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Scripting Cultures, Parametric Urbanism and Adaptive Ecologies

Marianna CHARITONIDOU[1]
MSc NTUA Design Space Culture

Abstract. This paper aims to examine how the role of the architect has changed as we shifted to the process of design that Kostas Terzidis calls "Algorithmic Architecture" [1]. The relationships between subjects and objects have changed and thanks to Computer-Assisted Conception and Fabrication (CFAO) systems we are able to manufacture different shapes of each object in the same series. In order to address the problem of global ecological crisis we should investigate how we can create hybrid environments which have characteristics of biological behavior, computational power, behavioral responsiveness, spatial articulation and communication capabilities. I aim to show the potential of the creation of systems that enhance self-organization processes. I encourage the adoption of an approach of responsive architecture based on the combination of material inherent behavior and computational morphogenesis. In order to combine the algorithmic approach to design with the urban planning there is a tendency to map emergent network spaces in real time and to promote urban transformation through the re-coding of urban gaps. In this way the "urban algorithm" is able to operate locally by exploiting constraints and by turning constraints into generative opportunities.

Keywords. simulation, interaction, algorithm, scripting, ecology

Introduction

An issue that is presented in this paper is the interaction between the designer and the scripting environments and the emergence of a different type of relationship between subject and object because of the use of Computer-Assisted Conception and Fabrication (CFAO) systems. The interaction between philosophy and simulation referring to the work of Manuel DeLanda, the interpretation of the work of Gilles Deleuze by John Rajchman, the use of genetic algorithms in architecture, the transferral of information into the production of a spatial and material organization, the simulation of evolution using genetic algorithms, the investigation of mapping patterns of information, the relationships between network science and information visualization are some of the issues that I aim to address in this paper. An important issue that we need to address is the problem of global ecological crisis. In order to address this problem we should investigate how we can create hybrid environments which have characteristics of biological behavior, computational power, behavioral responsiveness, spatial articulation and communication capabilities.

[1] Corresponding author: charitonidou@aaschool.ac.uk

1. Interaction Between the Designer and the Computer Integrated Design

Bernard Cache in the chapter of his book "Earth Moves: The Furnishing of Territories" entitled "Subjectile/Objectile" aims to examine the ways that Computer-Assisted Conception and Fabrication (CFAO) systems have transformed and continue to transform the ways of perception of the relationships between subjects and objects [2]. Cache emphasizes the importance of the fact that the second-generation systems lay the foundation for a nonstandard mode of production [2,3]. He focuses on the fact that the modification of calculation parameters allows the manufacture of a different shape of each object in the same series. The importance of the above statements is based on the fact that unique objects can be produced industrially.

Cache uses the term "subjectiles" to call variable objects created from surfaces and the term "objectiles" to call variable objects created from volumes. He is interested in investigating the question of what is an object. In order to investigate this question he tries to analyze the ways in which industry conceives and fabricates some set of things that we buy because they create use effects. According to Bernard Cache some of the factors that influence each stage in the life of a product are the following: consumption, production, representation, modeling, function and marketing. The use of parametric functions and the use of nonstandard mode of production allow the design of objects that are no longer subordinated to mechanical geometry.

Another relationship that seems to be extremely dominant in the discussion that concern the interaction between computation and architecture is the relationship between the designer and the simulation [4]. The relationship between the designer and the chosen computational design tools and the influence of these tools on the architectural design process is important in an era that the center of attention is shifted from the representation of form to the simulation of space. This relationship is connected to the discussion that concerns the way in which the designer is able or not able to control the result of the process. The investigation of the ways of interaction between the designer and the scripting environments aims to show that another relationship between subject and object has emerged from the moment that the parametric design and the algorithmic architecture has emerged.

Generative methods are procedures that have a liberating design force and can be related to the procedural aspects of the real design. Generative methods are processes that cannot be captured by static drawing. They are based more on procedure than geometric form. In many cases of generative design construction logic is considered with some rigor early on in the process. Manual and automated fabrication depend on tool paths that can be encoded directly in the generating script. The use of genetic algorithms, cellular automata, parametric procedures and other computer-based systems provide the opportunity to shift from an approach based on the representation of form to an approach based on the simulation of space. Digital fabrication in architecture is a recent phenomenon that emerged during the last 15 years. This process has facilitated a greater fluidity between design generation, development, and fabrication than in traditional approaches. The designer can engage with the entire process from concept to final product. A main characteristic of code-based systems is the use of mathematical systems. The script itself does not produce architecture but produces possibilities. Drawing and CAD are modes of representation. Scripting, on the other hand, is based on logical loops and cause–effect relationships and it is not so much a mode of representation as it is a mode of generation.

2. Genetic Algorithms and Virtual Space

In the essay "Philosophy and Simulation: The Emergence of Synthetic Reason" Manuel Delanda analyzes different genres of simulation from cellular automata and genetic algorithms to neural nets and multi-agent systems. He claims that these genres of simulation can be used as a means to conceptualize the possibility spaces associated with causal and other capacities [4]. Manuel DeLanda in "Intensive Science and Virtual Philosophy" focuses on the intersection of philosophy and science and he explains how Deleuze's system of thought is fundamental to a proper understanding of contemporary science that is based on self-organization, non-linear dynamics and complexity theory [5]. The shift from the representation of form to the simulation of space is related to the use of genetic algorithms that aims to simulate the space of all possible automata. The use of genetic algorithms aims to connect the space of possible rules to the space of possible ways of tiling a space. Genetic algorithms are based on the relation between genotype and phenotype [4,5].

Manuel DeLanda in "Deleuze and the use of the Genetic Algorithm in Architecture" refers to Deleuze's terms "abstract diagram" and "virtual multiplicity" and he underlines that Deleuze uses these two terms to refer to entities like the vertebrate body plan [6]. Sanford Kwinter claims that "soft systems evolve by internal regulating mechanisms, yet always in collaboration with forces and effects – that is, information – arriving from an outside source" [7]. According to Brian Massumi "form follows the design process". It is interesting to think of this slogan in comparison to the slogan "form follows function" of modern movement. According to Brian Massumi architects are no longer just representing forms taken from a preexisting repertory as in postmodernist architecture. The role of the architect is shifted to setting things up so that new forms can evolve. We are confronted with a case in which architects aim to integrate new technologies into their buildings in such a way that their role becomes the design of possibilities of experience. Their role is not limited to trying to build for practical function. Abstract spaces must be actively designed to integrate a measure of indeterminacy. As a consequence, the space of abstraction itself becomes active. Brian Massumi in "Sensing The Virtual, Building The Insesible" supports that "topology deals with continuity of transformation" and "engulfs forms in their own variation". According to Brian Massumi "approached topologically, the architect's raw material is no longer form but deformation" [8]. Form emerges from the process. Texts, information, images, and sounds are now all the object of numerical manipulation.

One of the aspects that this workshop aims to examine is the way that the viewer perceives digitally enhanced environments. John Rajchman in his book "The Deleuze Connections" refers to Deleuze's question about how information and interaction are "framed" so as to allow for common sense. Deleuze is concerned about this question in his study for cinema, twenty years after "Difference and Repetition" [9,10,11]. Rajchman claims that Deleuze "rejected the computer model of the mind". According to Rajchman "when form is no longer determined by a prior field or ground given to an independent or overseeing eye, it starts operate in other, less systematic or predictable ways" [9].

Brian Massumi in "Sensing The Virtual, Building The Insesible" notes that "one thing swept away is the popular image of the architect as autonomous creative agent drawing forms from an abstract space of Platonic preexistence to which he or she has inspired access" [8]. He also claims that "the architect must follow the same process that the form follows" and that "the architect's job is in a sense catalytic, no longer

orchestrating" [8]. As far as I am concerned I find interesting the following remark of Brian Massumi: "The design process takes on a certain autonomy, a life of its own" [8].

Manuel DeLanda in "Matter Matters" notes that evolvable materials have the capacity to profit from randomness. He supports that architects and urban planners should focus on using this quality of evolvable materials and he claims that they should try to simulate evolution in computers breeding new designs using Genetic Algorithms [12]. If we conceive matter and form placed in a dynamic rather than a fixed relationship we could refer to a morphogenetic model of urban design. Generative algorithms dissolve the opposition between mathematics and biology and between abstract models and concrete forms.

3. Future Cities and Mapping Patterns of Information

John Rajchman in his book "Constructions" refers to "Future Cities" and he chooses to use this name for the seventh chapter of the book. He begins this chapter questioning about what is the problem of "future cities" or "cities of the future". He is also interested in the investigation of the role that the architecture or architectural intervention might play in such future cities. He underlines that today there are two problems that should be perceived related the one to each other. According to Rajchman these two problems are the following:

- how to get away from certain utopian or transgressive images of thought - or the "future" of thought - and envisage other modes of critical intervention and critical analysis;
- how to develop a new conception or image of cities, their shapes, their distinctive problems, the ways in which they figure in our being and being-together, the manner in which they acquire their identities, the kinds of movement they introduce within and among us [13].

The focus should shift to the emergence of a model of architectural discourse that is based on the simulation of the evolution. The main idea is that through the deployment of patterns we can advance a new relationship between architecture and nature. The designers should focus to the simultaneous production of architectural objects and the environment surrounding them. The contemporary advanced spatial practices and CAD/CAM are now pushing patterns to encompass a greater range of structural, programmatic, aesthetic and material effects and properties.

Another issue that seems to emerge is the issue of mapping patterns of information. Manuel Lima in the book "Visual Complexity: Mapping Patterns of Information" aims to provide a comprehensive view of the visual representation of networks through the depiction of networks from a practical and functional perspective. Researchers, scientists and designer across the globe portray an increasing number of network structures in innovative ways. Manuel Lima's focus is to analyze the visualization of these networks. Lima in this book examines the relationships between network science and information visualization [14].

4. Scripting Cultures and Parametric Urbanism

Increasing importance has been given to the role of parametric design and recent developments in algorithmic design processes have opened the way to scripting that

allow complex forms to be grown from simple iterative methods while preserving specified qualities. Mark Burry in "Scripting Cultures: Architectural Design and Programming" investigates the cultural implications of scripting and the computer engagement in practice. He claims that "scripting affords a significantly deeper engagement between the computer and the user by automating routine aspects and repetitive activities thus facilitating a far greater range of potential outcomes for the same investment in time". Burry in this book enquires into the cultural implications of scripting and asks what are the cultures of scripting as, emerging in myriad ways, they more conspicuously influence the designer's toolkit [15]. Algorithms have become the objects of a new programming culture.

Nowadays, there is a tendency to focus on the edge of a rapidly expanding city, where the instruments of urbanization are directly applied to the raw landscape. This tendency could be explained by the fact that architects and urbanists try to reframe the study of cities and to understand the economic, social, environmental and political forces that influence urban growth and development. Parametric urbanism is a term used to express the method, the strategy of designing "city systems of infrastructural connections that are not simply preadapted to the environment, but are programmed to construct actual relations between already existing entities" [15]. According to Luciana Parisi "parametric urbanism includes rules for selecting, contrasting, and adopting data from previous sets in the computation of present and future quantities of relations" [16]. Luciana Parisi supports that algorithmic computation is not simply an abstract mathematical tool but constitutes a mode of thought in its own right. She claims that its operation extends into forms of abstraction that lie beyond direct human cognition and control.

The re-conceptualization of architectural function in terms of action-artifact networks and the shift from drawing to scripting contributes to the idea that architecture is not an autonomous discipline. The parametric approach of architecture is related to the realization that an interdisciplinary approach is necessary. Manuel DeLanda in "Philosophy and Simulation: The Emergence of Synthetic Reason" notes that "simulations are partly responsible for the restoration of the legitimacy of the concept of emergence because they can stage interactions between virtual entities from which properties, tendencies, and capacities actually emerge" [4]. He also supports that philosophy could be used in order to synthesize into an emergent materialist world view the powers of matter and energy.

In order to combine the algorithmic approach to design with the urban planning there is a tendency to map emergent network spaces in real time and to promote urban transformation through the re-coding of urban gaps. In this way the "urban algorithm" is able to operate locally by exploiting constraints and by turning constraints into generative opportunities. This kind of operation could contribute to the model of a self-organizing city. The idea that is hidden behind an approach to urban design like this is that the city is never complete or finished. The city is conceived algorithmically as a continuum. Marco Polleto in "Systemic Architecture: Operating Manual for the Self-Organizing City" defines urban space as "the product of processes of co-evolution of multiple agents behaving as a coherent assemblage" [17]. Two of the main issues that Marco Polleto and Claudia Pasquero try to address in this book are the ecology of the self-organizing city and the issue of urban algorithms. The algorithm is characterized by the fact that it is based on the acceptance that the relationship between input and output may not be deterministic or linear and may involve chance.

As far as the urban and architectural context for interaction is concerned there is a tendency to understand buildings as urban interactive artifacts. According to this tendency the role of the architect and the role of the urban designer is to design responsive environments. As far as the interactions of the digital and physical are concerned I would like to underline that the digitization of the design process is related to the incorporation of digital into physical. The potential for applying digital simulation for research in urban planning and development is promising. There is a shift from the use of standard drafting packages to the more experimental use of generative design tools and parametric modeling. The use of generative design tools, parametric modeling and digital technologies have come to play a major role in architectural production. In "Digital Cities" the main theme that the authors aim to address is how generative design tools, parametric modeling and digital technologies help architects to operate at the urban scale [18]. The importance of the use of "urban algorithms" is based on the fact that they are not conceived as complete and finished systems. This means that using "urban algorithms" the design, construction and evolution of a city are conceived as a continuum.

5. Self-organizing City and Performance-based Systems

The concept of the self-organizing city is based on the idea that the bottom-up mechanisms are the core of the way that the cities develop. An important issue that we need to address is the problem of global ecological crisis. In order to address this problem we should investigate how we can create hybrid environments which have characteristics of biological behavior, computational power, behavioral responsiveness, spatial articulation and communication capabilities. This is not far from the idea of performance-based design. The challenge is to design performance-based systems that are informed and tested through scenario based on performance simulations. Adaptive ecologies and homeostatic urbanism are based on the analysis of urban development through an adaptive model of ecology. I could refer to the concept of urban growth simulation. Another aspect that shows the challenges of generative approaches to architectural design and self-organizing computation is the emergence of the possibilities that offer the pattern generation tools.

Nikos Salingaros in “Principles of Urban Structure (Design/science/planning)” explains how cities actually work. In this book he underlines that there is an increasing awareness that a city needs to be understood as a complex interacting system [19]. There is a challenge to map complex interacting systems of the city. Manuel Lima in the forward of “Visual Complexity: Mapping Patterns of Information” notes that visualizations of complex data can make statements and ask "questions about the world by selecting parts in particular ways" [14]. We could use computing and programming in order to incorporate biophysical contingencies and situations that users, participants or environmental factors can make available to programming by adding more variables to intelligent network devices.

In order to examine some of the ways users develop bottom-up systems in order to analyze and investigate the contemporary adaptable city, I could refer to the potential for applying digital simulation for research in urban planning and development. The

designers, the urban planners and, in general, the people involved in the decisions that influence the formation and evolution of cities should adopt a strategy of environmental tinkering versus one of accommodation or balance with an external natural world. Associative design systems can control local dynamic information and should be used in order to reassess and propose alternatives to conventional urban masterplanning. I suggest the use of a parametric approach to urbanism that investigates how associative design systems can control local dynamic information flows through interactive systems, spaces and interfaces. The use of multi-agent simulations provides the opportunity to model a given phenomenon. Before we generate buildings using digital simulations of urban growth we should model the decision-making processes that give rise to them. Models of agent-based behavior can be developed in order to understand the decision-making processes within an actual city. The advantage of bottom-up emergent systems where individual agents respond to one another is that they offer behavioral translations of topology that can have radically varied outputs.

6. Examples of Applications

I could refer to "MIT Senseable City Laboratory" which investigates the emergent possibilities of the increasing deployment of sensors and hand-held electronics in the study of the built environment. I would like to present four examples of applications based on the use of the emergent possibilities of Computer-Assisted Conception and Fabrication (CFAO) systems. The "iSPOTS" project was, also, developed in the "MIT Senseable City Laboratory". The iSPOTS project aims at describing changes in living and working at MIT by mapping the dynamics of the wireless network in real-time. Thus, the complex and dispersed individual movement patterns that make up the daily life of the campus can be revealed, helping TO answer many questions: Which physical spaces are preferred for work in the MIT community? How could future physical planning of the campus suit the community's changing needs? Which location-based services would be most helpful for students and academics? Also, as many cities around the world are launching extensive wireless initiatives, the analysis of the MIT environment could provide valuable insights for the future. The "iSPOTS" project is illustrated in Figure 1.

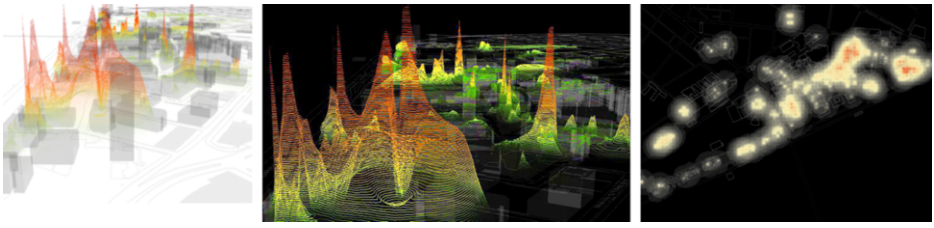

Figure 1. "iSPOTS" project show how wireless Internet is used on the MIT campus in real-time. Log files indicating the number of users connected to each WiFi access point are collected at 15-minute intervals and then interpolated as a color field, providing a visual comparison between different areas of the campus. Red indicates a large number of users per access point. (http://senseable.mit.edu/ispots/)

The "WikiCity" project, which was developed in the "MIT Senseable City Laboratory", investigates the scenario of how can a city perform as an open-source real-time system. Events that were occurring around the city are indicated at the corresponding location on the map at the time they occurred. The four key components of a real time control system are entity to be controlled in an environment characterized by uncertainty, sensors able to acquire information about the entity's state in real-time, intelligence capable of evaluating system performance against desired outcomes, physical actuators able to act upon the system to realize the control strategy. The "WikiCity" project is illustrated in Figure 2. The "Serendipitor" project was developed at V2_ Institute for the Unstable Media as part of a joint artist residency with Eyebeam Art and Technology Center. It is part of the Sentient City Survival Kit, a project of Creative Capital. You enter an origin and a destination, and the app maps a route between the two. As you navigate your route, suggestions for possible actions to take at a given location appear within step-by-step directions designed to increase the likelihood that, in the end, you will have encounters you could never have pre-planned. You can take photos along the way and, upon reaching your destination, send an email sharing with friends your route and the steps you took. The "Serendipitor" project is illustrated in Figure 2.

The "HygroScope - Meteorosensitive Morphology" project was developed by the Institute for Computational Design in the University of Stuttgart in the department of Transsolar Climate Engineering. It was developed by Achim Menges in collaboration with Steffen Reichert. It explores a novel mode of responsive architecture based on the combination of material inherent behavior and computational morphogenesis. The dimensional instability of wood in relation to moisture content is employed to construct a climate responsive architectural morphology. Suspended within a humidity controlled glass case the model opens and closes in response to climate changes with no need for any technical equipment or energy. Mere fluctuations in relative humidity trigger the silent movement. The material structure itself is the machine. This project is illustrated in Figure 3.

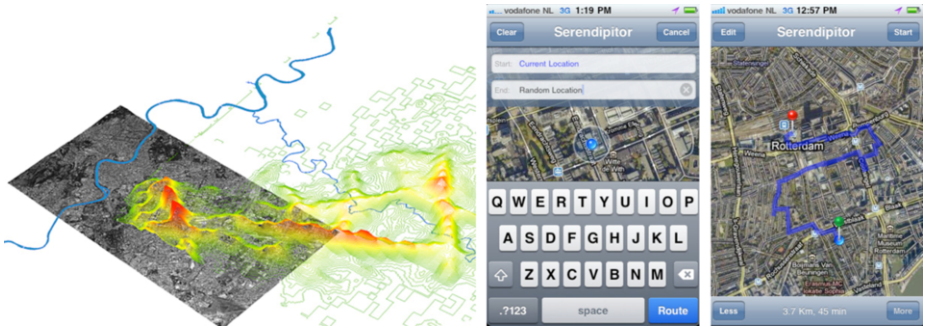

Figure 2. "Real Time Rome" project and "Serendipitor" project. "Real Time Rome" project uses six different visual software to present real-time information about Rome."Real-Time Rome" combines different datasets in a single interface: real-time data, GIS data and raster images. In "Serendipitor" you can enter an origin and a destination, and the app maps a route between the two. You can increase or decrease the complexity of this route, depending how much time you have to play with. As you navigate your route, suggestions for possible actions to take at a given location appear within step-by-step directions designed to increase the likelihood that, in the end, you will have encounters you could never have pre-planned.
(http://senseable.mit.edu/realtimerome/images/gis.jpg and
https://itunes.apple.com/us/app/serendipitor/id382597390?mt=8)

Figure 3. "HygroScope - Meteorosensitive Morphology" project, by Achim Menges & Steffen Reichert, Institute for Computational Design, University of Stuttgart, Transsolar Climate Engineering. (http://icd.uni-stuttgart.de/?p=7291

7. Conclusion

What is the place of the public in the form of parametric urbanism, and how this approach towards design can address the notion of common and collective spaces are two issues that should not be ignored. Another important issue is how to take into consideration the relationships between architecture and nature when we adopt an algorithmic approach towards architectural design and urbanism. As far as I am concerned I think that in order to create adaptive ecologies we should investigate the possibilities that an approach of homeostatic urbanism offers. In order to do that, we should try to construct actual relations between already existing entities in the cities. In addition, we should adopt an approach of responsive architecture based on the combination of material inherent behavior and computational morphogenesis. We should also elaborate on the concept of the self-organizing city which is based on the idea that the bottom-up mechanisms are the core of the way that the cities develop. Finally, we should develop mechanisms and processes in order to analyze the urban development through an adaptive model of ecology. This approach could be combined to the simulation of evolution of different parameters in using genetic algorithms. In this way, we could also investigate not only the evolution of different parameters but their interactions as well.

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