

Self Assembled Sculpture in Zero Gravity Proposal

Another idea for parabolic flights

and

a STK Sketch for Venus Transit scenario from a Maya Observatory

The Art and Science of Space Culture
Professor Marko Peljhan

By Andrés Burbano
PhD Candidate
Media Arts and Technology
University of California Santa Barbara

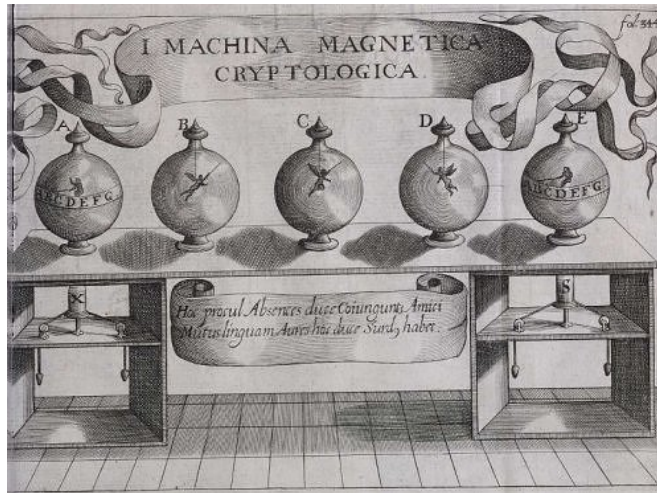
March 19 – 2009.

Abstract

In this project report Self assembled structures based on magnets are explored in order to propose different ideas for sculptures that will work in three dimensional space in the context of micro gravity in a parabolic flight. Concepts like “agents” and “programming matter” are important for the technical component of the project as well as “kinetic art” and “space art” are important for its' aesthetic component.

Historical Background

Magnetism has been an inspirational topic since ancient times, two interesting examples of the importance of magnetism in history that can be mentioned are: the use of magnets by Athanasius Kircher to create one of the first known systems of cryptography “Machina Magentica Cryptologica”. It worked thanks to magnets that moved a needle pointing at a specific letter, when moving the magnets it was possible to move the needle to point at different letters, in this way relatively complex texts could be transmitted.



“Machina Magentica Cryptologica” by Athanasius Kircher 1670.

Another example is Isaac Newton, according to Michael White in his book “The Last Sorcerer” a new biography about Newton, his principle of universal gravitation was strongly influenced by the studies on magnetism, concretely the “action distance principle” that actually has a strong alchemical background. Next to this theory the story about the apple seems like a way to hide the true origin or source of the concept.

Arts Background

In the context of art in the XXth century there are some interesting examples of artists using magnets or magnetic properties, from kinetic art to the work of people like Mario Ramiro, David Antin, Tom Shannon -among others- magnets have been used specially to create pieces where elements are suspended in the air, to show some sort of anti-gravitational properties.



"Past, Present, Future", 1986, sculpture by Tom Shannon

In interactive art, probably the best examples that I have in mind are the works that explore the ferro fluid material by controlling it with different magnetic fields, they create complex liquid/solid structures that change according to sound and the magnets in a speaker. The "Project Protude, Flow" by Sachiko Kodama and Minako Takeno is a good example of this kind of work.

Finally in popular culture there are some tutorials available on line on how to built a "magnetic sculpture" just for fun and the understanding of magnetic principles. I found at least two different tendencies, one is guided by the idea of levitation and the second one is related with a machine of perpetual movement. See for instance the Instructables: *"Make a magnet sculpture: Build this magnet sculpture and experience the magic of rare earth magnets firsthand. Two powerful NdFeB magnets attract each other making it appear as if the cube on the cord is levitating."*

Self Assembled Sculpture Project

From a general point of view the project is an attempt to go one step beyond traditional kinetic sculpture where "Self Assembled" is the key component to add new potentialities thanks to the attraction/repulsion behaviors and their relationships.

In absence of acceleration of gravity -in a parabolic flight for instance- it is possible to explore self assembled structures detached from the ground in three dimensions. The aim of the project is to create controlled conditions in zero gravity to build a self assembled small structure based on magnets, or probably the combination of magnets and velcro.

Magnets are versatile elements for this purposes as far as they have two states: attraction and repulsion that condition can be seen as a binary (one bit) information principle. Additionally there are surfaces on the magnets -often the sides- that can be neutral, so at the end we do have three different states of matter that can be the seed for "programming" the matter.

The main hypothesis behind the project is that magnets themselves can be considered "agents", as software agents for instance, and in a certain way they can be "programed" to create concrete structures it obviously needs preparation and deep understanding of the interactions between the forces.

In other words, it is possible to think about magnets in zero gravity as a way to explore the behavior of three dimensional "agents" in a tridimensional space because we are not attached to the ground given the absence of acceleration thanks to the force of gravity.

I see a big aesthetic potential in that context because the project is objectual and procedural at the same time. The process and the general conditions are ephemeral -as far as the zero gravity state is only half of a minute in parabolic flights- it adds a dramatic component to the project, finally the idea of an sculpture that assembly's itself is mysterious and inspirational because it is exploring particular conditions of the nature of matter. However there are also several critical aesthetic questions related to this project, one of them is about the role of the public, another one is how the project is going to be presented once the sculpture comes back to land?

Several concrete tests using Neodymium magnets (using more than 100 pieces) have been done.



Self Assembled Sculpture in Zero Gravity First Test.

Three different ways of doing it

1. First Approach: Using naked magnets

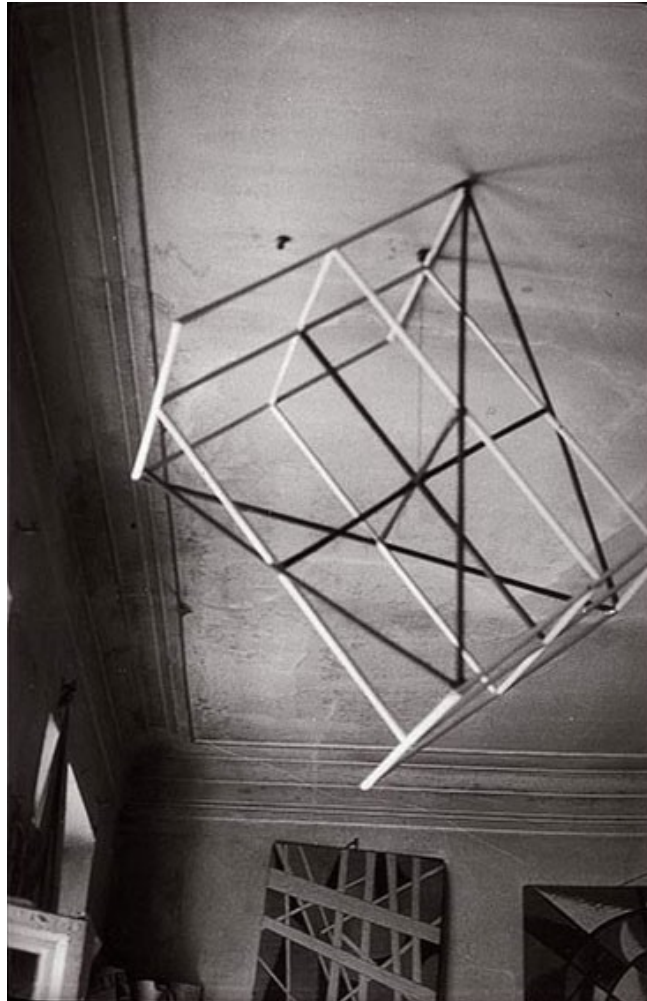
Depending on the shapes of the magnets and their combinations they can lead to different final results, the two most interesting were:

- a. Cylindrical magnets tend to create long piles of magnets, when there are many they create something like long lines, that is the distribution with less energy possible. The pile of magnets grows until they find a limit.



Self Assembled Sculpture in Zero Gravity Second Test. Using Only Cylindric Magnets.

According to that one idea is that it can be possible to place in the top of a box some strong magnets distributed symmetrical in a grid. Then in zero gravity we can free from the ground many cylindrical magnets which will float until they get stuck to the magnets above and they will form long piles of magnets. The final shape of the whole structure is somehow similar to the Alexander Rodchenko's sculpture from 1924.



Alexander Rodchenko's sculpture Popova's Studio, 1924.

b. Another test was done combining small cubic magnets and neutral spheres. The cubes are very small -ten times smaller than the spheres -. The spheres try to compound because of the force of the small cubes, but at the same times the cubes separate the spheres. The look and feel of this approach is similar the representation of certain kind of molecules, specially those drew by Irving Geis.



Self Assembled Sculpture in Zero Gravity Third Test. Using Neutral Spheres and Small Cubic Magnets.

2. Second Approach: Using magnets attached to flexible materials

The first attempt to develop the sculpture was using the magnets directly, but even though the initial conditions were very different the results were similar. It was because the magnets have the tendency to get together in a dense mass.

In order to explore new possibilities I made a test using the magnets but looking for a different look and feel, less metallic and more organic I decided to create “skins” for the magnets. Some magnets were placed into origami shapes, it looks like regular origami paper shapes but inside them there are magnets that can help to create bigger and stranger origami figures.

The origami can include a narrative component as well as providing a very nice and light look and feel, the problem that I encounter is that the magnet collision rips the paper apart.

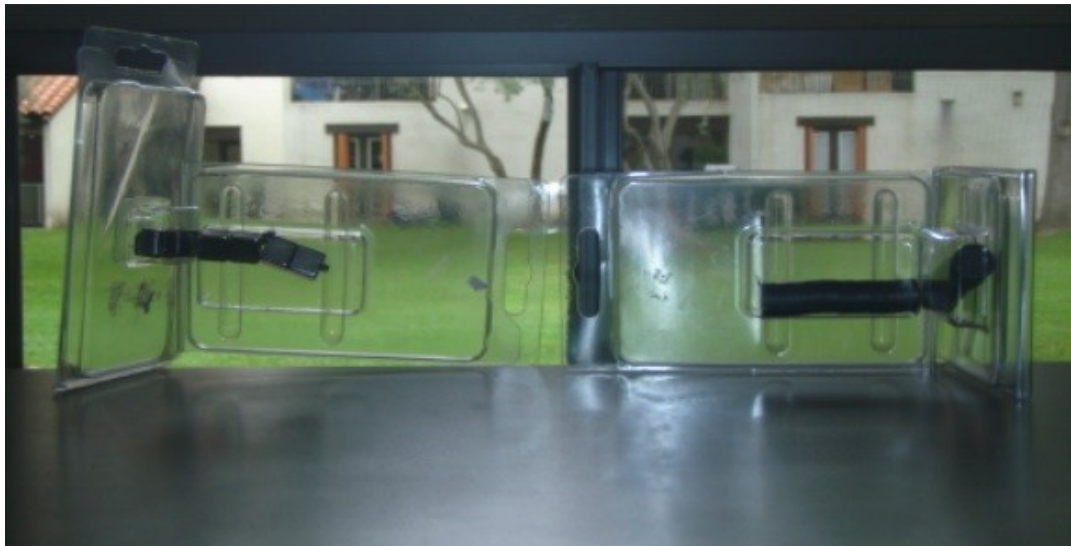


Self Assembled Sculpture in Zero Gravity Fourth Test. Using Small Cubic Magnets inside Origami Figures.

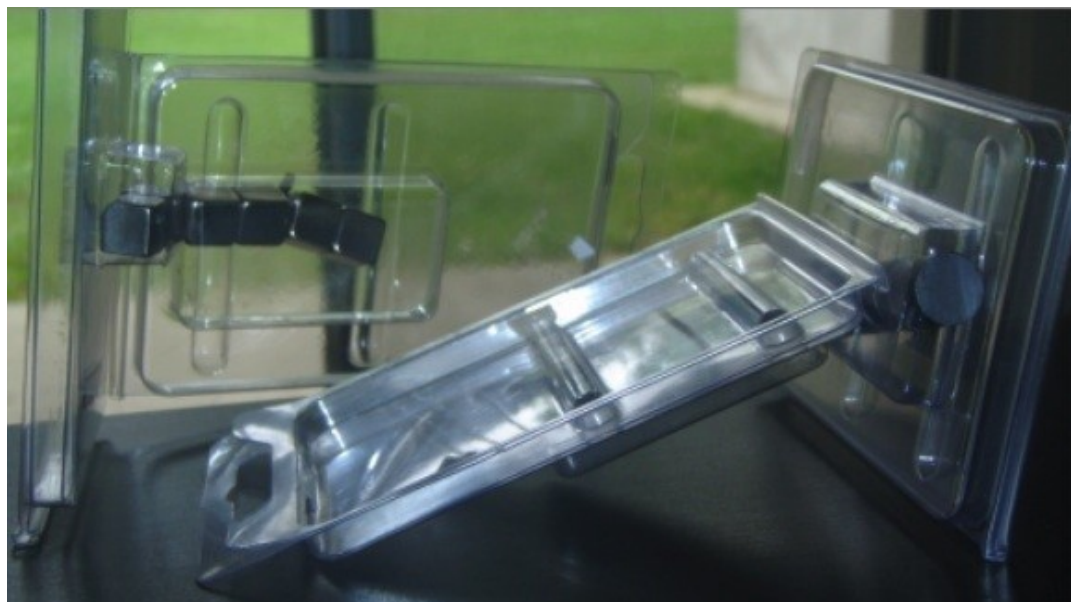
3. Third Approach: Using magnets attached to rigid materials

Considering that paper is a fragile material and thinking in a more robust possibility I decided to pack the magnets in specific order and position inside plastic cases.

Somehow it looks closer to the references by Samuel Griffith, but now the cases are transparent, without color. With the magnets inside this rigid shapes we can have a different possible combination of forms and more distance between the magnets, the final result feels much better the space.



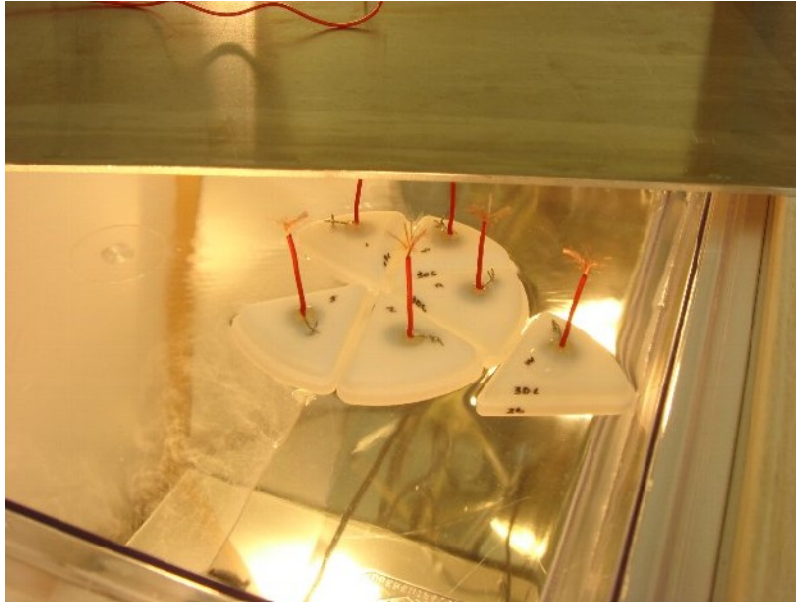
Self Assembled Sculpture in Zero Gravity Fifth Test. Using Large Magnets inside Translucent Plastic Shapes.



Self Assembled Sculpture in Zero Gravity Sixth Test. Using Large Magnets inside Translucent Plastic Shapes.

References.

The starting point of this Self Assembly Sculpture idea was a visit to a Artificial Intelligence Lab in Zurich. There I discovered the work by Shuhei Miyashita a post Doc in Rolf Pfeifer's laboratory working on physical models of “emergence” and “complex systems”.



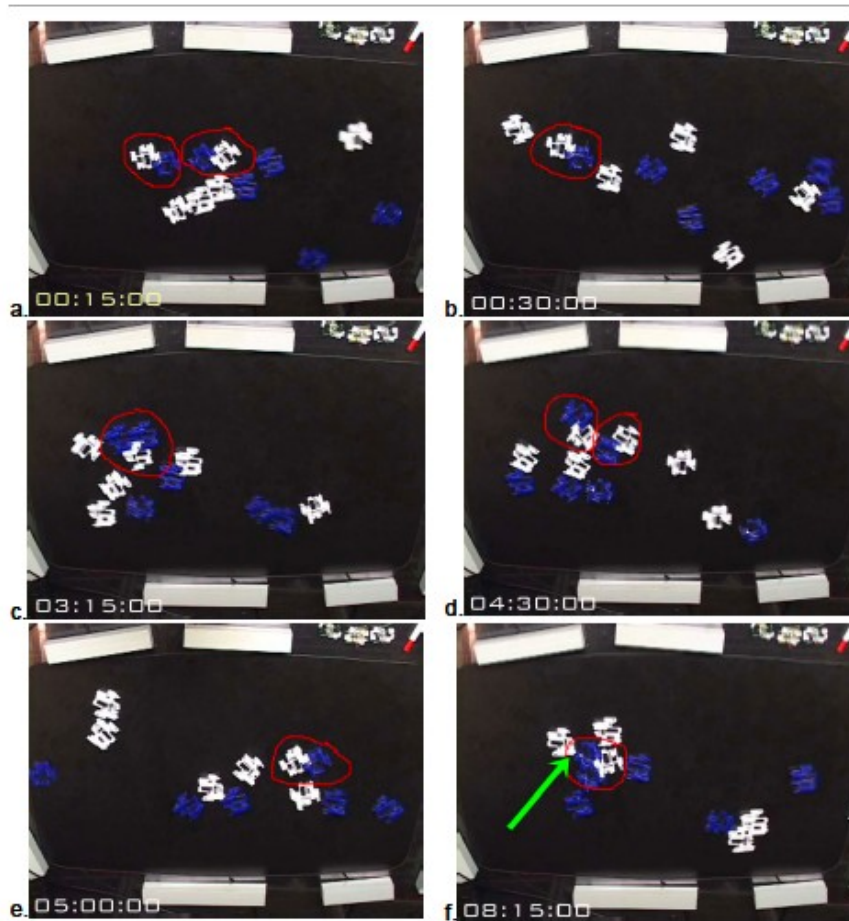
Water based self-assembly robots: Tribolon by Shuhei Miyashita - 2008

Rather than working in such a research from a purely software approach Miyashita is designing robotic units that self assembly thanks to simply behaviors in motion, vibration and magnetism. Because of those properties every one of these units can be considered also an “agent”. I got deeply impressed with the potential for those who work on the field of sculpture, concretely in a possible new way of exploring kinetic sculpture.

After that first approach I had a complement source in such field of research about self assembled processes reading the PhD dissertation by Saul Griffith from MIT who is working also in self assembled or as he call them “programmatically assembled” structures based also in the idea of agents programed with basic rules.

I noticed that despite the interesting results of both research projects and the fact that they consider seriously the three dimensions in their reasoning the results that I have seen remain in the bi dimensional sphere (The water surface in the case of Miyashita and the Air Jockey table in the case of Griffith).

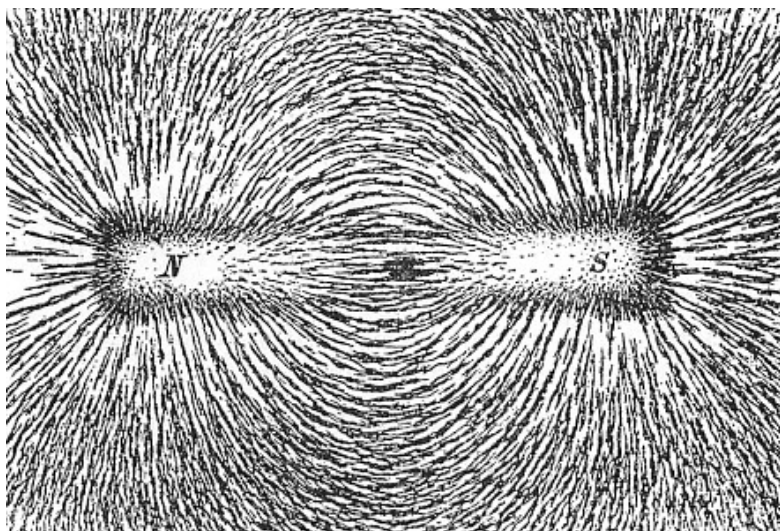
I had in mind the question about the possibility of doing something like that considering the richness of the three dimensions of space. The problem was that I didn't have any clue at that time that a possible answer will appear in a short while -this project-.



PhD dissertation by Saul Griffith 2007

Simulation

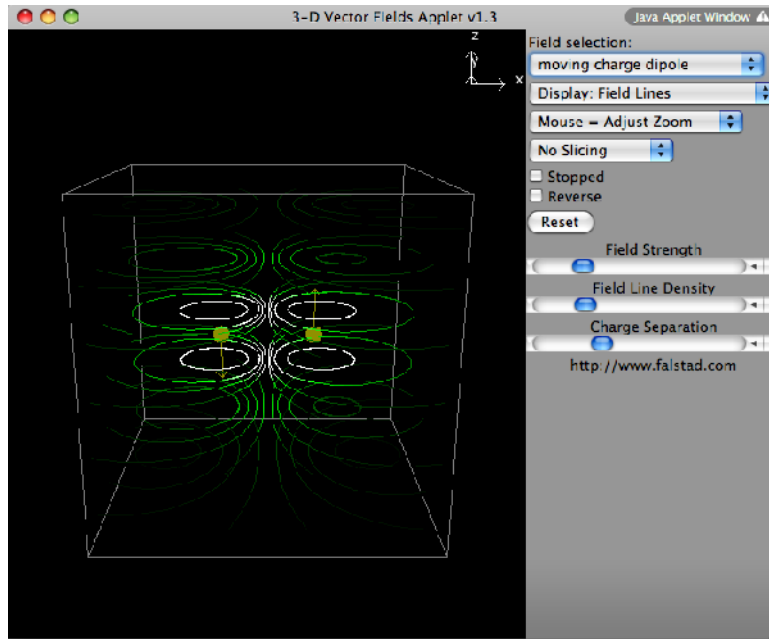
This process started with the research about the basic comprehension of magnetic dynamics, especially the behavior of a magnetic field.



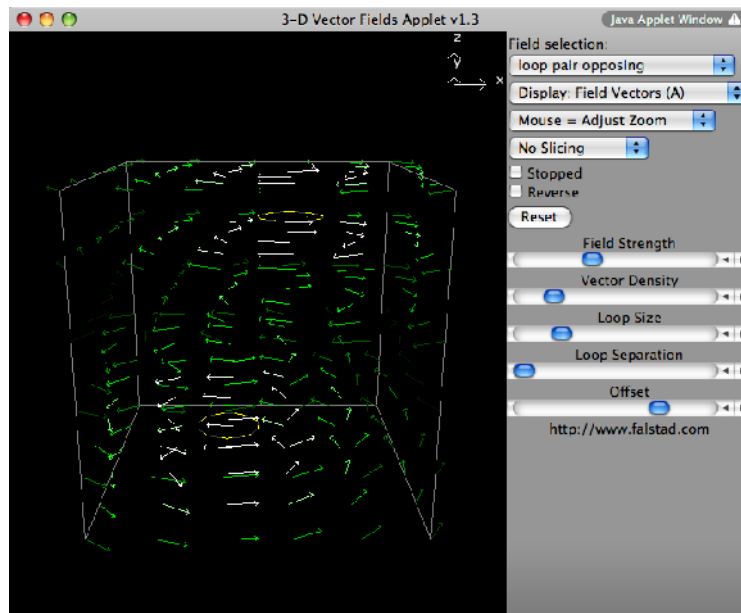
Magnetic field shape with the poles N and S

The simulations were done adapting an Open Source Java simulation for magnetic fields available on Paul Falstad's web site. Just after starting the basic calculations of a simple magnetic field I figured out the complex calculations that must be done if we consider the shape of the magnets and the interaction of many magnets, and magnetic fields with different shapes at the same time.

In that order of ideas I concentrated my efforts in the understanding of the direction (vectors) of the magnetic fields in a three dimensional container, here are some examples:



Simulation of magnetic fields shapes by Paul Falstad.



Simulation of the vectors in with 2 magnetic fields by Paul Falstad.

Vision

In principle if this project can be done and its results show an interesting way of exploring the relationship between zero gravity and sculpture we can think on inviting the scientists who gave the inspiration of this project to contribute with experiments that can be executed in future flights.

It can be interesting to see a collaboration between artists, scientists and engineers in a very concrete and imaginative way. I have ways of contact with both of the scientists – Griffith and Miyashita- so I think this is viable.

Possible scientific applications

One of the most interesting things about history of space exploration is to see how strange, mysterious but potent ideas became real despite they look like utopias at the beginning.

My vision as an exercise to be a “visionary” is that these kind of experiments can deal with the creation of a field of research: “**Self Assembled Structures in Space**”; for instance robots that can assembly themselves to complete a concrete task or **Satellites that can work as a Self assembled Structures**. Imagine a new way of space exploration, where elements are sent to the space and they self assembly there several different kind of structures and machines.

This idea can be contextualized with interesting notions related with the history of space exploration like the idea/utopia of a A Self-Reproducing Interstellar Probe by Von Neumann:

“Von Neumann probes

A von Neumann probe is a self-replicating spacecraft designed to investigate its target system and transmit information about it back to its system of origin. The concept is named after [Hungarian-born mathematician](#) and [physicist John von Neumann](#), who rigorously studied the concept of [self-replicating machines](#) that he called "Universal Assemblers" and which are often referred to as "von Neumann machines". While von Neumann never applied his work to the idea of spacecraft, theoreticians since then have done so.”

I must say that I am very surprised that one of the fathers of computations, actually the person who propose the architecture of computers that we have today the, so called “Von Neumann” architecture, is also related strongly with the idea of self replicating machines for space exploration. Von Neumann also gave origin to the idea of the “cellular automata” that is a very close concept to the notion of “agents” in computation.

One idea more:

Record the data of a parabolic flight using accelerometers and reproduce the motion on earth later on.

Last January Friday 6 of 2009 I attend to a talk by Randolph Crowson who showed a system created and commercialized by him, that is a way to capture low frequencies such as land vibrations and transfer it to sound or motion to create vibration.

It can be very interesting to do in a parabolic flight a multichannel record using accelerometers, and later on process those signals to work with in haptic experiences on earth.



Crowson Technology to reproduce motion and vibration.

A good description of what Crowson does is the following: “In our interaction with the world we commonly experience Full-body as well as Haptic vibration sensations that provide a great deal of information about our surroundings. These sensations provide a powerful contribution to our environment perception and our emotional state. By reproducing motion/vibration sensations in a home theater or lab, we can create new art or vastly improve Video Games, Movies, VR Environments and Music”.



Crowson Technology Large Platform to reproduce motion and vibration -recorded from accelerometers- and the amplifier to control the levels and parameters of haptics and sound.

a STK Sketch for Venus Transit scenario from a Maya Observatory (It Failed !)

Description

In order to practice a little bit what we have learned in the class about Satellite Tool Kit, I had the idea to change a bit and adapt one of the exercises that we did. The exercise about the Venus Transit:

“In this exercise you will create a scenario that will model a rare celestial event-- a Venus transit. Using that model, you will determine the best time to visualize the event and where you should point your telescope for optimal viewing. Upon completion, you will be able to: • Import and visualize planets and their orbits • Run an access calculation against an entire database of objects • Use multiple 3D Graphics windows in a scenario • Set your View/To and View/From objects to be different • Work with some advanced 3D Graphics window properties”.

When we did that exercise I was reading about the Maya's Dresden Codex. The ancient Maya culture had a very accurate calendar and it was mainly based in the Venus movements and orbits. The content of the Dresden Codex shows that Mayas knew more than any other culture about Venus behavior at that time. However there is a problem, apparently they never mention something like the Transit of Venus, it can be considered a lack of information in their calendar.

I decided to adapt the exercise in the STK manual about of Venus Transit to do the scenario and calculations from the largest Maya Observatory at Chichén Itzá and also in the times that those transits occur in the first 1500 years AC -Period of important Maya Civilization achievements -.

That is a big slice of time but considering that the Venus Transit happens twice every 150 years, the calculations must be done 10 times only.

I did that but I couldn't have the transit happening in the simulation in the dates that the transits are calculated to happened.



Caracol (The Observatory), Chichén Itzá, Mexico. Coordinates [20°40'58.44"N 88°34'7.14](#)

Problems

1st Problem

The first Venus Transit that I wanted to model was the last one that Mayas had before Spanish conquerors arrive to their lands, that one happened on May 26 of 1518 and May 23 of 1526.

The problem that I had is that it is not possible to do any scenario with data before 1900.

Then I realize that it is possible to load another database with older information but it goes only to the first decades of XIXth century.

2nd Problem

I decided anyway to create the scenario to calculate the oldest Venus Transit possible in STK with the database that we have with the information of Earth's position in the XIXth century.

It seems to work but I couldn't see the Venus Transit happening in any of the dates that it is supposed to happen, including three days before and three days after the Transit date. The dates that I have for the XIXth century are: December 9 of 1874 and December 6 of 1882.

In this case it is possible to see Venus close to Sun -seen from Earth- but not exactly over the Sun. Then when I calculate the Transit Angle, it cannot find any data to calculate. That means that the transfer was “not found”.

I am sure I reproduce correctly the exercise but with another place and time... **Any information on how solve the problem is highly appreciated.**



Dresden Codex – Fragment. Maya Civilization.

References

Bureaud, Annick. **Visibility-legibility of Space Art.** Course Web Site.

Daalder Here. **Is Always Somewhere Else.** Documentary 2007.

Dean, Tacita. **And he fell into the sea.** Bas Jan Ader Web Site.

Griffith, Saul. **Growing Machines.** PhD dissertation MIT 2007.

Kac, Eduardo. **Against Gravitropism: Art and the Joys of Levitation.** Eduardo Kac Web Site.

Malina, Roger. **Contextualizing Zero Gravity Art.** Course Web Site.

Malina, Roger. **In Defense of Space Art: The Role of the Artist in Space Exploration.**

* Malina, Roger. **Interview for this text.**

Spence Brad. **The Case of Bas Jan Ader.** Bas Jan Ader Web Site.

STK Fundamentals. Version 8. **AGI.**

Woods, Arthur. **The Cosmic Dancer: Sculpture and the Absence of Gravity.** Arthur Woods Web Site.

URLs:

<http://www.cosmicdancer.com/>