

## **CROSS-DISCIPLINARY STUDY IN COMPLEXITY AND TRANSFORMATION: INITIATING ARTIFICIAL LIFE**

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### **1. Complexity and transformation**

This paper has its origin in an ongoing art and science project in the design field, Complexity and Transformation, funded by the Swedish Research Council. The project has been coordinated by Cheryl Akner Koler, Professor at the University College of Arts, Crafts and design in Stockholm. Physicists, artists, designers, architects, curators and mathematicians have collaborated in a number of workshops where we have approached complexity and transformation. The different professions of the participants have given a rich spectrum of descriptions and observations of the experiments made in the workshops.

Two of the workshops contained experiments with Dendritic Growth and Cellular Automata, they will be explained and discussed below. I have in this paper chosen to see the experiments of the workshops as forms of Artificial Life, ALife, and tried to give examples from our research how ALife can be used in design.

The paper is written with the assistance of the architect Pablo Miranda and the physicist Narendra Yamdagni. With our three different backgrounds I will hopefully be able to present the workshops and the experiments from the architect's, the physicist's and the curator's point of views.

### **2. Dendritic Growth**

As a part of the Complexity and Transformation Arijana Kajfes and Pablo Miranda lead a workshop on dendritic growth. This phenomenon can be described as a growth of a cluster of very fine lines building up a system of branchlike threads. It can be very complex as in the finest veins in the brain or more systematic as the snowflake.

In the workshop we experimented with electrochemical treatment of different metals. With the use of electrolysis particles from the metal went from the minus pole to the plus pole generating branch like fractals. The metallic filaments assembled or "grew" between the conductors in the presence of condensed moisture and an electric bias.

We tested to use different liquids, metals and degrees of power to see how these would affect on the process. Some of us tried to create a smooth process generating a result as tidy as possible and some of us found it more interesting to fasten up the process which created more chaotic results.

We also tried to combine simultaneous processes to see what effect they would have on each other. A major part of the workshop was the documentation of the experiments in form of text, video film and drawings.

### 3. Cellular Automata

The Cellular Automata is a mathematical graphic construction that can describe complex processes. The base is a grid of cells. Each cell can have two states, on or off. You set a simple rule that decides if a cell is on or off. Starting from a given pattern a process starts creating a pattern that is reminiscent of the evolution of the dendritic growth. A simple rule can be that a cell that is in contact with two cells that has an on-status would be on as well. An extremely simple rule like that would generate a very complex pattern.

Narendra Yamdagni lead the workshops on cellular automata:

“By profession I am a physicist and over the past four decades I have done research in the field of elementary particle physics (study of basic forces of nature and their interactions with matter), cosmic ray physics, gravitation and related subjects. Before working in the present project my concept of complexity was too technical and my perception of complexity was limited and the project has persuaded me to look at complexity in a much wider context.

For most of us things appear to be complex when there is too much information which we are unable to grasp, when we are not able to see an underlying pattern in them or when they appear to be unpredictable and chaotic. Our attempt to understand a complex phenomenon starts with trying to seek symmetry or find a pattern which is repeated. By finding the transformation underlying the observed symmetry or by removing the repetitive pattern we reduce the amount of information and thus try to understand the order and design underlying the observed complexity. Unpredictable or chaotic phenomena are considered complex not because of the large amount of information they have but due to complexity in nature of phenomena.

I led the second workshop in this project and arranged to demonstrate many aspects of complexity by simple experiments. In a multidisciplinary project such as this it often happens that the same term is used with significantly different content. It is necessary to carefully explain the terms so that the multidisciplinary interaction becomes enriching. A part of the first workshop dealt with the formation of dendritic growth in electrochemical processes. In view of the fact that there are many manifestations of dendritic growth in nature (in the formation and communication of brain cells, in the growth of trees, etc.) and in industry (lifetime of many electronic parts and batteries, etc.) I felt that it would be very nice if we could describe the basic processes underlying dendritic formation. The basic concepts of dendritic growth are random fractal structures, Brownian motion and aggregation process and dendritic growth can be described by simple algorithms based on cellular automata.

So in the second workshop we introduced basic concepts of cellular automata. The concept was originally introduced by John von Neumann and Stanislaw Ulam to explain self reproduction in biological systems. We used simple workouts of cellular automata to demonstrate how complex pattern result from very simple algorithms. Using a simple algorithm the system develops deterministically (in a regular field of one, two or three dimensions) with discrete steps in time in a fully automatic and mechanical way. Hence the name cellular automata. In spite of the fact that the algorithm is locally defined many examples of cellular automata develop into large complex structures showing larger order and correlations in periodic and non-periodic structures. Using simple algorithms the participants in the workshop were able to develop on graph paper geometrical two dimensional structures and beautiful snowflakes! In a larger context these are basic examples of producing complexity by design.”

#### **4. Artificial Life**

What is artificial Life?

Artificial Life, ALife, is one of the last movements related to cybernetics, originated during the forties through a series of interdisciplinary researches and conferences, as the now mythical Macy conferences which span from 1946 to 1953. It was in this forum that engineers and scientists form diverse fields, ranging from mathematics and physics to neurophysiology or anthropology, set the guidelines for the development of much of computation and its status, value and general direction as a scientific project. The field of cybernetics came into being when concepts of information, feedback, and control were generalized from specific applications in engineering to systems in general, such as living organisms, abstract intelligent processes and language.

The foundation of ALife, could be described as the thesis that complex behaviours stem from the self-organisation at lower levels of complexity of simpler processes. From assemblies of cells that through how they structure themselves are capable of developing in to complex organisms. This and their complex behaviour lead to evolution, which explains the apparent design in nature. It can be described as a blind parallel search procedure performed by a vast number of self-reproducing individuals. Artificial Life takes these mechanisms, mostly originated in biology and other life sciences, and implements them computationally, and builds programs and robots that display some of the capacities of their biological analogues. There are two fractions in ALife, each having a separate interpretation and evaluation of the results of this analogy: the Strong Claim advocates believe that the artificial counterparts of natural systems are in effect also alive, and that the concept of life encompasses now both artificial and natural systems. The Weak Claim, on the contrary, emphasises the limitations of the analogy and distinguishes between the actual phenomena and their models and representations, and in particular stresses the quantitative and qualitative discrepancy in complexity between each of them.

#### **5. Reflections from the workshops**

Art, design and the process

In my work with art, as a curator, I have been very interested in real-time produced art. Art that is produced for the moment and reaches its audience in the same time it's produced. I have worked with different kinds of installations, performances and often with art based on advanced technology.

As often in the contemporary art the focus is more on the process than on the object. Here lies a great difference from design and architecture since it is hard to think of a design that won't deal with an object or a function or an architecture that is not some sort of a building. We have during the 20th century seen a non-object art taking a larger and larger part of the scene and in the contemporary art it is so common that it does no longer necessarily belong to the avant-garde nor the experimental art. It could then be interesting to see if there are methods in the art practice that can be transferred to design and architecture. What can a process based, non-object, design look like?<sup>1</sup>

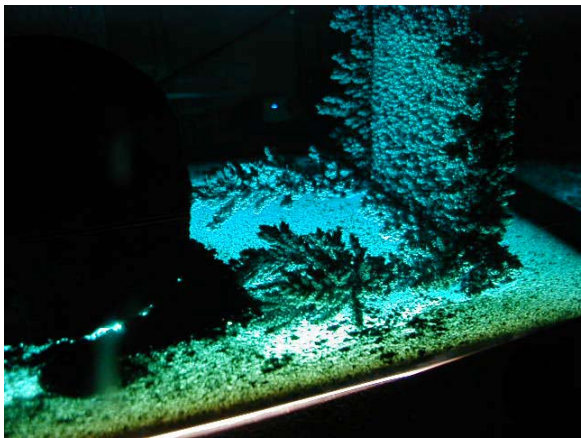
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<sup>1</sup> I am of course aware of the fact that there is a movement in design to focus more on the process, branding etc. Anyway, it is hard to think of a design that will have no function, no use, where it is up to the consumer to interpret it exclusively and that exists just for the moment.

## Dendritic growth and cellular automata

Working with the dendritic growth and the cellular automata in the workshops of the Complexity and Transformation project the similarities between these experiments and the methods of many artists working with real-time and conceptual installations became obvious.

I have often curated projects where artists have started with a set up, an installation, a computer with a special software or some sort of a mechanical machine. They have then left the installation to let it run on its own, processing on its own, and fantastic things have then started to happen. One obvious example is Arijana Kajfes piece *Mass Transaction* that was included in an exhibition I curated at Kiasma in Helsinki in 2004.<sup>2</sup> Kajfes had melted 1000 Swedish one Krona coins to a ball of metal and slowly dissolved it by the use of electrolysis. During the time it created quiet big dendritic growths that fell apart when the process was stopped in the end of the exhibition.



Arijana Kajfes: *Mass Transaction*. Shown at Kiasma in Helsinki 2004-2005. Photo: Kiasma.

When we made the set ups in the workshops we used the same approach. We arranged with the chemicals, electricity and metals and then the set up started to perform on its own. For me this was enough. The patterns that it created was of course something I studied, but I never found that they added anything. What made it interesting was the fact that something was performing, changing and living. We could only partly and initially control the process. For example we could adjust the speed. Increased power would lead to a fast development but also that the process would die out pretty fast in a blur of gas bubbles and metallic dirt. Less power would let the process go on and on creating more and more complex patterns. The latter was more interesting to me, since I was interested in the actual process rather than the outcome of it, and I wanted it to last as long as possible. The workshop with cellular automata lead by Narendra Yamdagni showed a mathematical model of the processes we had observed in the experiments with dendritic growth. By deciding some rules we could observe the same process again, but this time it was calculation. Still the similarities to what I have been practicing within the arts were there.

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<sup>2</sup> Get Real! was shown at Kiasma in Helsinki between November 12<sup>th</sup> 2004 and Januari 15<sup>th</sup> 2005. The exhibition was shown at the Museum of Contemporary Art in Roskilde in Denmark between April 15<sup>th</sup> and June 12<sup>th</sup> 2005. The exhibition was co-curated by Morten Søndergaard, curator at the Museum of Contemporary art in Roskilde.

## 6. ALife + art

The idea of initiating a creative process and then leaving it creating art on its own has been central for many artists. Somewhere around 1911-12 Raymond Roussel for example described some remarkable machines in his Impressions d'Afrique. One of them was a painting machine that would replace the artist. His ideas inspired the dadaists, like for example Marcel Duchamp and Picabia. Roussel never built such a machine himself but later on Jean Tinguely presented a sculpture that in some way realized it. One contemporary example, which I had the opportunity to work with in 2003, is the Norwegian artist Marius Watz who may work in this tradition. In his piece Drawing Machine 13 Watz initiates a process that runs on its own – a process that also is the art. The piece can be seen at

<http://www.unlekker.net/proj/drawingmachine13/>

Here a software was programmed to create images. Parts of it were predestined since it was programmed. Other parts of the process were random. The spectator could take part in the process by interacting via a web site. This addition is not only a possibility for the artist to give away the creation process to an external source it also depicts the relation between the art, the context and the spectator. By changing certain options the conditions alters and the process takes a new direction.

Looking at the dendritic growth and the cellular automata they involve simple units and rules creating patterns that evolve due to a process of very complex systems of certain conditions that all the time alters. In other words everything evolves due to a weave of circumstances affecting on each other. Roussels machine is replaced by something more complicated than just a machine. The set ups in Marius Watz piece and in the dendritic growth and the cellular automata create a process forming ALife, and I think that is, life, what is necessary to generate art.

Looking at the workshops from an architect's point of view or a physicist's the discussion will of course be different. Still we all have something in common when we all seek to describe the physical, social and cultural nature, what can be described as a reality. The Dendritic Growth of the electrolysis can be explained mathematically or at least it is possible to create mathematical models of them as the experiment with Cellular Automata showed.

Working with art I am in the fortunate position where I can choose to concentrate on the process and see the experiments as process based versions of art where the artist just set up the pre-conditions, decides the set up and then leaves the process. Art has a relatively long tradition of process based projects while design and architecture by necessity will have to put more focus on the result of the process. It has to generate some sort of an object in the end. The architect and the designer create a building or an object and it has to have some sort of a function while art often looks for something with no function.<sup>3</sup>I wrote that the artists try to describe nature. More correct is possibly to say that the artist reflects on and comments nature and leaves it to the audience to build up an interpretation.<sup>4</sup>Compared to this the scientist works in a very different way since s/he tries to explain nature by thesis and models.

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<sup>3</sup> As I noted above I am aware of that also design has a movement towards the process. But that is both a similar and a different discussion obviously.

<sup>4</sup> Here it would be necessary to add a paragraph on different views on communication, but there isn't space enough. Still I should mention Claude Shannon, who's theories on communication I think is applicable.

## 7. Implementation

I promised in the beginning to give examples on how ALife could be used in the design field. It would of course be possible to use the reward, to let ALife generate a product, f ex a pattern. It can then be used as it is, for inspiration for the designer or be seen as a model of nature that is easier to study than nature itself.

But would it also be possible to create architecture or design where the focus is on the process and that won't produce any other reward than what is seen at the moment? In other worlds, would it be possible to generate a dynamic process that creates a real-time based design?

To understand how this can be done and why it should be done it is necessary to look at how new medias are reshaping our society. I guess it will still take time before we realize the impact of the Internet technology development. We have gone from isolation both in space and time to globalization where space and time is shared within a few years in the end of the 1990's and this development is still operating at a very high speed.

I am quiet sure that this share of space and time has meant a lot for our understanding and interpretation of reality. One example is that just a year or two ago the term "real-time" started to get a new meaning. From being used in computer science it was suddenly being used to describe when something was actually happening here and now. Suddenly a broader audience has become interested in "real-time" television shows, films are being made in "real-time" etc. The new technology gave us an impact of a "truer" description of reality. We suddenly want to see when it is actually happening and not what happened.<sup>5</sup>

Since this development is changing our interpretation and understanding of reality it will also change the understanding, or even more important the expectations on, art, architecture and design. We can expect process based architecture and design that will fit the globalized society and industry, mediated rooms where design and architecture will be constructed by different media and information flows from sites all over the world only and where the design and the architecture is created by a process involving ALife and where the architect or designer has just initiated the process.

## 8. Conclusion/Implementation

This paper has started a discussion from two simple experiments with dendritic growth and cellular automata. The experiments has been seen as forms of Artificial Life, ALife, and I have with the help of physicist Narendra Yamdagni and architect Pablo Miranda given different views on how they can be understood. It has also suggested how ALife can be used within the arts where it is possible to focus on the process and what is happening at the moment. Through a discussion of the development of the media technology it ended up in a vision of architecture and design where the architect/designer set the rules and starts a ALife process that lives on its own creating design and room.

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What might be added to the discussion above is that a lot happens between the artist and the spectator since the actual conditions create a lot of "noise".

<sup>5</sup> More real-time theory can be found in the book Get Real! Real Time + Art, Informations Forlag, Copenhagen 2005 and George Brazillier, New York 2005.

This scenario puts a lot of important questions. Doesn't it suggest that the roles of the designer and the architect dramatically change and become more similar to the role of an artist? Will our understanding of room and form dramatically change? And what would this type of a design look like?

These are important questions that create a need for further and complicated research. This research would be of great interest not just for the design field but also for the industry since it will give a richer image of what demands new technology and media put and also since it would deal with a design reflecting the contemporary society while combining information from several different sources to a new message.