characters is most likely to be found in Batik. Another interesting part in batik process is in the distribution of fractal properties in Batik, which is uniform. This can be answered when we remember the concept of batik as a symbol of harmony and balance. In closer observation, the process of creating batik involves the reduction of dimension of objects that has three dimensional properties (animal, floral motifs). Not only that, the resulted dimension has fractional properties. Besides the involvement of pakem rules, it also related to media and tools of producing batik: textiles, canting to wax the textiles, and wax. The limitations of media and symbolical meaning behind Batik makes its dimensions exists between 1 and 2.

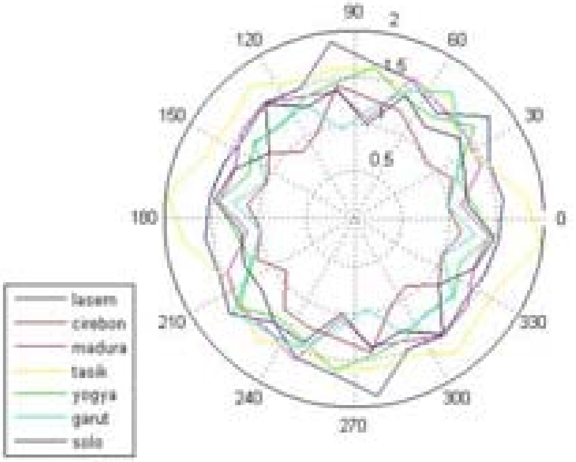

Figure 7a,
Fractal dimension of batik according to their regions.

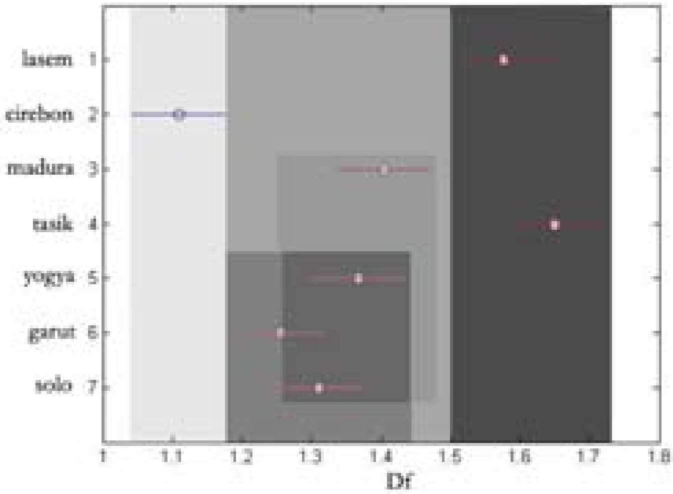

Figure 6b,
Anova testing for classification of Fractal Dimension according to region, which resulted in five category. Batik Cirebon has Fractal Dimension which is different than batik from other regions. While Fractal Dimension between 1.2 and 1.5 has classification that is juxtaposed between Madura, Yogya, Garut and Solo. Batik Lasem and Tasik is in Fractal Dimension of 1.5 – 1.7 classification.

4. Conclusion and Suggestions

Fractal Dimension Analysis through Fourier Transformation is able to calculate dimensions from two dimensional pictures. The analysis for classification of batik according to motifs and regions shows that Batik has fractal properties, which are evident in their dimension properties (1.5). Batik stands between the curvature and plane. Furthermore the fractal properties shows high degree of details. The details in different scales are the result of Isen process in Batik.

In terms of Generative Arts, Fractal Dimension can be used to control the batik that is produced using fractal. Pixel People Group of Indonesia has develops computer software to produce batiklike forms that uses Fractal Dimension to control the batik motifs. The batik is called Batik Fractal. Using PHP language program, this software aims to design batik motifs in contemporary or traditional means. The nature of PHP as free software also allows its user to develop this program to future needs.

Reference

Aouidi, J., and Slimane, M.B. Multi-Fractal Formalism for Quasi-Self-Similar Functions. Journal of Statistical Physics, Vol. 108, Nos. 3/4, August 2002 (© 2002).
Barron, U.G., and Butler, F. Fractal texture analysis of bread crumb digital images. Eur Food Res Technol DOI 10.1007/s00217-007-0582-3
Culik, K. and Kari, J. Computational fractal geometry with WFA. Acta Informatica 34, 151–166 (1997) cSpringer-Verlag 1997
Currey, J.D., Kaffy, C., and Zioupos, P. Tissue heterogeneity, composite architecture and fractal dimension effects in the fracture of ageing human bone. International Journal of Fracture (2006) 139:407-424. Springer 2006
Djoemena, Nian S. Ungkapan, Batik dan Mitra, Djambatan, 1986
Dorfman, J.R. Fractal Structures in the Phase Space of Simple Chaotic Systems with Transport. P. Garbaczewski and R. Olkiewicz (Eds.): LNP 597, pp. 193–212, 2002.Springer-Verlag Berlin Heidelberg 2002
Ewe, H.T. and Lee, P.S. Individual Recognition Based on Human Iris Using Fractal Dimension Approach. D. Zhang and A.K. Jain (Eds.): ICBA 2004, LNCS 3072, pp. 467-474, 2004.©Springer-Verlag Berlin Heidelberg 2004
Georgsson, F.,Jansson, S., and Ols´en, C.Fractal Analysis of Mammograms. B.K. Ersbøll and K.S. Pedersen (Eds.): SCIA 2007, LNCS 4522, pp. 92–101, 2007.Springer-Verlag Berlin Heidelberg 2007
Heurteaux, Y. and Jaffard, S. MULTIFRACTAL ANALYSIS OF IMAGES: NEW CONNEXIONS BETWEEN ANALYSIS AND GEOMETRY. J. Byrnes (ed.), Imaging for Detection and Identification, 169–194. 2007 Springer.
Isaeva, V.V., Pushchina, E.V., and Karetin, Y.A. The Quasi-Fractal Structure of Fish Brain Neurons. Russian Journal of Marine Biology, Vol. 30, No. 2, 2004, pp. 127–134. Original Russian Text Copyright © 2004 by Biologiya Morya, Isaeva, Pushchina, Karetin.
Jelinek, H.F., Cornforth, D.J., Roberts, A.J., Landini,G., Bourke, P.,Iorio, A. Image Processing of Finite Size Rat Retinal Ganglion Cells Using Multifractal and Local Connected Fractal Analysis. G.I. Webb and Xinghuo Yu (Eds.): AI 2004, LNAI 3339, pp. 961–966, 2004. © Springer-Verlag Berlin Heidelberg 2004
Kouzani, A.Z.Classification of face images using local iterated function systems. Machine Vision and Applications. DOI 10.1007/s00138-007-0095-x.
Marsh, R., Jia, W., and Iftekharuddin, K.M. Fractal analysis of tumor in brain MR images. Machine Vision and Applications (2003) 13:352-362. Machine Vision and Aplications, Springer-Verlag 2003
Siu, W.C., Lam, K.M., Guo, B., and Lin, K.H. Automatic Human Face Recognition System Using Fractal Dimension and Modified Hausdorff Distance.H.-Y. Shum, M. Liao, and S.-F. Chang (Eds.): PCM 2001, LNCS 2195, pp.277–284, 2001.Springer-Verlag Berlin Heidelberg 2001
Strichartz, R.S. Pieeewise Linear Wavelets on S i e r p i n s k i Gasket Type F r a c t

a ls. The Journal of Fourier Analysis and Applications Volume 3, Number 4, 1997
Szustalewicz, A., and Vassilopoulos, A. Calculating the Fractal Dimension of River Basins, Comparison of Several Methods. Biometrics, Computer Security Systems and Artificial Intelligence Applications
Teich, M.C. and Turcott, R.G. Fractal Character of the Electrocardiogram: Distinguishing Heart-Failure and Normal Patients. Annal of Biomedical Engineering. Vol. 24, pp.269-293. 1996
Vasselle, B., and Giraudon, G. A multiscale regularity measure as a geometric criterion for image segmentation. Machine Vision and Applications (1994) 7:229-236.Springer-Verlag 1994

Alter EVO: an interactive evolutionary computation tool for instant architecture processing.

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keywords: 3D modeling, generative approaches, automatic texturing, building design, formal grammars.

model: a simplified representation of an actual system.
modelisation: knowledge structuration process.
IEC: Interactive Evolutionary Computation

Abstract

This paper briefly describes a bio-mimetic principle used to solve a simple spatial allocation problem. We define an initial set of bidimensional figures by specifying their respective dimensions. An initial spreadout creates 144 random solutions, each with a multiple set of optional possibilities: the inner evaluation function points the best pattern combination in terms of compacity and/or non overlapping occurences. Henceforth user can choose - following the evaluation function or not - to rebuild a fresh set of combinatory patterns within a mutation range preset: according to the visual result of the prior refinement process, user can indeed choose to "gently nudge" the present combinatory set (simply by flipping an occasional random bit in the chromosome) or - on the contrary - to "smash badly" its phenotype by a full recasting of its genotype. The purpose of this experimental implementation is to substantially reduce computation or evaluation time to produce plausible solutions, according to initial spatial constraints and considering that human attention tends to rapidly decrease its efficiency.

Cognitive paradigm

Conventional Artificial Intelligence aims to model human or biological cognitive schemes. We certainly consider as an embedded property of the human mental faculty the ability to process in parallel huge amounts of data but most of all the aptitude to merge order and disorder to enhance creativity.

The computer efficiency - and therefore its velocity - is broadly overhelmed by human ability to treat and solve - in a parallel manner - nonlinear or conflictual contexts. Human creativity is - above all - unpredictable and emerges from a complex comportamental paradigm: a typical "black box" function with an indeterminate causality. Architecture design often follows such a similar scheme, and its creative process follows a non-deterministic pattern. Intuition, individual preferences, subjective evaluation, perception and knowledge define an individual cognitive context that leads data inputs interpretation to a very personal possible expression.

Scientific context

In architecture design, we believe that - in most cases - the more discriminant model able to represent the distributive complexity of present architecture is the horizontal plan. Thus, this very property will be exploited to improve a pluridisciplinaric integration process.

Interactive evolutionary computation (IEC) or Aesthetic Selection is a general term for methods of evolutionary computation that use human evaluation. Usually human evaluation is necessary when the form of fitness function is not known (for example, visual appeal or attractiveness) or the result of optimization should fit a particular user preference.

IEC methods include Interactive Evolution Strategy [Herdy 1997], Interactive genetic algorithm [Caldwell, 1991], Interactive Genetic Programming [Sims, 1991] [Tatsuo, 2000], and Human-based genetic algorithm [Kosorukoff, 2001].The application areas of IEC have been spread widely. IEC is a technology that joins human and evolutionary computation in order to optimize target systems based on a cooperative interaction between feature parameters and psychological spaces.Conventional approaches for these human evaluation-based systems have frequently modeled the human evaluation characteristics and embedded the substitute evaluation model in optimization systems. The analytical approach is a common approach in AI research, but it is difficult to perfectlt model, for example, a personal preference model. [Takagi 2001]

The number of evaluations that IEC can receive from one human user is limited by user fatigue which was reported by many researchers as a major problem. In addition, human evaluations are slow and expensive as compared to fitness function computation. Hence, one-user IEC methods should be designed to converge using a small number of evaluations, which necessarily implies very small populations. Several methods were proposed by researchers to speed up convergence, like interactive constrain evolutionary search (user intervention) or fitting user preferences using a convex function. IEC human-computer interfaces should be carefully designed in order to reduce user fatigue (Takagi, 2001).

There is a history of research relating to interactive evolutionary computing which, in the main, relates to partial or complete human evaluation of the fitness of solutions generated from evolutionary search. This has generally been introduced where quantitative evaluation is difficult if not impossible to achieve. In this research task, we quote as a "good idea" the solution provided by those individuals with an higher fitness value, an appropriate response to our initial constraints, set as "compacity value" and "non overlapping property". This means that top rated individuals respondoptimally and simoultaneously to compacity and non-overlapping needs. After very few recursive steps, we notice that not only upcoming individuals tend to enhance their inner fitness but the generative process also improves the fitness value of the whole population.

Programming environment

The briefly described system works within a HTML/javascript - MAYA/MEL gateway. Prior data inputs are gathered in a simple HTML-FORM descriptor and subsequent values passed and processed by a javascript runtime. In this very first trial we store 12 numerical values acting like position descriptors for every single figure, and there are 144 new generated individuals for every single generation step. For its first spreadout, the program generates random figures, according to initial input values given by user – respective height and width of 5 coloured squares - and plots them over a fixed size surface. Notice that the color-code of input parameters display (X1 Y1) match the resulting output color of displayed figures: 7x8 for the white square, 6x5 for the grid-filled etc.

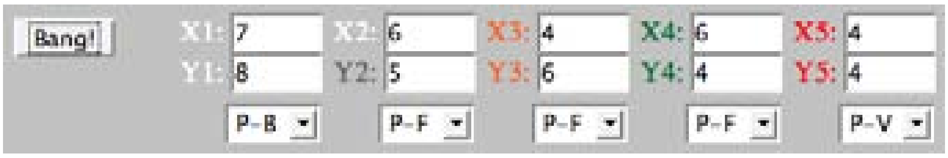


Fig 1: initial input values.

User could either anticipate the respective openings of future geometries; they won't be visible at this point but will be successively generated within the upcoming Maya 3D post-processing.

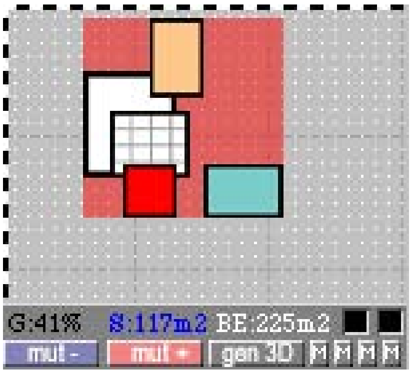


Fig 2: 1 out of 144 first generation of meaningless generated figures.

User is supposed – at this step – to pick his favourite figure in this randomly-generated cluster of possible solutions. The program gives a help, designating with a green flashlight the "best response" in terms of surface optimization VS non overlapping occurrences (fig. 3).

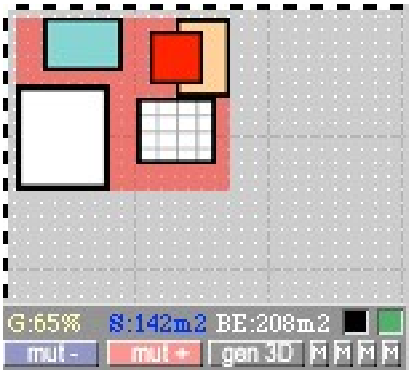


Fig 3: the first generation champion, with a 65% ratio between resulting squares surface (142m2) and the red bounding box surface (208m2).

Following the program suggestion could not only rapidly improve single best individuals performance but either globally enhance the common fitness ratio, as the recursive computation encloses part of parent phenotype. Next step reorders the general framework of upcoming figures but their expression obviously ensues their parent's.

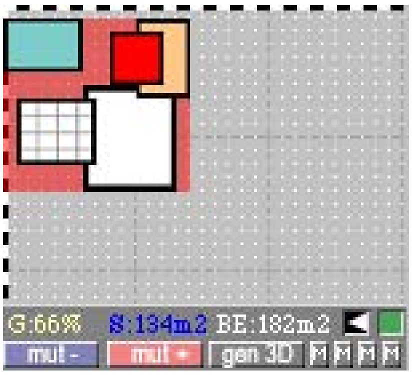
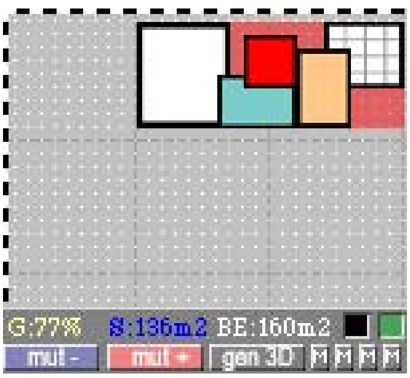


Fig 4: performance is still weak but rapidly improving, according to figure 7.

The full re-deployment button – labeled “mvt+“ - shifts the position of each square all the way through X **or** Y axis, as the local re-deployement button – “mvt-“ - gently nudges each square not more than 1 single snap per axis. In this very case, and only after 5 generations – yet following the program suggestion - the emerging system appears to be a “77% efficiency ratio“ cluster of squares. This means by the way that a “100% efficient“ figure would be a perfect lay-out of colored squares over



the underlying red bounding box.

Fig 5: 5^{th} step of this generative sequence with a 77% efficiency ratio.

Next figure shows the complete bio-mimetic arrangement sequence through a 12 generations process – in this case, for each generation the user follows the computer suggestion. The 12^{th} step generated object displays a 80% efficiency ratio: as a matter of fact, its good fitness response breeds a compact self-organization.

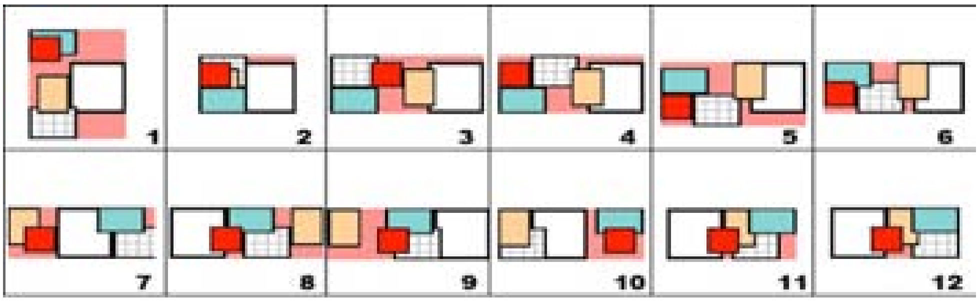


Fig 6: 12 generations refinement.

What we quote as a "good idea" is often the solution put forward by those individuals with an higher fitness value, an appropriate response to our initial constraints, set, as seen above, as "compacity value" and "non overlapping property". For the computer, top rated individuals respond simoultaneously to compacity and non-overlapping needs. Recursive replacement not only tends to enhance the inner fitness of single individuals but improves the intrinsic response of the whole population, as stated in the following spreadsheet, displaying a 13 steps computation.
The fitness peak of an IEC response is hard to localize: similar subsistems tend to be considered subjectively congruent, even if they are not: visual similarities may actually be broadly different, from a structural point of view.

Generative response

Besides a moderate general fitness improvement we notice a fast championship ratio growth, which means that most of the generated color clusters ensures a satisfactory response to spatial allocation needs. To provide a best variety spreadout we believe that generating a wide variety of average-satisfactory individuals is preferable, rather than locally optimize a little collection of super-items. We could roughly affirm that this peculiar aspect of this technology provides a faster average enhancement of generated objects aptitudes, giving more choice through collections diversity and providing a better spatial response to selected elements.
Any time, user can obviously diverge from the computer-based “best“ response – the most interesting aspect of IEC paradigm. Choosing another arrangement will clearly redefine the following reassembly of subsequent descendants, offering a new bunch of rearranged solutions, closely related to their “new rebel“ forerunner.

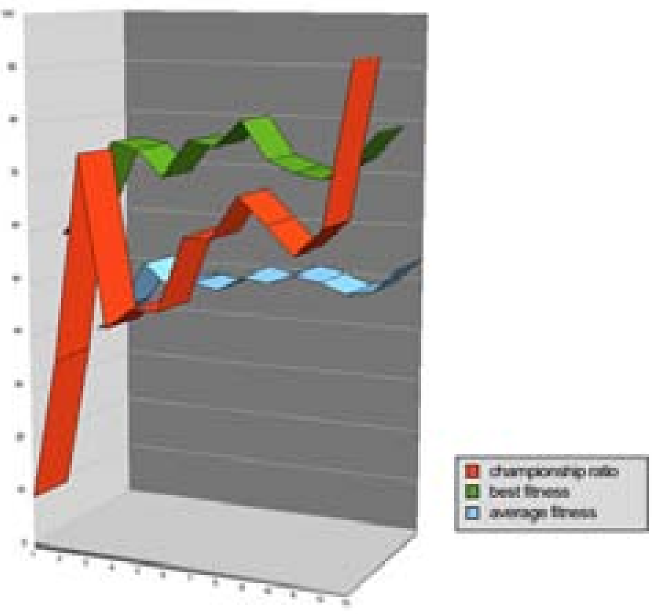


Fig 7: monitoring the generative behaviour.

This digression from traditional genetic algorithms causes radical rather than gradual change in the populations. This is most likely useful to accelerate somehow the interactive generative process as we stated that it could be tedious and rapidly boring. As stated above, specific mutation operators combat the tendency of genetic algorithms to converge on a few super individuals by insuring genetic diversity in the populations. The individuals spreadout offers a wide visual variety of “plausible“ solutions. When an interesting combination is reach, a fine-tuning process can be achieved to adjust preferred spatial combinations.

Experimenting with 3D

Since early stages of generation, user can export the well-liked combination toward an Autodesk Maya 3D environment. This can be achieved by a simple embedded runtime in javascript from the former HTML environment. At this point, according to prior openings designation and the specific positioning of surface elements, the program computes an input-geometry-based boolean transformation. First of all, the creation of cubic primitives, related in size and position to their respective referent in the 2D representation. The pertinence of the openings positioning is drived by a simple comparison between the positioning of square edges comparatively to the center of the global bounding box. The selected opening is automatically positioned on center of the most remote edge of the square; in any case, a door is consistently placed across the closer one (figure below).

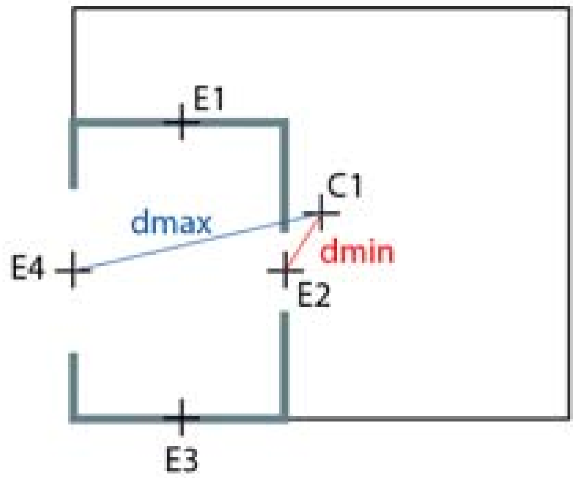


Fig 8: the openings positioning according to the distance of the support-edge to the center of global bounding box (C1).

This process is accomplished recursively for all the generated subspaces. Roof obliquity is obtained putting into practice the same principle: the closer-to-the-center (E2 in the above figure) edge of a square component is elevated vertically.

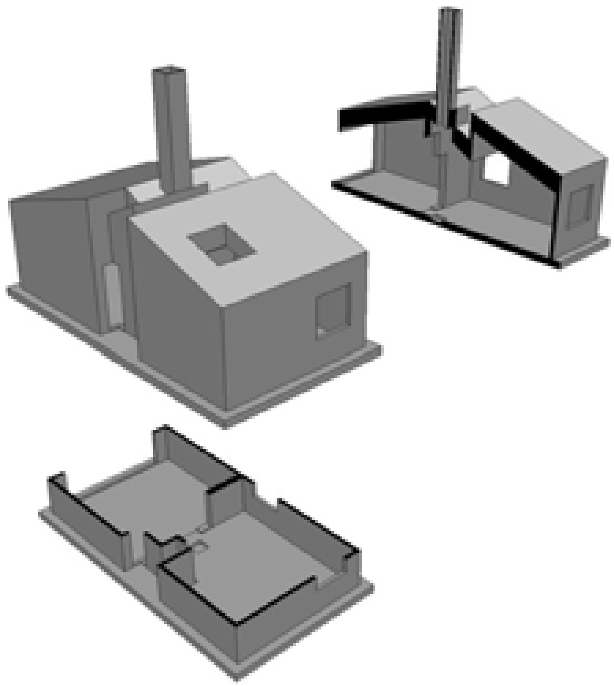


Fig 9: plan and cross-section of a 3D MEL-generated object

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Results

Experimenting with IEC techniques and 3D objects gives the opportunity to quickly produce interesting 3D standalones. Performing tests involving various parameters and extensible surfaces brings to life hundereds of plausible architectural objects, all different. At the moment the general framework is quite simple, our goal with this research task was only to validate some initial generative conjectures, thus experimenting with bio-mimetic interactive evolutionary computation tools. Next step of these generative technique could match closely architectural design process needs; according to specific inputs, i.e. topographic or climatic outsets.

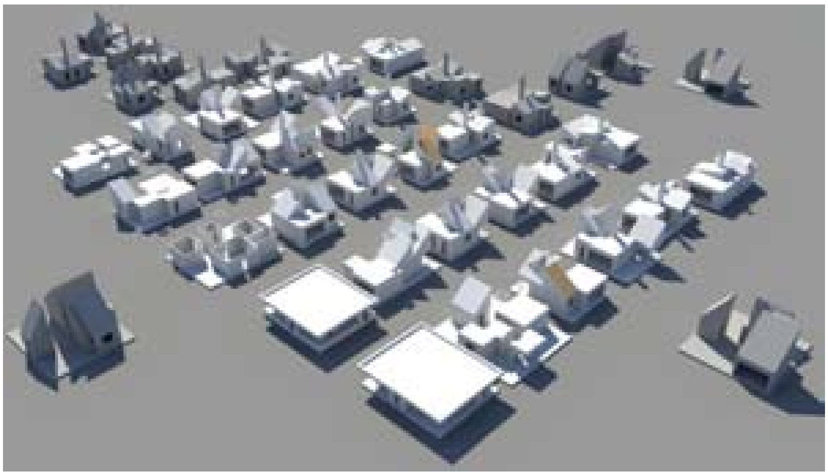

Fig 10:multiple objects created with the depicted program.

Conclusion

Present computer aided-design tools should be able to assist the former exploration that leads the entire design process. However, present software often calls an immediate actualization of geometrical intentions by forcing the user with pre-set intentional clusters - geometric primitives, textural resources, design procedures... - often uncompromising, with poor intuitive feedback and generally restraining imagination spreadout: "*most of CAD software act like over-equipped hand-drafting assistants, assuming the maturity of the designer as much as the maturity of the project itself*." [Chupin - Lequay 2000]

Fig 11:final textured rendering of a generated "architectone".

Recalling Nature with efficient generative paradigms seems to be relevant to discriminate the exponential spreadout of possible solutions of artificial growth

approaches. However, the drawback of such processes consists in its unpredictability or its poor response to domains where it is hard or impossible to define a computational fitness function.
Interactive Genetic Algorithms (IGA) or Aesthetic Selection uses human evaluation for the fitness function, tipically when the form of fitness function is not known, such as visual appearance or aesthetics evaluation.
What we aim to achieve is a computer-assisted interactive generation approach for creating architectural plausible geometries. This semi-automated process is intended to act like an "imagination enhancer" serving early conceptual exploration and improving IGA techniques in the domain of architecture design.

Related bibliography

[Caldwell 1991] **Caldwell, C. and Johnston, V.S.**, "Tracking a Criminal Suspect through Face Space with a Genetic Algorithm," *ICGA-4*, pp. 416-421, 1991

[Chupin - Lequay 2000] **Jean-Pierre Chupin – Hervé lequay** (2000) “Escalade analogique et plongée numérique“ Entre l’atelier tectonique et le studio virtuel dans l’enseignement du projet – pp 21 à 28 in “Les cahiers de la recherche architecturale et urbaine“

[Herdy 1997] **Herdy M**. “Evolutionary optimization based on subjective selection“ - Evolving blends of coffee, Proceedings of the 5th European Congress on Intelligent Techniques and soft Computing, EUFIT'97, 1997, pp 640-644.

[Korsukoff 2001] **A. Kosorukoff and D. Goldberg** “Genetic algorythms for social innovation and creativity“ IlliGAM Report 2001005, University of Illinois, Urbana Champaign 01-2001.

[Sims 1991] **Karl Sims** “ Artificial evolution for computer graphics“ ACM Computer Graphics 25(4), SIGGRAPH91 Proceedings.

[Takagi 2001] **Hideyuki Takagi** “Interactive evolutionary computation: fusion of the capabilities of EC optimization and human evaluation“ Proceedings of the IEEEVolume 89, Issue 9, Sep 2001 Page(s):1275 - 1296

References

Barber, C.B., Dobkin, D.P., and Huhdanpaa, H.T. "The Quickhull algorithm for convex hulls," ACM Trans. on Mathematical Software. 1996

Batty M., Longley P.A., “Fractal Cities: A Geometry of Form and Function“, Academic Press, London and San Diego, CA. 1994

Ben Saci, A. “Théorie et modèles de la morphose“, Thèse de la faculté de philosophie sous la direction de B. Deloche, université Jean Moulin. 2000

Berger V. , Saleri R. “Instrumentation du hasard numérique dans la conception architecturale“ Travail personnel de fin d’études – Ecole d’architecture de Lyon –

2005.

Biles J. A. “GenJam in Transition: from Genetic Jammer to Generative Jammer“ *Information Technology Department, Rochester Institute of Technology* Generative Art Milan Italy 2002.

Burks A. W. in: William Aspray and Arthur W. Burks: *Papers of John von Neumann on Computing and Computer Theory, chapter Von Neumanns Self-Reproducing Automata* , pages 491–552. MIT Press, 1987.

Dr Colakoglu B. Ph.D. - An informal Shape Grammar for Interpolation of Traditional Bosnian Hayat Houses in a Contemporary Context - *Yildiz Technical University, department of architecture, GA, Milan Italy, 2002.*

Chupin J-P, "Le projet analogue: les phases analogiques du projet d'architecture en situation pédagogique“ *Thèse présentée à la faculté des études supérieures de l'Université de Montréal, janvier 1998.*

Codd. **E. F.** *Cellular Automata* . Academic Press, New York, 1968.

Corcuff M. P. Architecture: Forme, Space and Order? *Actes du 7th International Conference Generative Art 2004, Milan, 13-16 décembre 2004*

Pr. Duprat B. LAF Lyon - Connaissance Morphologique, morphose et sémiose des conformations des édifices - *Colloque AISE, Lyon 5/6 juillet 2004*

Pr. Duprat B. LAF Lyon - La connaissance objective des formes architecturales et ses médiations: calcul des traits distinctifs vs sélection d'indices significatifs - *Colloque INSA LaRA / AISE, INSA de Strasbourg 15-16 mars 2004*

Pr. Duprat B. – Pr. Paulin M. LAF Lyon - Le système de la façade et de la baie: maisons à loyer urbaines du XIXème siècle - *Ecole d'Architecture de Lyon, Laboratoire d'Analyse des Formes*

Ebner M. A Three-Dimensional Environment for Self-Reproducing Programs. In: *Advances in Artificial Life: 6th European Conference* , ECAL 2001, Prague, Czech Republic, Berlin and New York: Springer, 2001.

Fischer T. Computation-Universal Voxel Automata as Material for Generative Design Education. In: Soddu, Celestino et al. (ed.): *The Proceedings of the 5th Conference and Exhibition on Generative Art 2002* . Generative Design Lab, DiAP, Politechnico di Milano University, Italy, 2002.

Frankhauser P. La Fractalité des Structures Urbaines, Collection Villes, Anthropos, Paris, France. 1994

Frankhauser P. “L’approche fractale : un nouvel outil de réflexion dans l’analyse spatiale des agglomérations urbaines “, Université de Franche-Comté, Besançon. 1997

Frazer J. H.. *An Evolutionary Architecture* . Architectural Association, London, 1995.

Gaildrat V. "Modélisation déclarative d'environnements virtuels: Création de scènes et de formes complexes par l'énoncé de propriétés et l'emploi d'interactions gestuelles" HDR Université Paul Sabatier Toulouse III - IRIT Toulouse. 2003

Killian A. Embodied Intelligence - Using Genetic Algorithms To Generate Developable Strips From Free Form Surfaces - *Dep of Arch. MIT*

Krawczyk R. J. Experiments in form generation using cellular automata. In: Koszewski, K andWrona, S. (eds.): *Design e-Ducation. Connecting The Real and the Virtual. Proceedings of the 20th eCAADe Conference* . Warsaw University of Technology, Warsaw, Poland, 2003.

Heudin J.C. "L'évolution au bord du chaos" Hermès Editions. 1998

Horling B. "Implementation of a context-sensitive Lindenmayer-System modeler" Department of Engineering and Computer Science and Department of Biology, Trinity College, Hartford, CT 06106-3100, USA. 1996

Khamphang Bounsaythip C. "Algorithmes évolutionnistes" in "*Heuristic and Evolutionary Algorithms: Application to Irregular Shape Placement Problem*" Thèse - Public defense: October 9, (NO: 2336) 1998

Henry H. Achten, Bauke de Vries, and Joran Jessurun. DDDoolz - A Virtual Reality Sketchtool for Early Design. In: Tan, B.K., Tan, M. and Wong, Y.C. (eds.), *CAADRIA 2000: Proceedings of the Fifth Conference on Computer Aided Architectural Design Research in Asia* , National University of Singapore, 2000.

Herr C. M. Generative Architectural Design and Complexity Theory - *Issues of Generative Arts under Digital Environment - GA, Milan Italy, 2002.*

Lindenmayer, A. "Mathematical models for cellular interactions in development", parts I-II. Journal of Theoretical Biology 18: 280-315. 1968

Y. I. H. Parish and P. Muller. Procedural modeling of cities. In Proceedings of ACM SIGGRAPH 2001, pages 301--308. ACM, 2001.

Prof Liou S. R. BSc MArch. DArch. Design from known to New - *Issues of Generative Arts under Digital Environment - GA, Milan Italy, 2002.*

Marsault X. – "Application des IFS à la Composition de Tissus Urbains Tridimensionnels Virtuels" - *UMR CNRS MAP, "Autosimilarité et Applications, CEMAGREF, avril 2002.*

Meyer A., Fabrice Neyret F. "Textures Volumiques Interactives" - *iMAGIS, laboratoire GRAVIR/IMAG-INRIA.*

Salingaros N. A. - Urban Space and Its Information Field - *Journal of Urban Design, Volume 4 (1999) pp 29-49.*

Donald Schön , A . "Kinds of seeing and their functions in designing" Design Studies 13 [2 avril 1992] pp. 135-156

Saleri R. “Pseudo-Urban Automatic Pattern Generation“ in Chaos and complexity in Arts and Architecture – Nicoletta Sala editor, Università svizzera italiana 2006.

Soddu C. “La citta ideale – Generative codes design identity“ in Generative arts 2002, politecnico di Milano 2002.

Sikora S., Steinberg D., Lattaud C., Fournier C., Andrieu B. (1999) “Plant growth simulation in virtual worlds : towards online artificial ecosystems. Workshop on Artificial life integration in virtual environnements“. European Conference on Artificial Life (ECAL’99), Lausanne (Switzerland), 13-17 september.

Takase N. Y. Sho A. Sone K.Shimiya Automatic Generation Of 3D City Models and Related Applications - *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences Vol XXXIV - 5/W10*

Tannier C. Simulation spatiale et cartographie participative in "Cartographier Aujourd'hui les Espaces d'Aujourd'hui" - sous la direction de Jacques Lévy 2002

Torrens P. “How cellular models of urban systems work” , CASA. 2000

Turing A. M. The Chemical Basis of Morphogenesis. *Philosophical Transactions of the Royal Society* , 237:37–72, 1952.

Woloszyn P. “Caractérisation dimensionnelle de la diffusivité des formes architecturales et urbaines“ Thèse de Doctorat – Université de Nantes 1998.

Wonka P. Wimmer M. Sillion F. Ribarsky W. - Instant Architecture - *ACM Transactions on Graphics, Volume 22, Number 4, page 669-677 - july 2003*

AutoMAKE: Generative systems, digital manufacture and craft production

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Abstract
The project on which this paper is based concerns combining computer based generative systems with craft knowledge and digital production technologies to create a new way of designing and making works which challenges the boundaries between maker and consumer, craft and industrial production.

This ongoing research project involves the development of a digital generative system for the creation of one off craft/design works based on randomly generated 3D matrixes. The system is to be used by the maker/researcher involved in the project to develop new work, and most significantly, by consumers who will then become 'co-creators' of their own craft/design works. To this end software with a user friendly interface is being developed to facilitate the creation of new works by users with no previous experience of CAD. The data produced by this new software will then be used to directly control a range of rapid prototyping and manufacturing technologies, and CNC machinery, which will physically produce the new designs in a range of materials at different scales.

The introduction to the paper will provide a brief context for this project and include an outline of the principal issues it raises for both consumers and makers. The main body will discuss the development of the generative software and its interface using game authoring software. The procedures developed to translate the generated virtual forms into physical works will also be discussed. The conclusion will involve a critical reflection on the project to date and discuss its future development.

1.Introduction

1. Project's location within the wider field

This project sits within the broad context of the growing interest in the use of generative design processes in theoretical and practice-based research in art, design and architecture. This involves exploring the potential for mathematical algorithms to provide computer generated inputs for the creation of artworks, three-dimensional forms or architectural propositions.

This research was undertaken by maker and researcher, Justin Marshall. His background is in using digital design and production technologies to create physical works, however he has had no previous experience in creating software. As a programmer and CAD expert Ertu Unver has worked in collaboration with Marshall and has provided expertise, support and training for the development of the software within this project. Paul Atkinson, has managed and overseen the project

1.1 Project Aims and Objectives:

The overall aim of this project is to investigate the potential of using a generative system to facilitate the design of unique one-off works by both an established maker and by 'consumers'. An additional aim is to investigate the use of a range of rapid prototyping technologies, along with CNC equipment, as a means of physically manifesting these newly generated forms.

The specific objectives of this project were to:

1. Design a piece of software, involving a generative element, which allows users to easily control the generation of unique and complex forms.
2. Build upon and extend pre-existing systems for the outputting of forms in a format appropriate for digital production.
3. Investigate a range of digital production technologies for their appropriateness to creating physical objects from the data generated by the new software.
4. Test this new form of design and production through the creation of new work by the maker/researcher.

2. Context

AutoMAKE is a discrete project within 'Post Industrial Manufacturing Systems' (PIMS), having its own aims and objectives. Previous work within PIMS has included 'Future Factories'[1] – a research project of work by Lionel Dean considering the development and use of generative software in conjunction with parametric modelling and rapid prototyping to enable the creation of unique products from a continuously, randomly changing form. This work has been conceptualised and developed very much from the perspective of an industrial designer trained in the process of product design and development within a mass production manufacturing context. The project explored the possibilities of and developed a system which essentially allows the mass individualisation of products – the direct digital manufacture of visually closely-related but unique forms of various product types.

While this project has been successful in producing a system for production and work displayed in exhibitions, the most interesting aspect from the overarching view of PIMS has been the philosophical and theoretical debates raised by this work. Issues of authorship of design and the status or value of the products created are two aspects which have been discussed elsewhere [1] as has the debate raised by the nature of the products created. In so far as the products and the envelope within which they mutate are specified by the designer (parametric modelling), they are designed objects (not withstanding that a particular iteration of a design produced by the software and selected by a customer may never actually be seen by the designer). As none of the products are exactly the same, they could legitimately be described as one-off pieces of art – a performance conducted by computer. Yet the variations of similar forms, the limited production runs involved, and the involvement of the customer in the process of selection mean that the relationship between the object and its consumer are elements more associated with the craft production of artefacts. This affinity with craft is in spite of the fact that no item is made, or even touched, by hand in the process of creation. These factors are the ones which are of interest to PIMS – the impact and potential of new and emerging technologies to further blur the already contested distinctions between art, craft and design.

The research question for this project, then (from the point of view PIMS) was to explore the differences in approach taken and the potential of the system to perform differently if the system was made available to be adapted and developed by a craft practitioner as opposed to an industrial designer.

3. The Project

A broadly pragmatic and exploratory approach was taken in undertaking this research. Many makers and craft practitioners approach the use of technologies, not with a rigid predefined aim to achieve a particular result, but to explore the possibilities the technology affords. The attitude taken by the principal researcher falls within this approach and the project was initiated with no fixed aim to produce work of a particular type, or solve a particular problem.

Previous work by Marshall has involved the use of 2D periodic and aperiodic tessellation systems to develop infinitely complex non-repeating patterns and structures[2]. This broad area of interest provided a starting point for the software development. From Marshall's perspective, the AutoMAKE project provided an opportunity to extend the use of tessellation into 3D with the potential of creating complex and unique matrix structures.

Virtools[3] game authoring software was employed throughout this project to create the systems described in this section. It was selected for a number of reasons, including;

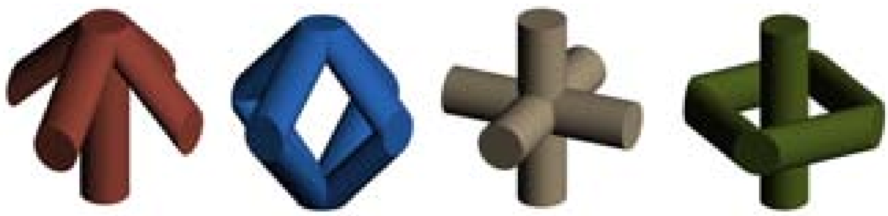
- All systems developed using this software run on a web browser using the freely available '3D life' player.
- Software development is based on an intuitive building block method rather than hard scripting.
- It allows the creation of highly functional user friendly interfaces relatively easily.
- It can import data from a range of CAD software, including 3Dmax.
- It has been used for creating a range of applications beyond the gaming market, including visualisation for architecture and design, and tools for online learning.
- A strong user community with active forums providing problem/solution

sharing.

The software described in the section has all been designed with user interaction in mind. However, to date it has been exclusively used by Marshall in the creation of new works and test pieces. Some of the work shown below is the result of a direct translation of the designs generated by the software into physical form, while other works involve a more complex process which involved the employment of other CAD and image manipulation software. Therefore some results of this research are specifically concerned with extending the practice of the maker/researcher, while others focus on users.
In order to provide worldwide access to the software and therefore have the potential to capture a broad constituency of individuals to try the systems developed, a project website has been created[4].

3.1 Development of 'Matrix Build 1& 2' Software

As discussed in section 2, using parametric objects provides a mechanism for creating mutable and unique forms. This approach, adopted in the Future Factories project relies on the setting of an envelope within which mutations of a pre-existing form/s can occur. An alternative method for creating unique forms is to use a modular system where the required complexity is created through rules being applied to the repetition of simple units rather than the mutation of a pre-existing object. Marshall was keen to develop a system for building/growing forms therefore a modular approach was taken with the aim of creating a complex range of 3D matrix structures. Both Future Factories and AutoMAKE provide opportunities for the consumer to interact with a system to create a unique object, but at different levels. Future Factories allows no interaction other than for the consumer to select the exact moment that the product mutation ceases. In contrast AutoMAKE provides a range of mechanisms for users to interact with the process of creating forms.. These opportunities were provided with the aim of engaging the user and so creating some sense of ownership of the forms created.
In order to provide a simple basic structure to the matrixes a rectilinear format was selected and a small series of units designed in such a way that they always joined together when placed next to each other.



2. Original units modelled in 3Dmax and used in first matrix build software

The first software developed gave the user the opportunity to select any, or all, of the units.
The generative system was then set in motion. This involved one randomly selected unit, (from those chosen by the user), being placed in one of the free spaces next to the initial unit, the system then checked all the spaces around the units and randomly selected one of the free spaces to place another randomly selected unit. This

process continued until the system was stopped and a file saved.

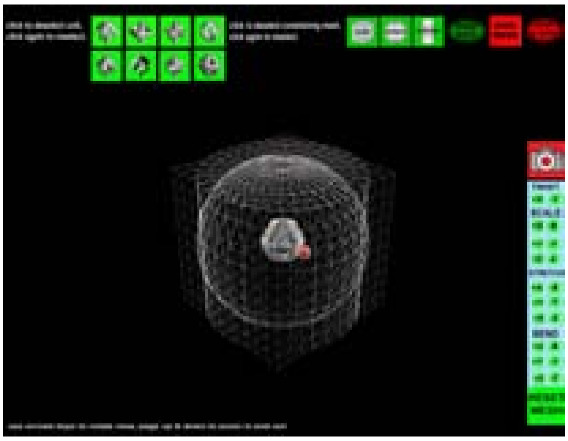
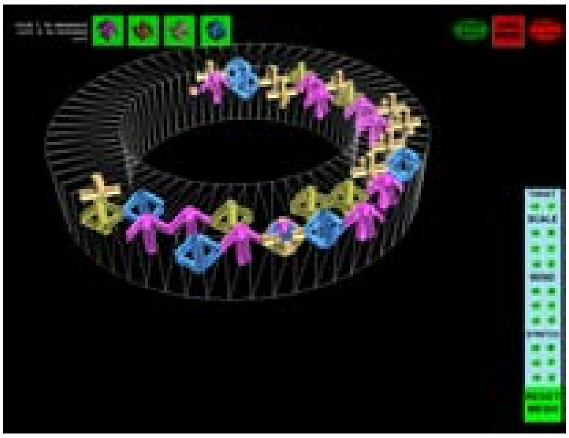
3. The random placement of four basic units to create an abstract form

This process succeeded in creating random matrix structures, however as the structures grew in size the number of spaces which required checking grew significantly, therefore the system became slower and slower, eventually crashing. In addition the file saving process was based on writing a 3D file in the .obj format. As there was no optimization or file compression within our system, the exported files were extremely large even when the matrixes were made up of a small number of units. It had always been intended that the matrixes could be made up of many hundreds, or even thousands, of units. Therefore a new approach to placing new units and to exporting files had to be considered.

These issues were solved by adapting the space checking procedure so that only the spaces around the previously placed unit were checked. This resulted in a system that did not significantly slow down because the number of spaces checked stays constant as the matrix grows.

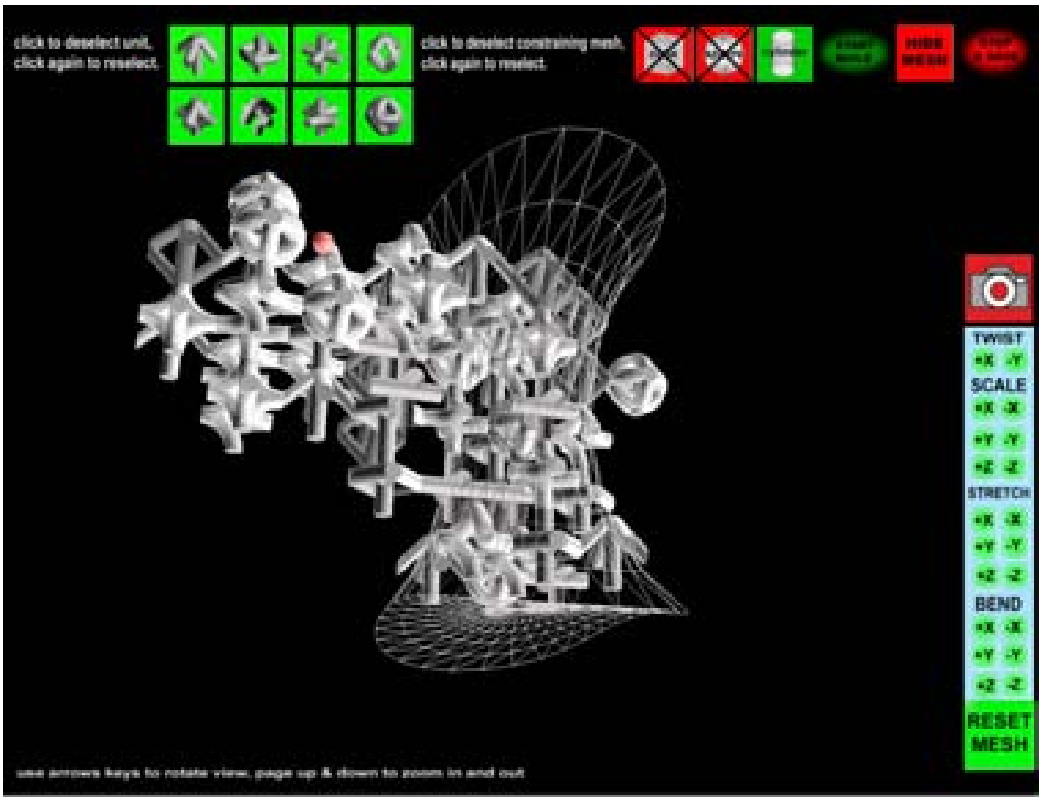
To solve the file size issue a script was created that allowed a dataset of unit codes and coordinates to be exported from the software. These text files are extremely small, and are therefore easily sent via email. This system has proved very successful, however it did require the creation of a script to be run in 3D Max that recreates the forms generated in the build software. 3D Max can then export the structure in a file format appropriate for digital production (i.e. .stl).

To create a greater level of user control and put some restriction on the generation of potentially infinitely large matrixes, a series of constraining meshes were introduced. These meshes function by acting as an obstacle to the growth of the matrixes. In ‘Matrix Build 1’ three meshes were introduced, any of which could be selected by the user and distorted using a range of tools. In ‘Matrix Build 2’ a torus mesh was introduced which restricts growth of matrixes to a shape appropriate for the production of rings, bangles and bracelets.

4&5. Matrix Build 1 interface and Matrix build 2 interface

As a restrictive mechanism, the constraining meshes have been moderately successful, although if the meshes are heavily distorted then units can often ‘leak’ beyond the mesh and once this has occurred the matrix will grow unrestricted. On one hand this can be frustrating and lead to a build being abandoned, on the other hand it produces forms that exhibit visual characteristics that are a balance between the random nature of the underlying generative system and the control the user has attempted to impose, which can have a unique appeal.



6. Example of a build where the form has ‘leaked’ out of the constraining mesh.

In conjunction with these constructional developments the screen interface went through a series of iterations in order to make it as self-explanatory and user friendly as possible.

There are still issues with the constraining of developing forms and the memory intensive nature of this software which limits build sizes on a standard desktop machine to a few hundred units. However it is believed that this software has reached a stage in its development where enough flexibility and functionality has been created to allow a level of play and experimentation which can engage users and it is ready for testing.

This software has also been adapted to generate 2D patterns and has been employed by Marshall to produce the digital print and CNC cut work described in section.3.5.

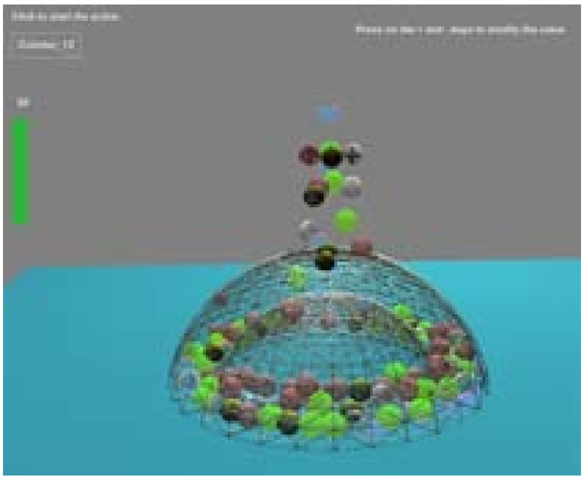
3.2 Development of 'Random Fill' software

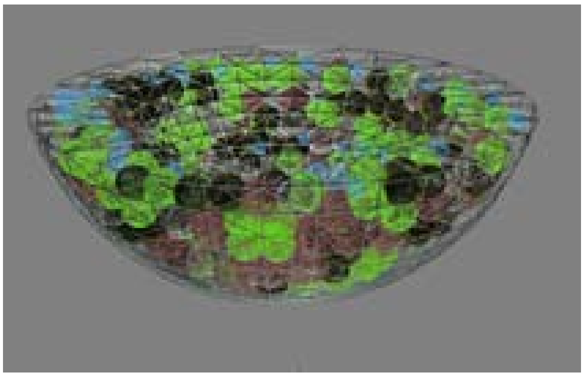
This more recent system was developed in order to counter some of the limitations of the 'Matrix build' software, specifically the high level of memory use and the highly regimented, rectilinear format of the structures.

This system creates structures from the same basic units as the 'Matrix build" software but the mechanism for construction is significantly different. Instead of forms growing through the random placement of units, they are created by dropping units into a hollow form or 'mould'.

The use of physics engine capabilities within Virtools allows each unit to be given a different set of characteristics (e.g. weight, elasticity etc.) and the complex interactions between objects to be modelled. Initially spheres were used to represent the units and a simple hollow bowl form was filled. The use of different scaled spheres helps create both variety in the density of the generated form and greater structural coherency. Once the mould has been filled, (or the user chooses to stop the process), the spheres are replaced by the corresponding units and the complex non-rectilinear structured form can be reviewed and saved for production.

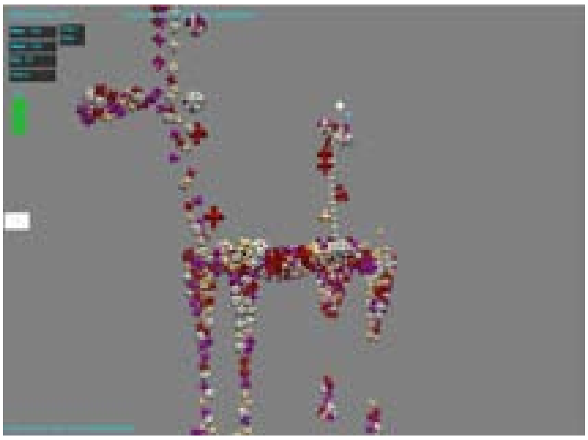
Due to using spheres rather than the more geometrically complex units during the build process and each of the object's movements being controlled by adjacent objects this system has a considerably more efficient use of RAM than the 'Matrix build' systems. Therefore the number of units that can be used within a single build can be increased by at least a factor of 5 before memory usage becomes an issue.



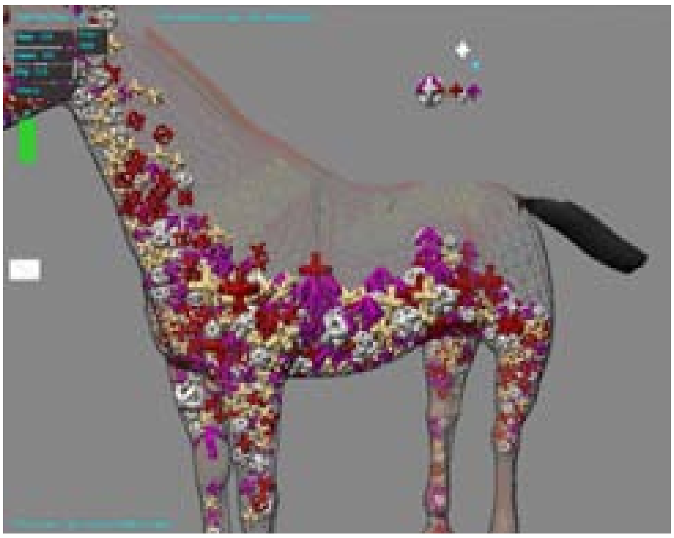


7& 8. First 'random' fill software using spheres to represent units during the build process and image of filled bowl 'mould'

Significant developments have been made with this system which can now use actual units in the build process. To provide an example of how complex a form can be created a pre-existing CAD file of a horse has been employed as the 'mould' and further refinements and optimizations have been undertaken which allow many thousands of units to be used in a single build.



9&10 Example of build in progress, with and without the 'mould' mesh visible



11. Example of build where over 1000 units have been placed in less than five minutes.

Currently an export protocol for this new system is being created which can concisely code the additional geometric information needed to describe all the units' positions and orientations in the non-rectilinear structures created using this method.

When fully functional it is believed that this method will result in a more engaging experience for the user than the 'matrix build' systems and have the potential to create novel and aesthetically engaging new works.

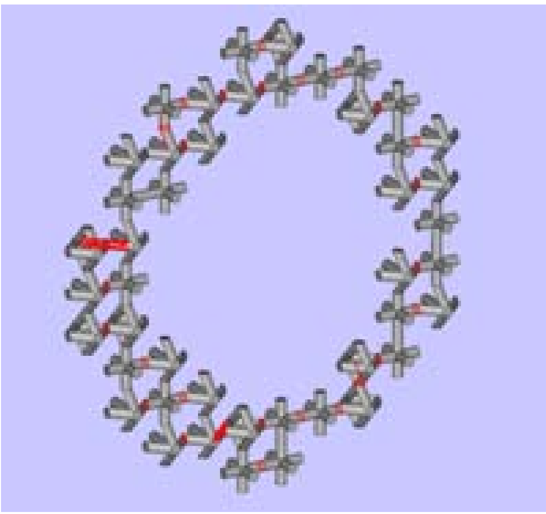
3.4 Post processing

Although one of the aims of the research was to create a method by which objects could be designed online and data could be generated from this process to directly create physical works, currently post processing involves a number of stages.

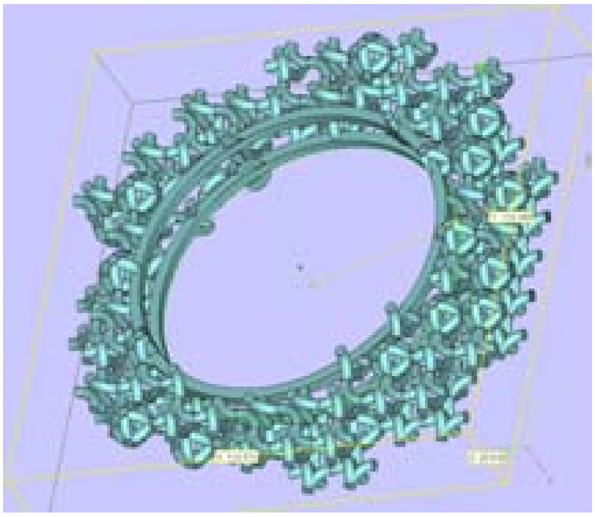
The first stage is the automatic creation of output files by the software once the user has finished creating their designs. These small files, which embody the information needed to recreate a users' design can be emailed to a member of the research team.

The second stage involves the recreation of the matrix forms in 3DCAD software by running a script that places appropriate units in the coordinates provided by the text file and saving the resulting file in appropriate file type for the intended digital production process. The development of this system has been crucial to the success of this project and is considered one of the most significant results of this project.. In theory the files exported from the CAD software should then be able to be used directly for producing physical objects, however this is rarely the case.

The third stage, for the production of rapid prototyped or rapid manufactured objects, involves using specialist file preparation software. Stl models of complex forms, such as the matrixes being generated by our software, are rarely perfectly constructed and require 'mending' before they can be physically produced.

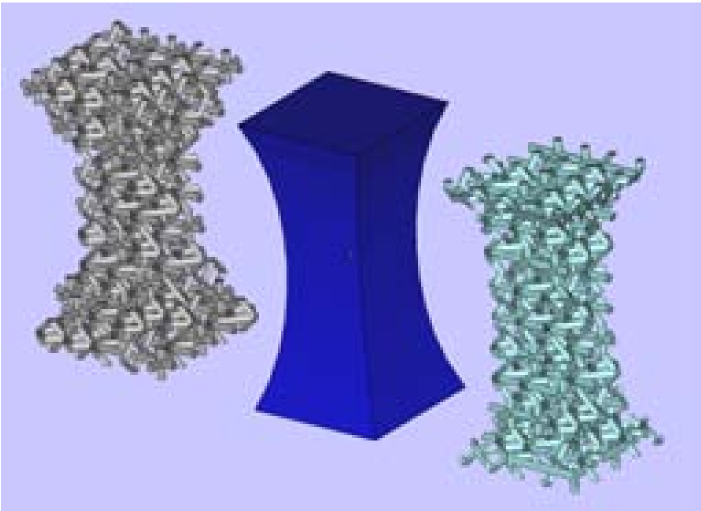


12. errors indicated in a bangle form



13. generated design with additional elements

At this stage the generated forms can also be rescaled to fit personal requirements (e.g. the size of someone's wrist) or to be amended by the addition of extra structural elements. The use of this software also provides the opportunity to 'trim' a matrix with the mesh files saved from the same build sequence, so adding another level of the possibility of creating forms with a different aesthetic.

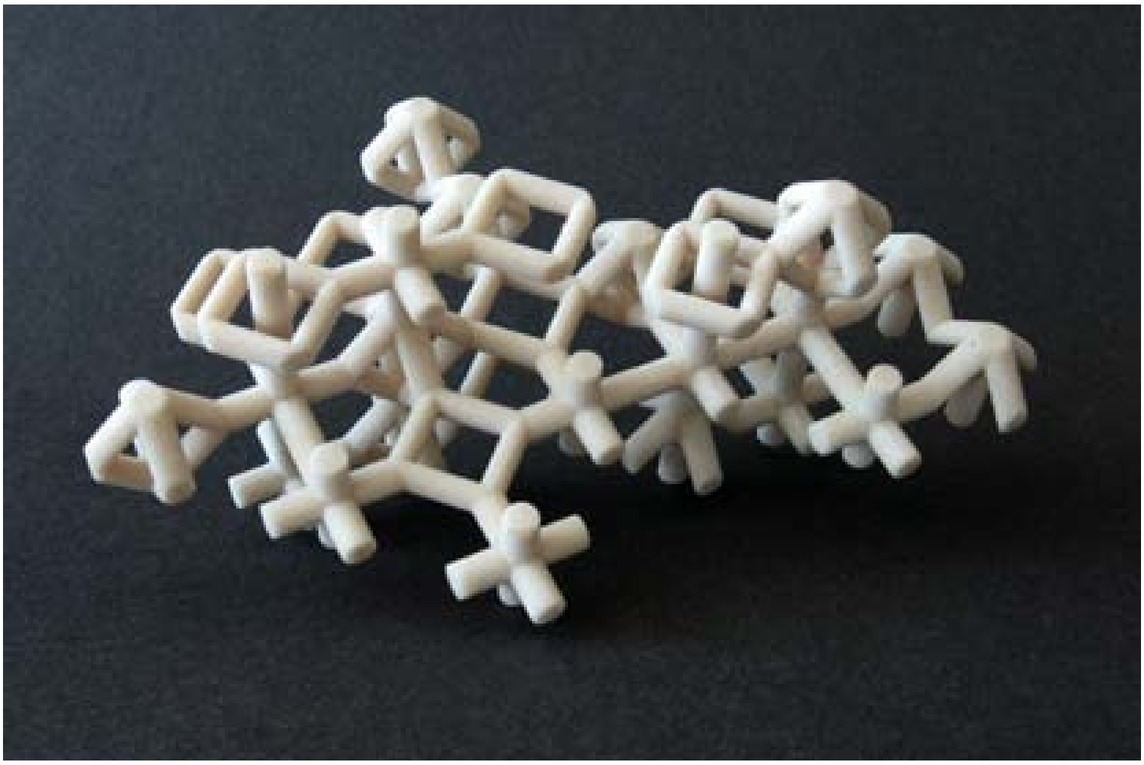


14 Untrimmed form left, exported constraining mesh centre & trimmed form right

The third stage for other types of digital output can range from colouring and layering 2D patterns in Illustrator to output image files for digital printing, to using 3D CAD software to integrate vector patterns with 2D panel layouts which will be CNC cut and used to construct large scale structures.

3.5 Digital production of generated forms

A range of digital production technologies have been employed within this project. A Z corp 3D printer[5] has been used to produce some test forms. Compared to many other Rapid Prototyping technologies, it is cheap and quick form of digital production. However it is not a production technology appropriate for small scale or intricate designs.



I5. Generated matrix test piece created using Z-corp technology, 150x80x60mm

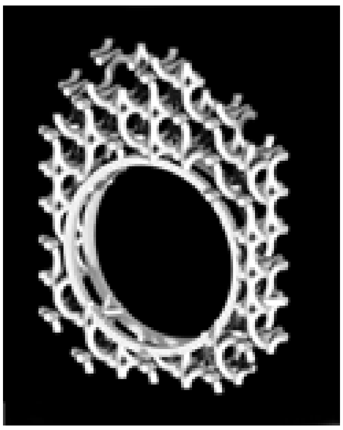
An Invision 3D printer[6] has also been used to produce a range of test pieces. This system has the capability to produce relatively cheap highly detailed and delicate structures, however models from this process are not durable enough to produce final works.

16&17.Two examples of bangle forms created using Invision 3D printer

18&19 Examples of silver plated Rapid Prototyped models

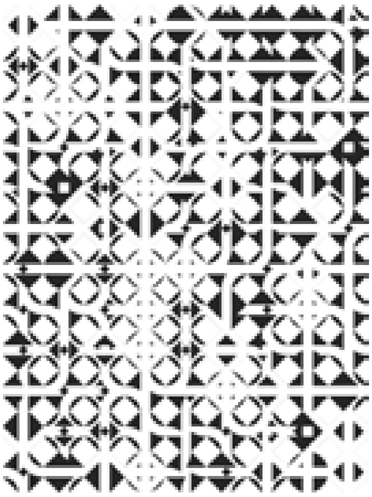
It was intended that rapid manufacturing technologies would be investigated which can produce artefacts metals and ceramics and so produce functional parts rather than prototypes. However, access to these more recently developed technologies proved difficult within the budget available. The well established[7] Selective Laser Sintering (SLS) process that produces durable nylon parts will be used in the production of medium scale artefacts designed by users.

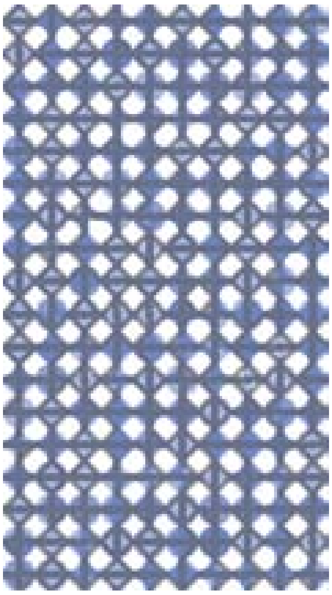
Rapid prototyped parts can also be used as an intermediate stage in the production of final works. Specialist RP technologies[8] have been used to produce wax models for the casting of silver jewellery..



20, 21& 22 CAD Visualisation of a ring ,Wax RP model for casting, final silver ring

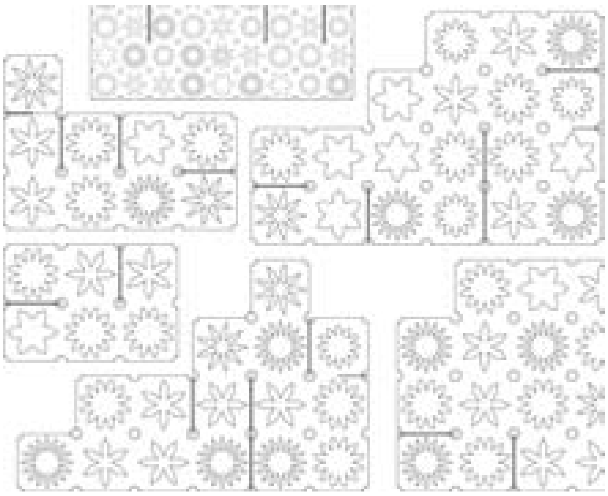
In addition to the 3D rapid prototyped work, 2D patterns have been created using an adapted version of ‘Matrix build 1’ in conjunction with post processing software and a 2D CAD package. The build software was used to create a series of randomly generated patterns based on a range of selected shapes. Within a 2D graphics software (i.e. Illustrator) these patterns are used as the basis for investigating the visual possibilities of colouring, combining and layering, a number of these generated patterns.





23, 24&25 randomly generated patterns layered and coloured, digitally printed fabric lampshades employing 2D random pattern generation system

Other work based on this adapted software involves the generation of 2D vector paths that can be used by a CNC laser cutter or router/mill to produce 2D elements. In the example below these elements interlock to form space dividers/shelving systems.



26&27 .Randomly generated patterns mapped onto flat panels for the creation of space divider, Laser cut scale model of 3mx3mx35cm space divider

4. Conclusions and Further developments

In relation to objective 1, a range of software applications at different stages of development have been created, all of which have the potential to create unique objects. However, user testing of these systems has yet to be systematically undertaken and it is recognised that further development of both interface and functionality will be required in response to user feedback. In addition to responding to user feedback, there is a range of developments the research team would like to investigate further, these include;

- Increasing the role and significance of the generative processes in the software through the introduction of more complex rule systems based on cellular automata or evolutionary algorithms
- In order to introduce further complexity and structural interest, introduce more complex aperiodic grid systems using 3D Denzer or Penrose tessellation into the Matrix build software systems.
- Create a more interactive experience for the user when generating designs.
- Using the physics engine capabilities of Virtools as a mechanism for creating new algorithmic methods that have the potential to compile and reveal embedded orders. These methods could potentially be used to construct forms which are not only aesthetically novel, but also have useful physical characteristics (e.g. structural coherency, increased strength, superior rigidity etc)
- Increasing the choice of build units available to the users by providing a library of 3D CAD models or create the ability to drop their own models into the design system. This would provide a greater variety of outcome and increase personalisation of generated designs while reducing the control the software developer/designer has on the final aesthetic of pieces being created.

In relation to objective 2, systems have been developed which create concise data files appropriate for transfer by email and which can be used to recreate the complex designs generated by online users/co-creators. However further work is needed to produce design files which require less post processing, automate the post processing stage to the point which files can be sent directly to digital manufacturing bureaus, and to create more sophisticated online experience for users.

In relation to objective 3; a range of digital output devices and strategies have been investigated. However, to some degree a pragmatic approach has been taken and technologies have been employed to which the research team have had affordable access, these tend to be more appropriate for the production of tests pieces than final products.

Rapid Manufacturing technologies which can produce objects directly in desirable and durable materials are currently undergoing rapid development. There is considerable work to be undertaken in studying the application of these technologies to the production of art, craft and design works. It is an area that Marshall intends to investigate in the future.

In relation to objective 4; the design and production systems that have been developed have been tested through the production of a range of physical works by Marshall. Economically viable medium and small scale products are being produced using rapid prototyping technologies[9] and Marshall's jewellery based work illustrated in section 3.5 fit within this context.

Some work large scale work (see figure 27) has also been created, chiefly by converting the 3D structures generated into 2D sections that could be cut on a flat bed CNC router. For the independent maker the economic viability of producing large scale 3D complex forms using digital production technologies is problematic. It is an area which requires further research and the development of new production techniques based on scale and affordability, rather than precision and repeatability, as is the case to date.

4.1 Final thoughts

The most significant outcome of this project, is not the development of the generative systems themselves, which it is recognised is relatively unsophisticated, or any other particular element. Its significance is in the integration of a number of processes and procedures to create a range of systems that have the potential to engage individuals in a form of design and production that questions their familiar relationship with consumer products.

If seen in the wider context of a post industrial manufacturing era involving increased use of smart technologies and the development of personal fabrication techniques, these systems can be considered as part of a growing number of speculative projects and theoretical debates that seek to redefine the relationship between people and objects. Bruce Sterling, for one, has considered the effect on this relationship when the integration of technology grows to the state where the embodied information within a product becomes more important than its physical manifestation [2]. Research projects into advanced manufacturing such as the FAB Lab [3] and forums such as MAKE magazine also consider the social impact of these technologies.

In relation to established craft practices, it could be argued that the digital systems developed within this project propose a new way of creating objects which can be related to the older tradition of bespoke commissioning, but potentially in a more democratic and widely available way. Therefore this type of system has the potential to rekindle and expand a craft tradition in which maker and client work together to develop a design that is unique to the individual. However, as Emily Campbell argues, craft contains the idea of personal meaning, which she feels has been lost in much recent product design [4]. This personal meaning for the owner of a craft object is created through a complex range of psychological associations. There is a question whether the new design and production systems described here have the potential to produce objects which have enough ‘craft’ characteristics to retain the ability to create personal meaning. On the one hand they produce unique objects, but on the other hand, they are not ‘handmade’. There is a range of skills employed within the development of the systems that allow the creation of new artefacts, however they are not the traditional skills associated with craft practice. Furthermore, the aesthetic characteristics of the objects produced are inherently a balance between the generative system, the software designer and the user, rather than solely the vision of the maker. As users begin to try the software and the systems tested, the significance of these issues can be reviewed and the hybrid nature of the project assessed.

References

1. Atkinson, Paul (2004) Post-Industrial Manufacturing Systems: The impact of emerging technologies on design, craft and engineering processes, Proceedings of 'Challenging Craft', Aberdeen ISBN 190108583x

2. Sterling, Bruce (2005) Shaping Things, MIT Press, ISBN-10**:** 0262693267

3. Gershenfeld, Neil (2005) Fab: the coming revolution on your desktop-from personal computers to personal fabrication, Basic Books, ISBN 0 465 02745 8

4. Campbell, E, (2006) '*Personal Touch'*, in Crafts Magazine, May/June issue.

[1] See: www.futurefactories.com
[2] Visit www.autonomatic.org.uk for documentation of previous projects.
[3] See: www.virtools.com for details of this product
[4] Visit www.automake.co.uk
[5] See: www.zcorp.com
[6] See: www.3dsystems.com
[7] The SLS system has been used by many designers over the last five years for the creation of RM lighting, seating and other domestic products, see www.materialise-mgx.com and www.futurefactories.com for a range of examples
[8] See: www.3dsystems.com/products/multijet/invisionHR/index.asp
[9] See: http://within4walls.co.uk/ for an example of retail outlet selling a wide range of rapid prototyped work.

Painting with light: generative artworks or "setting in motion" the fourth dimension

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The Camera and the Visible

"I'm an eye. A mechanical eye. I, the machine, show you a world the way only I can see it. I free myself for today and forever from human immobility. I'm in constant movement. I approach and pull away from objects. I creep under them. I move alongside a running horse's mouth. I fall and rise with the falling and rising bodies. This is I, the machine, manoeuvring in the chaotic movements, recording one movement after another in the most complex combinations.

Freed from the boundaries of time and space, I co-ordinate any and all points of the universe, wherever I want them to be. My way leads towards the creation of a fresh perception of the world. Thus I explain in a new way the world unkown to you."

Dziga Vertov, 1923

Abstract

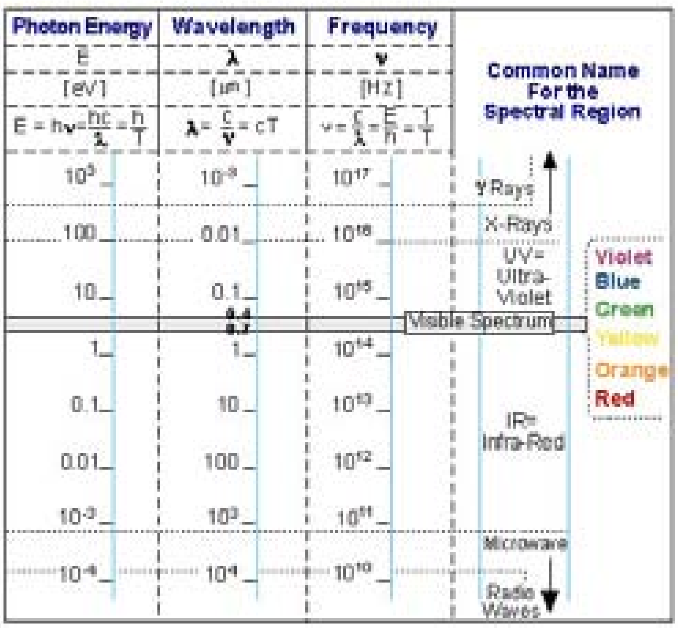
The word "Photography" comes from two Greek words, Photos (light) and Graphos (writing, painting), so "drawing with the light". Taking pictures needs some devices and a particular process in Space and Time. According to Einstein the basic structure of our world is SpaceTime and things exist in a spacetime continuum, a world of four dimensions: height, width, depth and time. A generative process is usually referred to as "setting in motion". Motion is the essence of Life. To be alive is to move. Selecting particular initial conditions, adding a fourth dimension and photographing motion by means of randomised generative processes can give rise to very expressionistic results, in full agreement with Galanter's definition of Generative Art ("any art practice where the artist uses a system […] which is set in motion with some degree of autonomy contributing to or resulting in a completed work of art").

A very simple yet effective installation was exhibited during Generative Art 2007 Conference. It was basically composed of several light sources of different colors, in a dark room. People were invited to participate at different levels. The result was a generative installation and generative shots, that will be published on the web. A physicist (one of us, MF) was also there to give scientific explanations about light phenomena and Maxwell's and Einstein's theories of Electromagnetism, Relativity and SpaceTime. In addition, a selection of light paintings were exhibited during the conference.

0. Introduction

Starting from the laws of Visual Perception, from the anathomy and physiology of the eye to the cerebral cortex and the elementary laws of Optics, several devices using these properties have been built. Already known at the time of Aristotle, the “Camera Oscura” is an optical instrument the principles of which are at the base of Photography and Cinematography. Optics is that part of Physics that studies light, describing its phenomena of emission, propagation and absorbtion. Light is thus a physical phenomenon of electromagnetic nature; emitted by some sources (for example, the Sun, fire, lamps, etc.) it propagates into transparent media and is reflected, diffused or absorbed by matter, following Maxwell’s physical laws, which, in particular, predict a transport of “electromagnetic energy” through “waves”. The spectrum of irradiating energy goes from the gigantic radio waves, the lenght of which is million of chilometres, to the tiny gamma rays, millions of times smaller of an atomic nucleus. This electromagnetic spectrum is usually divided into families, that overlap at the extremes, called microwaves, ultraviolet, infrared, etc. This subdivision is basically due to teaching reasons and it is important to consider the unifying nature of radiating energy. In the Physics of XX Century there is also, besides the wave-like nature, also a corpuscolar aspect, the so-called “wave-particle duality”.

Human retina is sensibile to electromagnetic waves with frequency in the range nr ≈ 4x 1014 Hz and nv ≈ 8 x 1014 Hz (corresponding to wavelengths between lr = 780 nm and lv = 380 nm) : the term “light” is usually referred to electromagnetic wave-frequencies within these intervals. Thus *visibile* light is a very small region of the electromagnetic spectrum (see Figure 1). A light wave, irradiating into space at the constant velocity of about 300.000 kilometers per second, can therefore “energetically” interact with a detector, that could be a film, a retina or a photoelectric device.



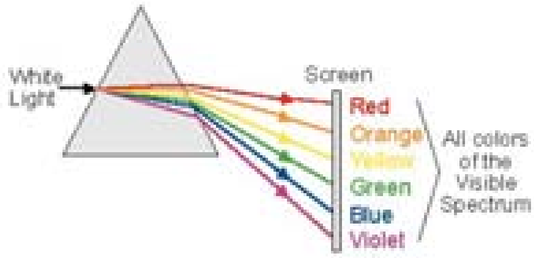


Figure 1: Electromagnetic Spectrum and visible light.

From its inception, Photography had an identity crisis: the chemical registration of light as an optical phenomenon was simultaneously invented by an artist and by a scientist.

The invention of chronophotograhy – from the Greek "*writing, painting of time*" will lead to the rise of Cinematography – from the Greek "*writing of movement*". The animation techniques, that consent to produce the illusion of movement in inanimated objects, have preceded the cinematographic shots on film. Muybridge's work in fast motion photography led to major developments in still photography and painting plus the invention of motion pictures, directly affecting Marcel Duchamp and others at the turn of the XX Century. His images of people and animals in motion forever changed the way these figures were viewed.

"I often think the night is more alive and more richly coloured than the day."

Vincent van Gogh to his brother Theo Letter 533, Arles, 8 September 1888

1. Photography: it's all about light

Many people do not realize and even experienced photographers can forget, that Photography is all about light. The word "Photography" comes from two Greek words, *Photos* (light) and *Graphos* (writing, painting), so "*drawing with the light*". Photography is not about objects or people or scenery, rather it is about how the light reveals those things. The action of light on a light-sensitive material (film or electronic devices) creates the image. An object can be lighted so that it almost disappears or so that it is virtually three dimensional.

The acceptance of Photography as an art was hotly debated during the the Nineteenth Century. The Photography we have seen for the last 160 years has been created within a very narrow spectrum of the range of imagery that a camera could create. The sharp picture capability of Photography is both so powerful and useful that it has been easy to ignore the other possibilities. In general photographers have concentrated on perfectly exposed, fast shutter, well focused pictures of people and scenes in the real world. There certainly are exceptions such as the work of Man Ray, but in general a convincing illusion of the real world has been Photography's goal.

As early as 1859, Alphonse de Lamartine wrote defensively: *“Photography is an art. Photography is more than an art. It is a solar phenomenon, where the artist collaborates with the Sun.”* Almost a century later, in *Vision and Motion,* Moholy Nagy wrote *“It is unprecedented that such a ‘mechanical’ thing as a photography – regarded so comptemptuously in the creative sense – should have acquired in barely a century of evolution the power to become one the primary visual forces in our life.”* Paradoxically, it was greatly helped by painters such as Degas, Vulliard, Man Ray and Moholy Nagy, and writers like the zealos Zola, who purchased a dozen cameras and took thousands of photographs which he developed in the three labs he had built.

Color photography is a relatively recent invention, so it is not only the intensity of the light, but also the color of the light that creates the image. This complicates things: for example, a scene may include different light sources which have their own particular color (color temperatures and wave lengths) and subtleties of color that may be seen differently by the camera than by the human eye. In the middle of this Century, the single lens reflex (SLR) camera was a technical breakthrough. For the first time the photographer could see exactly what the lens saw. Digital Photography goes one step further and lets the artist see what the camera is seeing in "real time" on a LCD screen. The LCD screen is an approximation, however, it is good enough so that a photographer can learn to work with it, with no need to guess how the final image will turn out.

There is another useful aspect of the LCD screen: it allows a photographer to review pictures that he or she just shot. This immediate feedback allows an artist to learn quickly in new situations, experimenting unusual pictures. There are many, many ways to experiment.

> *Today scientists no longer limit themselves to the three dimensions of Euclid. The painter have been led quite naturally, one might say by intuition, to preoccupy themselves with the new possibilities of spatial measurement which, in the language of modern studios, are designated by the term: the fourth dimension.*
>
> *Regarded from the plastic point of view, the fourth dimension appears to spring from the three known dimensions: it represents the immensity of space eternalizing itself in all directions at any given moment. It is space itself, the dimension of the infinite.*
>
> *Guillaume Apollinaire, from the Cubist Painters, 1913*

2. Painting with light

Therefore if in the past “still Photography” couldn't get no respect - “color Photography” in particular, being thought of as a mechanical process having any potential for an artistic vision, rarely considered as a valid art form - now with Digital Photography, those with artistic ideas can realize their imagery in strikingly individual and unique ways. A full understanding of light and color means that, in the hands of a master, modern Photography is a rich, complicated, sophisticated and expressive art form. Already in the Nineties, in his essay “*Is digital photography the new expressive visual art?*” Rick Doble affirmed: *“Digital photography could be a major art form in the next century. It may be the culmination of the development of photography. Digital cameras may give us the power to set photography loose.”* Can an art form, which has been committed to creating high resolution images of the real world, find happiness as a contemporary art form that includes things that photography has been avoiding up to now, such as blurriness, overexposure, underexposure, camera movement, subject movement, graininess and long exposures in which the unexpected happens? *“In a sense we (photographers) will have to learn how to be ‘bad’ photographers, to deliberately go after blurred, unsharp, oddly exposed images - in other words to do all those things we have learned to avoid.”* These images are, at best, very difficult with traditional film. The immediate feedback of the digital camera, however, means that we can try a lot of different things and quickly see the results without spending a fortune.

For a variety of reasons the real time LCD screen lets a photographer "paint with light" - light that is in the real world – by simply using the traditional photographic controls of adjusting brightness, contrast, color balance and range. While some of these effects could be approximated with the aid of a computer, images created in the real world have a vitality to them that a computer manipulated image cannot approach. It is the difference between the real and the artificial. This vital instant is the "decisive moment" of snapping the shutter as stated by Henri Cartier-Bresson.

The photograph can be used to record a passage though time, a movement through a space, even an emotion characterized by the movement of the camera. The elusive change of light, the fleeting expression, the ephemeral form – all could be captured by the camera, *“an instrument for working both in time and space”* as the English painter John Piper pointed out. Indeed taking pictures needs some devices and a particular process in Space and Time.

According to Einstein the basic structure of our world is SpaceTime and things exist in a spacetime continuum, a world of four dimensions: height, width, depth and time. A generative process is usually referred to as “setting in motion”. Motion is the essence of Life. To be alive is to move. It seems that both Cubism and Futurism were deeply affected by Einstein's Special Theory of Relativity, which was published in 1905. The goal of the Futurists was to include motion (and therefore Time) in a painted image, much like the cubist wanted to include multidimensions in a portrait.

“Light painting”, also known as “light drawing”, is a photographic technique in which exposures are made usually at night or in a darkened room by moving a light source or by moving the camera. In the former case, light can either be used to selectively illuminate parts of the subject or to "paint" a picture by shining it directly into the camera lens. Light painting requires a sufficiently slow shutter speed, usually a second or more. Like night photography, it has grown in popularity since the advent of digital cameras because it allows photographers to see the results of their work immediately. Light painting can take on the characteristics of Tableaux Vivant or a quick pencil sketch. Flash lights or light pens can also be used to create Full Bleed images. The different colored light are used to project an image on the CCD. Light painting by moving the camera is the antithesis of traditional Photography. At night, or in a dark room, the camera can be taken off the tripod and used like a paintbrush. An example is using the night sky as the canvas, the camera as the brush and cityscapes (amongst other light sources) as the palette. Putting energy into moving the camera by stroking lights, making patterns and laying down backgrounds can create abstract artistic images. A variety of light sources can be used. Manual focus is often used since autofocus systems may not perform well in low light. In addition, photographers often use a slow film speed or low ISO setting on a digital sensor to minimize grain (or digital noise) and increase exposure tolerance. When moving the camera, longer exposures can create more intricate images.

One of the first experimenter with light painting, in the Eighties - thus before digital cameras, is Yulla, who describes her work as follows: *“The eyes within the camera shift and capture each moment. This act of perception trasmutes and trasfigures each object* *perceived creating a montage of unique and pivotal images."* It is interesting to notice some kind of coincidences, that Yulla Leben's education focussed on the study of Mathematics and Physics and that, when she was sixteen, she met Einstein for the first time, being impressed by him and his suggestions.

> *I suppose I am interested, above all, in investigating the golden ability of the artist to achieve a metamorphosis of quite ordinary things into something wonderful and extraordinary...*
>
> *Eduardo Paolozzi, The Metamorphosis of Ordinary Things, 1959*

3. Generative Artworks: setting in motion the fourth dimension

So, if as said before a generative process is usually referred to as "setting in motion", definitions of Generative Art refers to *"art that has been generated, composed, or constructed in an algorithmic manner through the use of systems defined by computer software algorithms, or similar mathematical or mechanical or randomised autonomous processes"* or "a widely used artistic method inserting an automated system between the artist and the artistic expression". In a well-cited text, Philip Galanter formulates the following definition: *"Generative art refers to any art practice where the artist uses a system, such as a set of natural language rules, a computer program, a machine, or other procedural invention, which is set into motion with some degree of autonomy contributing to or resulting in a completed work of art."*

Even though Generative Art is often reduced to merely a branch of software art, Galanter's definition proposes a view that does not restrict Generative Art strategies to its digital forms. There are many traditions for basing artworks on systems, procedures, and instructions in most fields of Art. John Cage, Yoko Ono and many other conceptual artists have worked with procedural and instruction-based work. The defining trait of Generative Art is rather that the artist establishes a system, which can generate a number of possible forms rather than one single finished form. The role of the artist is to construct, initiate or merely select the frame of procedures for the generation of possible expressions; the constructions of art-making systems substitute the making of static forms while in other cases the systems rely on input from human actors or information feeds.

Selecting particular initial conditions, adding a fourth dimension and photographing motion by means of randomised generative processes can give rise to very expressionistic results, in full agreement with Galanter's definition of Generative Art.

Rick Doble, who was by himself "action painting with a camera", proposed a new term for this Photography, namely "*photo –expressionism*". Generally speaking the most interesting effects will occur at extremes, because it is at these "edges" that the normal relationship between light and film breaks down and something unusual happens.

Figure 2: *Flocks* (Eindhoven, 2004). Photo copyright Marcella Giulia Lorenzi

Figure 3: Fotoesordio 2005 International Contest. *Lux* Photo copyright Marcella Giulia Lorenzi

One of us (MGL) started experimenting with "Light Painting" since 1998. The first digital photographs (see Figure 2) were taken with a Creative PcCam 600. Recent ones are taken using a Canon IXUS 750. Some of them were selected for the "Fotoesordio

2005 International Contest" and exhibited at the GNAM National Gallery and in the Aula Magna at Tor Vegata University, both in Rome (see Figure 3). All the pictures were taken at night or in twilight, hand held and involved a lot of rapid camera movement (see Figures 4-8). Most images were created with a low ISO setting (usually 50) adjusted to suit lighting sources and conditions. Usually she carries her own camera, looking for the appropriate lighting conditions, especially the color and intensity of the light sources: neon public display signs, normal house bulbs, stop lights several different street lamps can produce a range of colors in one scene. There are now dozens of different lamps that put out wavelengths that are quite different from daylight or even household lights or fluorescents.

The LCD screen on the back of digital cameras has a number of advantages over a traditional viewfinder much of which remains to be explored. The immediate feedback means that a photographer can experiment and learn at an unprecedented pace, then making some decisions about how realistic or abstract the imagery to be. Camera movement combined with a slow shutter speed can create fluid images full of energy. At the beginning, starting experimentation in this way she was taking some fifty images before finding one that she really liked. As she became more experienced, that ratio went down a lot. This is not unusual for any kind of photography, but in the case of abstract photography is really important.

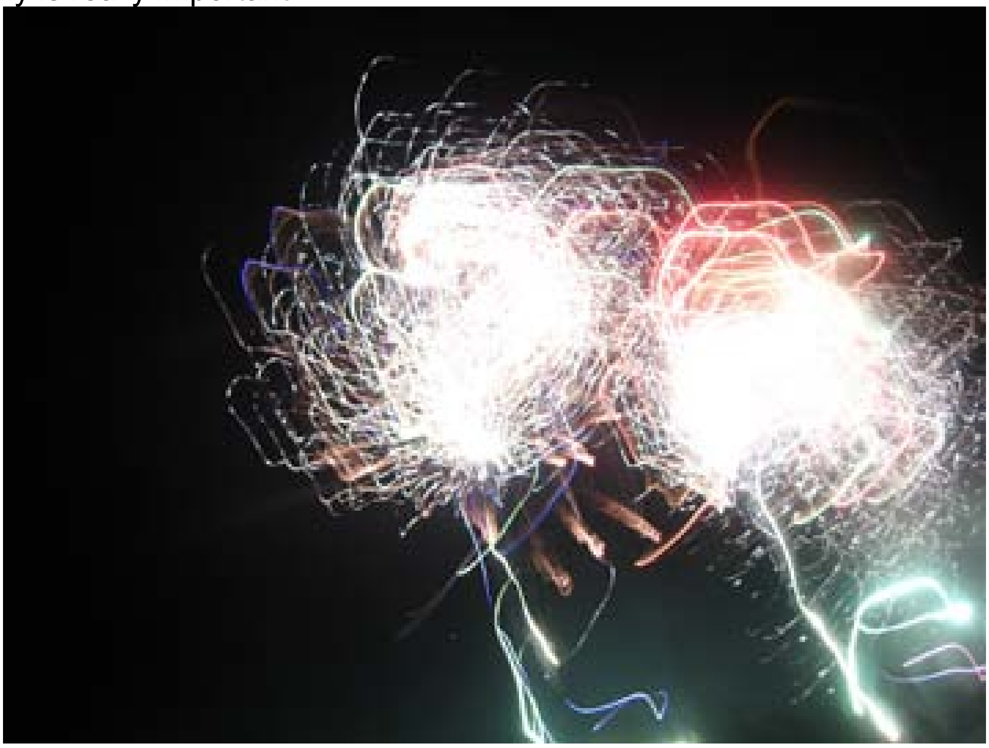


Figure 4. This picture reminds of two flowers, both for the form and the colors. It was taken in Lorica (CS-Italy) mid-summer 2007, moving the camera during some fireworks. Photo copyright Marcella Giulia Lorenzi.

Figure 5. This picture was taken in Torino (Italy), in front of the "Porta Palazzo Market", to which a lot of neon signs were added, reproducing the terms for the concept "I love difference" in different languages, for the Christmas period event "*Luminarie – Luci d'Artista*". Photo copyright Marcella Giulia Lorenzi

A very simple yet effective installation was exhibited during Generative Art 2007 Conference. It was basically composed of several light sources of different colors, in a dark room, put in apparently random positions. Visitors were invited to choose their favorite color source and change its position, move it and so on, following simple rules. People were also invited to take shots of the installation, experimenting with different shutter speeds and camera movements. They were also free to play with the lights, moving them in the air, while other people were taking pictures. The result was a generative installation and generative shots, that will be published on the http://mars.unical.it/emc2 Website. A physicist (one of us, MF) was also there to give explanations about light phenomena and Maxwell's and Einstein's theories of Electromagnetism, Relativity and SpaceTime.

In addition, a selection of light paintings pictures were exhibited during the conference.

Figure 6. This picture was taken in Frankfurt airport (Germany 2006), along a connection gallery, where light continuously change color: the perfect location for Painting with light! Photo copyright Marcella Giulia Lorenzi

Figure 7. This picture was taken in Lisbon (Portugal 2006) from the ceiling of my hotel. Photo copyright Marcella Giulia Lorenzi

Figure 7. This picture was taken near Niagara Falls (Canada 2006). Photo copyright Marcella Giulia Lorenzi

Figure 8. This picture was taken in Montreal (Canada 2006) from a light exhibition. Photo copyright Marcella Giulia Lorenzi

Categorema

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"A new vase will preserve for a long time still the smell in which the first time has been impregnated"

Abstract

This paper is the inquiry about a creative design process that starts as a temporal connection with past structures. Categorema is the process of an historical category connected in expanse with a new predicative for reaching an evolutionary character. The challenge is that a new creative attribute of a past category can define an Art scenario that belongs to the future, but in the same time it is recovered in the past age. Definitions, catalysts, exempla.

"Pasa Kynesis atelès"(every movement is symptom of imperfection)
Aristotele, Metaphys.,IX,1048 b 28 e Phys.,III 201b30.

1. Andante con brio

"…Solicited therefore from this hope we are proposed to write for you and for your children something that extends to science, and if this will have been of your pleasure, on the escort of your approval, we will get the judgment of the others… But since science treats both the reality and the language and since reality is or substance or accident, will treat now of the substance, and we will do this according to the philosophy: of a same subject, in fact, we can discuss in way dialectical, or sophistical, or rhetorical, or philosophical. In fact, to consider of a subject if it is unusual or universal this is dialectical; to try that this same subject is that what it is, this is sophistical; to try that it is worthy of praise or of punishment is rhetorical. But to discuss of its nature, of its behavior is philosophical. The dialectical, therefore, the sophistical, the orator and the philosopher can dispute around to a same thing, considering, however, different aspects.
Some people, however, not understanding these things, banished them from the dialectical and sophistical dispute, they took of them, nevertheless, the words and they said that only these are universal or singular.
But a more foolish age arrives that excludes the things and their names, and it has reduced all the disputes to four names or about, but the one or the other, for the reason that they were not God, went down by themselves.
We decided, therefore to study the substances from the point of view of the philosophy, thing this, that, if considered with diligence, profit will result…. of now in then we treat of the substances and; as the uniformity of the exposure produces satisfaction and the satisfaction the boredom, we will divide our discourse in form of dialogue…."

2. PROLOGUE

XX: "And happiness? So brief? So few? "
XY: "If a word exists for telling the feelings of Sardinian people in the millennia of isolation between nuraghe and bronzetti this it is happiness."
XX: "Is our destiny marked? "
XY: "We sang, we died, we danced from father to son, growing of number and of experience in our island, we were happy."

3. About translation

XY: "There is not a theory of translation released by a theory of destiny, destiny in connection to the verb istemi, as to remain, but at the same time to sink and to rise. It shows the image of a point and at the same time the image of a vertical; or better: of a vertical semi straight line marking the point from which the walk departs upward or downward. The destiny becomes this semi straight line, spring board istemico of the sinking or the flight". **XX**: "A broken eternity, that maintains its icon by exact breaking itself. Anyway disappears the place in which it appears, objects and relationships always appear still in a place. Appearance becomes the over-sensitive one, that far to overtake the object, it annuls itself in the cognitive process of ***recognizing***".

4. Chorus:

"I have now found a sense and a measure:
I know that pain is the salt of life
And that joy is into looking at the sky
By random, and in recognizing the blue""

5. About air

XX: "If the rainbow is anything else than the image of the sun that appears in a cloud, and the sun is round, how happens that we never see in that image the total circle?
XY: "The sun is much taller than the clouds, and when it touches the superior part of the cloud, it gives its image; consequently, how much the sun is more next to the rising or to the sunset, so much greater the rainbow appears."
XX: " Why the moon, that is very shining, doesn't produce ever in the air an arc but a circle? "
XY: The air of the night, when it is not too much dark neither too enlightened, is touched by the rays of the moon: this, then, since it is very low and round, performs in the air a round figure. Even if this circle seems to encircle the moon, in reality it is not very distant. Such image, in fact, is formed not away from the earth, but our sight is deceived and we believe that that circle is inside the moon."

6. About city

Rivers are walking streets,
That bring people where they want to go.
Pascal, Thoughts

Chorus: "The sailors.. told of fabulous cities that born in the world: a city on islands, connected one to the other with bridges…a city where every Christian wisdom was meditated and discussed by thousand of male and females monks, some of them wrote poetries and painted, a city between two rivers on the intersection among three people, where every people maintained each own language, speaking and also writing the others two; a city lived by young women, tall as orange tree, with clear skin as milk and with eyes colour of the sea or the sky."

7. Invocation in mother tongue
In Serrenti o Vida santa a tui benint'is devotus
De tui ottenenti cunfurtus cuddus chi ti pregant
Consolaus si ndi andanta de custa bidda amorosa.

8. About time
A singing sundial in the night:
I am that shadow that rises
And dies with the sun
Marking an indelible trace
Into the double flux of life
Fluctuating in the eternal passage
among ethereal imaginary and flowing realities.

9. About number
"Having just said before…about virtue and strength of the one and of the other quantity, i.e. continuous and discreet, i.e. arithmetic and geometry with their proportion, as diffusedly you have seen, it seems to me not indecent, here continuing, to put some strengths and natural virtue that proceed from themselves to themselves from their fundamental teacher, called Nature… These things, certainly to people that ignores its secret, appear as miracles… "

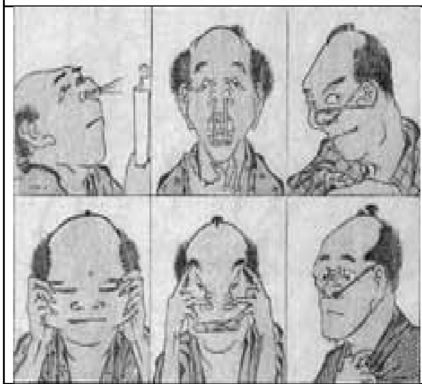
10. Exempla

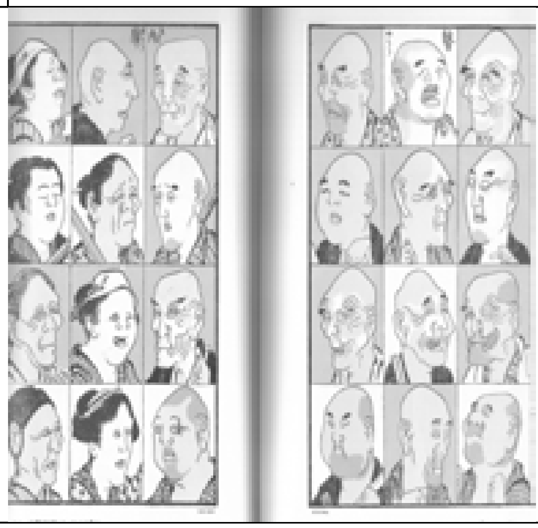
The power that opens by a key, that attracts by a hook.

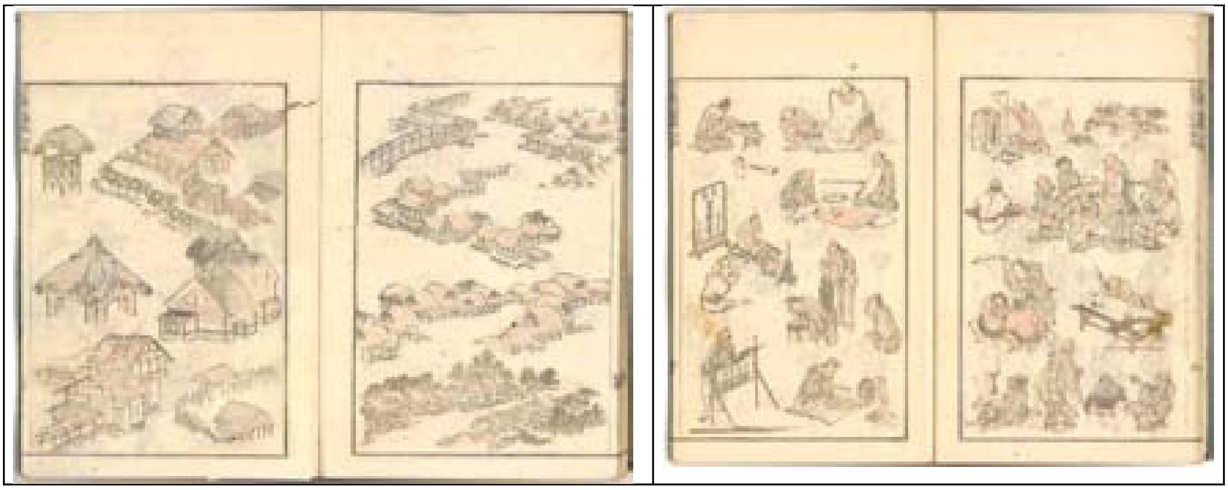
Nature diversifies and imitates,
Arteficium imitates and diversifies.
Pascal,Thoughts.

10. 3 [1- 3] About Translation
Key word: character.
Process: from impression to expression.
1th exemplum: *Attribute: singular.* Different views of a singular subject in Leonardo and in Hokusai


2th exemplum: *Attribute: similar.* As the different same: Leonardo "Five studios of grotesque" , Hokusai Katsushika, a picture of China and 6 pictures from Manga





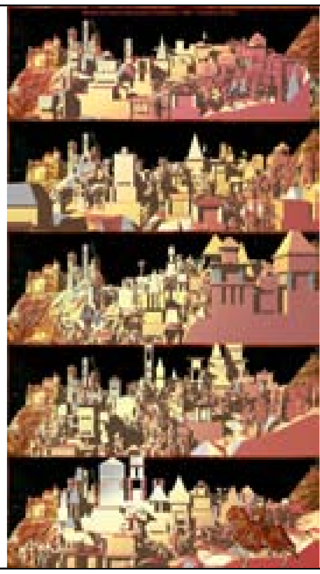


3th exemplum: Li Bo’an “*A Song in Praise of the Tibetan People”* in “*The origin of the Great River”*,1999

Li Bo'an's work reflects the spiritual world of Tibetan people as well as expressing the most central key of Chinese aesthetics: conveying the spirit. Conveying the spirit is the process of using forms to uncover the human spirit or the essence of things. This is already a difficult task when painting an individual person, but in when painting a group of people it is all the more challenging. With an open mind and broad vision, Li used all his strength to attain his goal. Every individual created by his hand shows the organic nature of the Tibetan spirit. Furthermore, in order to even better express the spiritual aspect of his painting, he used traditional methods of abstraction to dial with background and objects. Background is only a hint of suggestion where he lent himself to creating an innovation on the tradition methods with a power never before seen. While his use of ink varies in intensity and shade, attracting the eye of viewer.

10. 6. [1-2] About city
1th exemplum from “ La città ideale “ by Piero della Francesa Variation#53 “Ideal City “ by Celestino Soddu

2th exemplum from Simone Martini ,“Guidoriccio da Fogliano”, 5 Variations(#23,#32, “#35, #41, #53) of Medieval Towns “ by Celestino Soddu



10. 8.1 About Time

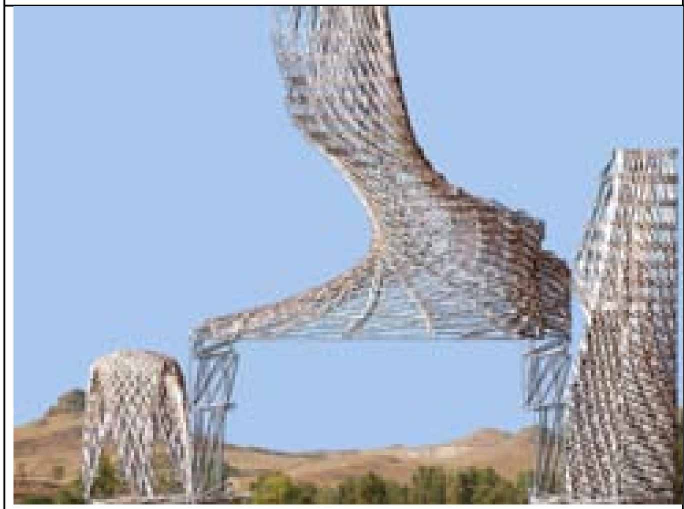
1th Exemplum:Evolutionary scenarios from Nuraghe by Celestino Soddu with Enrica Colabella

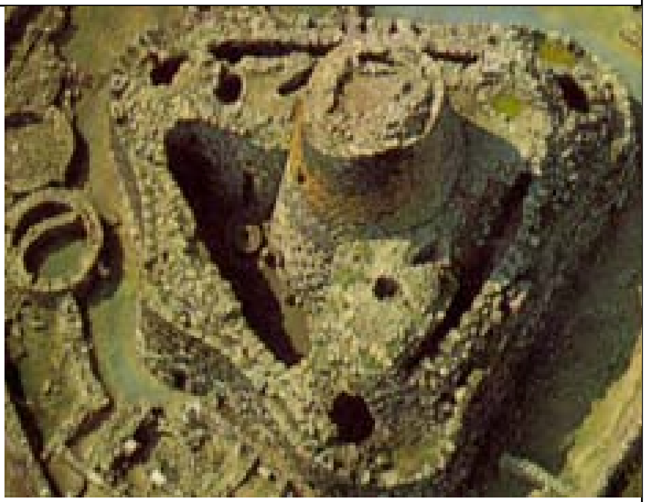
DESCRIPTION

"The mystery of ancient Sardinia is become more and more mystery"

OBJECTIVE:

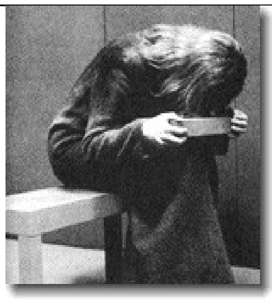
Dominant theme of this project is the reconstruction of figurative icons of the Sardinian culture. Nuraghe and menhir as codes of definition of contemporary spaces projected in the imaginary collective. The figuration of the tradition as category of the future. Categorema is a logical linguistic structure able to connect with algorithms different elements in a process of transformation. Linguistic passages in the space/time. Variations are visionary scenarios of unique codes that are strongly identified inside the Sardinian culture. A fragment of visionary Atlantide is projected into the future by the light of the indelible eternity.





10. 9.1 About number

1h exemplum from “Tryst” to “Ghost Trio”, a television play, by Beckett.
Attribute: Three
Nickname of Beethoven's Piano Trio in D op.70 no.1 (1808), so called because of the slow movement's ghostly atmosphere. The formal structure of the second movement of the Geister Trio *the “Largo assai ed espressivo”(3 words)* was used by Beckett. In his book “Words and music” *the figure of words appears as dramatis personae”*. He said that with words ” *the music always wins*” “*That is definitely end with the victory of music”.* Television play is his III language. “*All the old ghosts, Godot and Eh Joe over infinity”* . 3 parts. 3 actors. 3 camera movements. Largo movimento is a clear binary form followed by a coda. The inner structure of the largo two main parts is also binary, etc. *”No attempt has been made to bring it into line with the finished work”* Beckett wrote in the preface to the script of film.

11. The minimum, as smallest amount, of this paper

XX: CATEGOREMA, Categorema, Cate**GO**reMa!

XY: etc.; etc. ; Etc............

References:

Sergio Atzeni, Passavamo sulla terra leggeri. Ilisso Ed., Nuoro 2003

Pascal, Pensieri. Einaudi ED, To 1962

Insel Marty, I Poeti ed il tempo che verrà. Nuova Cultura ED, Bellino(Ro) 1996

http://www.artcyclopedia.com/artists/hokusai_katsushika.html

http://www.samuelbeckett.it/tv.htm

http://www.generativeart.com/

http://www.generativedesign.com

Architecture is Performance

Giorgos Artopoulos and Stanislav Roudavski

The complete "body" of the "mature" Parasite was "grown" as two shells, suspended in a stairwell space in the Museum of Modern Art in Prague. Four video projectors cast moving images through the cellular surfaces and onto the walls. People came into the light and cast shadows. In response to the visual rhythms, the Parasite "sung": this time quiet, now aggressive, never exactly the same.

The installation in the Museum of Modern Art was but a moment in the Parasite's life that extended through the interests of its "authors", through its painful formal birth as a virtual structure, towards its part-real, part-imagined coming-of-age as a dramatic eruption and further on towards inescapable disintegration and oblivion. Its story is still in progress. Its architecture is not of matter but of performance; it is forever becoming.

Design Process

The pavilion was designed to fit into a stairwell that connected the main exhibition hall located on the ground floor, the secondary entrance to the museum (that became the primary entrance during the evening events) and the performance/exhibition spaces of the lower level. The structural form of the pavilion consisted of two organically shaped, topologically cylindrical shells consisting of 1,510 unique cells and the interactive audio-visual system able to respond to the behaviour of the visitors.

The design process was in three phases. Firstly, dynamic simulation and time-based processes were used to produce two organic surfaces fitting into the stairwell space. Secondly, the computer-driven responsive audio-visual system was laid out in relationship to these surfaces. This system incorporated image-based computer vision and was able to create real-time audio and video compositions in reaction to peoples' movement through the space. Thirdly, the two organic surfaces produced during the first phase of the design process were materialized as building components. This materialisation was enabled by a technical framework for the procedural production of a built structure under a variety of situational constraints and in response to the performative requirements of the audio-visual system.

The spatial intervention in the form of a built structure was a significant part of the project. It intended to provide two kinds of impact. Firstly, the structure impinged on peoples' behaviour such as movement through space or visual access with the intention to engender new social encounters. Secondly, the structure in combination with projected images created a visual field that could inform the visitors, redirect their attention and involve their bodies in the making of the dynamic visual form. Plant-cell microscopy images, urban-texture photographs and dance movies were processed so that their pattern-based nature was made apparent. The visual field consisted of the pattern-based spatial structure, pattern-based video imagery and the participants' bodily movement through the space. While static after construction, the structure was intended as a procedural response to the given environment. Its responsive nature called for a modular, component-based arrangement able to conform to geometrically complex surfaces and flexibly adapt to the changes in local conditions (Fig. 1). These requirements led to the interest in honeycomb and similar structures.

Fig. 1. A fragment showing local curvature-dependant variations (photograph)

Previous experimental work (Kudless, 2005) explored the use of honeycomb structures for the construction of curvilinear geometry. One of the Parasite-project's goals was to see if the cell-based approach could be taken further with the use of non-periodic patterns capable of local change. The pattern adopted after preliminary research was a Voronoi diagram defined as "the partitioning of a plane with *n* points into convex polygons such that each polygon contains exactly one generating point and every point in a given polygon is closer to its generating point than to any other" (Weisstein, 2005).

During the design stage, several clusters of random points were generated along a set of construction surfaces defined to respond to the dimensions and performative characteristics of the location. Dynamically responsive three-dimensional curves were drawn through these points. Next, two periodic surfaces were lofted through the curves. Multiple dynamic fields were set, positioned and adjusted as the simulation was run through multiple iterations. When an acceptable intermediate shape was arrived at, an array of dynamic particles was distributed along the surfaces that were squeezed to fit into the stairwell. The distribution and form of the cells was arranged via more multiple iterations in response to further constraining conditions.

From this point, the task was to reach from the virtual to the real. The details were laid flat and prepared for manufacturing. The cell-walls were laser-cut and scored by computer-driven machines. The plastic skins were plotted and cut out. The components were then brought to the Museum galleries (Fig. 2) and the assembly work began. After many metamorphoses and temporary dwellings, the shells condensed into the patches that were left to occupy the exhibition spaces.

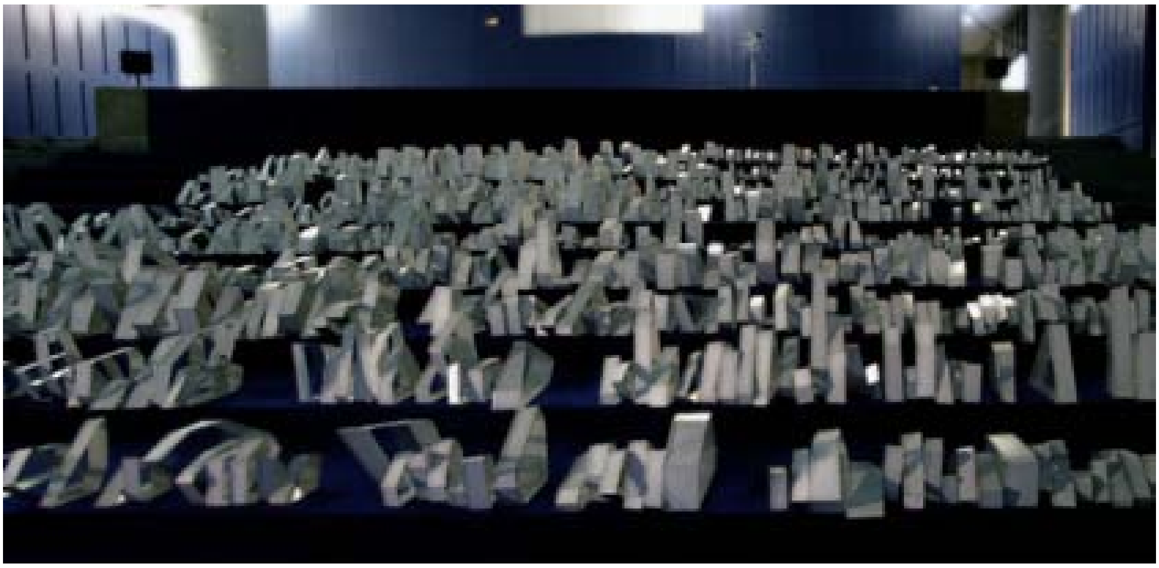


Fig. 2. The cells of the outer shell arranged in the order of assembly (photograph)

Methodology

The project's methodology was a first step towards an approach incorporating architectural form-finding, multi-media design and fabrication of building components in a unified performative process. In the foundation of this process are the protocols for the cross-platform data exchange. In the contemporary technological environment, all of the three areas utilize digital tools capable of programmable data-wrangling. The unified digital-fabrication workflow offers other benefits apart from convenience. Design via parameter-readjustment allows for work with relational diagrams. During development, the designer is able to, and in fact has to, move up and down the branches of the process tree, reviewing the feedback and readjusting the inputs. Even though everything in the computer system is ultimately solvable, the designer waives the right to control results explicitly and instead guides the process with multiple indirect measures. The sacrifice of direct subjective control leads to gains in the capacity to deal with complex systems holistically, without reducing them to basic components. The bifurcations of the process with which the designer becomes intimately involved often lead to solutions that could not have been pre-specified from the start as spatial layouts or even as design goals. The feedback is often real-time or comparatively fast. The ability to tweak different components of the process allows the designer to learn about system relationships via experimentation. It becomes possible to plot alternative design paths in terms of multiple sequential versions. This process of probing and recoiling is exploratory by nature. The design process acquires a character of an investigative tool rather than that of a method with which a wilful author promotes his or her worldview. Significantly, the design suggestions derived from the procedural design process can be very different from those intuited at the beginning. Insights gained in this way can both educate the designer and lead to innovative solutions.

It is often said that specification of the problem is part of the solution. Thus, educating the designer is a significant goal. Within this project, the educated designer was providing a vital link between the solvable system and the fuzzy reality of the in-world situation. As designers, we were aware of many practical circumstances such as constraints on resources, materials, money, time and knowledge or multiple design goals related to various stakeholders. The design process began when on-site observations were expressed in the digital domain in terms of virtual forces impacting upon geometric systems and proceeded as interactions between these systems and the designer.

The results had to satisfy a number of structural and experiential criteria. The most fundamental of these were cell sizes and proportions. A related negotiable criterion was the degree with which the cell-walls and cell-skins were able to conform to the curvilinearity of the input surfaces. Cell quantity, together with other parameters, would have a direct impact on the weight of the structure and the number of operations required for its production. Experientially, the iterative process looked to uncover the effects on visual density and variety of surface texture (Fig. 4), visual permeability along varying view lines and production of shadow patterns.

Fig. 3. A fragment of a cell-patch on the floor (photograph)

The curvature/density relationship as implemented in the custom-written scripts exemplified the adaptive capacity of the approach. Other procedural relationships of this kind can be established and the controlling input can be provided via on-site observations or computational methods. The examples of such data might include isovists/viewsheds, light-level and body-movement measurements or simulative AI routines. The parameters of the structure that might be driven by such data include fenestration; cell-skin and cell-wall transparency, colour, light reflectance, light transmittance and other material properties; cell-wall widths, cell-wall orientation, cell density, cell uniformity and the like. For example, the project featured experiments linking the orientation of the cell-walls to the positions of the video projectors. Such linking enabled the structure to guide the moving-image formation by opening or blocking light cones, controlling shadow distributions, framing views and articulating the sculptural properties of the structure.

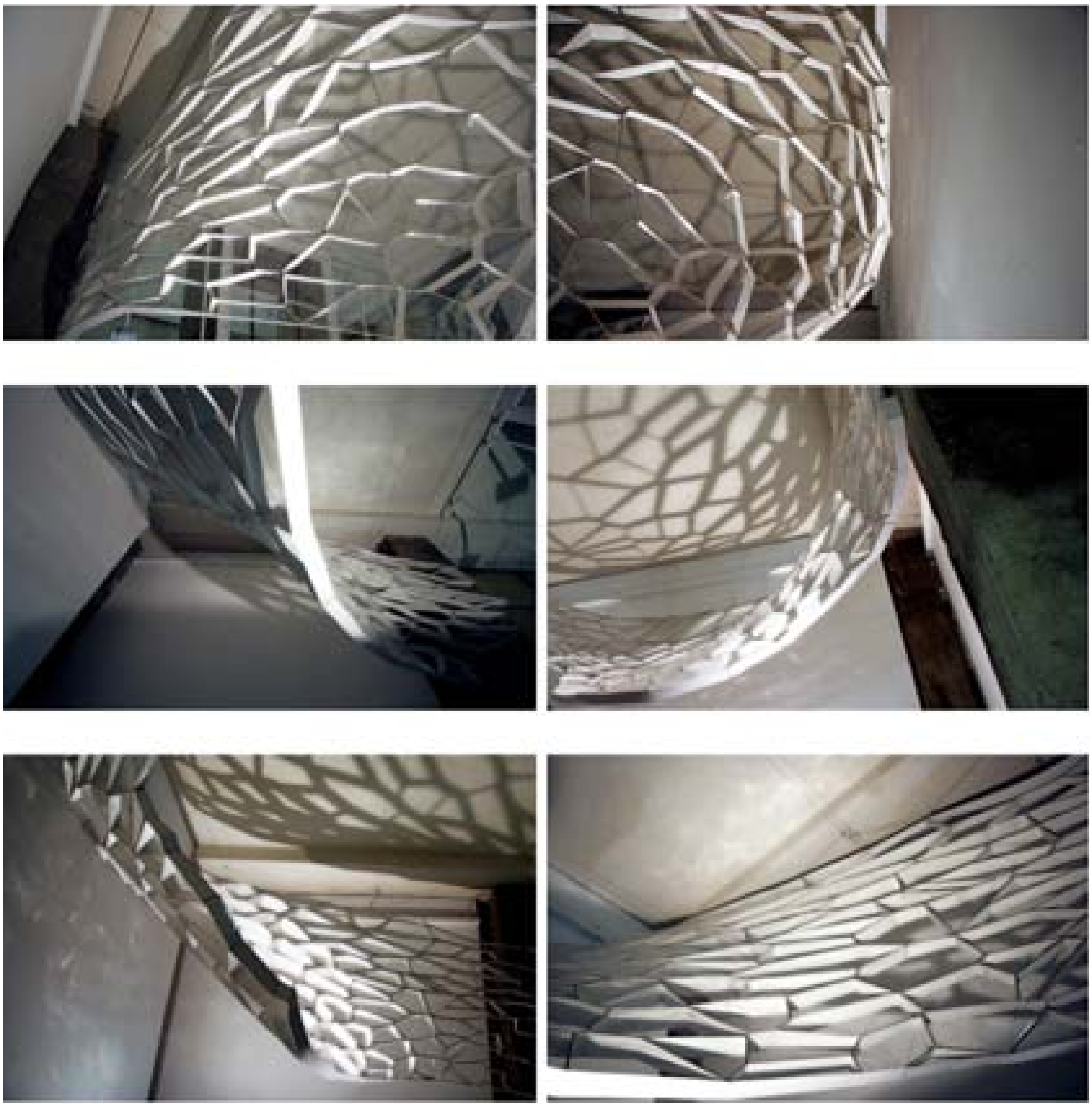


Fig. 4. Fragments of the structure installed in the stairwell showing variations in cell densities, cell-wall heights and cell-wall orientations (photographs)

The primary research aspiration behind this work was a desire to develop the backbone process that could illuminate the significant theoretical and practical issues and serve as a basis for future work. The experimentation has confirmed that adaptive non-periodic patterns such as Voronoi can be implemented into a procedural design workflow. This integration provided the first steps towards a unified design approach that considered place-specific form-finding together with custom-built audio-visual design. It was shown how structure uniformity and density, cell orientation, cell depth, and parameters of cell-skin can be procedurally fine-tuned as interrelated system components.

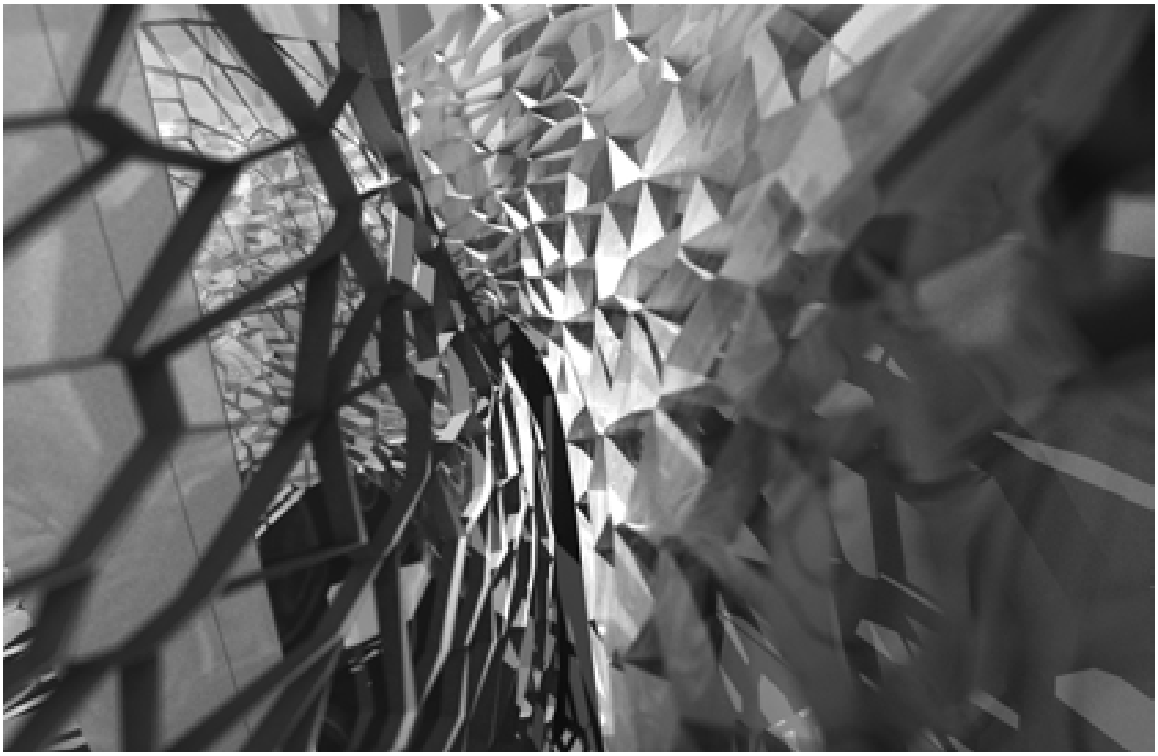


Fig. 5. A perspective along the direction of the inter-shell canyon (a digital rendering).

Future work might look at two areas: the use of patterns other then Voronoi and more intelligent generation of patterns. For example, Cambridge University's Department of Plant Sciences (2005) works on computational simulative models that strive to uncover the way plant-cells specialize, grow, adapt and make up complex structures via cell-to-cell interactions under the influence of local conditions. While this kind of research seeks to understand and modify the growth of plants it can also provide techniques and insights to inform the architectural design of adaptive structures able to host responsive performative situations. Morphogenetic models of growth and cell division can be adopted to and around a unified system able to satisfy the multiple spatio-mechanical, functional and performative factors of a complex design situation.

Interactive Media

The moving images were derived from dance, urban life and biology. These three distinct themes have, at the first glance, little in common. Yet, assembled into a dynamic collage, they exhibit striking similarities of temporal and spatial patterns. Visitors were able to explore the patterns of complexity, growth and self-organisation emerging from the interaction between this dynamic collage and the cell-based architectural structure. The sounds and melodies fluctuated in parallel with the visuals.

Pattern selection and sequencing in visuals and sound were governed by the character of visitors' movements through the stairwell. A video camera was installed to survey the "stage" before the disused lift. The amount and character of movement in its image stream determined the composition and energy of the interactive audio-visual response.

Fig. 6. A perspective of the stairwell (a digital rendering)

Performative Situations

Fundamental to the project was a theoretical perspective that understood architectural environments as time-bound performative situations made up of social, practical and motivational involvements. One of the project's ambitions was to establish a workflow that could lead to a synergy between traditional architectural concerns and the situations of direct engagement as developed by performance practitioners, game designers or, recently, by new media artists.

The goal was not to create a "beautiful" object but to set up conditions for the emergence of meaning. For example, the audio-visual field of the installation would come to life only with the arrival of people who cast shadows, moved through the structures, assumed and shed social stances. The installation did not have a meaning by itself, as a structure devoid of people. Rather, its meanings emerged as a story of tensions: between the perfect completeness of the digital and the untidy of the physical, between ambitious concepts and practical constraints, between goals seen as the desire to make objects and goals seen as playful exploration that is meaningful in its own right. The work on this project strived to develop and test the techniques that could help to erode the boundary between the digital and the physical by establishing multi-modal and open-ended design processes able to accept and guide imagination and respond to inputs normally left outside of the architectural domain.

For additional information on this project and the related concepts, refer to our formal papers (Artopoulos, 2006 and Roudavski, 2006).

Acknowledgements

Giorgos Artopoulos and Stanislav Roudavski were responsible for the production, direction and the bulk of work on the project. However, the project would not have been possible without the generous help of more than fifty people. In particular, we would like to mention content contributions from Andrew Kudless (programming), Chris Rogers (interactive system development and programming), Panos Demopoulos (sound), Iannis Artopoulos, Popi Iakovou, Nikon Microscopy (USA) (source images). We are also grateful to the following organizations for financial support: James Cropper (UK), Kappa Attica (UK), Automated Cutting Services, Ltd. (UK), Buro Happold Engineers (UK) and several Cambridge University bodies (CUMIS, Kettle’s Yard, King’s College, Queens College and Worts Fund Committee).

References

ARTOPOULOS, G., ROUDAVSKI, S. (alphabetically) and PENZ, F., 'Adaptive Generative Patters', in *Proceedings of The Second International Conference of the Arab Society for Computer Aided Architectural Design (ASCAAD 2006)*, ed. by Jamal Al-Qawasmi and Zaki Mallasi (Sharjah: The Arab Society for Computer Aided Architectural Design (ASCAAD), 2006)

ROUDAVSKI, S., ARTOPOULOS, G. (reverse alphabetical order) and François PENZ, F., 'Digital Design Techniques for Adaptable Systems: Prague Biennale Pavilion', in *GameSetAndMatch II: The Architecture Co-Laboratory on Computer Games, Advanced Geometries and Digital Technologies*, ed. by Kas Oosterhuis and Lukas Feireiss (Rotterdam: Episode Publishers, 2006)

KUDLESS, A., 2005. *Material Systems Organization* [online]. http://www.materialsystems.org/ [Accessed 9 November 2005].

WEISSTEIN, E. W., 2005. *Voronoi Diagram* [online]. http://mathworld.wolfram.com/VoronoiDiagram.html [Accessed 9 November 2005].

Developing Cyberspace Design as a Digital Extension to future Interior Spaces

[A Genetic Programming (GP) Approach to Cyberspace (Modeling)]

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Abstract.

As architecture enters the new era of digital representation, geometrical theories and processes are being implemented, tested, and pushed to their limits. Recent theories of form in architecture have focused on computational methods of form exploration and expression. From "topological geometry" and hypersurfaces to blobs and folds, there is a clear tendency to seek and explore formal properties as sources of ordering systems. Through computational methods and algorithms, geometry, as we knew it, is being redefined and reconfigured.

Many algorithms have been developed in the past, however recently evolutionary techniques have emerged as an alternative approach to their solution. In this paper, a Genetic Programming (GP) approach, one variation of evolutionary computation, is discussed. A representation of cyberspace interiorities (modeling) problem suitable for genetic programming is presented along with some implementation details and results.

1. Introduction

The Internet, in its diverse manifestations and applications, is showing us daily the traffic of our global consciousness, allowing us to rapidly modify input and output through the formless medium of cyberspace, where time contracts and matter-consciousness is disabled by communications based largely on mind rather than body [1]. That ongoing transition from energy to information helped to discover new space within information, a space free from limitation of the physical world and amenable to explorations of alternate laws .within this space we created new public realm in search of architecture appropriate to its nature. Cyberspace is fast becoming an extension of our physical and temporal existence [2].
For Marcos Novak [3], cyberspace as a whole and networked virtual environment in

particular, allows us to construct ‘spaces for human inhabitation’ in a completely new kind of electronic non-local, public realm and to think in terms of genetic engines of artificial life. Novak is convinced with the idea of the inhabiting in the cyberspace [4]. Cyberspace is more than a breakthrough in electronic media or in computer interface design. With its virtual environments and simulated worlds cyberspace is a metaphysical laboratory, a tool for examining our very sense of reality [5]. The new extensions, of man and the environment they generate are the central manifestations of the evolutionary process [6].The process that extends to form "Evolutionary architecture" which is the digital embodiment of the dream of an unfettered, creative process. Just as architecture defines people's environments, so too do people define architecture's. There seems no more logical way to achieve harmony than to set the two evolving together [7].

As Karl Chu [8] points out the infinite value of cyberspace in comparison with physical world, he suggests that the actual limits of cyberspace are the limit of computer. By mentioning the infinity of cyberspace, he presents the logical inevitability to use digital based world as a territory for architecture and the computational capability to generate an artificial living form with the ultimate complexity [9]. Genetic algorithms, by specifically addressing the temporal and evolutionary aspects of cyberspace, provide us with the access to new environments and the ability to design complex and meaningful spaces within them [7]. The use of Genetic algorithm model is the evolution of virtual spaces actively engages this abstract notion of accessibility. The algorithm presented here and its use in evolving virtual spaces has tested the feasibility of a paradigm for design with new implications for the theory and practice of architecture [7].

2. Research Problem

One of the central challenges of computer science is to get a computer to do what needs to be done, without telling it how to do it. Genetic programming addresses this challenge by providing a method for automatically creating a working computer program from a high-level problem statement of the problem. Genetic programming achieves this goal of *automatic programming* (also sometimes called *program synthesis* or *program induction*) by genetically breeding a population of computer programs using the principles of Darwinian natural selection and biologically inspired operations. The operations include reproduction, crossover (sexual recombination), mutation, and architecture-altering operations patterned after gene duplication and gene deletion in nature. The genetic programming paradigm represents a leap forward in the ability to optimize computer programs in a wide array of fields. It is a unique departure from the standard genetic algorithm model. In that it circumvents the need for a phenotype which is usually responsible for providing the context for fitness evaluation.

Inside Cyberspace man experiences a new feeling of freedom some thing which looks like a dream in it's purity and transparency, but the true challenge which may face the cyberspace designer, is that he was used to face certain obstacles and barriers in space of reality, which may oblige him to follow some rules concerning Architectural Data, Ergonomics, and many other natural given facts like weather, wind directions, sun rays, law of gravity etc. But now inside such free world known as cyberspace all obstacles and rational facts have been removed to open the horizons of the designer's pure imagination the thing which stimulates debate & questions concerning the relation between inner and outer space, solid & void and the truth about the virtual enclosure of net- architecture. All that may lead the designer to search for some alternative rules & boundaries or let's say some new design strategies & concepts, inspired from his own visualization, memories, culture & background but at the same time must achieve interactivity with the space visitors(participants) whom may accept it not to be reasonable but will never forgive being not comfortable. Moreover producing representations of morphological changes in form and space requires different level of skill than the more basic task of generating so called "flythrough'. So the question is; should cyberspace designers produce their own algorithmic self-learning tools, such as the work of john Frazer and team (evolutionary architecture), or is it a perfectly reasonable position for the designer to rely on the algorithms that come with the various software packages? [10].

This paper tries to develop algorithms and computational methods that would encapsulate the processes that lead to the generation of alternatives of cyberspace interiorities and that is by the use of Evolutionary design concepts to create design alternatives in a spontaneous way by using GP and this will be applied on a cyberspace project called Peace Shelter [navigable space] (fig 1).The project aims at investing and exploring the structures and processes, of algorithmic design to develop a topological body that inhabits cyberspace and is characterized by its complicated geometrical and mathematical non-Euclidean model using a couple of different softwares. The project "Peace Shelter" is based on the idea of spreading peace among children and teenagers allover the world and achieving interactivity and communication between the children who belong to different cultures and back grounds which may increase awareness of such children and give them strong assets and resistance to face war lies and hatred and let them grow in a better atmosphere and be able to deal with problems, such project will also help to raise a new generation of young people who have better knowledge and able to deal with others and accept different thoughts and points of view.

This project can act like a "Virtual Peace Shelter" which envelop the children and let them navigate through it and be opened to a huge amount of information transmissions and offer them new experiences to enjoy different activities. The project therefore is based on the concept of a (communication chain) working out a global communication concept using each element of the chain as a dynamic vector of diffusion and access to information.

Genetic programming will be used for applications in the field of spatial Composition which could be used to generate spatial forms inside the cyberspace from a set of geometrical structures, deformations and other given cases therefore the process will pass by two main phases:

- -learning by case
- -predicting new cases

And that takes place by choosing number of cases and features which will be transformed into a mathematical formula (in puts) to facilitate dealing with GP and let it generate new cases (out puts) to facilitate the design process in the future.

fig(1) Peace Shelter, Interior view of the play area.

3. Significance & Future work

The future work involves the identification of a larger number of cases and transforming it into a mathematical formula so it can be manipulated by the GP to help generating new
Design alternatives of spatial forms inside cyberspace which represent different generations which will facilitate the design process and help the designer to focus on innovation rather than wasting a lot of time and effort in dealing with such sophisticated non-Euclidean virtual structures.

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*References

[1] Gluck, Jeremy S –<u>The Transparent Revolution: Spiritualizing Cyberspace</u>- Published paper.
[2] Kalay, Yehuda E. & Marx ,John -<u>Architecture and the Internet: Designing places in cyberspace</u> - Published paper, *First Monday,* volume 11, number 2 (February 2006).

[3] **Marcos Novak**, A pioneer, a traveler through alien architectural terrains. His seminal work has included
many virtual architectures and essays that is crucial to those architects who are interested in the swiftly blossoming architectural cybertheory.

http://www.aud.ucla.edu/~marcos[4]
[5]Heim, Michael- The Metaphysics of Virtual Reality/ The Erotic Ontology of Cyberspace- New York: Oxford University Press, 1993: 82-108
[6] Mc Luhan Playboy Interview march 1969
[7] Berto, Daniela-Designing Digital Space-John Wiley& sons, New York, 1996.
[8] **Karl Chu**, originally from Burma, is an architect working in Los Angeles. He has taught and lectured at various universities and published throughout the world. Currently, he works at the theory and design faculty at the Southern California Institute of Architecture (SCI Arc). He is the founder of X KAVYA, a research and development studio dedicated to the re-conceptualization of architecture through the metaphysics of possible worlds. Presently, he is involved in the development of evolutionary computations for the generative construction of hyperstructures in "Modal Space".
[9] www.aac.barlett.ucl.ac.uk/ve/theorypaper.
[10] Burry, Mark- Cyber Spaces (The World Of Digital Architecture) – Images Publishing.

Books

*Ange Brayyer, Morie- Archilab(Radical Experiments in Global Architecture)-Thames & Hudson, 2003.
* Baker, Robin-Designing The Future -Thames and Hudson, 1993.
* Di Cristina, Giuseppa-Architecture& science- Wilet-Academy, 2002.
* Steele, James-Architecture & Computers- Laurence King, Hong Kong, 2000.
* Zellner, Peter- Hybrid Space (New Forms In Digital Architecture)-Thames &Hudson, 2000.

The Abstract Video “Triangular Vibrations”

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Abstract

Triangular Vibrations is an abstract video with surround sound, based on the vibrations of an idealised drum (circular membrane). The vibrations of the drum generate both sound and image.

1. Modes of Vibration

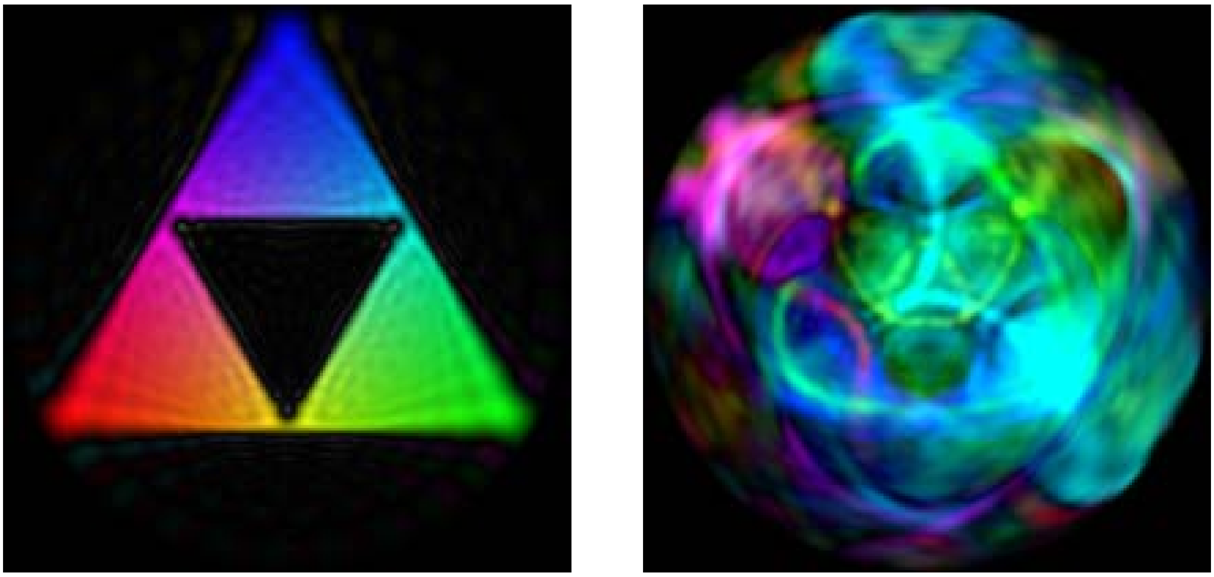
Triangular Vibrations is based on the idea that an arbitrary displacement of a circular membrane can be analysed as a sum of modes (Fourier-Bessel modes) [1,2]. If we hit a drum with a triangular hammer, for example, this triangular displacement can be expressed as a sum of certain modes, in a way analogous to representing a waveform as a sum of sine waves. To represent a triangular impulse exactly an infinite number of modes is needed; if a finite number of modes is used, the representation will be somewhat blurry.

In *Triangular Vibrations* three superimposed drums are used, coloured respectively red, green and blue. Nine hundred modes are used for each drum. The representation of the initial impulse at the start of the video is shown in Figure 1 (left); it appears a little blurry, and also a mottled pattern has been induced in it, as a consequence of the limited number of modes used for each drum.

Each mode of vibration has a natural frequency associated with it. The modes are not harmonic, that is they are not integral multiples of a fundamental frequency. For example, the red drum has lowest frequency 50 Hz and second-lowest frequency 79.7 Hz. The green drum has lowest frequency 100 Hz and the blue drum 200 Hz. The mode with the highest frequency has frequency 11 320 Hz.

2. The images

The images show the vibrations of the modes greatly slowed down, by a factor of approximately 18 000. These slow oscillations are quantised, in that each mode undergoes a whole number of oscillations during the video, with the lowest frequency mode executing just one vibration. This was done to provide a coherent stopping-place for the video, as otherwise, since the true frequencies of the modes are inharmonic, the modes never come back into any sort of synchronisation. The quantisation means that the video is symmetric about its midpoint.



. **Figure 1: The start of the video (left); a frame from the middle of the video (right).**

3. The sound

The sound consists of the various modes heard at their natural frequencies (not slowed down and not quantised). However, each audio mode is modulated (faded in and out) according to the speed of its slow video counterpart.

The slow vibrations are also used in the distribution of the sound in the surround space. There are two sorts of drum modes, those with circular symmetry and those with lower symmetry [2]. The sounds for modes with circular symmetry are treated as omni-directional signals. For the modes of lower symmetry, it is possible to associate an angle or direction to each mode. The sound corresponding to the mode is treated as a point source oscillating back and forth in the appropriate direction, something like a pendulum, with speed according to the video modulation of the mode. The sound is then distributed, treating the five speakers of the surround set-up as a quad array with an additional front centre speaker.

The glissando effect heard during the piece is an illusion, in that each mode has a fixed frequency. The effect arises from the way the different modes fade in and out.

4. References

[1] Strauss, Walter A. *Partial Differential Equations*. New York: John Wiley & Sons, 1992, pp. 251-256.

[2] Fletcher, Neville H. and Thomas D. Rossing. *The Physics of Musical Instruments*. New York: Springer-Verlag, 1991, p. 74.

Cross-Section: Performance

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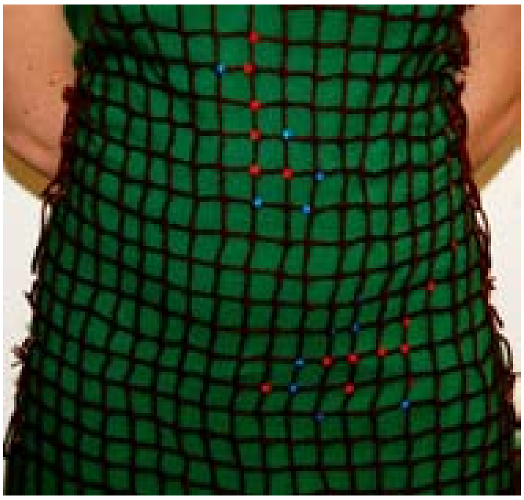
Cross Section uses a gameplay of Omok, an old Asian game, as a main performance vehicle. The concept grew from a strong belief that its constant pattern recognition and reactions created in playing the game are reflective of interactions and dichotomies found in different social contexts.
The game involves a different sex pair. Players alternate placing stones on a grid, which is on the body of the female player. The game ends when five-stones-in-a-row, horizontally, vertically, or diagonally, has been achieved by one of the players.
The sound is also an integral part of Cross-Section and it consists mainly of a spoken text, which reflects what is considered ideal, good and "expected" of people. Those texts are generated when each player makes a move. Therefore, each game, although same rules are applied, results in a different pattern and a different set of texts.

Figure 1.



Hypothetical Gene Movement: Structural Animation

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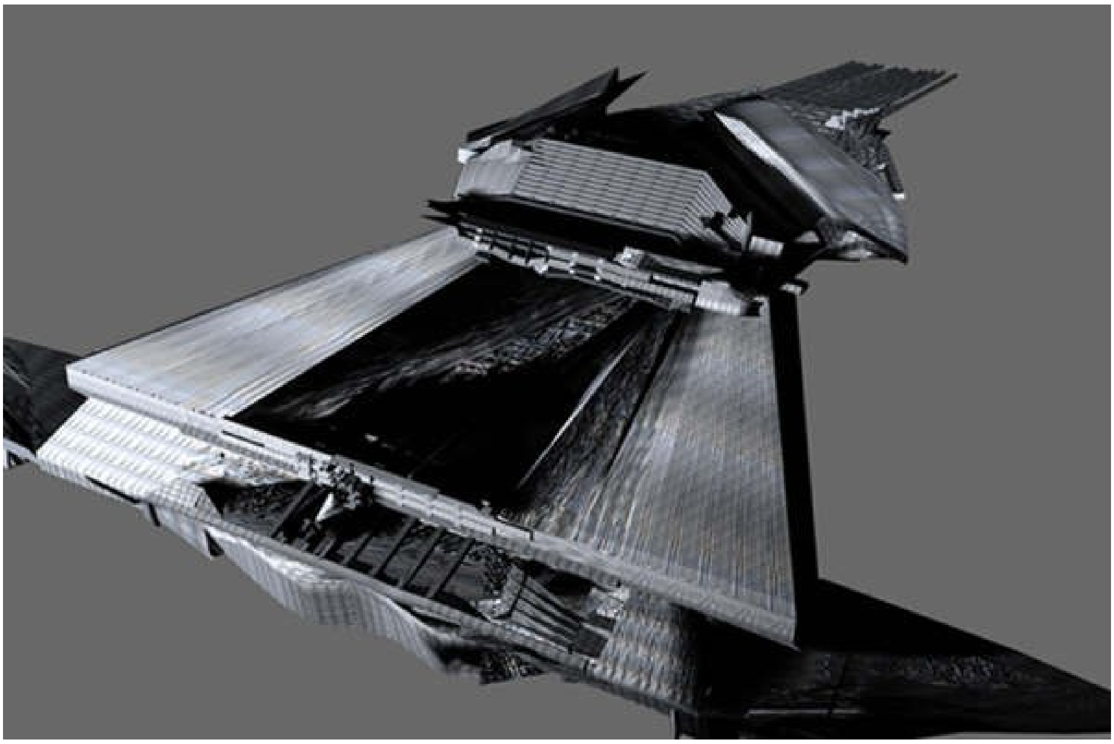

ABSTRACT

Dual Passages II concerns the dialectical relationships, tensions, conflicts, between opposite images that signify layers of the human mind, psyche and spirit that have been conditioned and structured, and other dimensions that are in transition. The content of **immaterial and material** '*explores inner movement'*, which '***encapsulates** rigid structures and which **extenuates** scanned ray-like forms to explore boundaries inside & outside* of the structures. The vehicle for the immaterial and material aspects in the work, forms a language, (open to interpretation but has resemblances to machines and engineering structures**), *to make material that which is immaterial*.** The sensed things of the environment form striations that produce forms that is incomplete, becoming, and impermanent to allow creative regeneration. The *'constructions of movement',* for inner states of the human condition, take the form of infrastructures as signifiers, which are suspended in space, which are reflexive and transitory.
The work explores an exegesis of '*resonant image forms'* that are essentially immaterial and that signify other multi-dimensional, unseen aspects of human psychology perceptive systems that interpret via memory, recollection, data, and the mind/bodies sensory abilities of the present and the environment. Crossing transactions, transversals, trajectories, fissions, interweave and hope to question a dialogue of parallaxes or states of inner being, particularly experiences of darkness, because perception in darkness can bring us closer to realties.

The 3D structural animations and explore branching, regeneration, morphing, & restructured forms continue to grow and create new structures.

Structural Animation: MAYA, 3D Studio Max, Motion Builder, Genr8, Sound & interactively image processed by software sound operators, and midi controllers.

BODY DEGREE ZERO-INTERACTIVE PERFORMANCE

Alan Dunning -Paul Woodrow-The Einstein's Brain Project

Description

Two participants are wired to various biolelectrical sensors ranging from electrodes that track brain waves to sensors attached to the skin which record galvanic skin responses. The sensors track the participants' activity and bioelectrical output and visualize this in real-time in the form of synthesized and manipulated images which are back projected onto two large screens in front of the participants.
Accompanying the images are sounds generated from the activity of the participants. Local environmental conditions are monitored and streamed into the system where they modify the participants' data. As the resultant mix becomes more and more complex and its characteristics more and more an amalgam of the three data entities, it becomes increasingly uncertain as to what is being represented, and exactly what space this new recombinant form demands as the participants' identities are lost in the ensuing environmental data storm.

Using EEG electrodes connected to a PC via a Mindset24 EEG system,, and custom EKG sensors connected to a Macintosh computer via Teleo hardware, evoked potentials are translated into sounds and forms using, respectively, specially designed data acqisition modules in EONReality, and MAX/MSP/Jitter The sounds and images produced are of two kinds: those that are limited in interpretation and clearly indexed to bio-activity and those that are polysemous and open to interpretation.
The visualization is a combination of abstract generated forms and found imagery. The frequency, amplitude, and percentage differences between samples of incoming data are mapped to forms moving in computer 3-space. The data is used to change the position, scale, shape and physics of simple primitive meshes where each vertex of the mesh starts at 0, 0, 0, and the object has no velocity, mass or other property. The incoming data is visualized as spikes, amoeba-like blobs and particles that indicate the degree of activity of the participants. Random numbers create noise in the system creating errant and misleading signs. Some visualizations are easily identified: the throbbing of a shape is a beating heart, the increase in particle production is a rise in GSR. Others are suggestive rather than indicative: taking the form of erratic, distorted, cinematic or historical images which are streamed into the space or mapped onto primitives, or of shapes morphing from one form to another too rapidly to comprehend. Similarly, sounds are generated in real-time using a software synthesizer, and are an index of peak voltages, frequency and percentage differences. Data is mapped to harmonicity - values close to whole numbers are harmonious while fractional values produce inharmonic timbres. Data sampled over longer periods is mapped to the spatial properties of the sounds and
images: the degree of movement and orientation of objects, images and sounds varying proportionally with respect to the general dynamism of the participants. As data from the participants indicates a rise or fall in bio-activity, so texts and images relating to corresponding highs and lows in the film are sent to the screens.

Invisible World is an installation that draws its content from the context within which it is placed.

Based on principles of Electronic Voice Phenomenon (EVP) the work uses video and audio noise as a malleable medium to suggest a means to replay traumatic events recorded in the material of the architecture of the installation site.

Invisible World

The work investigates the characteristics of specific sites by evoking memories potentially embedded within the electrical atmosphere and physical material of the location. This work suggests that there is a complex relationship between physical sites and the viewer that goes unnoticed in everyday life. The bio-electric body is in constant interaction with electromagnetic fields that surround it, and the movement of these fields activates changes within the body. In terms of Generative Art the installation clearly demonstrates the possible employment of latent and undeveloped sources of energy in the urban environment which can be transformed into innovative configurations.

Scientists have suggested that electromagnetic fields can cause hallucinations and visions in individuals. Such visions might be the result of induced electrical currents and distorted fields in the visual cortex being transformed directly into images in the brain, just as trans-cranial magnetic stimulation of the brain's language centres has been seen to damp or produce disembodied voices or out of body experiences. New advances in technology make it possible to induce and observe these phenomena, compelling us to recognize the power of technology to create new worlds.

"Residual haunting is thought by some to be a replayed haunting in which no intelligent ghost, spirit, or other entity is directly involved. Much like a video tape, residual hauntings are playbacks of auditory, visual, olfactory, and other sensory phenomenon which are attributed to a traumatic event, life-altering event, or a common event of a person or place, like an echo of past events. Residual hauntings often center on moments of intense emotion: someone's beheading, a great battle, a murder, or even a celebration. Paranormal researchers theorize that residual hauntings are the result of discharged personal energy of a person or group of people being imprinted on the surrounding environment, most commonly at or just after death." (Wikipedia)

This project uses ideas about residual haunting and Stone Tape theories to suggest that our world is a conflation of time and space. The Stone Tape theory is a popular possibility for parapsychologists to explain ghostly events. It is an example of our ongoing sense that there is an invisible world that surrounds us, and that the experience of this world does not rely on the perception of visible external data, but, rather, everything is perceived in the mind.

EVP

Electronic Voice Phenomenon is the recording of errant noises or voices that have no explainable or physical source of origin. These recordings are made when the recorder is alone, or under controlled circumstances.

It has been argued that the voices are simply subjective interpretations - that we tend to hear voices in random patterns of sound, in the way we recognize forms in random visual patterns. For others, the voices are genuinely mysterious, opening up the possibility of communication with the dead.

This installation uses the ideas inherent in EVP to examine ways in which we construct the world through pareidolia, (a psychological phenomenon involving a vague and random stimulus - often an image or sound - being perceived as significant), apophenia (the seeing of connections where there are none) and the gestalt effect (the recognition of pattern and form).

Using techniques of EVP the installation sets up an environment in which participants can listen to noises generated from apparently silent spaces.
The Installation

In this installation internal noise from a CCD in a light tight box is mapped to audio by sampling pixels in a Quicktime matrix and using the values to manipulate white noise.

Software looks for similarity between the noise and a very large set of spectrograms of spoken words. When two are congruent enough the results are spoken by the computer and projected into the space.

Software pans across and zooms and changes the blur, brightness and contrast of the camera noise, as it looks for hidden images. These are standard EVP strategies for teasing images and sounds from visual and audio noise.

The context of the installation, its location, architecture and history, ultimately establishes the narrative.

For plan of the installation and documentation of previous exhibition please go to the Invisible World link:

http://www.ucalgary.ca/~einbrain/Invisble_World/invis.html
http://www.ucalgary.ca/~einbrain/Invisble_World/rosariob.mov

CRUFT

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Abstract

"CRUFT"
Borrowing the computer hacker term "Cruft" I have applied it to my current series of images. I create these CRUFT images by writing 'recipes' (also known as an algorithm). These scripts are written in shell script and perl, using imagemagick for command line image manipulation. An automated system follows the instructions, first harvesting selected source material from the Internet, and then processing that information into a CRUFT, generating images 24 hours a day, 7 days a week.

"Distress Cruft (my fellow americans)"

"Distress Cruft (my fellow americans): Visitors to the Empire State Building are required to have their photo taken. This security photo is cleverly disguised as a tourist friendly service with a beautiful night view of the Empire State in the background. You and your party then have the ability to purchase this photo as you leave the building. (When I tried to opt out of the photo, I was specifically told I could not for security reasons.) This cruft process downloads one of these photos andcreates a composite image with an American Flag.

Section 8a. of the Flag Code states: "The flag should never be displayed with the union down, except as a signal of dire distress in instances of extreme danger to life or property."

URL:
http://www.robertspahr.com/work/cruft/distress/
"Crayon Cruft (Childhood's End)"

This cruft process downloads an image from the Arabic website "Asharq Alawsat" (http://www.asharq-e.com/). From one hundred official Crayola Crayon™ colors, one is selected and a composite image is created.

URL:
http://www.robertspahr.com/work/cruft/crayon/

"Babylon Cruft"

This cruft algorithm extracts images from the United States Air Force site (www.af.mil) which are then combined with images from Internet sex sites.Theimages are manipulated and a composite is then created.

URL:
http://www.robertspahr.com/work/cruft/babylon/

Brief Bio:

ROBERT SPAHR B.F.A., Art Academy of Cincinnati, M.F.A., Parsons School of Design.

Robert Spahr is a visual artist and educator, who produces digital images, generative art programs, and time-based media. He lives in NewYork City.

Internationally his work can be seen in festivals such as: Online Gallery D-ART 2006, London, England and the CGIV 2006, Sydney, Australia; Trampoline Event #19, Nottingham, United Kingdom; Hz Journal, Stockholm, Sweden; 6th International Salon of Digital Art, Havana, Cuba.

Nationally his work can be seen in exhibits such as "Adding Insult to Imagery? Artistic Responses to Censorship and Media" at Indiana University of Pennsylvania which then traveled to Central Missouri State University in September 2006, the recent edition of the refereed on-line journal DrainMag.com, as well as the festival and symposium "2006 Perform.Media" hosted by Indiania University in Bloomington.

Teaching experience includes the University of the Arts, Hartford Art School, Dowling College and the State University of New York, Purchase College. He has been a visiting artist at the Art Academy of Cincinnati, and Xavier University.

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Dynamic Painting

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The Dynamic Paintings I'm designing are examples of generative art - an art that has been generated algorithmically by a computer system. There have been many attempts at producing generative art; the history of it goes back to the early days of computer development. Many of these works have used fractals and pretty much none of them accounted for more than just basic artistic principles. This is not the case for my Dynamic Paintings. I'm a strong believer that innovation is often born when several drastically different disciplines come together, and I think that being an experienced programmer and an artist gives me an edge.

Another big challenge with dynamic pictures has been the inadequate computing power of personal computers to handle advanced algorithms that describe artistic principles of a computer generated painting. My technology uses powerful video cards to generate real-time images that rival most of the conventional contemporary paintings that cost thousands of dollars. This is not something that has been attempted before. Also, being able to generate images in real time enables me to set paintings in motion and create a new experience never seen before. The painting is always in the state of a perpetual transformation. It never repeats itself. Every time a new image is created, there is an opportunity for a peaceful receptivity and then the work disappears forever.

Many of the modern CPUs are still not powerful enough to generate these images in real time; only the latest developments in programmable video cards (GPUs) have made this technology possible. Instead of using video cards for rendering 3D images like video games do, my technology taps into the video card's raw computing power. Painting algorithms, translated into pixel shaders - programs used by GPUs - painstakingly construct paintings pixel by pixel at any desired resolution with an unprecedented level of detail. This is an example of using video cards for what is called general purpose computing on GPU (GPGPU). The rendering engine is constructed in such a way that we are not limited by the video card's native resolution, so I am able to produce images as big as 80 to 100 Mpixels for printing on a real canvas.

I'm confident that dynamic paintings will be widespread in the near future. The falling costs of powerful computers and high-quality LCD or plasma TV panels will make it affordable and widespread. The benefits of this genre are obvious: an endless supply of unprecedented and unpredictable paintings in place of one static image.

How the Ai art works?

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Abstract

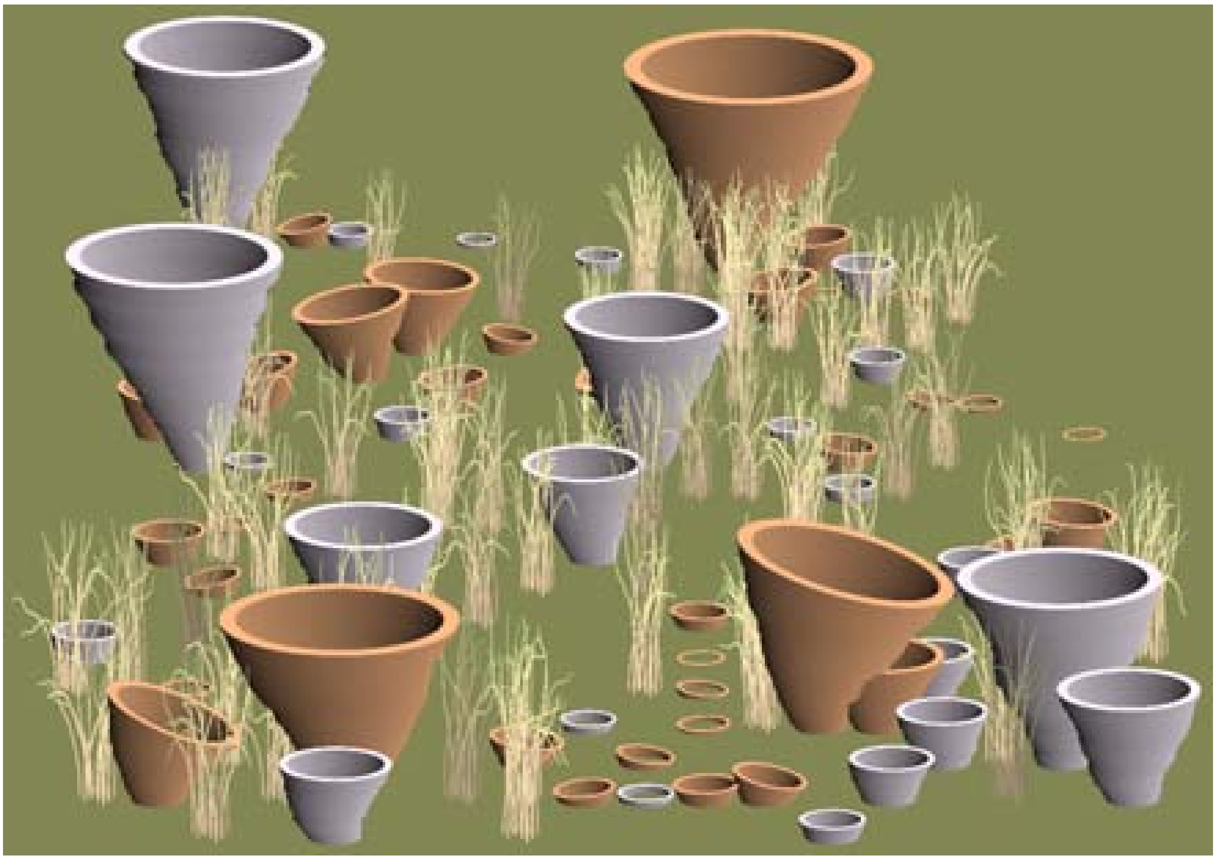
Ai art enables the rendering of arbitrary sized graphical images. It features a two dimensional (2D) graphical space, and some advanced possibilities of graphical definition, for example recursion. It is

1. The Program

It was a command line program for unix-like systems. It is an environment for editing and rendering design grammars Features:

- Simultaneously available for Macintosh, Windows and Posix/Unix.
- Progressive image update: watch it generate
- Save generated images in PNG or SVG format.
- Produce animations
- Edit grammars and re-render easily.
- Render very large images (as large as 100 Mega-pixels).
- Can handle generated images with millions of shapes.
- Carefully tuned graphics rendering

2. The Output



```
//----
//---- T U B U L E   G A R D E N
//----
//----
//----
//----
startshape garden
background { b -0.5 sat 0.4 hue 64 }
rule garden
{
	20* { y 1.5 z -1000 s 0.98 } row { x -25 }
}

rule row
{
	20* { x 2.5 } plant { }
}

rule plant { tubule { sat 0.05 h 300 } }
rule plant { segule { sat 0.5 h 26 } }
rule plant 2 { straw { sat 0.3 h 32 b 1 } }
rule plant 7 { }
```

```
// *********** SEGULE ***********
rule segule 0.037
{
	ringule { s 0.95 0.28 b 1 }
	ringule { s 1 0.3 b 1 }
}
rule segule
{
	ringule { s 1 0.3 }
	segule { r 1.2 y 0.02 s 1.01 z 1 }
}

rule segule
{
	ringule { s 1 0.3 }
	segule { r -1.2 y 0.02 s 1.01 z 1 }
}

// *********** TUBULE ***********
rule tubule 0.06
{
	ringule { s 0.95 0.28 b 1 }
	ringule { s 1 0.3 b 1 }
}
rule tubule
{
	ringule { s 1 0.3 }
	tubule { x 0.02 y 0.025 s 1.01 z 1 }
}
rule tubule
{
	ringule { s 1 0.3 }
	tubule { x -0.02 y 0.025 s 1.01 z 1 }
}
rule tubule
{
	ringule { s 1 0.3 }
	tubule { x -0.01 y 0.025 s 1.01 z 1 }
}
rule tubule
{
	ringule { s 1 0.3 }
	tubule { x 0.01 y 0.025 s 1.01 z 1 }
}
rule ringule
{
	180* { r 1 b 0.008 } CIRCLE { x 1 s 0.09 z -0.1 }
	180* { r 1 b 0.008 } CIRCLE { x -1 s 0.09 z 0.1 }
}
```

```
// ************ STRAW *************

rule straw { straw { b -0.1 } }
rule straw { straw { b 0.1 } }
rule straw
{
        wheat { s 1 0.3 }
        wheat { x -0.2 y 0.2 s 1 0.3 }
        wheat { x 0.2 y 0.2 s 1 0.3 }
}
rule wheat
{
        root { flip 180 s 0.05 0.5 }
}
rule root
{
        grow { x 0 y 0 b -0.2 }
        grow { x 5 y 1 }
        grow { x -5 y -1 }
        grow { x 10 y 0  b -0.2 }
        grow { x -10 y 0 b -0.1 }
}
rule grow { jump { } }
rule grow { jump { flip 90 } }
rule jump
{
        spot { }
        jump { y -0.2 r 0.5 s 0.9968 h 0.08 }
}
rule jump 0.03
{
        spot { }
        jump { y -0.2 r 0.5 flip 90 s 0.9968 h 0.08 }
}
rule spot
{
        SQUARE { }
}
```

Is it possible to defend an optimistic view for the future generations?

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Abstract

This article reflects the actual worry about the destruction of the nature and the future o four planet. The acts of the modern human being are consequences of the traditional science, which imposes the reasoning as the only way for the truth. Nowadays we perceive that the absolut truth do not exist. In consequence of this absence, the human being feels abandoned. As we try to understand issues as diversities, mutations and new technologies, the world gets more and more complex to us. To solve this problem, the human beings need to look around and search for new solutions. This search finds in Ilya Prigogine an inexhaustible source of reflection. The author states that the future is not something established, but in constant build. Another future is possible, it is necessary to act to modify it. In his “Letter to the future generations”, he convokes the young people to act for a different tomorrow. In the same way, the thoughts of Cacique Seattle, 1855, in a letter to the president of the United States of America, are a declaration of love to nature and to the memory of the human being that is into the Universe. As the art is in all the human manifestations, it is fundamental for the rescue of the lost sensibility. Through the humanity existence, man and art have always been partners and this cannot be forgotten. The artist Lygia Clark proposes to the contemporary man the rediscovery of the body through its sensory memory and Franz Krajcberg makes his way of life an alert against the destruction of the nature. Prigogine, Cacique Seattle, Lygia, Krajcberg an people who look for “aesthetic actions” try to show the possibilities of the “Reenchantment of the World” through the creativity and love as future builders.
Key Words: Love, Creativity, Construction, Memory, Aesthetic Action.

1. Introduction

The arts take us to the aesthetic dimension of the existence and - as the proverb that says the nature imitates the work of art - they teach us to see the world aestheticly. (...) It is about, at last, to demonstrate that, in all great workmanship, of literature, cinema, poetry, painting, of sculpture, it has a deep thought on the condition human being. in all great workmanship, of literature, cinema, poetry, painting, of sculpture, it has a deep thought of the condition of the human being. (Morin. 2000:45)

This communication is composed for a break up of the thesis - “The Organic-Machinery Semiose and the Hipercomplexity of Human being in the Evolutionary Process” - of Heloisa Helena da Fonseca Carneiro Leão. The research states to the return of the unit of the man, for the rational and the sensible thoughts. The use of sensitivity makes the man to see the nature as its partner. The base of the work finds in Ilya Prigogine, Seattle Chieftain, Lygia Clark and Franz Krajcberg basic echoes. The actions in defense of the nature had not been understood in the past, as the speech of the Seattle Chieftain in the year of 1855. The chieftain in reply, to the North American government, called the attention on the continuity of the transiency of life, facing the threat of the loss of Suquamish indians lands. The words of the Chieftain, in that instant, had not been understood and received, but today with certainty they would be, as well as Prigogine are. The new environment and climate are propitious for “sensible hearts” to listen to and to assimilate its affirmations, as we verify in the reception of the present time to the concerns and the thoughts of Ilya Prigogine. Beyond the ideas of Prigogine, the research finds pertinent subsidies in the works of some artists, between them, Lygia Clark on rediscovery of the body and Franz Krajcberg with actions on the nature. Another valuable contribution comes of individuals, moved by love, that act in the life and are interested in improving other people lives. This we call “aesthetic actions”.[3]

2. Creativity in the Art, the Life and the Actions

The artistic object has the power to make the receiver to feel, to enjoy and to enrapture when confronted over it. The action to usufruct the work of art is a natural action, it occurs without effort and it awakes instinctive and deep sensations. When the artistic object presents to the receiver, floods its body and keeps it live. Even the strangest work of art provokes life reactions. Alive being is to react, is movement. To discourse on the deep effect of the art, to explain of safe form, the power of the artistic object when stimulating the man, is an arduous, complex task and predestined to errors if there is intention to find a necessary definition.

The aesthetic actions, in the same felt as the art, make the deepest interior of the men act and serves of seeds of information for future acts. It is probable that the love act is conducted by aesthetic feelings, as is impregnated of quality of feeling. Kandinsky affirms that “all art is son of its time” and the artist portrays this time. When showing of sensible form the moment where it lives, the artist, emphasizes, with its work, the mystery of the life. On the other hand, the aesthetic action, for being a love act, is the concretion of sensitivity and the feeling to act at definitive moments. This flow in the time feeds the sígnica chain with the quality of feeling.

The artist, when creating, is worried in opening the eyes of the public to the senses and sensitivity. The same happens when a person practices an aesthetic action. As the two actions play with the feelings, there is the convergence between them. The artistic creation and the aesthetic action construct the individual and help their limitations in life.

3. **Ilya Prigogine**

Prigogine, in her research, explains that the system “life” is not closed and is not in balance, in contrast, is opened and is far from balance. As consequence, from its opening to the environment, it becomes unstable and it suffers disturbances from the system as a whole. Prigogine argues on the importance of the flow of the time, of a time that is not reversible but, irreversible. When explaining that it does not exist a equivalence between past and future, points a new way. This new direction is not linear and makes possible the emergency of the creativity as a constructive element of the future. Calls attention for the event, what arrives without being waited, the contingent, the unexpected one. It affirms the impossibility of if including the creativity in a determined world already.

It is possible that the construction of the future, conducted for the creativity and the aesthetic action, is a evaluative alternative for the XXI century. Our thesis is that the concept of aesthetic creation if extended, through the times, suffered mutations and arrives at the present moment with the probability to modify the evaluative way.

Prigogine argues on the right of choices that the man possesses and show that classic science when creating the determinists and reversible laws, did not respect the flow of the time and did not allow the emergency of the choices. “The classic materialism, that assimilates the universe to a machine, asks for a watchmaker! Instead, a universe that organizes itself is a universe in which you have right to choose”.

The action of the art can obtain the return of the union man/nature. As consequence of this union, the man perceives the complexity of the future. The complexity gives potential to the strength of the present moment in constructing tomorrow, a time that produces diversities and bifurcations. The bifurcations are fruits of the freedom to create ways and the complexity is the optimistically and intermediate way between the determinists, skeptical views of a pessimistic past. The creativity denied in the determinist world becomes the reflecting center in the indeterminate world. Prigogine states that the notion of complementarities between the repetition and the creativity will construct the future.

The union of the reason with sensitivity emphasizes the dialogue between the objective and poetical thoughts and gives potential to the human reflection and the expansion of the mind. The research defends the action of the artist and of individuals in the world, or, proposes and executors of action. The artist, by means of the Percipient Performances, Installations etc., contributes for the development of the relation man/nature for the bias of complexity.

Prigogine, in her optimistically vision, knows that it is not easy to arrive at a happy future. She knows about the difficulty in positively directing the use of the new technologies, a time that commercial interests are in charge. However, it is necessary to be hopeful and look at the future in a nice way, not bitter. For Prigogine, the future is a construction and it always has the possibility of reverting the destructive way.

With this optimistic spirit, Prigogine writes a Letter to the Future Generations with intention to alert youth to take decisions in front of the future:

“It fits to the future generations to construct a new coherence that incorporates the human values and science, something that ends the prophecies as the " end of science ", " end of history " or about the advent of the after-humanity”.

4. **Lygia Clark**:

The modern man, in its evaluative trajectory, concentrated in the vision its important door of perception. The hearing was the second door and the other entrances of perceptions had been relegated to inferior plans. Lygia perceived the importance of the directions to complement the being. Why not to rescue the asleep sensations? If the man is composed by the union of *homo sapiens* and *homo demens*, why to forget *demens* and concentrate only in *sapiens*? Lygia brings for the artist the responsibility to show the alternative ways, to balance and to join this shared and nostalgic body.

Lygia, since 1976, proposes the human being to free its alive sensitivity and live the instant. To free the individual of its mooring cables, it considers: “To live the present moment, the art without art”. Goes beyond when saying that “the modern man must discard itself of this excess of rationalism that is in the heart of the contemporary thought”. The vanguard work of Lygia exactly represents the look of the individual for itself, for rediscovery of lost sensations. Lygia when seeing the body in its totality makes the interior and the exterior dialogue and anticipates the current concern. The body, as unique, points to the inexistence of an interior part and another exterior. “In the sensorial Phase of my work, that I called Nostalgia of the Body, the object still was an indispensable way between the sensation and the participant. The man finds its proper body through touchable sensations carried through in exterior objects itself”.

Lygia Clark calls attention for the necessity to extend the arts in the direction of the exploration of all the directions, not only of the vision. This search for new meanings of ME is a way for a poetical of the body. Lygia affirmed that she was not an artist and yes a propose and, in 1968, she wrote the manifesto:

We are the proposes: we are the mold; to you fits the blow, in the interior of this mold: the direction of our existence.

We are the proposes: our proposal is the dialogue. Alone, we do not exist; we are yours to make use. We are the proposes: we embed the work of art as such and request you so that the thought lives for the action.

We are the proposes: we do not consider nor the past nor the future, but now.

In this manifesto it is possible to understand as the work of art provokes the action and creates the individual. It is almost as a divine action. As it was a life blow. It is the sensorial experimentation that transforms the body. Lygia expands the borders of artistic making, when interacting with the diverse languages, the public and thinking the body. It promotes in 70/80 years a new relation between the artist and the spectator. Of this form, Lygia presents a new position to the artists, who at this time already were worried about the artistic object, for the optics of the reception.

5. **Franz Krajcberg**

Krajcberg, Pole, naturalized Brazilian, felt in the skin pains of the war and, when seeing the forest fires in Brazil perceived that the man does not like to live in peace, he always wants to destroy. From this experience he dedicated to his life and art in the defense of the nature. He affirmed several times that his intention goes beyond the art. The desire of Krajcberg is to contribute in the maintenance of the complexity of the nature. In his work, he uses the residues of the fields devastated by man, that seemed battlefields. The sculptures are done monuments of trunks, twigs and debris of forest fires and deforestations.

The artist engaged with the future of the life argues on his work: “If it is art or not, it is subject for others. It does not matter if the people like or not what I make… My work is the only way to express myself. If I start to cry out on the street, they take me to a hospital of crazy people ". (Franz Krajcberg)

6. **Aesthetic actions to improve the World**

Some actions of individuals and news articles show aesthetic actions, that make the difference:
“The house of the mason turned library” – O Estado de São Paulo - 5/10/2005
“Children who want to make the difference” – O Estado de São Paulo -12/10/2007
“Pensioner Extends Communitarian Pharmacy in the Yard of House” – O Estado de São Paulo - 8/9/2007
“The Dumb That Takes Books to Children” – O Globo 16/9/2007

7. **Conclusion**

The present time of the thinkers, artists and individuals that dedicate to the aesthetic actions, presented here, allow us to believe in another future. These altruistic gestures are full of love and spill life on the life. To dream, to imagine, to project: the period of war yielding place to the one of peace is a possible conquest in century XXI.

The fusing of sensitivity with the reason and the unfolding of this fusing is in the base of the reflections of this work. The affirmations of Ilya Prigogine on the freedom and the creativity in the construction of the future, point in the direction of the love as constructive base of a differentiated future. In the same direction, the function of the artist as proposers of diverse sensations influences the return to the unit of the man. The research emphasizes the aesthetic action as an instrument capable to make possible transformations of lives and behaviors.

We live in an opened system, complex, that allows the emergency of the creativity. Thus, we can imagine that the man in constant contact with the poetry of life, either in works of art or in aesthetic actions, he can modify the evaluative way. In the letter to the future generations, Prigogine defends the action, the optimistically vision and the possibility of the reenchantment of the world. She defends the freedom to act and shows the inherent responsibility to this freedom.

Lygia, when saying that she was not an artist, but a proposer, shows a new position of the artist in front to the public. Krajcberg, when dedicating his life to show the abuses of the man on the nature. These artists, as others, create a new artistic object that is not the final result anymore - the workmanship itself, but the proper act. The action as poetry.

It is possible that the aesthetic works of art, actions and the concern with all of the life obtain the Reenchantment of the world defended for Prigogine. The feeling of the love has the power to nourish and to contribute for the evolution of the cosmos, the nature, and the people. When managing the actions, the love, shows the possibility to occur the so waited transition of the culture of the war for the culture of the Peace. We finish with the phrase of André Comte-Sponville: “Weakest the same love, unhealthiest, earns more than some omnipotence that was without love”. (2007: 45)

8. References

1. The letter of the Seattle Chieftain can be chore in Perry 2006
2. Seattle chieftain. Francis Pierce, president of the United States, considered in 1854 (5) to buy lands of the Suquamish indians. The Seattle Chieftain, head of the tribe, sage of its limitations front to the government decides to accept the order, however, makes a gorgeous speech where he shows the transitorily of the life, a transitorily that is part of the continuity, a time that is full of memories, habits and changes of habits. The aboriginal changes of habits and actions always take in consideration the respect for the nature.
3. The speech later was transformed into letter for Perry (2006) and it is one appeal in defense of the Mother Nature.
4. We leave here registered some news articles that strengthen and illustrate what we call “aesthetic actions”.

“The house of the mason turned library” – O Estado de São Paulo - 5/10/2005 “Children who want to make the difference” – O Estado de São Paulo -12/10/2007 “Pensioner Extends Communitarian Pharmacy in the Yard of House” – O Estado de São Paulo - 8/9/2007

“The Dumb That Takes Books the Children” – O Globo 16/9/2007

5. Prigogine.2002: 74
6. Complexity is on the multiplicity of behaviors, the systems which future we cannot foresee. (Prigogine.2003: 49)
7. The letter, in the complete one, is in the end of the text.
8. Prigogine.2002: 74
9. Edgar Morin shows homo *sapiens sapiens* as *homo sapiens* and *homo demens*. It emphasizes that the freedom to create is on the part of the madness that we find in the reason.
10. (Milliet.1992: 100).
11. (Milliet, 1992: 102)
12. (Milliet, 1992: 119)
13. (apud. Milliet.1992: 156)
14. From the interactivity, the artists prefer to mention as integrators etc.

9. Bibliography

CARVALHO, Edgard de Assis e ALMEIDA, Maria da Conceição. *Ilya Prigogine Ciência razão e paixão*. Trad. Edgard de Assis Carvalho, Isa Hetzel. Belém. Pará: Eduepa, 2001.

MENDONÇA, Teresinha (org). *Ensaios de complexidade 2*. Porto Alegre: Sulinas, 2004.

_______ . *Ciência razão e paixão*. In: CARVALHO, Edgard de Assis e ALMEIDA, Maria da Conceição (org). Trad. Edgard de Assis Carvalho, Isa Hetzel. Belém, Pará: Eduepa, 2001.

COMTE_SPONVILLE, André. A vida humana. SP: Martins Fontes, 2007.

MILLIET, Maria Alice. *Lygia Clark: obra – trajeto.* São Paulo: Edusp, 1992

MORIN, Edgar. A cabeça bem feita. pensar a reforma e reformar o pensamento. RJ:Bertrand do Brasil, 2000

PERRY, Ted. *A carta do Cacique Seattle*. Trad. Alice Galeffi. RJ: Versal editores, 2006.

PRIGOGINE, Ilya. O fim da certeza. In: MENDES, Candido (org*). Representação e complexidade*. RJ: Garamond, 2003.

_______ . Criatividade da natureza, criatividade humana. In: CARVALHO, Edgard de Assis e MENDONÇA, Teresinha (org). *Ensaios de complexidade 2*. Porto Alegre: Sulinas, 2004.

_______ . *Ciência razão e paixão*. In: CARVALHO, Edgard de Assis e ALMEIDA, Maria da Conceição (org). Trad. Edgard de Assis Carvalho, Isa Hetzel. Belém, Pará: Eduepa, 2001.

CO^2nscience

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Abstract

The possibility of an art that encloses the theoretical horizon, the innumerable intentions and the social context, still with an independent and private symbolic space, where aesthetic, cultural and social objects can be ranks in confrontation are the great desire of researcher in the technological art.

The platform of open code in the Second Life, allows cultural and social interchanges, increases the malleability of the individuals, through the net of information that consequently will bring a change in the artistic experimentation contemporary.

A space to cover, to try and to be together for a new type of art that works the subjectivity and the collective elaboration of the direction.

CO^2nscience
This project is in AgenciaClick - Second Life.
http://slurl.com/secondlife/Agenciaclick(119,155,22)

The art in the SL, prepares for a future next, a world of innumerable possibilities abandoning and reconstituted another space inhabited for the humanity until today. We learn to inhabit a world that follows daily pay-conceived ideas of the real world, but where new models of action now can be created by the art. Using the expression of Michel Certeau, we are lodgers of the culture, in the cultural recycling, the invention of the daily one and the organization of the time.

In the Second Life, new modalities of subjectivity if create through the creative possibilities of objects, images and sounds, creative tools to invent new relations with the body, the time, the information of thoughts and behaviors. The art of today can be understood as a work process, a production way that soon that the public reaches, immediately becomes a collective of interator and creator. We affirm now , the public loses its quality of being that one that he looks at, today it starts to have a paper in the accomplishment of the workmanship, existing more space between workmanship and does not publish. We are in the time of the manipulation, the taking of decisions and in the complementation of the technological workmanship. The aura of the work of art disappears according to Walter Benjamin. We work with aesthetic a relationary one.

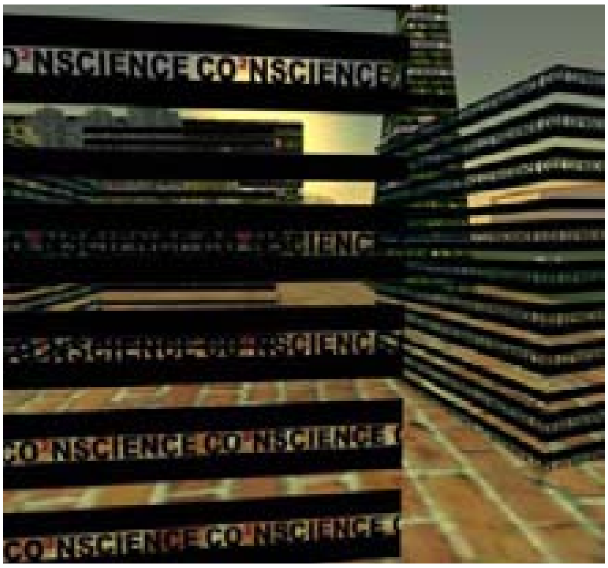
In this environment, the concept of Mijail Bajtin, if reaffirms. For it "does not exist limit between author and spectator when the expression material if converts formal into creative material".

In a similar way that Peter Weibel affirms about the screen of the monitor its looks like as a sponge, space without limits between the action and the interaction. Space of transference, conscientious of accomplishment of the workmanship, as an aesthetic osmosis through the material, that works for personal account, if also disclosing as a plan of concepts and methods, as a hybrid zone. Second Life platform provides a land of privileged experience.

I have been developing the environmental and global warming issue in the Second Life platform. The goal is to question how engaged we are in taking a new stance in order to face this critical real world issue in a virtual world.
The project CO^2nscience leads the SL avatar to try to get free of his own co^2nsciencia. In the SL space, he gets an object, a box that goes with him everywhere he goes. With this object, he feels persecuted by his own consciousness. In SL's interactive platform, he can try to hide from the box, accept it and even select the texture of his consciousness-box, defining his position regarding the problem we are facing. The consciousness-box carries behaviors that do not allow one to leave the expositive space and, thus, at the end of the exhibit, we will have a visual sampling of the general public's awareness regarding this theme.

Taking advantage of the code and of SL's interactivity, I propose the avatars build – or not – a forest. My concern is calling people's attention to the environmental problem we face in the real world, proposing nothing more than people gain real-world awareness in the virtual world. These projects are related to the CO^2science blog, with texts and panoramic images of the glaciers, in addition to photos of other unique locations, with major biological diversity and importance or scenic beauty. The world's "wonders" are being impacted by the CO^2 effect and in danger of disappearing or changing so much they will lose their characteristics. Within this proposal, a series of interactive net art projects explores the SL platform in an attempt to issue a warning and generate awareness about negative actions against nature. The goal is to make the public more sensitive in order for people to exercise their power of decision and survive in a planet that have been changed by people's own actions.

2.1 Figures



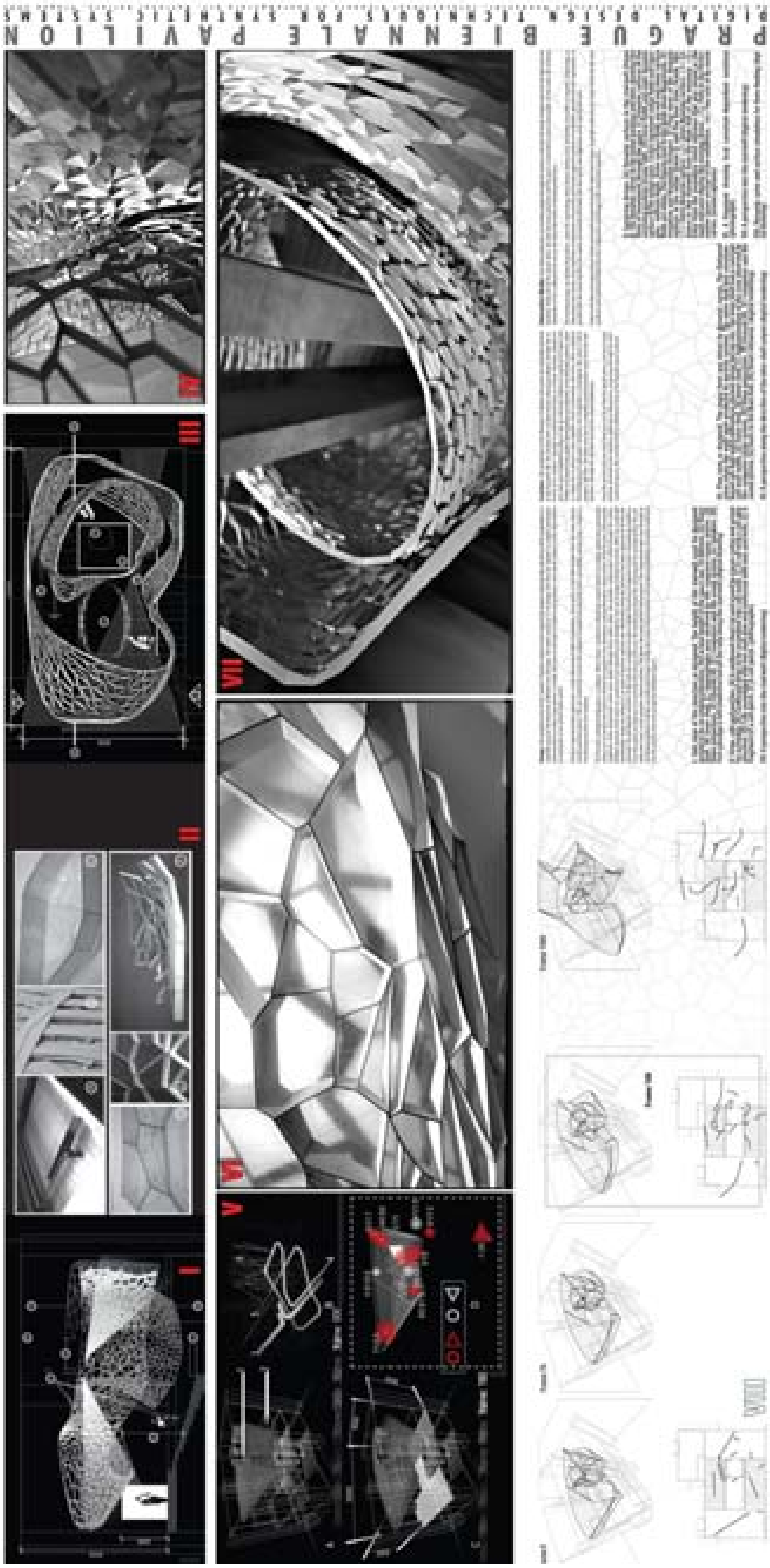

2.2.Some links
www.artzero.net/conscience/index.htm
http://galerianoema.typepad.com/co2nscience/
http://www.noema.art.br/br/

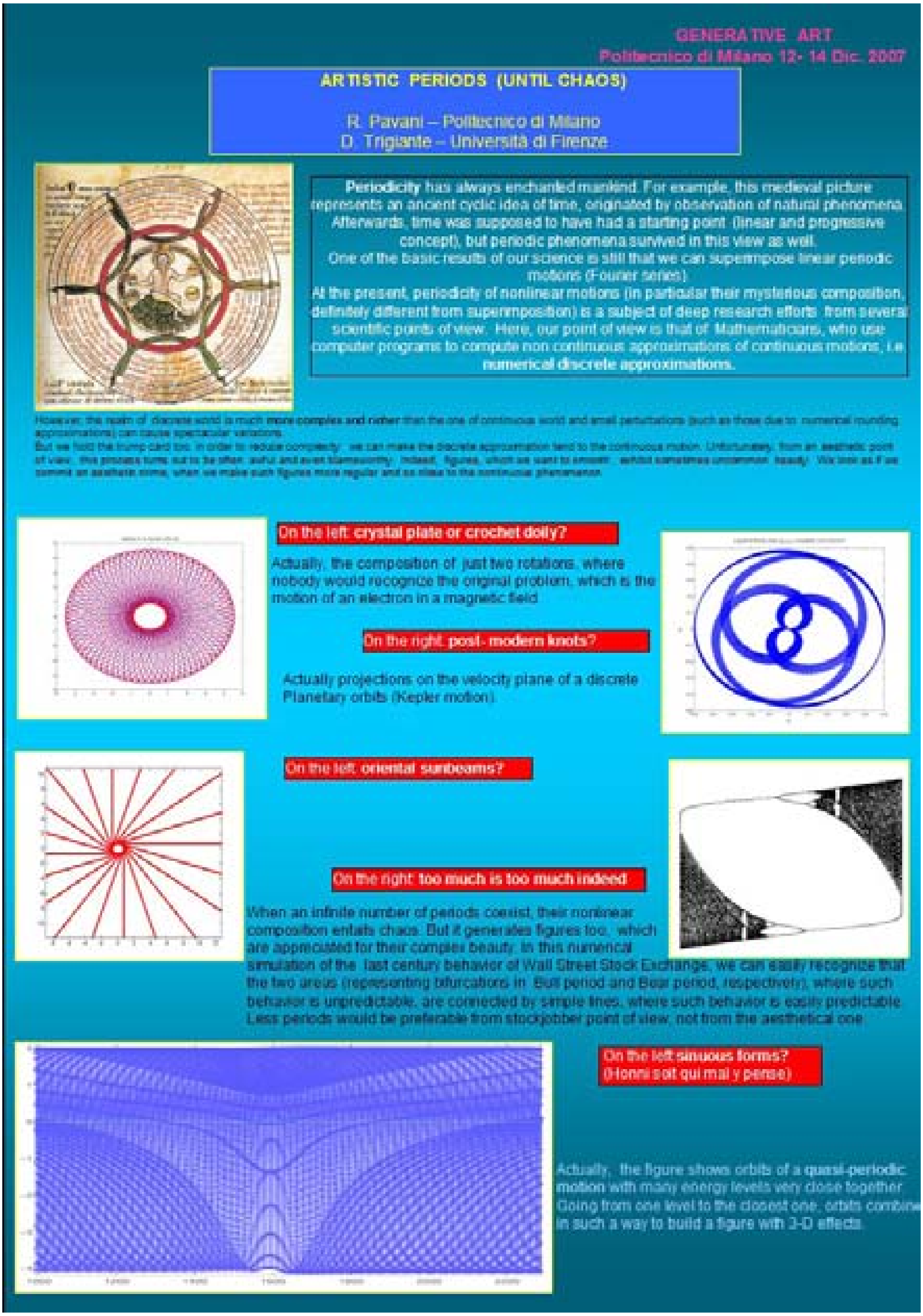
2.3 Bibliography

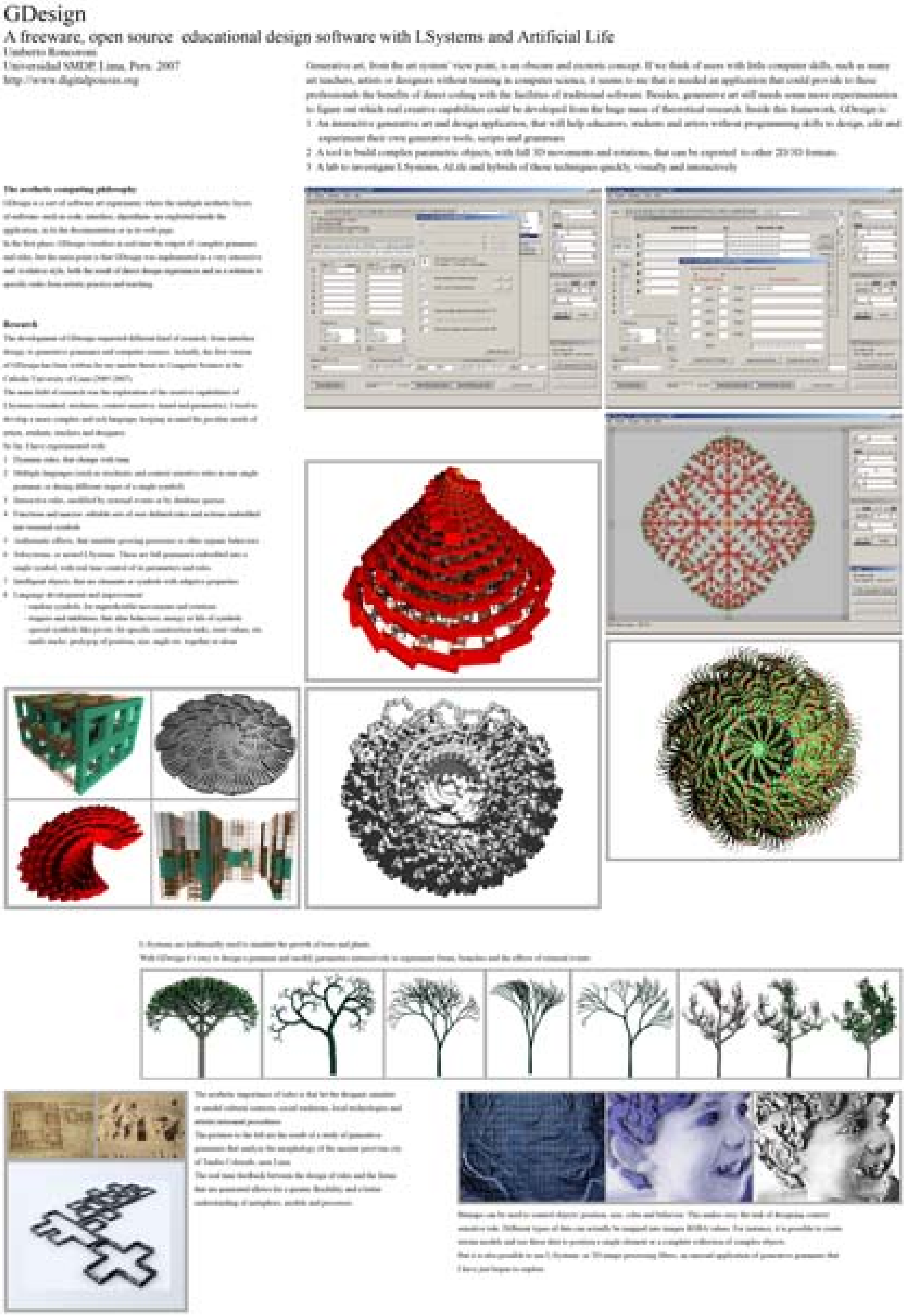
Bourriaud, Nicolas, Estética relacional. Adriana Hidalgo Editora S.A, 2006 Córdoba, Argentina
Michel Certeau, La invención de lo cotidiano, I: las artes de hacer, - Universidade Iberoamericana, México, 1999
Walter Benjamin, La obra de arte em la época de su reproducibilidade técnica, em Discursos interrumpidosI, prólogo, traduccion y notas de Jesús Aguirre, Madrid, Taurus, 1989, p. 24

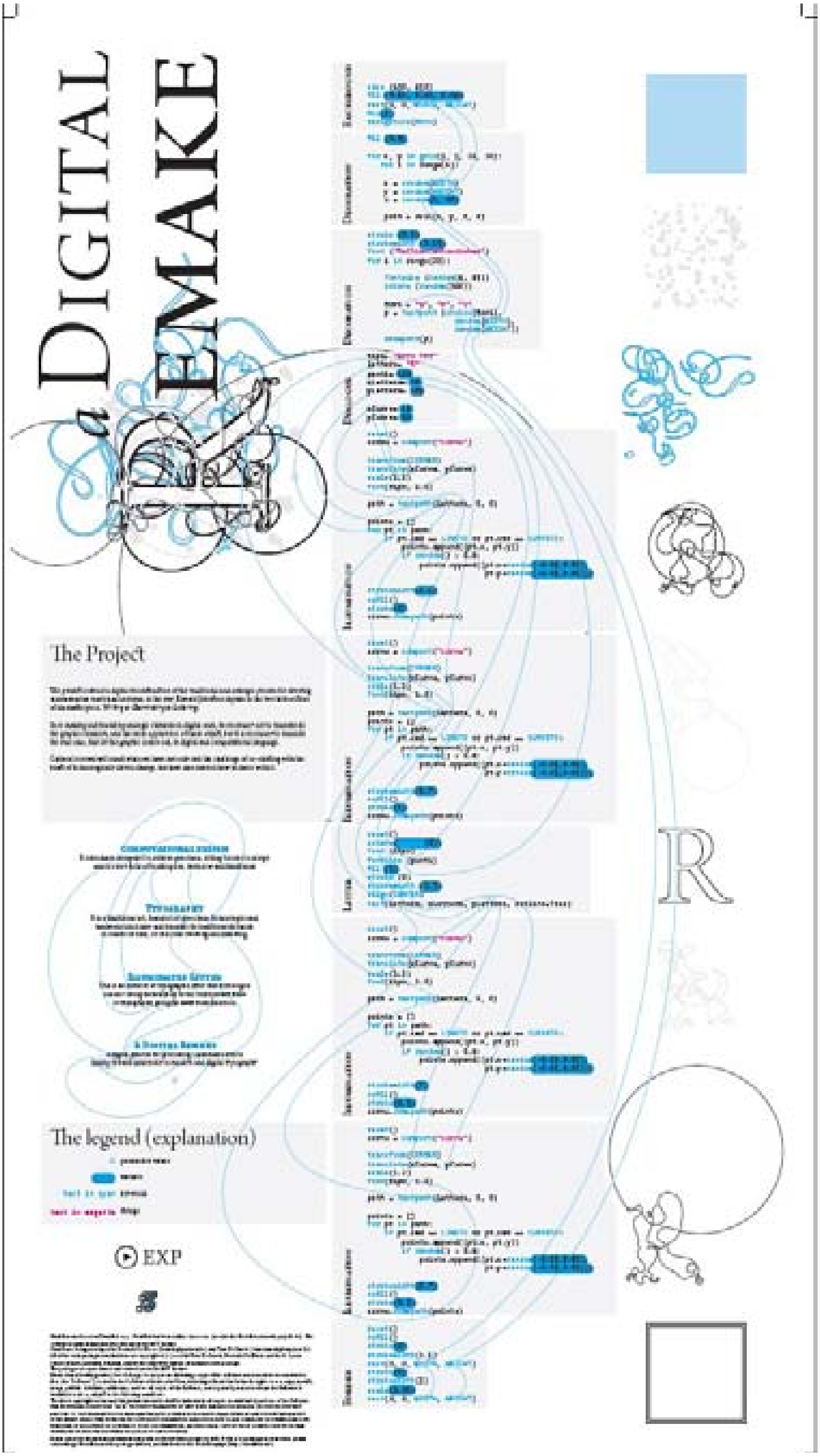
2.4 References

1 Bourriaud, Nicolas, Estética relacional. Adriana Hidalgo Editora S.A, 2006 Córdoba, Argentina.
2 Michel de Certeau, La invención de lo cotidiano, I: las artes de hacer. Universidade Iberoamericana, México, 1999.
3 Walter Benjamin, “La obra de arte em la época de su reproducibilidade técina”, in Discursos interrumpidos I, prólogo, tradução e notas de Jesús Aguirre, Madri, Taurus, 1989, p 24.
4 WEIBEL, P. (2004). "La Imagen Inteligente: ¿Neurocinema o cinema cuántico?" Parte 5 do Seminário Arte Algorítmico. De Cézanne a la Computadora, ministrado por Peter Weibel e organizado por UNESCO e MECAD/ESDi. Disponível em http://netart.incubadora.fapesp.br/portal/referencias/doc2/document_view
5 Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis


PRAGUE BIENNALE PAVILION
DIGITAL DESIGN TECHNIQUES FOR SYNTHETIC SYSTEMS


GENERATIVE ART
Politecnico di Milano 12- 14 Dic. 2007
ARTISTIC PERIODS (UNTIL CHAOS)
R. Pavani – Politecnico di Milano
D. Trigiante – Università di Firenze
Periodicity has always enchanted mankind. For example, this medieval picture represents an ancient cyclic idea of time, originated by observation of natural phenomena. Afterwards, time was supposed to have had a starting point (linear and progressive concept), but periodic phenomena survived in this view as well.
One of the basic results of our science is still that we can superimpose linear periodic motions (Fourier series).
At the present, periodicity of nonlinear motions (in particular their mysterious composition, definitely different from superimposition) is a subject of deep research efforts from several scientific points of view. Here, our point of view is that of Mathematicians, who use computer programs to compute non continuous approximations of continuous motions, i.e. numerical discrete approximations.
On the left: crystal plate or crochet doily?
Actually, the composition of just two rotations, where nobody would recognize the original problem, which is the motion of an electron in a magnetic field.
On the right: post- modern knots?
Actually projections on the velocity plane of a discrete Planetary orbits (Kepler motion).
On the left: oriental sunbeams?
On the right: too much is too much indeed
When an infinite number of periods coexist, their nonlinear composition entails chaos. But it generates figures too, which are appreciated for their complex beauty. In this numerical simulation of the last century behavior of Wall Street Stock Exchange, we can easily recognize that the two areas (representing bifurcations in Bull period and Bear period, respectively), where such behavior is unpredictable, are connected by simple lines, where such behavior is easily predictable. Less periods would be preferable from stockjobber point of view, not from the aesthetical one.
On the left: sinuous forms?
(Honni soit qui mal y pense)
Actually, the figure shows orbits of a quasi-periodic motion with many energy levels very close together. Going from one level to the closest one, orbits combine in such a way to build a figure with 3-D effects.


GDesign
A freeware, open source educational design software with LSystems and Artificial Life


a DIGITAL REMAKE
The Project
The legend (explanation)
EXP