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# The Socio-Temporary in Architecture: Territories of Second-Order Cybernetics

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## ABSTRACT

*The temporary in architecture is a state of territorial instability that emerges out of interactions between transdisciplinary narratives and architectural theory and its practice. This article extends this notion to the socio-temporary, which is a state arising from constant synergies between the social context and worldmaking. Such narratives were originally influenced by the field of cybernetics and later on by second-order cybernetics reflected in the emergent participatory art practice of the mid-twentieth century through transdisciplinary research. Derived from the theoretical underpinning of this article a simulation is exhibited, which illustrates theoretically elements of Varela and Maturana's autopoietic system behaviour and its close relation to temporality in the worldmaking of architecture. This is a theoretical article – with an element of practice – that seeks to highlight the temporality of the process of worldmaking in architecture.*

**Keywords:** Architectural Theory, Becoming, Second-Order Cybernetics, Situations, Socio-Conscious, Socio-Temporary, Worldmaking

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## WORLDMAKING AND THE EXPERIMENTAL IN ARCHITECTURE

In architecture's recent history, experimentations witnessing the involvement of current transdisciplinary praxis of cybernetics and biotechnology have contributed a great deal to the worldmaking of new design imperatives of semi-natural systems and theoretical discourse in the field. The article explores interim stages of such experimentations theoretically and practically derived from biology and cybernetics, based on the writings of philosophers, scientists

and architectural critics such as Nelson Goodman, Francisco Varela and Sanford Kwinter.

The change and development in the media of representation in architecture under the influence of transdisciplinarity accounts for the emergence of various forms of past, present and future design tools, presentation techniques and drawings as well as the experience of architecture as a whole, and this has also been the motivation of this article. Both representation and individual as well as collective experiences of the emerging architectures have a direct impact on the development of the tools of design, generation, and generativity of worldmaking in the field. This is due to the influence of the technological/digital and biological advancements of the current age (Cook, 2008, pp. 177-178). In

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response this has had a great impact on the way we perceive and conceive architecture and as a consequence our experience of architecture as well as our consciousness is constantly changing to adapt itself to new trajectories of perception and cognition (Rattenbury, 2002, p. 1). The main two strands that shaped this article are: the experimentation of worldmaking in architecture under the influence of the biotechnological age and the territorial relevance of cybernetics on the field. Both strands are at the core of transdisciplinary debates concerning complex systems and technological generation that have contributed a great deal to the dynamism of the architectural system of generation, representation and experience (Kwinter, 2002, p. 11).

The relevance between the ideologies of worldmaking in nature and architecture is immeasurable. Nature like architecture builds entities composed of trillions of interacting components where the number of their interactions increases exponentially with the number of the components themselves and therefore these entities are inevitably complex. However, in architecture this complexity confounds conventional design methods. Thus, superficial attempts to copy nature in which rigid modularity is enforced - for example by claiming a correspondence between cells and bricks - will be certain to fail. Hence architectural design methods must have some kind of basis in natural systems in order to model natural survival, but the outcome of such methods does not necessarily have to be the same as that of nature. In fact, this article focuses on obtaining relevant knowledge from natural systems, analysing it, reconstructing it, and using it to build a new hypothesis, a hypothesis for worldmaking in architecture evoked by experimentation. Nelson Goodman emphasises the necessity of the ideology of worldmaking as a remaking process where making always starts from an existing world (Goodman, 1978, p. 6).

Attempts at reaching some levels of investigation in this field of worldmaking of semi-natural systems in the art world can be seen stretching from the work of artists such as Oron Catts and Ionatt Zurr in their Tissue

Culture & Art Project (initiated in 1996), the work of architects such as Marcus Cruz and Steve Pike in their prosthetic architecture, and furthermore to Philip Beesley's immersive and interactive environment created for Venice Biennale 2010 Hylozoic Ground. Cruz and Pike's praxis deliver a degree of integration between biological entities and design practices on a conceptual and experimental level. This is evident in their publication *Neoplastic Design*, which is full of vivid examples of experimentation and explorations of the field of biology in relation to design and representation practices in architecture. This collection features their own work such as *Contaminant* and that of invited guests from *Comfo-Veg Club* (1970s) by Peter Cook to *Density Fields* in *Viscous Bodies* (2008) by Tobias Klein (Cruz & Pike, 2008, pp. 6-15). By covering an array of practical and conceptual examples throughout the history of experimental architecture, Cruz and Pike have emphasised Goodman's rule of worldmaking in that it is a process of making that always starts from an existing world. In their own words, Cruz and Pike describe such new bio-architectures as composites that sometimes appear as constructed entities and other times as living beings, explaining "The line between natural and artificial is progressively blurred" (Cruz & Pike, 2008, p. 6).

In their work, Cruz and Pike strive to connect design processes to current biological phenomena such as genetic engineering, cloning, and transgenics. Such attempts to model biological principles in architecture are not unprecedented. They extend historically back to Le Corbusier's suggestion of buildings that function as an organism, passing by designs by Buckminster Fuller and Frei Otto (inspired by D'Arcy Thompson's key work *On Growth and Form*), reaching the Neoplastic designs of Cruz and Pike. In fact, this historical background of the use of different techniques in design and representation in relation to the current tools and media of representation has played a great part in shifting the purpose of technology from the use of mechanical and clinical machines into the involvement of prosthetic technoscientific

devices that have become an extension of our own bodies. Such a shift was reflected in the tools and media of representation and communication. The use of different techniques and the shifts in the purpose of certain ideologies in design and architecture follow different ways of looking at the making of worlds, which are inevitably changing due to our changing culture. As Goodman puts it: “there is no more a unique world of worlds than there is a unique world” (Goodman, 1978, p. 10).

## **TERRITORIES OF SECOND-ORDER CYBERNETICS**

We have established earlier the synergies between nature and architecture in terms of systems complexity. In this section the emphasis will be on the components of such systems. Architecture, like nature, is composed of overlapping and interacting complex processes based on the methods and designs of its generation, tools and representation as well as the media in which it is experienced whether it is physical, digital or hybrids of both. Most such complex patterns in nature are formed out of equilibrium; i.e., they are not in their most thermodynamically stable state (Kwinter, 2007, p. 16). In other words, they are systems, which never reach equilibrium, and their processes always have a cyclic nature, such as, the flow of rivers, the growth of cities, and the complexity of networked societies.

Nature's various patterns have always fascinated architects, engineers and designers. Furthermore, the fascination extended to pattern formation that appears on multiple scales and levels of sophistication. Nevertheless, there is a single aim; it lies in learning the techniques and rules that can be taken from nature and applied into another field, such as architecture. Thus nature could act as the medium of all interim stages of experimentation and exploration on different scales, relating to the technology and potentiality of materiality, principles and processes of formation and existence, or meta-perception

and cognition of its innovative speculations. The methodology of extracting principles and processes from a certain field and applying them into a different field is in its essence a cybernetic approach “[...] the science that studies abstract principles of organization in complex systems” (Heylighen & Joslyn, 2001, p. 2).

The first-order cybernetics focuses on the possible behaviours of its variables rather than their material presence (Wiener, 1961), however, most relevant for this article is the second-order cybernetics (also called the new order) and this is defined as “[...] the study of the role of the (human) observer in the construction of models of systems and other observers” (Heylighen & Joslyn, 2001, p. 2). Cybernetics was popularised in the late 1940s by Norbert Wiener, a mathematician and scientist who was especially interested in the structure and behaviour of machines. More importantly he focused on principles and processes of control and communication in self-regulating systems such as the animal and the machine as well as their elementary mechanisms of behaviour (Wiener, 1961).

Based on Wiener's findings and in an attempt to define behaviour in architectural terms; change can occur to any architectural form and space in their environment and context. In architecture, output might mean changes in the material and immaterial representation of spatial architecture, while input can mean changes in the architectural experience; such as, the behaviour of the observer/user as well as changes in the environment, day and night, etc. Therefore, and in order to establish the behaviouristic approach to architecture as a worldmaking system; generation, representation and experience are vital processes that feed back into each other, and hence, cannot be separated (Murrani, 2009).

To imply behaviour in architecture through cybernetic principles is to refer to the relationship between the underlying forces that construct a cybernetic system in architecture rather than to architecture that attempts to illustrate cybernetic processes, and nor to architecture that embodies cybernetic machines such as robots.

These underlying forces are what Wiener refers to as the changes between the output and the input that result in behaviour. On a deeper level the underlying forces link directly to the circularity, feedback and communication processes of cybernetic systems, such changes in behaviour will alter our perception, and allow us to realise and utilise new techniques of representation which in return will evoke new experiences, experimentations and conceptions in architecture on a theoretical and practical level.

Cybernetics relates directly to inventions of current contemporary design and presentation tools in architecture such as the use of Computer Aided Design (CAD) programs. However, this is just the superficial relevance of cybernetics to architecture. Gordon Pask in 1969, described a deeper level of this relationship, where he states "The argument rests upon the idea that architects are first and foremost system designers who have been forced, over the last 100 years or so, to take an increasing interest in the organizational (i.e., non-tangible) system properties of development, communication and control" (Pask, 1969, pp. 494-496).

In his famous article *The Architectural Relevance of Cybernetics* in 1969, Pask refers to examples of system designs such as the ingenuity of Temple Meads Station (1840 by I. K. Brunel) and the Crystal Palace Exhibition (1851-1936 by J. Paxton). Their inventions of the use of iron and glass to fulfill certain emerged needs in society, were excellent examples of system designs. Pask had predicted a cybernetic theory of architecture that would make use of Computer Aided Design (CAD) programs to help develop useful instruments in design via implementing principles and processes from different disciplines such as psychology, ecology and economics. A cybernetic theory will have a greater unified influence on architectural theory for analysing or generating system designs. Architecture will "act as a social control" where it will be difficult to isolate or separate it from its users and their experiences, and eventually be able to generate dialogues between the architectural environment and its inhabitants, users and observers through

new material innovations and involvements in Artificial Intelligence (AI), Virtual Reality (VR) and later on Interactivity (Pask, 1969, pp. 494-496). These predictions meant that architects will eventually be able to create complex architectural systems out of simple inputs. This is in principle what architecture in the mid 1800s evidenced by the innovative designs of Paxton and Brunel achieved, and this is at the core of the elementary principle of worldmaking and complex systems from which cybernetics as a field emerged.

The key writings by Gordon Pask of the New Cybernetics relate to the observer who has been placed at the heart of the system of observation (Pask, 1961) and emphasising von Foerster's vision for "a cybernetics of cybernetics" where the observer enters the system and is allowed to stipulate his or her own purpose (von Foerster, 1979). The cybernetics of cybernetics (also known as second-order cybernetics) carries principles of the first-order. It in fact came into being in the 1970s as a continuation rather than a break between the generations with its elementary focus on autonomy, self-organization and more fundamentally, cognition (Varela, Thompson, & Rosch, 1991).

In their book *Autopoiesis and Cognition: The Realization of the Living*, Humberto R. Maturana and Francisco J. Varela define living systems as units of interaction that follow the structure of their organization while maintaining the circularity of their interactions with the observer (Maturana & Varela, 1980). "A living system defines through its organization the domain of all interactions into which it can possibly enter without losing its identity, and it maintains its identity only as long as the basic circularity that defines it as a unit of interactions remains unbroken. Strictly, the identity of a unit of interactions that otherwise changes continuously is maintained only with respect to the observer, for whom its character as a unit of interactions remains unchanged" (Maturana & Varela, 1980, pp. 9-10).

This indirectly leads to the assumption that the cognition of spatial/temporal and social architecture is dependent on the articulate

organizations recognised in patterns that can be derived from abstractions of such architectures' worldmaking systems. Concurrently, returning to the assumption that irregular patterns are formed out of equilibrium, meaning they never reach a stable state, we can conclude that the socio-temporary in architecture emerges out of patterns that are potentially transient too. As a consequence, layers of patterns of articulated organizations and abstractions become part of the spatial and temporal architectural system, which will evoke constant change in the outcome, whether the outcome is the entire system in general, or socio-form and space in particular.

Cybernetics extended from the first-order (Wiener, 1961), which mainly deals with the behaviour and functionality of systems to the second-order, which mainly focuses on the involvement of the observer, his/her behaviour and consciousness as influential contributing parts to the development in any system (von Foerster, 1979). This is elementary to architecture as the observer and the user are crucial variables for the construction of multiple overlapping experiences through a socio-conscious worldmaking practice. Professor Paul Pangaro, a professor of cybernetics, performer, and technology executive for the design of products that serve the cognitive and social aspect of cultures and societies in the USA, puts second-order cybernetics in a context that is most relevant to this article by stating: "The two elements, the shifts of form from prose to performance, and the shift of information from conveyance to construction manifest the very essence of second-order cybernetics" (Pangaro, 2002).

Both these elements are based on attributes of control that emerge from interactions between the observer and the observed. These attributes are the basic elements that distinguish the first-order from the second-order cybernetics (Pangaro, 2002). Here, control is used in the sense of subjective observations that are based on distinctions between, for examples, edges and boundaries of observed systems that depend on the object being observed. However, there are also cognitive distinctions that are based on our

consciousness, for example, the way we see and think about something seen for the first time as opposed to being seen several times and in different contexts. Ranulph Glanville refers to such systems as "observing systems" which is a cognitive spatial and temporal boundary of control over the observing and the observer as well as the observed (Glanville, 1981).

## THE SOCIO-CONSCIOUS

To embed the socio-conscious in architecture through cybernetic principles relates directly to the relationship between the underlying forces that construct a cybernetic system and its observers'/participants' behaviour towards architecture. Eventually these underlying forces will evoke new experiences, experimentations and conceptions in architecture on a theoretical and practical level.

In the 1960s, Roy Ascott became the first cyberneticist and artist to introduce this vision to the art world, establishing links between cybernetics and what he termed "Behaviorist Art" through Wiener's thoughts on the relationship between the output and input of the behavioristic approach, where he states:

*"Behaviourist Art constitutes a retroactive process of human involvement, in which the artifact functions as both matrix and catalyst. As matrix, it is the substance between two sets of behaviours; it neither exists for itself nor by itself. As a catalyst, it triggers changes in the spectator's total behaviour. Its structure must be adaptive implicitly or physically, to accommodate the spectator's responses, in order that the creative evolution of form and idea may take place. The basic principle is feedback. The system Artifact/Observer furnishes its own controlling energy; a function of an output variable 'observer response' is to act as an input variable, which introduces more variety into the system and leads to more variety in the output 'observer's experience.'"* (Ascott, 2002, pp. 95-104)



Alongside Roy Ascott's behaviorist and participatory work of the 1960s, *Cybernetic Serendipity* was one of the early exhibitions that exposed the relationship between participatory art and cybernetics. In 1968 Jasia Reichardt curated this exhibition that was held in the Institute of Contemporary Arts (ICA) in London with a main focus on the relationship between the computer and art, and a particular focus on exploring the links and dimensions between creativity and technology (Reichardt, 1971). The *Cybernetic Serendipity* exhibition achieved more than was originally intended, which was a selection of artwork based on the use of technology, it in fact narrowed the intellectual and social gap between artists, scientists and engineers. Therefore, the exhibition acted as a powerful catalyst connecting cybernetics to the creative process through ideas, objects and acts exchanged between the creators and observers/participants/visitors (Reichardt, 1971).

Although several attempts were undertaken to revive the exhibition in later years after the invasion of digital technology, these attempts were never as successful as the original exhibition. The lack of success was due to the decrease of interest in collaborations between artists, scientists and engineers (MacGregor, 2002, pp. 11-13). Besides, repeating the focus of the *Cybernetic Serendipity* exhibition, which was purely on the materiality of the technological apparatus and its products, such as robotic devices and computer graphics was never going to have the same impact as the original attempt (Shanken, 2002, pp. 433-438).

However the absence of collaboration between artists and scientists/engineers as well as the lack of conceptual re-thinking of the relationship between art and information technology shifted towards the end of the 1970s when festivals of art, technology and society appeared in central Europe, firstly in Austria's *Ars Electronica* Festivals, internationally known annual events based on exhibiting digital and interactive artwork that utilises technology and, in most cases, second-order cybernetics in order to reach its goals. At the same time, the art critic Jack Burnham curated the exhibition

*Software, Information Technology: Its New Meaning for Art* at the Jewish Museum in New York in 1970. In this exhibition Burnham pushed for experimentation in the conceptual relationship between art and information technology through explorations of dematerialised forms of experimental art through software and social interaction (Burnham, 1971).

One of the exhibition's most controversial works was an architectural environment titled *SEEK* which claims to be a behavioural cybernetic world. It was designed and executed by Nicholas Negroponte and students of the Architecture Machine Group at MIT (Nelson, Negroponte, & Levine, 2003). *SEEK* is a large glass box environment full of very lightweight metal boxes; gerbils attempt to organize this landscape by pushing the boxes around. All this is achieved with the help of a giant robotic computer connected arm that is programmed to read and identify the behaviour of the gerbils and respond accordingly by moving the boxes around in an attempt to help the gerbils arrange their world. Despite the disasters of gerbils attacking each other at one point and computers failing to respond at another point during the exhibition, for some observers, this piece constituted an early attempt to create cybernetic based intelligent architecture.

Notwithstanding such explorations in architecture, it remained the last form of art to be exposed to collaborations between other disciplines and experimentations within a socially interactive context. Cybernetics was first introduced to architecture when an unconventional British architect named Cedric Price had a vision for designing interactive and highly flexible structures with a wide range of activity spaces that would be capable of responding to their users. This was the *Fun Palace* project (1960s), a vision for Joan Littlewood where architect Cedric Price worked with cyberneticians and artists to conceive a new paradigm for interactivity in architecture. The project was never realised; however, the intensive thinking and discussions that occupied a great part of their minds were immensely fruitful later on. Thereafter, the *Generator Project* (1978)

vision of Cedric Price and Walter Segal with John Frazer's consultancy was the first spark of a built interactive architectural system. The project consists of a kit of parts to be arranged and re-arranged to meet the clients' needs, which was the Gilman Article Corporation (Frazer, 1995). A site in a forest in Florida was proposed to have foundation pads and to provide a permanent mobile crane for moving components to allow the users to interact with the building's organization. These pads were connected to microchips that were eventually connected to a computer program, which was developed to suggest new arrangements of the site in response to the user's needs. Frazer stated that the Generator project has the ability to register its own boredom when the user stops interacting and to suggest options for its own organization (Frazer, 1995, p. 41). Such attempts have provoked the emergence of intelligent structures and systems in architecture that can learn from their use. Later on, further development in the field of systems architecture was evident during the six-year experimental project of the Architectural Association, *An Evolutionary Architecture* (1989-1996), led by John Frazer where Gordon Pask played an important role in linking cybernetics to architecture (Frazer, 2001, pp. 641-651).

Pask's vision of the future of architecture was a real depiction of what current experimental practices in architecture strive to become. One of the most recent and fascinating immersive and interactive environments created for Venice Biennale 2010 titled: *Hylozoic* (*Hylozoism* is the philosophical doctrine of the belief that all matter has life). Ground was created by Philip Beesley, professor of Architecture at the University of Waterloo, Canada, in collaboration with international scientists and engineers. The installation considers, to a great extent, aspects of biological development such as swarm behaviour, social interaction, technological development, and aesthetics all in an architectural environment fed by viewers' and observers' interactions. The installation is believed to be first of many attempts to get

closer to producing life in artificially intelligent environments out of inanimate matter, which means, producing life in architecture through the interactions with its participants (Beesley, 2010).

## **GENERATIVITY BETWEEN BEING AND BECOMING: SITUATIONS AND EVENTS**

The relationship between the notions of being and becoming in architecture takes a philosophical turn but nevertheless, it stems from the effect of the complexity of natural systems on architecture that numerous architectural theorists and critics wrote extensively about, one of whom is Charles Jencks. In 1995 Jencks wrote a book *The Architecture of the Jumping Universe, A Polemic: How Complexity Science is Changing Architecture and Culture*. In this book he endeavoured to explain sudden changes and shifts in architectural influences through time, from the idea of the static to the mechanical universe of the Modernist Era, eventually reaching a Cosmogenic Era in which development is constant (Jencks, 2002, p. 207). Many architects such as Peter Eisenman, Rem Koolhaas, Greg Lynn and others, have written theories, which extended to their practice, about the extensions of a cosmogenic universe with its dynamism and complexity in architecture. They drew on the critical philosophies of Deleuze, Derrida, and Foucault, as well as cutting-edge scientific debates, to reach a supercritical position in architecture (Steele, 2010). Eisenman comments on the supercritical future of architecture, where he states "A future as a constant becoming rather than being, not an avant-garde of the perceptually new but the becoming of the critical act of an art that can only destroy itself, and which only by destroying itself can constantly renew itself" (Eisenman, 2007). Ideologies of Being and Becoming were extensively debated among philosophers and mainly Heidegger on the subject of "Being" and Deleuze on the subject of "Becoming".



Essentially both philosophers refer to their ideologies to be read as interpretive thoughts.

*"[...] The concept of Being is indefinable. This is deduced from its supreme universality, and rightly so, [...]. Being cannot indeed be conceived as an entity; [...] nor can it acquire such a character as to have the term entity applied to it."* (Heidegger, 1962, p. 23)

*"[...] A becoming lacks a subject distinct from itself; but also it has no term, since its term in turn exists only as taken up in another becoming of which it is the subject, and which coexists, forms a block, with the first. This is the principle according to which there is a reality specific to becoming (the Bergsonian idea of a coexistence of very different durations, superior or inferior to ours, all of them in communication)." (Deleuze & Guattari, 2004, pp. 262-263)*

In architecture, both being and becoming can be considered as processes – implying making and re-making of worlds. The process of being ends when the object or architecture is represented physically and/or virtually, while the process of becoming implies constant change, transience and dialogue due to the reflections of the observer's interpretations of his/her own consciousness and experiences onto architecture. The process of becoming implies that architecture is not a static experience but rather unfolds patterns of behaviour reflected in its generation and representation and this is experienced both spatially and temporally through the process of its worldmaking. Hence the outcome of such process can be seen as an event or a situation generated through interactions between rules and processes to create unstable formative relational patterns rather than a descriptive form or space. Tschumi's introduction of the idea of event explicitly supports the notion of the Deleuzian becoming in that it is generated by interactions of multiple movements and activities in and around space. "[...] promiscuous collisions of programs and spaces, in which the terms intermingle, combine and

implicate one another in the production of a new architectural reality" (Tschumi, 1996, p. 13).

On the other hand, back to the circularity of the system of worldmaking, not only generation and experience, but also representation is considered a dynamic process. For Doreen Massey and other contemporary philosophers, representation produces space-time not through the process of fixation, but rather through the continuation in production of the process of becoming rather than being (Massey, 2009, p. 28). This article takes on Massey's attributes of representation as an active and productive engagement within the process of becoming and a constitutive rather than a mimetic experimentation of the world in which its notions of materiality and immateriality are constantly influencing one another in an exchange of states.

An attempt to reflect some of the philosophies and theories discussed above into the current practice of architecture can be seen in the work of Michael Hensel of the Architectural Association in London, and others such as Benjamin Aranda and Chris Lasch of the Graduate School of Design at Harvard University. Those architects fit within the wide range of designers and architects who have attempted to generatively produce formative relational designs through the use of algorithms. Aranda and Lasch who in their architectural pamphlet *Tooling* explored principles of morphogenesis in design by utilising an algorithmic language for each process, have suggested creating, at the basic level, the first seed for the growth and development of patterns and later on forms. It seems that by inventing such algorithms they have created patterns of form that can be assembled according to the rules governing the formation of this particular pattern (Aranda & Lasch, 2006, p. 6). Kwinter undeniably expresses his support of such methods of form exploration, where he argues "[...] design must not focus uniquely on first order regulatory processes but must target the second order controls that regulate the regulatory processes themselves. The genius of nature and design meet precisely here" (Kwinter, 2006, pp. 92-93).

The basis for the biologically inspired methods of form exploration can be traced back to the Turing theory of morphogenesis. Turing explains the effects of random disturbances to the equilibrium of systems of chemical reactions, based on the assumption that each organism – when slightly disturbed – develops from homogeneity into a pattern rather than from one pattern into another. Later on he developed a non-linear theory of instability due to differences in reaction rates as functions of concentrations in patterns, also known as Turing Instability (Turing, 2004, p. 560). Such theories were the basis for the emergence of speculative and inspiring fields of computer science such as Artificial Intelligence (AI), and Artificial Life (AL), which have had a great impact on generation, pattern formation and experimentation in art and architecture.

In architecture, Alan Turing's breakthrough of algorithms has been recalled by the theories of Sanford Kwinter in his attempts to explain the complexity of nature, where "numbers could be automated within functions" (Kwinter, 2006, pp. 92-93). Kwinter stresses the benefit of algorithms and the way they function in design when derived from complex natural systems, stating: "The rule derives the algorithm and the rule is not a number. The rule is a pressure that is always limited by another rule. Rules do not make forms – the limitations that rules impose on one another do" (Kwinter, 2006, pp. 92-93). In representing the world as a complex dynamical system and fluid manifolds, he identifies two kinds of influence that occur in time during the process of becoming by distinguishing those that are random, and incoherent, passing through the system without influencing it, and others that leave a trace in the process and are called singular. The singular ones are the ones that "give rise to potential or real morphogeneses within and across the system" (Kwinter, 2002, pp. 24-25).

The existing knowledge of the field of computer science and in particular the promise of ultra-artificial intelligence that will be marked by the development of machines or robots that achieve superhuman intelligence has contrib-

uted a great deal to Kwinter's idea of singularity in architecture. Those machines will later be capable of building still more sophisticated intelligences creating what is known as "intelligence explosion" (Good, 1965). The American mathematician John von Neumann originally coined this hypothetical event with the term "The Singularity" in the 1950s as he described the impact of technological advancements on societies, cultures and their consciousness.

In his book *The Singularity Is Near: When Humans Transcend Biology*, Ray Kurzweil predicts the "technological singularity" of human-like intelligent machines revolutionising most aspects of human consciousness where humans and machines will become one and the same (Kurzweil, 2005). The connotations and interpretations of the word Singularity were not limited to the field of Artificial Intelligence (AI), but rather extended to its use in architecture on a socio-worldmaking level (Murrani, 2011).

A computer simulation, *Cubeolony* (Murrani, 2010) shows how simple rules can drive the components of a system to create complex patterns and structures. This simulation emphasises the involvement of technology in a spatial and temporal worldmaking process.

The behaviour of the model is characterised by three distinct phases.

In the initial phase, a number of cubes are generated in the virtual environment (the number of cubes to be generated has been chosen by the user). Each face of each of the cubes will be labelled with a code consisting of six symbols which have been selected to be analogous to the main four amino acids from which DNA is composed: Adenine (A), Cytosine (C), Guanine (G) and Thymine (T). As with DNA, each amino acid has a complementary amino acid to which it is drawn: G and C are mutually attracted, as are T and A. This attraction will not become active until the second phase of the simulation.

As the simulation enters its second phase, the program begins to identify matching pairs of faces (for example AACATG and TTGTAC). While each pair is identified, a virtual spring is created which draws the cubes together with a strong attractive force. Similar to the behaviour

of a real spring, this force is proportional to the distance between the cubes; this proportionality is an important factor in the dynamics of the system as it provides sufficient force to draw distant cubes together while allowing assemblies of cubes to be relatively loosely coupled together. As a consequence of the operation of this process, cubes begin to aggregate together to form small clusters. At this point each of the clusters can be seen to be similar to any other, and the behaviour of the system as a whole is quite stereotyped.

In the third and final phase, the rules from phase two continue to apply, but the increasing level of organization of the system causes much richer dynamics to be generated. The merging together of smaller clusters creates larger clusters. These larger clusters contain more faces; as each face is a potential target for matching larger clusters have a greater ability to draw in smaller clusters and cubes which have yet to become part of any cluster. This is a powerful positive feedback effect. As the size of the largest clusters increases, it becomes possible to observe that the system tends to significantly reorganise itself when a large cluster is joined by a small cluster; this is due to the fact that the strength of the impact of the collision exceeds the strength of the force holding the large cluster together due to the fact that its elements are relatively close to each other and so the springs binding it together are proportionally more relaxed. While the simulation can exhibit generative behaviour for a significant period, a stable state will eventually be reached. The time taken for this depends on the parameters of the simulation, most importantly the number of cubes specified. While the rules are simple, the interaction between these rules and the physics of the simulated environment produces rich spatio-temporal dynamics. Each cube can act collectively as a member of a cluster, but also has powerful individual behaviour that is seen when it becomes attracted to a member of a distant cluster and the whole system must reconfigure itself to accommodate this. The balance between individual and collective behaviour will be important for future projects

aiming to create emergent behaviour in interactive architectural worlds. Maturana and Varela define an autopoietic machine as "...a network of processes of production (transformation and destruction) of components that produces the components which: (i) through their interactions and transformations continuously regenerate and realise the network of processes (relations) that produced them; and (ii) constitute it (the machine) as a concrete unity in the space in which they (the components) exist by specifying the topological domain of its realisation as such a network" (Maturana & Varela, 1980, pp. 78-79). The simulation described above can be viewed as an example of autopoiesis; it behaves in a self-producing way as a consequence of interactions between its constituting components.

The folds and thresholds of cybernetics have contributed a great deal to developing the rules of this experiment. This lies in both its attempt at extracting life processes and principles of complex systems in their collective states, as well as its examination through a simulation of the possibilities of generating behaviour in architectural situations and declaring architecture as a transient product of the process of becoming that depends on the socio-conscious context. Furthermore, this confirms the influence of the field of biology and the technological generation and the affects seen on architecture directly and indirectly, through both bottom-up and top-down trajectories. These effects were embodied in this experiment's processes of representation and experience for the generation of unstable states and situations. In this article situations are defined as spatio-temporal generations of objects, forms, spaces and events that exhibit unstable states in a system. They are considered as seeds of emergence in the process of becoming in architecture – a singularity in-between complex systems and architecture. "To be human, indeed to be living, is always to be in a situation, a context, a world. We have no experience of anything that is permanent and independent of these situations" (Varela, et al., 1991, p. 59). Accordingly, the collective generative situations of architecture that emerge out of interactions between the processes of their

formation, generation, representation and experience, exhibit notions of Maturana and Varela's autopoietic system (Maturana & Varela, 1987). Through oscillations between the processes of being and becoming, the worldmaking of generative situations in architecture maintain their existence, instability and incompleteness through their socio-temporality.

## CONCLUSION

This research establishes that principles and processes in biology and subsequently cybernetics have a direct impact on the creation of behavioural socio-temporary situations in architecture. The principles of the second-order cybernetics are based on the first-order. It in fact, came into being in the 1970s as a continuation rather than a break between the generations with its elementary focus on autonomy, self-organization and more fundamentally, cognition (Varela, et al., 1991). The first-order cybernetics of the 1950s and 1960s was mainly concerned with the behaviour of systems or machines, where engineers and scientists will study a system as a passive and objective entity that can be observed and taken apart without studying the influence of the observer on that system. On the other hand, second-order cybernetics came as the cybernetics of cybernetics focused on the criticality of the influence of the role of the observer onto the system where observer and observed cannot be separated and the result of such observations will depend on the interactions between the observer and what is being observed (von Foerster, 2003). Due to the nonlinear dynamic nature of these phenomena, such interactions are difficult to unpack and interpret although they can be seen across most living processes, artificial systems and networks. Unpacking the dynamics of such processes will only result in distorting our understanding of their collective nature. However, it is vital to endeavour to unfold their complexity in order to interpret them in architectural terms.

Architecture has formed a great part of such complex phenomena. It is not only a constantly changeable process but also involves

high levels of overlapping, interaction, emergence of certain events and phases of transition that lead to many aspects of the experience of architectural forms and spaces which this research identifies as the temporary situation. Each temporary is a product of emergence that is unleashed after phases of transformation in the process of becoming and interaction within its socio-context and participation. In architectural terms, this translates into the spatial and temporal representation of form (Form is not only a representation of an external shape or appearance of an object. Form can mean any behaviour, structural configuration, pattern of organization, and system of relations that occupy a space and time. This article defines architectural forms as actions represented by relationships of everything assembling the environment around us that we encounter in space-time.) and space as experienced by the observer(s)/participant(s). This indirectly leads to the assumption that the cognition and world-making of spatial architecture is dependent on the articulate organisations recognised in patterns that can be identified, not only is abstractions of biological systems, but also through the interactions of its participants in space-time. As a consequence, layers of patterns of articulate organizations and abstractions become part of the spatial and temporal architectural system, which will evoke constant change in the outcome, whether the outcome is the entire system in general, or form/space (Maturana & Varela, 1980). Such constant transitions in the system will enforce the notion of temporality as it carries a meaning of circularity and change, which takes place in a certain time. On the other hand, the notion of socio-temporality emphasises the process of feedback between form/space and its participants and their consciousness. The process of feedback is crucial to the creation of each temporary form (Murrani, 2007) in its wider context while remaining the elemental process of communication in second-order cybernetics. Therefore, the outcome of the socio-temporary in architecture will always be in a process of nonlinear oscillation that acts



as a metanarrative between the socio- and its context in a worldmaking process.

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