

Starting hypothesis

A proposed biological-artificial mutualism

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We imagine the buildings of a not too distant future (constructions that we will inhabit) as the combination of digital design, additive manufacturing, advanced robotics, sensors, transmitters, information in the cloud, information of networks, information of other robot networks, etc. all interconnected and with autonomous response. We imagine the skin as a biomimetic envelope of autonomous response to environmental changes. We perceive that skin, or the envelope of the architectural construction made with personalized products, a physical object created by printing layer by layer of a three-dimensional model or 3D digital drawing, an additive manufacturing or 3D printing. We do not rule out that this physical object can be printed in 4D in a process in which the skin itself or envelope built by a process linked to advanced robotics and AI can generate products that modify themselves to respond to changes climatic.

Keywords: *Mutualism, Biogital-Artificial, Biological-Digital, Mechatronic Architecture*

INTRODUCTION

In the not too distant future, we imagine buildings (constructions that we will inhabit) as the combination of digital design, additive digital manufacturing, the inclusion of advanced robotics, the integration of sensors, transmitters, information in the cloud, network information, information from other robot networks, etc. all interconnected and with autonomous response to improve the physical fitness of the spaces we inhabit. We imagine the skin or external volume of the architectural construction as a volumetric biomimetic envelope of autonomous response to environmental changes. We perceive that envelope of architectural construction as a volume made with personalized products, a physical object created by

printing layer by layer of a three-dimensional model or 3D digital drawing, additive manufacturing or 3D printing. We do not rule out that this physical object can be printed in 4D in a process in which the envelope itself, built through a process linked to advanced robotics and AI, can generate products that modify themselves to respond to climate changes. We also do not rule out the idea of a kind of bio-printing, as in medicine with the advances in 3D printing and genetic publishing. We think of a volume composed of cells in 3D, with appearance similar to soap bubbles, or a membrane composed of lipids with hydrophilic head and two hydrophobic extremities, where tension and traction are the physical forces of its consolidation. The combination of computer design, addi-

tive manufacturing, AI and biology.

STARTING HYPOTHESIS

The first hypothesis is: If there is mutualism between individuals of different biological species; then it is also possible that there is mutualism between biological and artificial species.

The second hypothesis is: If a biological species is a set of biological organisms; then we can also state that an artificial species is a set of artificial organisms.

The third hypothesis is: A biological organism is a living being and the set of organs of that living being; then it is possible to suggest that an artificial organism is an artificial being and the set of its component parts.

BACKGROUND

The initial prototype is the result of the research presented in 2018, The inclusion of decentralized and self-organized system in the process of construction of design thinking.

By continuing with the investigations and carrying out the first prototype, we have introduced changes and modifications related to the transformation of a theoretical model into a real one. In this research we proposed a segmented surface that has become a volume, a dynamic stereo structure that has the positive characteristics of the previous theoretical model. We refer here to the ease of part replacement and to the possibility of building spare parts with 3D printing. It is to imagine that in the present and in the first stages this impression and replacement will be carried out by man while in the future and in later stages we imagine the impression in 4D, the self-construction made by smaller artificial organisms that can be moved by the stereo structure and print these artificial organisms in the place of replacement directly in 3D, generating the replacement in situ.

Below we present a summary table with background and architectural references analyzed for such research.

Construction	Author/s	Year	System	Reproduce
Eastgate Center	Michael Pearce	2004	Natural	Anthropod technique
IMA	Jean Nouvel, et al	2007	Mechanic	Phototropism (-)
Kiefer Technic Showroom	Ernest Gisbertsch		Mechanic	Phototropism (-)
Brishbane Airport	UAP+Ned Kahn		Natural	Wind dynamics
Al Bahar Tower Facade	AEDAS		Mechanic	Photo nastia
Center City Gallery	UNStudio		Mechanic	Camouflage
One Ocean Facade	SOMA	2009	Mechanic	Respiratory organ of aquatic animals
Sede Q1	Chaix & Morel, et al		Mechanic	Phototropism (-)
Sherif-Ha House	dRMM		Mechanic	Heliotropism
SDU Campus Holding	Hennig Larsen Architects		Mechanic	Phototropism (-)

Table 1
Synthesis of the analysis of the architectural background found in the following table: Table 1.jpg

MUTUALISM AND ORGANISMS

Mutualism, in its meaning for biology: is the biological interaction between individuals of a species, but we must also clarify that for biology a species is a biological classification, a basic unit of organisms, a set of them, and also an organism It is a living being and the set of organs of that living being.

First, we suggest identifying the concept of artificial species. Following the concepts of biology and for the purposes of this research, we suggest calling the envelope or external volume of the constructions as artificial or bio-artificial organism, has the characteristics of organization, homeostasis, irritability, reproduction and adaptation.

The organization is given by the basic units that make up the surrounding volume, conceived as a three-dimensional pattern. Meets the condition of

homeostasis, dynamic equilibrium is made possible thanks to the network of control system fed back by sensors and the AI to process the information generated by the sensors (such as the regulation mechanisms of living beings) Responds to external stimuli also making use of the sensors and AI fulfilling in this way with the irritability conditions. They also consume energy to perform different tasks fulfilling the characteristic of metabolism, they will be able to add elements to improve their performance condition linked to physical development, they will be able to generate copies of themselves with improved condition that is linked to reproduction and adaptation. As well as the quality of Autopoiesis

The technology in bio-printing, 3D printing made it possible for the medicine to create custom biomedical implants, dental pieces, and from 2011 the creation of complete organs.

For biology, a biological organism is a living being and the set of organs of that living being. Based on this concept we can infer that an artificial organism is a set of bio-printed parts or organs of complex organization involving artificial neuronal communication (AI) systems that relate it internally and with the environment, but unlike human beings living do not need an exchange of matter and energy in the metabolic sense and can perform basic functions functioning by themselves without losing their structural level and unlike biological organisms their expiration will not depend on homeostasis or metabolism.

In our research, we suggest calling the AI and the set of 3D printed elements that make up physical objects as artificial organisms, which form an artificial species. In this case, our fundamentals are the research that exists in bio-printing: 3D printing and genetic publishing.

This artificial organism is made up of spatial cells with dimensions in the 3 axes of the Euclidean geometry, with appearance similar to soap bubbles, where tension and traction are the physical forces of its consolidation. A structure similar to a protobionte.

In our case we seek to realize a symbiosis that in-

tegrates man, his habitat, his well-being with the AI. It was then when we began to analyze the possibility of biological interaction and how it occurred in nature. At that time, we arrived at the concept of mutualism, which is effectively described in biology as the biological interaction between individuals of different species. In this interaction, both species benefit and improve their biological fitness. The mutualism understood as mutual benefits without becoming parasitism, or depredation, to bring the material and spiritual welfare of both species. The man has experienced mutualism with the dog or the horse, in both cases the mutualism is optional, this means that an organism does not depend on the other to survive, this type of mutualism has been given frequently for reasons of protection, reproduction and feeding. There is also compulsory mutualism, for example, in the case of pollination, where the interaction is of a biological organism of the animal kingdom and a biological organism of the plant kingdom. In other cases, the interaction occurs with two species of the animal kingdom, such as birds and hippos, rhinoceroses, etc.

With the above, it is suggested that they will form a biological-artificial mutualism between man and the AI. This interaction between individuals of different species will enhance and benefit the biological aptitude of the biological species, we understand that this mutualism will be facultative in the case of man and obligatory in the case of AI as in the case of pollination as a service-resource relationship.

The artificial species will protect the biological species from the effects of climate change, will make impressions in 4D that will benefit and improve the physical fitness of habitable spaces for the biological species or man. While the biological species will offer the necessary maintenance for the artificial species, that maintenance that cannot be done by itself. The decision to purchase supplies and the decision to dispose of waste. We think that this interaction takes advantage of the potential of disruption, quantum computing, layer by layer printing, advanced robots, sensors and transmitters that allow communication

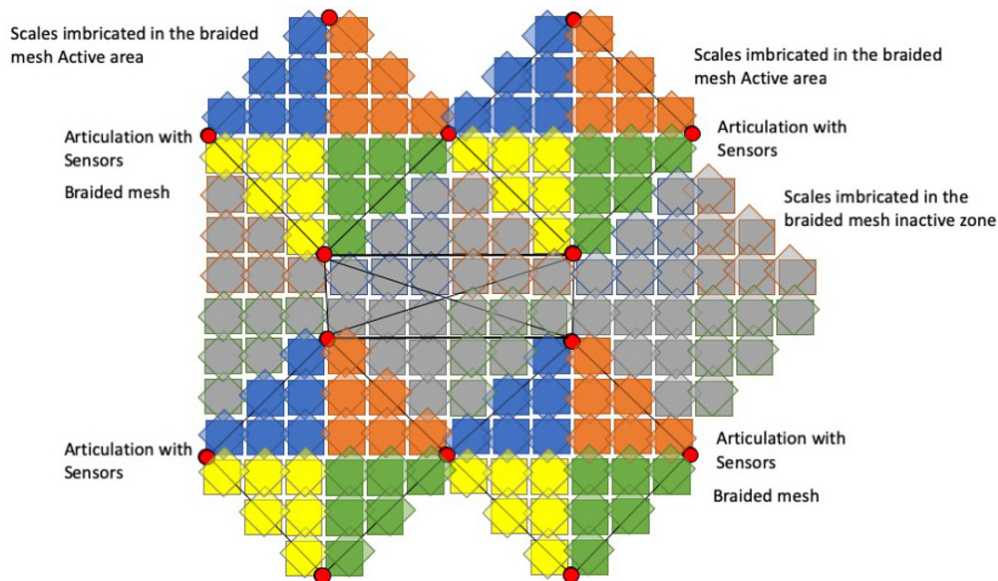


Figure 1
Proposal seen from the front - Source: Own elaboration

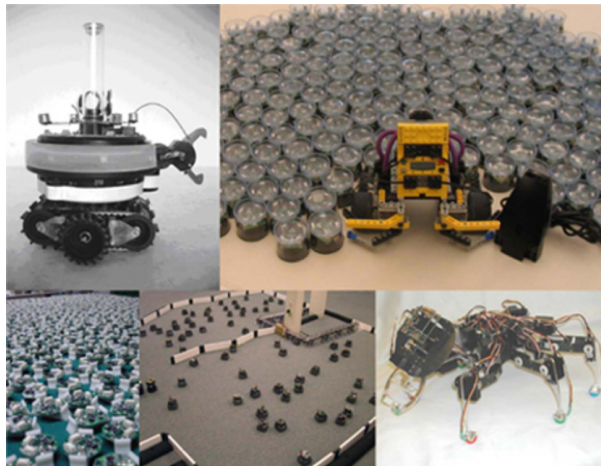


Figure 2
Swarm Robotics - Source: <http://www.galactic-suitedesign.com/blogs/GSmoon-race/?p=102>

and understanding with information in the cloud and other robot networks and answer orderly manner. We do not rule out the use of the internet of things, home automation, remote monitoring.

As a result of previous and current research regarding biology and biomimetics, we have detected that the physical variations of the parts that make up biological organisms are resources of the species to evolve and adapt to change. These same changes have been proposed in the artificial organism because its evolution and adaptation can be carried out in a reasoned manner and in less time

STRUCTURE

When we initiate the investigation, we imagine the architectural envelope as a three-dimensional cell, with a similar appearance to the soap bubble, where the internal tension and the axial forces are the physical forces of its consolidation. We start in the investigation with the works done with two-dimensional patterns, the language of the patterns, the design of the patterns and the laws of Bravis. From the tiling of Dirichlet, the triangulation of Dalaunay and the work with patterns in n dimensions in DeWall for the structure of the artificial organ skin that we suggest as volume that limits the architectural space. During the development of the work this initial concept was evolving and led us to the proposal of a stereo structure.

Each point of the triangle in the different states responds to: Form 1.jpg

The proposed stereo structure will be composed of a module, a three-dimensional cell. This stereo structure is the skeleton of the external volume of the architectural construction, it will be composed of three-dimensional cells whose geometric construction in space allows a partition of the architectural space. These partitions correspond to a dynamic semi-regular polyhedron, an initially uniform anti-prism, a three-dimensional geometric body polyhedron enclosing a finite volume, with two parallel faces, one side of the dynamic semi-regular polyhedron is the limit of the internal architectural space

and the other side of the semi-regular dynamic polyhedron is the limit of the external architectural space. Both sides of this polyhedron are formed by squares rotated at 45 ° and joined to both sides of the semi-regular dynamic polyhedron, by equilateral triangles. The inner face of the stereo structure is static and is the one that adheres to the traditional construction. The rest of the stereo structure is dynamic and facilitates adaptation to different changes in the environment autonomously.

The edges of the equilateral triangles are developed with 3D printing technology and work or work as pneumatic pistons interconnected with the other pistons that construct the edges of the triangles, the vertices work like the joints of the wrist of man, a system articulated in three levels printed in 3D that also have sensors that record the data that the central system processes to make travel decisions. In addition, this joint has a cover that holds and holsters to maintain the internal tension made with 3D printing and Voronoi pattern application, applying the critical points of its movement to establish the pattern.

ESTIMATED IMPACT

The footprint will be higher in some countries, will cause the substitution of capital for work, will generate new occupations with a marked increase in intellectual capital. We suggest it will be necessary to adopt strategies that allow responding with new goods and services in real time, before such a scenario. Adopt strategies that facilitate advanced manufacturing, decentralized replication will occur that will lower costs and each of the elements thus achieved will undergo a permanent analysis in search of improvement, and modifications and updates will appear in reduced time periods. It will be like a permanent production of experimental models with technology.

There will be extensive experimentation with robots and swarm algorithms. It will generate the search and experimentation with new materials. A mechatronic architecture

In short, each revolution has impacted on man

and society, producing changes, we believe that the fourth revolution will offer opportunities for all those who dare to adopt a position of critical convergence.

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