Algorithmic architecture

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What should be the exact scope of computer involvement in architecture design? What ways of thinking should we use in order to completely utilize computer programming possibilities?

There is a notion of observing nature and using its ways of coping in architectural design. We, architects could perform design techniques closely similar to those observed in natural processes. Evolution, natural selection and effectiveness could be phrases used in reference to architectural design.

Architecture is an art of meeting people's needs, an art that creates different styles and trends. There are always human related topics in that kind of design. Is technology able to meet its needs?

Keywords and phrases: algorithmic architecture, genetic algorithms, architecture, population thinking, topological thinking, intensive thinking.

Introduction

There is a growing computer involvement with architectural design nowadays. What should be the exact scope of it and what influence will it have on our future and space around us? For the last five decades architects have been increasingly interested in computer's use in the process of design, beginning with CAD programs, through object based software (i.e. Architecture CAD) to building information modelling software (Autodesk Revit).

Moreover, architects took interest in the spectacular development of computer graphics and some sort of fascination arouse about strange forms and blobs, that could be possible due to development of scripting languages available in 3D packages (i.e. Rhinoscript, 3dMaxScript).

The dominant way of utilizing computers in architecture, already briefly described could be called computerization. That is a process of drawing and creating 3D models for already existing solutions (in the architect's mind). It means that the results are predictable.

The opposite way of using computer power is to take advantage of its computational possibilities. Computation is a process of calculating — determining something by mathematical or logical methods [1]. There's a small number of architects and researchers who think that it has become unavoidable to get further into programming and to creatively use the computer and its real possibilities.

Algorithmic architecture

In order to be able to use programming in architectural design one must become familiar with the term *algorithm.* It's a set of instructions that is given to a machine by a human to accomplish a given task in a finite number of steps.

Algorithms are already widely used among recent designers. Experiments that are advertised as an imitation of biological processes [2] are nothing more than clever tricks performed with the use of computer programming to receive nature-like patterns. Benjamin Aranda and Chis Lasch widely known avant-garde architects create interesting forms that are inspired by nature observations in algorithm using processes, which can be unfortunately considered only as tools for architectural design process not as the process itself.

An interesting trend of using genetic algorithms occurs in the contemporary architecture. It can be the

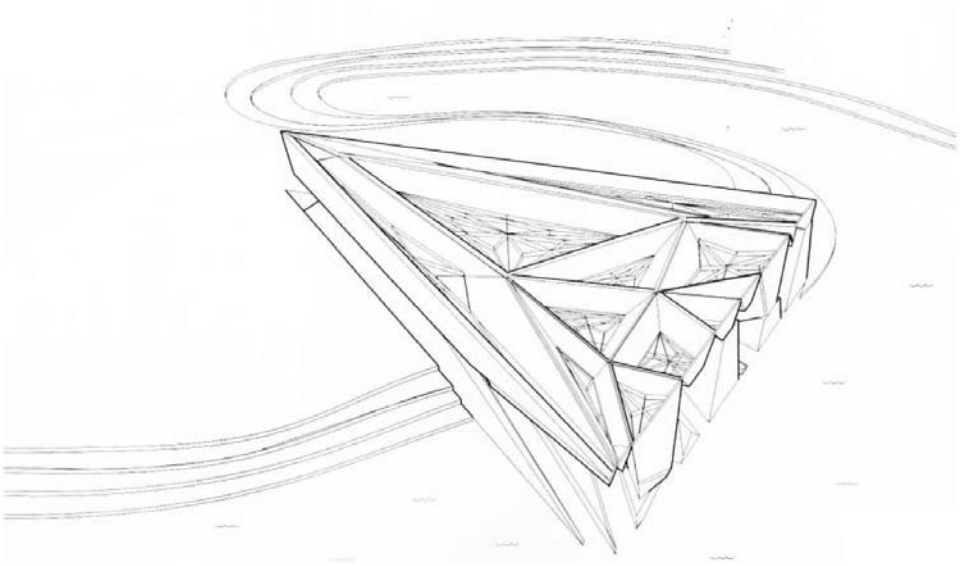

Fig. 1. The Busan Ecology Museum, by Aranda and Lasch. The cracking procedure allows for both an organisation and distribution of tidal movements that make the building behave like a mouth of a river.

Fig. 2. Project: Grotto, by Aranda and Lasch. Each of the boulders behave in its own way. Rings connect together to form arches and vaults.

solution to the problem of creative and full usage of computation possibilities.

Genetic algorithms

Genetic algorithms were invented by John Holland in the 1960s and were developed at the University of Michigan in the 1960s and the 1970s. Original goal was to study the phenomenon of adaptation as it occurs in nature and to develop ways in which mechanisms of natural adaptation might be imported into computer systems [3]. Later it was discovered that genetic algorithms can be used in problem solving and optimization. Genetic algorithm derives its structure from the observation of nature. The simplest genetic algorithm contains three kinds of operations: selection, mutation and crossover.

Genetic algorithms are already used in architectural design, but the processes are variations of mating of few already designed solutions in order to receive interesting outcome. Typical example is Martin Jameson's 'Genetically Modified Terrace House' in Blackpool, UK. The author received interesting results, however they are still a representation of predesigned solutions' crossover [4].

The real opportunity for architects is to use advanced programming techniques such as genetic algorithms in the real design process. In order to do that one must consider some philosophical ideas, which can be traced to the work of Gilles Deleuze [5]. Three ways of thinking present in Deleuze's works and described by Manuel DeLanda in reference to architectural design are: population thinking, intensive thinking and topological thinking [5].

Population thinking

Population thinking is a style of reasoning created in the 1930's by the biologists who brought together Darwin's and Mendel's theories and synthesized the modern version of evolutionary theory [5]. Its main concept is that the population is a sort of a matrix necessary for a natural selection to occur.

Natural selection is a process discovered by Charles Darwin. We know that it is the explanation of both the existence and the apparent purposefulness of all the life forms [6]. It works without a goal, it has neither an

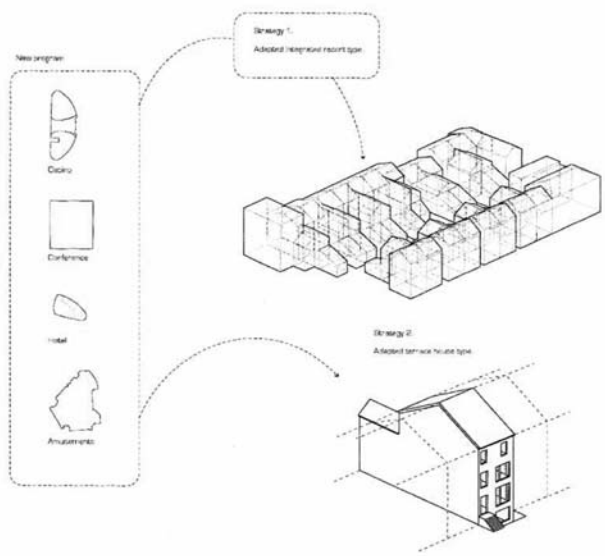

Fig. 3. Martin Jameson, Genetically Modified Terrace House, Party wall split and front-to-back circulation.

imagination nor a brain, however it leads to results that make sense and often are optimal for given environment.

In order to design a building using genetic algorithms we have to create a population of virtual buildings, that will mate with each other leading to next populations, which will provide better outcome — optimal building.

With increasing concerns for sustainability and efficiency, the need to optimize performance in terms of environmental, structural, economic and other concerns, demarcates a new ethical horizon of possibilities. Once a performative logic has been written into a script, the results are already optimized [7].

Intensive thinking

Intensive thinking is derived from thermodynamics. The modern definition of an intensive quantity refers to magnitudes, that are spatially not dividable (i.e. temperature. pressure or speed). In architectural design we deal with extensive quantities like lengths, areas or volumes.

It is crucial to refer to intensive quantities while creating virtual populations of buildings, since their differences are productive, as they drive processes in which the diversity of form is produced [5].

It is a real challenge to create a virtual environment, that will constitute a canvass for evolution of buildings, and will be able to substitute reality for the sake of the process, which obviously couldn't be performed in reality.

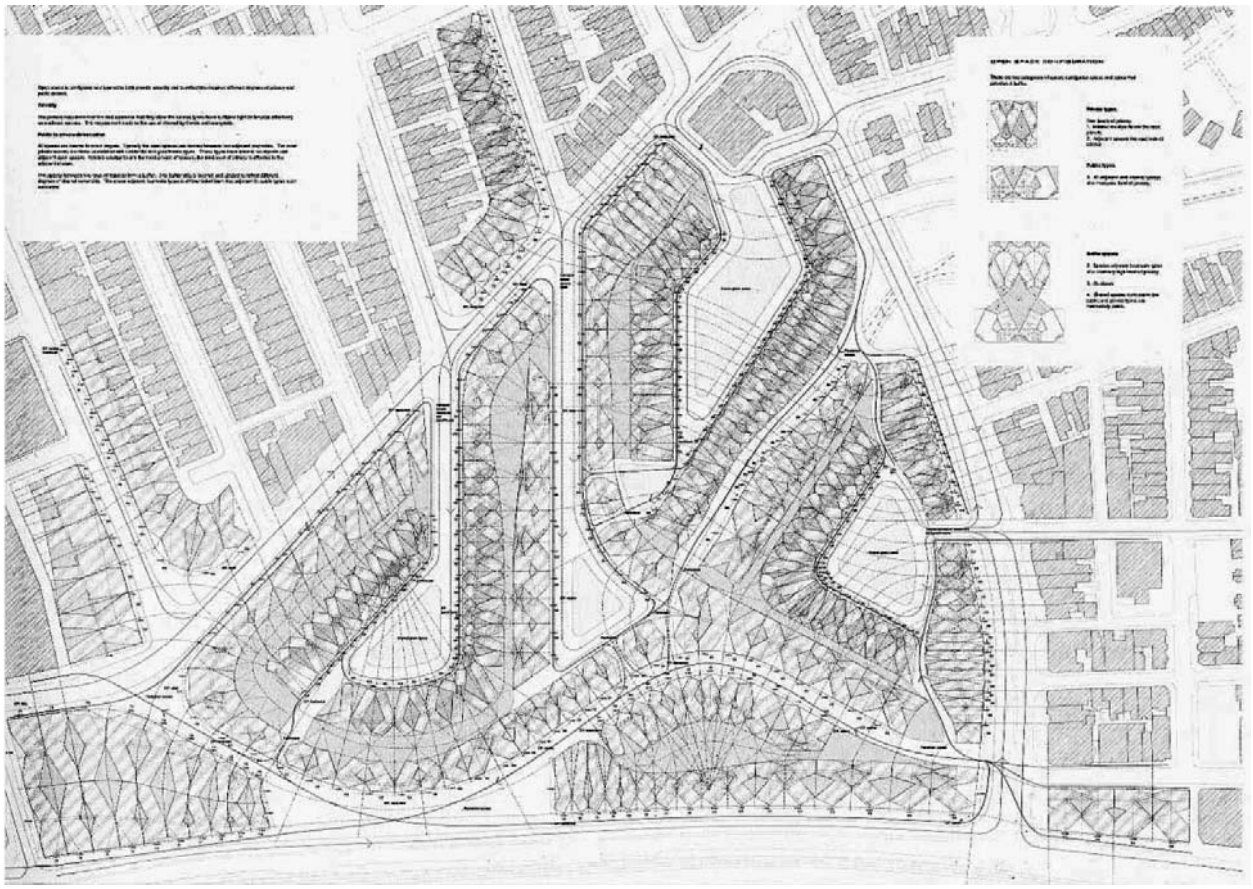

Fig. 4. Martin Jameson, Genetically Modified Terrace House, Open space configuration.

Topological thinking

Topological thinking is a common notion among recent architects. It is a way of describing buildings as a set of parameters and relations between them, so that we don't get a final form, just the necessary rules of creating it.

An important feature of genetic algorithms concerning form production has been discovered — once a few interesting forms have been generated, the evolutionary process seems to run out of possibilities [5]. In the contrary there is a great productivity of natural evolution. The possible solution to this concern may be the topological way of thinking, creating a 'body plan'. It refers to an abstract diagram, with which we can describe i.e. every vertebrate on the planet (certain organs which are the products of evolution and are similar for different types of animals). Reason for existing of the 'body plan' is the cumulative selection. In the process of cumulative selection given population always starts with the results of the previous population selection's outcome [6].

Architect's role

It is crucial to understand what outcome can this revolution have on architect's role in the process of design.

Architect may become only a breeder of virtual buildings, which can be considered as a form of art, but hardly the kind of creativity that one identifies with the development of a personal artistic style. This way architect's taste would become another parameter, or gene of a virtual building. Probably the most of architects will defend their previous role, but it is important to answer to a question of what are we willing to sacrifice in order to accomplish efficiency and perfect (or close to perfect) form and function for given conditions.

Another possible approach is that the architect's mind is enhanced, complemented or synergized with an intellectual entity of a computational nature, independent of a human presence. It's existence starts where human mind fails. Armed with such allo-reasoning the human mind can be described as a cyborg in the intellectual sense [1].

Will we kill building's 'soul'?

Once we use high-end technology to design, we can be able to receive optimal form, function, insolation, energy self-efficiency etc., but is that all that buildings consist of? What about the *genius loci*? What about the human nature that should be the prime concern for architects?

It is a matter unsolved whether it would make a difference for a user to live in a building designed by a machine. Simply because there is no such building.

It seems like a fascinating opportunity to create energy self-efficient buildings, which would be designed to be perfect in every matter, that we want them to be. Still, there is a question about human nature and higher needs, which can't be expressed in numbers (or can they?).

It is probably our future to find out answers to all these questions. Maybe we will have to use Tom Wolfe's words: 'Sorry, but Your soul just died' [8].

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