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Murrani, Sana

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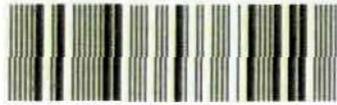
**UNSTABLE TERRITORIES OF REPRESENTATION:
Architectural Experience and the Behaviour of Forms,
Spaces and the Collective Dynamic Environment**

S. Murrani

Doctor of Philosophy

2011

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UNSTABLE TERRITORIES OF REPRESENTATION:
Architectural Experience and the Behaviour of Forms, Spaces and the Collective
Dynamic Environment

by

SANA MURRANI

A thesis submitted to the University of Plymouth
in partial fulfilment for the degree of

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Sana Murrani

Unstable Territories of Representation:

Architectural Experience and the Behaviour of Forms, Spaces and the Collective Dynamic Environment

ABSTRACT:

This thesis applies an interdisciplinary cybernetic and phenomenological analysis to contemporary theories of representation and interpretation of architecture, resulting in a speculative theoretical model of architectural experience as a behavioural system.

The methodological model adopted for this research defines the main structure of the thesis where the narrative and the contributing parts of its complexity emerge. The narrative is presented through objectives and hypotheses that shift and slide between architectural representation and its experience based on three key internal components in architecture: the architectural forms and spaces, the active observers that interact with their environment, and finally, the responsive environment. Three interrelated research questions are considered. The first seeks to define the influence of the theoretical instability between complex life processes, emerging technologies and active perception upon architecture. The second questions the way in which the architectural experience is generated. The third asks: Does architecture behave? And if so, is it possible to define its behavioural characteristics related to its representation, experience and the medium of communication in-between?

The thesis begins by exploring the effect of developments in digitally interactive, biological, and hybrid technologies on representation in architecture. An account of architectural examples considers the shift in the meaning of representation in architecture from the actual and literal to the more conceptual and experimental, from the individual human body and its relations to the multifaceted ecosystem of collective and connected cultures. The writings of Kester Rattenbury, Neil Leach, and Peter Cook among others contribute to the transformation of the ordinary perceptual experience of architecture, the development of experimental practices in architectural theory, and the dynamism of our perception.

The thesis goes on to suggest that instability in architectural representation does not only depend on the internal components of the architectural system but also on the principles and processes of complex systems as well as changes in active perception and our consciousness that act as the external influences on the system. Established theoretical endeavours in biology of D'Arcy Thompson, Alan Turing, and John Holland and philosophies of Merleau-Ponty, Richard Gregory, and Deleuze and Guattari are discussed in this context. Pre-programmed and computational models, illustrative and generative, are presented throughout the thesis.

In the final stage of the development of the thesis architecture is analysed as a system. This is not an unprecedented notion, however defining the main elements and components of this system and their interactions and thereafter identifying that the system behaves and defining its behavioural characteristics, adds to the knowledge in the field of theoretical and experimental architecture. This thesis considers the behavioural characteristics of architecture to be derived from the hypothetical links and unstable thresholds of its non-dualistic notions of materiality and immateriality, reality and virtuality, and finally, intentionality and interpretation.

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AUTHOR'S DECLARATION:

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without prior agreement of the Graduate Committee.

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Throughout the research time, advanced workshops in the expression of BioArt (Kings College 2005) and Bio-Computational Art such as Designing for the 21st Century (University of Westminster, 2005), as well as Models of Machine Learning in Creative Design (Eindhoven 2006) and theoretical enquiries into nanoart in SlidingScales (University of Plymouth 2006), were undertaken, which have contributed a great deal to the knowledge gathered about morphogenetics and computational generativity.

Relevant scientific and artistic based seminars and conferences, such as the Planetary Collegium's own sessions and conferences were regularly attended at which work was presented, and papers were prepared for publication. All publications are enclosed at the end of this manuscript.

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MURRANI, S. 2003. Transphenomic Architecture. *In*: MACIEL, K., PARENTE, A., ASCOTT, R., NOBREGA, G., eds. Sensational Net International Conference Fortaleza – Brazil. 27.

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CHAPTER ONE: PRESENTING THE NARRATIVE

1. Definitions

The words defined below will be used extensively in this thesis, and hence a clear statement of their meanings in this research is crucial to the smooth understanding of its narrative.

Architectural forms and spaces: 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 thesis defines architectural forms as actions represented by relationships of everything assembling the environment around us that we encounter in space-time. Architectural forms represent an amalgamation of forces, structures and patterns that are represented and experienced in spaces and environments. The architectural forms and spaces most relevant to this thesis are constantly affected by the tensions of the changing dialogues between their embodiment in a spatial and temporal context, and the cognitive and perceptual influence of the observer on the system as a coherent whole. Thus in a way, architectural forms and spaces can be seen as a representation of representation, a medium that uses different media to allow the observer to experience his or her own environment.

Representation: As defined in the Concise Oxford English Dictionary, representation means:

"The action or an instance of representing or being represented. An image, model, or other depiction of something" (Soanes and Stevenson, 2009, p1220).

Additionally, according to the online Dictionary.com, representation means:

"[...] a presentation to the mind, as of an idea or image. A mental image or idea so presented; concept. The act of portrayal, picturing, or other rendering in visible form. A picture, figure, statue, etc. The production or a performance of a play or the like, as on the stage. Often, representations. A description or statement, as of things true or alleged" (Dictionary.com, 2010).

In this thesis representation means both an action and a depiction of architectural relations by means and tools of materiality and immateriality, whether conceptual, mechanical, digital, and/or interactive, representing a medium, used as a tool or being represented in a process of becoming.

Architectural experience: Experience in general means an unfolding of events happening through time. It unfolds through the means of representation with emphasis on two main values: functionality on a complex formation level and aesthetics on a collective pattern emergence level. This is the direct implication of the word however, in this thesis experience is considered to be simultaneously both an action and a relation of processes. It is created by both the architect's intentions and the observer's interpretations through time, and is therefore instantly connected to their perception, cognition and consciousness. It is dependent on the dynamics between its creation, interpretation, functionality, and aesthetic. This dynamism in the architectural experience as a whole is evidenced by transformations in its tools and means of representation as well as transformations that follow both changes in the environment and changes in the perception and the consciousness of the observer experiencing architecture. Therefore, the architectural experience is confirmed as a transient open system.

Behavioural architecture: The use of the word behaviour in this thesis is strongly connected to change in time. In the Concise Oxford English Dictionary, behaviour is defined as:

"[...] the way in which an animal or person responds to a situation or stimulus". (Soanes and Stevenson, 2009, p122).

Even though the definition of the word implies that only animate entities can exhibit behaviour, the research at hand proposes behaviour in architecture, which is a statement that embeds a shift in the current paradigm of our understanding of the word *architecture* in relation to its own behaviour as well as the observer's behaviour and the implications of his/her own consciousness onto architecture through representation and experience. This demands that architecture will no longer be seen as an inanimate entity and instead be viewed as a living apparatus.

Dynamic environment: The phrase *dynamic environment* does not only mean dynamic as opposed to static, rather it means hybridized states of being and becoming. The states of unfolding forms and spaces, their materiality and representation; one's observations, intentions and interpretations, their experiences; as well as the medium in which all these states take place in time, whether analogue/physical, digital/cyber or hybrid/interactive, it is always transient.

2. Introduction

The influence of interdisciplinarity in architecture accounts for the change in its medium of representation from the past, present and future of presentation techniques and drawings to the experience of architecture as a whole, and is also the motivation of this research. These changes continue to influence each other to the present day with advances in biotechnology being reflected in our culture and environment, contributing change and evolution in our consciousness and thereafter our experience of architecture. This change produces dynamism in the system of

architectural representation, experience and behaviour. The main elements of this dynamic system are identified by the relationship between complex life processes from which principles and processes exploited by biotechnological developments emerged, and the perception and conception of the phenomenon of architecture erected in front of us in time and space. This relationship is reflected in architecture in its media of representation and in the observer in her or his own experience of this representation. The outcome of this relationship could be seen as a representation of representation governed by the dynamism of the system of observation, conception and interpretation.

Both representation and experience are acts and actions that can influence our perceptual understanding of architecture. Thus, the tools of representation have changed and developed dramatically under the influence of the technological/digital and biological advancements of the current age (Cook, 2008). This has had a great impact on the way we perceive and conceive architecture and to some extent has called for a divided age of representation (Vesely, 2004). 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). The dynamics of this system if studied in time can be interpreted as behavioural patterns incorporating the behaviour of our consciousness and the behaviour of architecture. The inputs of this research are at the core of interdisciplinary debates concerning complex systems, active perception, and technological generation that have contributed a great deal to the dynamism of the architectural system of representation and experience (Kwinter, 2002); (Ballantyne, 2007); (Cruz and Pike, 2008). These

debates have led to contemporary theories of representation and interpretation in architectural discourse and practise through new perspectives into our environment as it becomes more responsive, interactive and collectively connected through different media, be it analogue, digital, cyber or the hybridization of all (Anders, 1998); (Novak, 1998a). The methodological approach adopted for this thesis was necessarily defined by the research inputs; it is of a collective, communicative, dynamic and systematic nature to deal with the complexity of the interwoven structure of the thesis.

Furthermore, the system's behaviour, which is a core drive for this thesis, has led to the combination of cybernetics and phenomenology as a methodological and analytical model. *This thesis applies an interdisciplinary cybernetic and phenomenological analysis to contemporary theories of representation and interpretation of architecture to produce a speculative model of architectural experience as a behavioural system.*

This thesis focuses on theories of architecture concerning representation of form, space and the architectural experience as a whole. The research considers architecture as a system which coexists through interactions and influences between the most influential theories of representation in architecture and their practices. It therefore can be seen as a tool which acts to narrow the gap between theory and practice in architecture through investigating the impact of new technologies, for example; kinetic, digital, virtual, biological and interactive, on such theories and practices. The most critical point of discussion here relates to the medium in which such technologies were used and how the outcome, in this case; be it real or virtual, was perceived and experienced by the observers, and eventually the impact of this relationship between

different media of representation and experience in architecture on our consciousness and in turn on the behaviour of architecture.

Conventional materials and media of representation in architecture have developed dramatically over the last century or so. They have undergone vast changes in use and meanwhile influenced our experience of architecture. From sketches with ink or pen on paper where a pictorial image was literally translated into a building in the real world, such as Le Corbusier's famous 1951 sketch of the *Ronchamp Chapel* in France (Figure 1), passing by the idea of collage/montage of different ideas to represent the process of design on one sketch, such as James Sterling's 1979 *Fogg Museum* in Cambridge, Massachusetts (Figure 2) and later on a more experimental process in the work of Lebbeus Woods and the montage of the *Centre for New Technology* (Figure 3), and further on to using colour, etching and other techniques, such as the *Apeiron* or *Chaos Embodied* by Raoul Bunschoten's piece of the formless void, Berlin (Figure 4). Several of these techniques have evolved over time however the most closely related to the subject at hand are those that evoke conceptual thinking and embody process and interaction as opposed to just a mere representation of an actual instance of architecture.

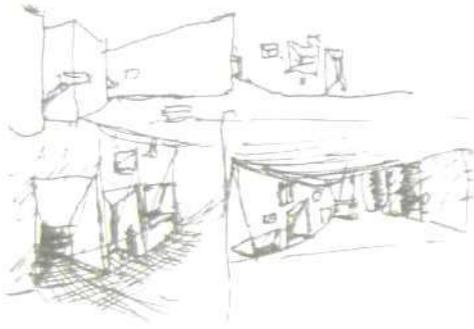


Figure 1: Le Corbusier's 1951 sketch of the *Ronchamp Chapel*, France (Fraser and Henmi, 1994, p8).



Figure 2: James Sterling's 1979 *Fogg Museum*, Cambridge, Massachusetts (Fraser and Henmi, 1994, p50).

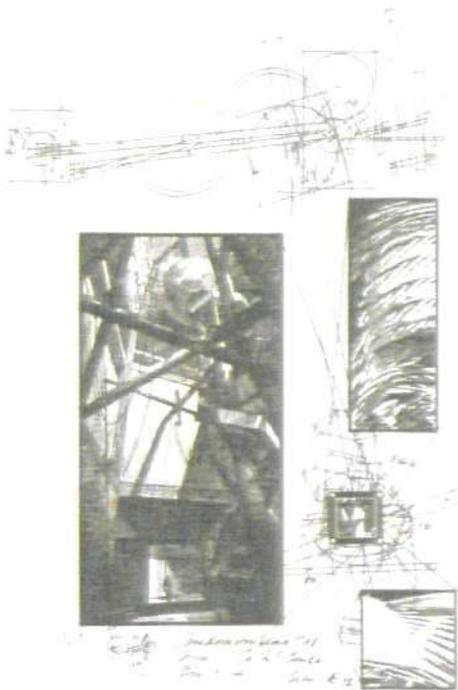


Figure 3: Lebbeus Woods' montage of the *Centre for New Technology* (Fraser and Henmi, 1994, p155).

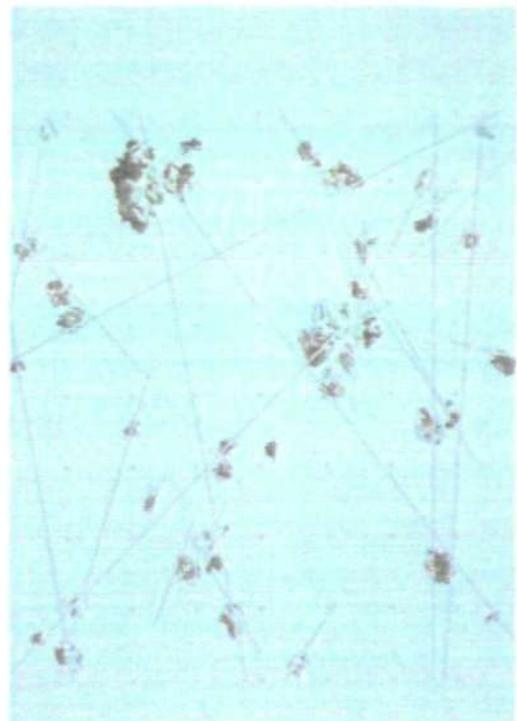


Figure 4: Raoul Bunschoten's *Apeiron or Chaos Embodied*, Berlin (Shimizu, 1993).

The thesis investigates, in parts, the impact of the use of different media of representation, such as technological, biological and perceptual, on architectural form, space, and the responsive environment in an attempt to analyze and synthesize the hybridized architectural experience. These experiences act as a crucial contributor to the architectural system which produces patterns of behaviour in the form of non-dualist notions of materiality and immateriality, reality and virtuality, and intentionality and interpretation at a certain space-time.

This research considers architecture as a system of a living apparatus constantly influenced by the interwoven fields of biology, perception and the technological change which in turn contribute to its instability and incompleteness. The constant change is seen here as behaviour of form, space and their environment reflected in the experience of architecture as a whole in time. This transience in the architectural experience as a whole is portrayed by transformations that take place following changes in the environment and changes in the perception and the consciousness of the observer experiencing architecture on one hand, and changes in the representation of architecture itself on another. Such changes are constant and always in flow given the instability of its constituents, therefore, architecture as a system is never static. It is constantly in a process of making and transforming, being experienced, inhabited, and interacted with, therefore, perpetually incomplete and unstable. Its instability, if studied through time, can be interpreted as behaviour. The behaviour that emerges out of the system is not a mere expression of change in the materiality of architecture through technological advancement but also transformation in the notion of immateriality and subjectivity of architecture itself.

The thesis, therefore, acts as an open system to develop our understanding of interdisciplinary thinking from the orthodox approach to a more collective endeavour across several disciplines in an attempt to conceptualize, generate and experience the now and future of architecture.

Before arriving at the starting point of this research, it must be mentioned that my interest in the subject of the interdisciplinary approach to the analysis of architecture began with a Masters thesis undertaken in the *School of Architecture, Baghdad University*. This was completed, submitted, and defended just four months prior to the start of my doctoral research with the *Planetary Collegium*, at the *University of Plymouth* in the year 2003. In collaboration with my father who is a professor of Genetics and Biostatistics, the Masters thesis described an approach to analyzing the growth of a city through developmental genetics, and furthermore, establishing starting points at which predictions for the growth of any city can be made. A case study of a part of the city of Baghdad was taken into account. In the research outcomes, a speculative proposal for further research was put forward to suggest future possibilities for the creation and growth of living architectures based on the biological understanding established in the dissertation.

This was the initial spark of interest for the topic of this thesis, which was to create generative/responsive architectural forms, as this seemed an ideal compliment to the fact that developmental biotechnology and the current cultural shift as well as the inhabitation of both real and virtual spaces were becoming more evident in our day to day lives. Interventions such as the *Aegis Hypo-Surface* (Figure 5) by Mark Goulthorpe

in 2001 (Bullivant, 2006) and kinetic wind powered creatures *Strandbeests* (Figure 6) by Theo Jansen (Jansen, 2008) as well as hybridized digital and analogue challenging designs such as *Vivisections* and *Robotic Membranes* (Figure 7) by Mette Ramsgard Thomsen and Simon Lovind (Thomsen, 2008b), are all evidences of such a shift. The ultimate goal at the time was to create biologically inspired generative architectural forms or wet cyborgian architecture in an attempt to get as close as possible to nature and to be as sustainable as possible in the design process. This is what currently Rachel Armstrong and Neil Spiller are attempting to achieve through their research on bioengineering and nanotechnology to create homeostatic environments which constitute a biosynthetic ecology of biological matter and technological mechanisms to help maintain the internal system of architecture at equilibrium despite external conditions (Armstrong, 2008).

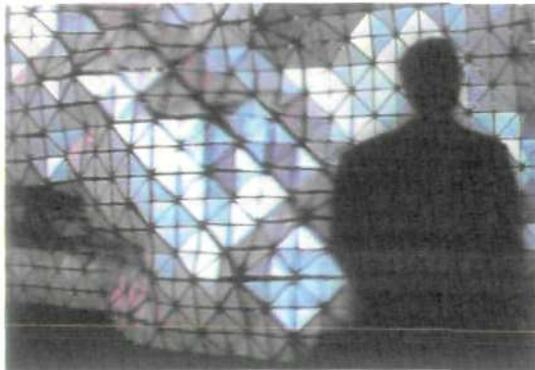


Figure 5: *Aegis Hypo-Surface* by Mark Goulthorpe and dECOi office, Birmingham 2001 (Rattenbury, 2002, p21).



Figure 6: *Strandbeests* by Theo Jansen, exhibited on Exmouth Beach 2010 (Photo taken by Sana Murrani).



Figure 7: *Vivsections* by Mette Ramsgard Thomsen and Simon Lovind, Charlottenborg Art Museum, Copenhagen 2006 (Thomsen, 2008b, p95).

Eventually these ideas, for this research, subsided due to the rapid realization that in order to develop such systems we first need to understand the impact of their existence onto architecture, the surrounding environment and emerging cultures. Therefore, the argument of this thesis has developed into the study of the potential behavioural characteristics of such representational and experiential systems and the way these systems influence the generation of forms and spaces in between environments and cultures whether digital or analogue. A study of potential *spaces-in-between* was realised.

Soon after the research developed, a new paradigm of experience of such systems became a great part of the argument and this was portrayed by the influence of the observer on the experience of architecture. By allowing the observer to enter this complex system of dynamic interactivity, the whole system shifted from being a closed system, where building biologically inspired objects in space was the main goal, to an open system that changes constantly with the consciousness of the observer and his or her own experience of such environments in space, which is a more theoretical and philosophical notion. In order to keep the system open and in flux, the idea of creating constantly changing and interactive environments, of forms and spaces, was still an

attractive one. But this time the medium of representation and the materiality of these forms and spaces were as important as the observer's experience of such responsive environments. Later the importance of this thesis was defined by the process of becoming rather than the process of being in architecture. This interest has led to the train of thought that architecture is not a static experience but rather it unfolds patterns of behaviour reflected in its representation and this is experienced both spatially and temporally.

The thesis considers architecture to be a living apparatus, a hybrid of forms, spaces, and responsive environments portrayed through its representation, and the observer's experience which is a reflection of his or her own consciousness. Therefore, it is crucial to define the architectural problem as an ecosystem of fields, forces and folds of energy that help sustain the continuity of such a dynamic system. In order for this continuity to remain active, changing and transforming, it is essential for all forces contributing to this sustainability to coexist within architecture as a system.

The observer is an active part of this system where dynamic perceptions of inter-subjective material and immaterial expressions of presence and cognition have direct influence on creating and analysing the architectural experience through its representation. Hence, a cybernetic/phenomenological model was chosen to unfold the complexity of the system and to expose its structure, yet to discover that the interwoven interactions within the system as a whole are greater than the sum of its parts. The realization of the impact of the unstable states of interaction between the changes in the materiality and medium of representation of the architectural

experience during the influences of the biotechnological, digital/interactive, perceptual/cognitive involvements, form the source of energy that stimulates the system. Furthermore, maintaining the flow of this energy is essential for the system's transformation and existence as these states will influence change in architecture by confirming it as part of a transient ecology.

This thesis presents a speculative model of cybernetic and phenomenological analysis of architectural experience as a system. The narrative is derived from the notion of unpacking the influences and the changes of the medium of representation in architecture on the architectural experience. This will be analysed through the cybernetic phenomenological model, arguing that architecture needs to consider a collective dynamic *space-in-between*, the form, space and their environment, in conjunction with the observer and his or her own consciousness. It unfolds the influence of current interdisciplinary debates of cybernetics, digital interactivity, and biotechnology on architectural representation and experience. Furthermore, it conveys the concept of behavioural architecture through a series of pre-programmed models that encapsulate the ideas of complex systems and perception under current and speculative technological change.

The first chapter focuses on presenting the narrative and laying out the main hypothesis and methodology for the work as well as proposing some fundamental questions. This chapter lays the foundation to establish a methodological model of the integration of second-order cybernetics and phenomenology which when combined is

fit to unpack the complexity of the suggested arguments. It also acts as an introduction to the research questions posed.

The second chapter introduces the central grounding of theories of representation in architecture beginning from the return of the body and re-humanisation in architecture which happened in the second phase of the theories of *Modern Architecture*. The positioning of the theories of architecture continues, passing by the influence of cybernetics in the 1960's on architecture and through the technological and biological involvement of the 1990's which occurred firstly on the digital level and later on stimulated an interactive and speculative future in the creation of architecture with a focus on new creative media of representation from the 21st century onwards. The final main point of this chapter is organized around the introduction of the notion of architecture as an open system of living apparatus where both architectural representation and its experience contribute a great deal to the dynamics of that system.

The third chapter suggests the first interwoven field of influence on architecture, that is the amalgamation of complex biological systems, and technological generation. Principles and properties of complex systems are introduced. The impact of generative and emergent systems influences the development of the thesis as a whole. This chapter is supported by several models that embed aspects of emergence and complex systems to assist in the creation of self-organized and adaptable architectural forms and spaces. The first and second parts of this chapter define the word *system* one of the most influential terms used in this thesis. The third part of this chapter

introduces the technological emergence which acts as an interim stage to the speculative future of architecture. The effect of technological advancements on interactive artwork and especially architecture is unpacked. A further programmed version of the model presented earlier in the same chapter is developed and explained.

The fourth chapter introduces the second interwoven field of active perception and the dynamic culture. Active perception is presented focusing on visual and cognitive aspects. Furthermore, it sheds light on the changes in our perceptual experiences of architecture and the emergence of the dynamic culture. Several philosophical arguments that entail the influence of the notion of the *space-in-between* are addressed as they eventually develop the intentions of the chapter further. This chapter is supported by a digital and a physical model that justifies some of the issues discussed such as the complexity, dynamism, and instability of the perceptual system.

The fifth chapter suggests a conspicuous instability which exists in the architectural system between the sub-systems and the system as a whole. The first sub-system is embodied in the influence of the interwoven fields on architecture. The second sub-system concerns initiating dialogues between suggested non-dualist notions of materiality and immateriality (representation), reality and virtuality (medium) and finally, intentionality and interpretation (experience) in architecture. The collision of the two sub-systems allows the system to emerge through integrated states of representation, medium and experience by establishing the notion of behaviour in architecture and the overlapping layers of complexity where this behaviour can be

realised. This eventually confirms the architectural experience as a dynamic open system. The last part of this chapter unpacks the speculative future of architecture and further potentials for research investigations in this field. This chapter serves as the conclusion of the narrative but at the same time acts as an open ground for debates concerning the integration of experiential and experimental theory and practice in architecture. This section of the thesis confirms architecture as part of an open system which is influenced by the consciousness of the observer when he or she enters the system and is expressed through its representation into events and situations, behaviours and spaces-in-between. Furthermore, it confirms architecture as a living apparatus that is always undergoing dynamic change in time. This basis contributes to the humanisation and placement of architecture in the consciousness of the observer and recognises it as part of a transient ecosystem. Moreover, it establishes incompleteness and instability in its representation and experience, which in turn is reflected as behaviour. A final model is developed which concentrates on the influence of the representation of the spaces-in-between and the behaviour of architectural situations on our spatial and temporal experience of architecture and relates to the systems of behaviour established in previous chapters. The sixth chapter acts as a stand-alone piece that questions the validity of the methodology used for this thesis.

3. Hypotheses and Objectives

3.1. Hypotheses

To some extent, the thesis argues that hypothetical links exist between life processes and architectural representation and its experience. Catherine Ingraham, an architectural critic, suggests an asymmetrical condition between life and architecture.

She bases her ideas on a matrix of mind and matter, culture, architecture, life and genetics. She draws nonlinear relationships and links between the elementary components of this matrix from the geneticist Francois Jacob's writings on the history of heredity and on the difference between the biological and the technical - the division between animate beings that reproduce and inanimate matter that is reproduced. This is what Jacob calls the split between the active and the passive voice (Jacob, 1982). Ingraham continues explaining:

"Architecture belongs chiefly to what Jacob calls 'mental memory', cultural memory. Life, on the other hand, is neither art nor discipline, although capable of being disciplined. Life too is concerned with its own logic... and it belongs to what Jacob calls 'genetic memory'. Very little from mental, or cultural, memory becomes inscribed in the genetic memory by which the body is reproduced over time, although almost everything about the body and its biological life has been a subject of enquiry in contemporary cultural life" (Ingraham, 2006).

Both living beings and architecture are products of the same forces namely technological, biological insights, computational flexibility. All these elements influence change, whether it is development or evolution in the observer's consciousness and as a consequence this tends to influence change in architectural expression and experience through the intentions and the interpretations of such experiences. The influence of this change feeds back into the architectural system in its representation on one hand and in its experience on another. For example, changes in the media of representation from analogue to digital to hybrid challenge our perceptual fields and cognition, and so provoke new paradigms of analysis and investigation of architectural experiences. The sequential hypothesis and objectives for this thesis emerged in an attempt to unpack and evolve such complex interactions between architecture and its observers as creators:

- The main hypothesis suggests the existence of unstable states of integration between complex life processes and active cognition under the technological generation, advancements and change of the current age. These unstable states constantly influence architectural representation by confirming architecture as a living apparatus that is part of a changing ecology. (Architectural representation)

- Two main values in architectural experience are emphasized; functionality on a complex formation and development level as opposed to utility, and aesthetics on a perceptual and pattern formation level as opposed to beauty. These values challenge the integration of architectural experience on different scales; context, space and the active observer's impact. (Architectural experience)

Norberg-Schulz echoed much the same regarding the connotations of functionality as it takes on a new authority where he says:

"Functions are no longer merely adjuncts to quantitative needs that are satisfied through material resources; instead, they consist of a respectful use, in which each and every action forms part of the entire context" (Norberg-Schulz, 2000).

Function – complex formation and development level as opposed to utility

+

Aesthetics – on a perception and pattern formation level as opposed to beauty

- The flux of these challenges in time influences the emergence of behaviour in architecture as a system (system of flux of representations and experiences).

In a 1943 paper titled: *Behaviour, purpose, and teleology*, Rosenblueth, Wiener, and Bigelow were the first to unfold the multifaceted definitions of the word *behaviour*.

They defined *behaviour* as:

"[...] any change of an entity with respect to its surroundings" (Rosenblueth et al., 1943, p18).

They discussed the actions emerging out of change as output and input, where output is defined as any change produced by the object to the surrounding environment, and input is defined as any external event to the object affecting it by any means (Rosenblueth et al., 1943, p18). They specifically concentrated on the output of an object to its surroundings and considered this as behaviour. Furthermore, they classified this behaviour into two categories; active and passive behaviour. Active in which the object is the source of the output energy involved in a given specific reaction while passive is in which the output can be traced to the immediate input (Rosenblueth et al., 1943, p18). For example mechanical repulses in automatically closing doors when approached and opened are passive behaviour, however, an example of active behaviour would be if the object is powered by local information that is processed before an action takes place by the object, such as our natural ability to actively choose not to respond or react to an aggressive move by an external object or subject. Examples in architecture include programmable architectural pieces and spaces with computationally distributed network systems. The selected examples used in this thesis examine interactivity and spatial flexibility as well as active behaviour; therefore, the attribute of activity as opposed to passivity is most relevant to this research.

3.2. Objectives

- **One of the main objectives is the existence of instability and incompleteness in-between the interwoven fields of biology, perception and technology.** More specifically the focus is on conceptual and hypothetical links and boundaries in-between the interwoven fields and architectural representation – both the product in process and the process of becoming.
- **The influence of architectural representation upon its experience.** The system is a flux between form, space, and the responsive environment on one hand and the active observer on the other.
- **Locating architecture in the consciousness of the observer and claiming a dynamic perceptual and complex system between form, space and the architectural experience where representation can be perceived and conceived in a behavioural context.**

4. Research Questions

The research questions can be divided into three main levels of complexity:

- **Theoretical instability**

How does the instability between the interwoven fields influence architecture? And what would be the impact of a conspicuous instability on architectural representation?

- **Generation and existence of transient architecture**

Under these new influences, how does the architectural experience formulate/generate in a transient ecology?

- **Behaviour of architecture as a system**

Does architecture behave? And if so, is it possible to define its behavioural characteristics relating to form, space and the architectural experience as a whole?

How does architecture behave?

Architecture is not a social fixed space which users simply enter and navigate through; it is a living apparatus that creates dynamic complexity in the perception of the observer which depends hugely on active perception. There is dynamism in architecture that lies in the perception of the observer. Therefore, to some extent, the behaviour of architecture depends on the consciousness of the observer.

To unpack the dynamism of this behaviour, it is essential to collate an understanding as to the involvement of its parts. This involves form, space, the responsive environment, the active observer's experience and consciousness, which form the internal part of this living apparatus. In addition, the influential fields of complex biological systems, perception and cognition, technological change and generation, and their reflection on architectural representation form the external part of the living apparatus. However, we can look further to the internal contributors of form, space, environment and active observers, and the external fields of influence; all lie in the *space-in-between* the internal and the external which forms unstable hypothetical thresholds. Such hypothetical thresholds belong to both internal and external influences on architecture and they become the generators of the system of behaviour in architectural representation and experience.

The amalgamation and interaction of the internal and external parts forms the system as a whole. The hypothetical borders and spaces in between the internal and external

parts form transient states within this system and it is from these that the energy for this system emerges. The system will keep generating new media of representation, new materials, new technology which will evoke new behaviours in the observer and as a result our consciousness will evolve and hence our experience of architecture which will result as a reflection of our intentions and interpretations, our phenomenological impact. These processes in time will fuel nonlinear circular feedback loops into the system impacting architectural representation and experience. The circularity in return will sustain the systems generation of novel series, sequences and patterns of behaviour, behaviour in the consciousness of the observer and eventually behaviour in architecture.

Considering architecture as a system is not an unprecedented notion, however, defining the main elements and components of this system and their interactions and thereafter, identifying that the system behaves and defining its behavioural characteristics, is an addition to the knowledge in the field of theoretical and experimental architecture. This thesis suggests behaviour in architectural representation and experience. It proposes the creation of an active model of the fusion of biologically inspired systems and dynamic perception, which allows this behaviour to be generated and analyzed. It then evolves this notion, considering multi-layers of complexity derived from natural phenomena, observation and cognition as well as new technological media and imperatives.

5. Methodology: The Cybernetic Phenomenological Model

The methodology of this thesis takes a discursive and analytical approach to an interdisciplinary field of interaction between architecture, science, technology and perception, through a cybernetic phenomenological model.

Cybernetics³ has been defined as:

"[...] the science that studies abstract principles of organization in complex systems" (Heylighen and Joslyn, 2001, p2).

In addition to this, cybernetics focuses on the possible behaviours of its variables rather than their material presence (Ashby, 1957). Most important for this thesis is second-order cybernetics which is 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 and Joslyn, 2001, p2).

This is elementary to architecture as the observer and the user are crucial variables for the construction of experience and representation in architecture. Professor Paul Pangaro, a professor of cybernetics, performer, and a 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 which is most relevant to this thesis 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 which emerge from the interactions between the observer and the observed. And these attributes are the

³ The word cybernetics is derived from the Greek word *kybernetes* meaning steersman.

basic elements that distinguish first-order cybernetics from second-order cybernetics (Pangaro, 2002). Control in the sense of subjective observations which are based on distinctions between, for examples, edges and boundaries of observed systems which depend on the object being observed. However, there are also cognitive distinctions which 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).

Cybernetics was originally introduced by Norbert Wiener in 1947-48, a mathematician and a 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).

In an attempt to define behaviour in architecture based on Wiener's findings; change can occur to any architectural form and space in their environment and context. In architectural terms, output would mean changes in the material and immaterial representation of architectural form and space, 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 system; representation and

experience are vital processes which feed back into each other, and hence, cannot be separated.

To imply behaviour in architecture through cybernetic principles does not mean referring to architecture which attempts to illustrate cybernetic processes, nor to an architecture which embodies cybernetic machines such as robots. On the contrary, it is the relationship between the underlying forces which construct a cybernetic system in architecture that is the crucial concern here. These underlying forces are what Wiener refers to as the changes between the output and the input which result in behaviour. On a deeper level the underlying forces link directly to the circularity and feedback processes of the cybernetic systems, such changes in the 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. In the 1960s Roy Ascott became the first cyberneticist and artist to introduce this vision to the art world where he established links between cybernetics and what he terms "*Behaviourist Art*" through Wiener's thoughts on the relationship between the output and input of the behaviouristic 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, p95-104).

Cybernetic Serendipity was the first exhibition that exposed the relationship between art and cybernetics. In 1968 Jasia Reichardt curated this exhibition which 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 (Figure 8) 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 (Figure 9). Therefore, the exhibition acted as a powerful catalyst which connected cybernetics to the creative process through ideas, objects and acts exchanged between the creators and observers/participants/visitors (Reichardt, 1971).

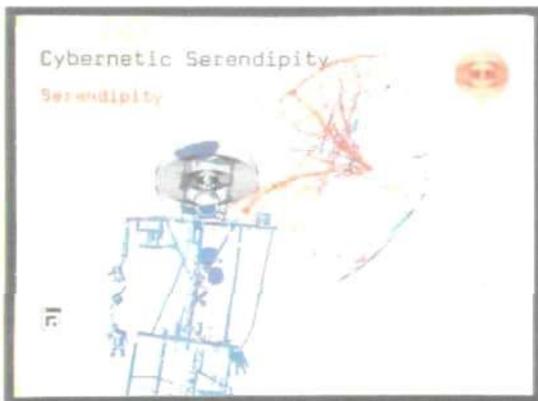


Figure 8: *Cybernetic Serendipity* exhibition poster, Institute of Contemporary Arts (ICA), London 1968 (Daniels et al., 2003).



Figure 9: Photograph of the *Cybernetic Serendipity* exhibition, Institute of Contemporary Arts (ICA), London 1968 (Daniels et al., 2003).

Although several attempts were undertaken to revive the exhibition again 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). 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).

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* which are internationally known annual events based on exhibiting digital and interactive artwork which 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 dematerialized forms of experimental art, through software (Burnham, 1971).

One of the exhibition's most controversial works was an architectural environment titled *SEEK* which claims to be a behavioural cybernetic world (Figure 10). It was designed and executed by Nicholas Negroponte and students of the Architecture Machine Group at MIT (Pangaro, 2005). *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 done with the help of a giant robotic computer connected arm which 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 (Figure 11). 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 cybernetically based intelligent architecture. Theodor H. Nelson, Nicholas Negroponte, and Les Levine in a critique of their own work have stated:

“For one group of observers the gerbils and robotic arm seemed to form a prototypical cybernetic circuit: it was an inspiring image of a machine that paid attention to the preferences expressed by the gerbils and then completed and organized them into new, pleasing structures. Others took SEEK as an image of the less sunny side of human-computer interaction and its future possibilities” (Nelson et al., 2003, p247).

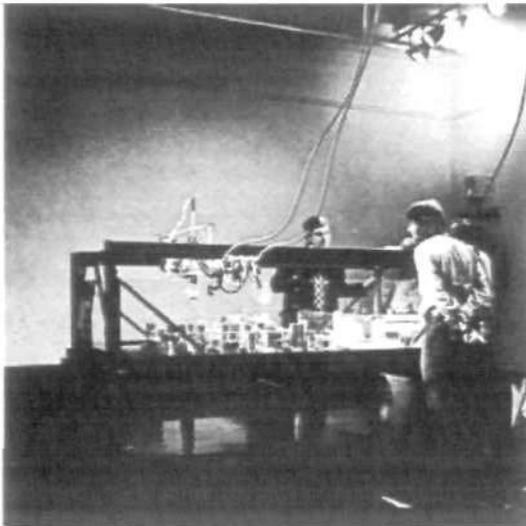


Figure 10: *SEEK* project by Nicholas Negroponte and students of the Architecture Machine Group at MIT, exhibited in *Software, Information Technology: Its New Meaning for Art* at the Jewish Museum, New York 1970 (Pangaro, 2005).



Figure 11: *SEEK* with Gerbils' interaction (Pangaro, 2005).

Despite such explorations in architecture, it remained the last form of art to be exposed to collaborations between other disciplines and experimentations with its materiality. 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 (Figure 12) (1960s) a vision

for Joan Littlewood where architect Cedric Price worked with cyberneticians such as Gordon Pask and artists such as Roy Ascott and others to realise a dream at that time. The project was never realised, however, the intensive thinking and discussions that occupied a great part of their minds were immensely fruitful later on. These discussions and debates had a huge influence on architectural history and later on theories of design and conceptualization. The *Generator Project* (Figure 13) (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 Paper 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 which were eventually connected to a computer program that was developed to suggest new arrangements of the site in response to the user's needs. In Frazer's own words, the whole model was turned into a:

"[...] gigantic reconfigurable array processor, where the configuration of the processor was directly related to the configuration it was modelling" (Frazer, 1995, p41).

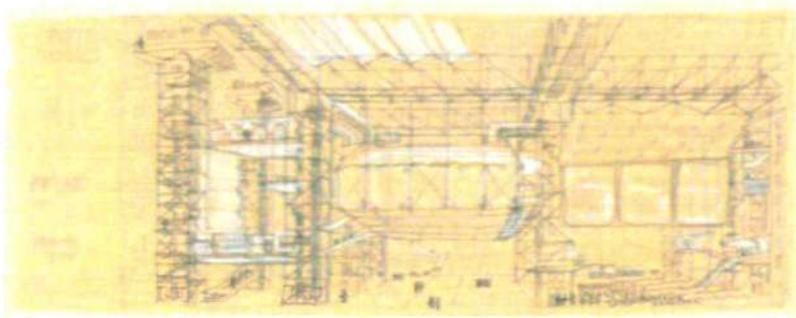


Figure 12: *Fun Palace* by Cedric Price, London 1960 (MoMA Online Collection).

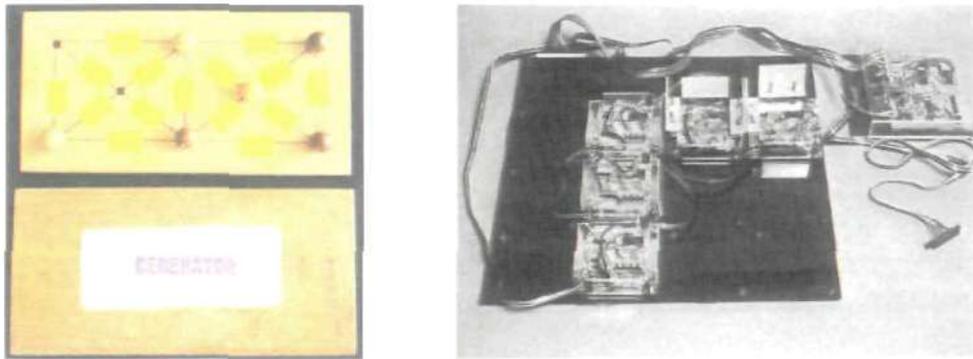


Figure 13: *The Generator Project* by Cedric Price and Walter Segal with John Frazer, London 1978 (Frazer, 1995, p40).

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, p41). Such attempts have provoked the emergence of intelligent structures and systems in architecture which 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).

Cybernetics contributes a great deal to inventions of current contemporary design and presentation tools in architecture such as Computer Aided Design (CAD) programmes. However, this is just the superficial relevance of cybernetics to architecture. Gordon Pask in 1969, on the other hand, 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, p494).

Pask referred in his famous article titled: *The Architectural Relevance of Cybernetics* in 1969, 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 fulfil certain emerged needs in society, were excellent examples of system designs. Pask had predicted a cybernetic theory of architecture which would make use of Computer Aided Design (CAD) programs to help develop useful instruments in design, and principles and processes in different disciplines such as psychology, ecology and economics. A cybernetic theory will have a greater unified influence on architectural theory for analyzing 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, p496). 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 with the innovative designs of Paxton and Brunel was all about, and this is at the core of the elementary principle of complex systems from which cybernetics as a field emerged.

The key writings by Gordon Pask of the *New Cybernetics* and Ranulph Glanville of “*Objects*” are about putting the observer in the heart of the system of observation (Pask, 1961) and (Glanville, 1994, p141) 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, p3). Glanville challenges the subject/object relationship to put forward a theory of "Objects" where he states:

"The theory is built around what I call 'Objects', which are taken to be 'self-observing'. Objects are taken to have two roles: self-observing and self-observed. But each Object is just one Object, so these roles are seen as switching, which they do by generating time (they are oscillators)" (Glanville, 1994, p142).

He goes on to explain the power behind these oscillations which blend the boundaries between objects and subjects by saying:

"When the Object is self-observed, a slot is left open for observing which other Objects may look into (providing they are in their self-observed role, and so are free to observe): an Object can observe another Object by occupying that Object's 'observing' slot while it is empty, which it is when the (self) Object is not in the (self) observing role, but in the observed role. Each Object generates its own time, which means their times appear different to each other, and also that one Object might observe several different, other Objects simultaneously, allowing observations of different Objects to relate several Objects together through (the synchronising times of) our observations of such Objects" (Glanville, 1994, p143).

Glanville blurred the hypothetical thresholds between objects and subjects. Further to that, cybernetics blurred the boundaries between natural and artificial systems through the application of feedback mechanisms (Bryant, 2000). This produced significant leaps towards an age of integration of both natural and artificial principles under one system, the cybernetic system. This influenced further advancements in technologies in art and architecture starting from Price's *Fun Palace* in the 1960s, and then *The Evolutionary Architecture* project by John Frazer between 1980s and 1990s. Moreover, current cutting edge innovations have encouraged the creation of new materials that are biotechnologically produced, called *Transmaterials* which are inspired by day to day materials such as, fabric, metal, concrete, glass, and so on and so forth, but most of which are designed for the materials to interact with the user

(Brownell, 2008), such as; *White Noise White Light* (Figure 14) by Meejin Yoon, which is an interactive sound-light installation piece commissioned and installed for the Athens 2004 Olympics (Brownell, 2008, p238).



Figure 14: *White Noise White Light* an interactive sound-light installation by Meejin Yoon, Athens Olympics 2004 (Brownell, 2008, p238).

The principles of 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). 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 (Heylighen and Joslyn, 2001, p4).

The architectural phenomenologist Juhani Pallasmaa describes the exchange of such experiences between the observer and what is being observed in art and architecture

as a lived experience of material and immaterial relevance. However, and despite the validity of Pallasmaa's general thinking, it is the intention of this thesis to widen the influence of phenomenology in architecture to go beyond the individual experience into the effect of collective observers and furthermore the collective culture.

Architecture in this thesis is judged by the interactions of collective observers and their influence on the changing environment around them as well as on the feedback of such interaction to the observers' consciousness. Phenomenologists in the field of architecture for centuries have focused on the individual haptic and mental experience of the environment around the inhabitant or the user, and this is where Pallasmaa states:

"An architectural work is not experienced as a series of isolated retinal pictures; it is touched and lived in its full and integrated material, embodied and spiritual sense. A profound work is always a world and a complete microcosm. It offers pleasurable shapes and surfaces moulded for the touch of the eye, but it also incorporates and integrates physical and mental structures, giving our existential experience of being a strengthened coherence and significance. A great building enhances and articulates our understanding of gravity and materiality, horizontality and verticality, the dimensions of above and below, as well as the eternal enigmas of existence, light and silence" (Pallasmaa, 2009, p137-138).

However, phenomenology, very much like cybernetics, crosses over several similar principles and processes such as; communication, circularity, and feedback in systems and is not bound by the perceptual experience alone. Both disciplines have examined and analysed the structure of systems, whether visual and haptic or neuronal and biological. Phenomenologists in the field of architecture have concentrated on the study of the structure of our visual field as well as the relationship between the objects/subjects constructing the field of vision that is being observed, while cyberneticians have focused on the structure of complex natural systems and their behaviour. However, eventually both disciplines extended their interests to the

behaviour and consciousness of the observers perceiving and conceiving the context that is constructed around them. Neil Leach extends the definition of phenomenology to include the human experience beyond the visual appearance of the phenomena, where he states:

"Phenomenology may be defined as the study of how phenomena appear. However, this is not limited to the visual domain. Phenomenology demands a receptivity to the full ontological potential of human experience" (Leach, 1997, p83).

Neil Leach sheds a light on the role of phenomenology in architecture, which extends beyond the explorations of ontological significance of architecture where he states:

"Space for them² is to be perceived not as abstract, neutral space, but as the space of lived experience" (Leach, 1997, p83).

Leach introduces the history of phenomenology in architecture in his book *Re-thinking Architecture: A Reader in Cultural Theory* where he criticises key ideologies of the ontological understanding of architecture and phenomenology which are self-referential systems that lack normative foundations and/or legitimizations of their claims (Leach, 1997, p84). Nevertheless, phenomenology continues to flourish in current architectural debates with emphasis on the philosophies of Bachelard, Heidegger, Deleuze, and Lefebvre, and most recently by architects such as Pallasmaa, Leach and Holl.

In his book *The Poetics of Space* Gaston Bachelard takes the house as the narrative through which he explains the experience of intimate spaces. Bachelard suggests that in order to understand the importance of the meaning of intimate space we ought to

² Neil Leach is referring here to phenomenologists.

experience it, and therefore, move away from the Cartesian conception of its reality to enter a daydreaming phase where memory and imagination remain our only associations (Bachelard, 1994).

"[...] in the most interminable of dialectics, the sheltered being gives perceptible limits to his shelter. He experiences the house in its reality and in its virtuality, by means of thought and dreams. It is no longer in its positive aspects that the house is really 'lived', nor is it only in the passing hour that we recognize its benefits. An entire past comes to dwell in a new house" (Bachelard, 1994, p5).

Similar to Bachelard, Martin Heidegger's philosophy is underpinned in architecture through the concept of dwelling. For Heidegger, man's situatedness in the world is linked directly to the question of dwelling. Leach explains Heidegger's position of the concept of dwelling by contextualizing space where he states:

"The world is not 'in space', but 'space' is in the world. 'Space', for Heidegger, contains a sense of 'clearing-away', of releasing places from wilderness, and allowing the possibility of 'dwelling'. 'Space' is therefore linked to 'Being'" (Leach, 1997, p98).

While Bachelard takes the house as his subject for explaining the experience of intimate spaces, Henri Lefebvre attempts to lay the foundations for the production of space on the basis of a living experience. Lefebvre criticises architects for their abstracted methods of representation, which led to the reduction of the world to a world of blueprints (Leach, 1997, p138). In his book *The Production of Space*, Lefebvre explicitly points out the negative effect of abstract representation on our cognitive, and consequently our conscious understanding, of the production of space, where he states:

"Consequently, before the concept of the production of space can fully be grasped, it will be necessary to dispel ideologies which serve to conceal the use of the productive forces within modes of production in general, and within the dominant mode of production in

particular. The ideologies which have to be destroyed for our immediate purpose are those which promote 'abstract' spatiality and segmented representations of space. Naturally, such ideologies do not present themselves for what they are; instead, they pass themselves off as established knowledge. The difficulty and complexity of our critical task derives from the fact that it applies at once to the 'mental' forms and practical 'social' contents of space" (Lefebvre, 1991, p90).

Following the same train of thought regarding the connotations of images and pictures to abstract spatial representations, James J. Gibson states:

"A picture cannot at the same time possess high fidelity for something concrete and high univocality for something abstract" (Gibson, 1998, p248).

The above conceptions, however debatable and variant suggest a conflict between abstraction in representation and cognition. On the other hand, a degree of ambiguity as opposed to absolute clarity in representations helps generate interpretive qualities of the imagination which are vital for the creative process. This is all the more reason why methods of representation in architecture need to move towards the experimental and the lived experience in response to our changing cognitive behaviour and ultimately our changing consciousness. Both representation and experience in architecture are at the heart of Bachelard, Heidegger and Lefebvre's philosophies. They may also be linked indirectly to the principles of second-order cybernetics through the observers' interpretations of the environment around them due to responses in their behaviour and consciousness. Edmund Husserl, the father of phenomenology, once described consciousness through phenomenology as *phenomenological residuum*, he continued by stating:

"[...] that consciousness has, in itself, a being of its own which in its own absolute essence, is not touched by the phenomenological exclusion" (Husserl, 1991).

Philosophers in both disciplines have crossed the boundaries of the other discipline. Heinz von Foerster was a mathematician and a cybernetician who studied perception and cognition as well as the structure of systems and neural networks (von Foerster, 2002) while Maurice Merleau-Ponty (known for his contribution to the field of perception and phenomenology) shifted his interests in the last few years before he died to focus on studies of the structures of behaviour, consciousness and the visible and invisible (Madison, 1981, p1-3). This confirms the connectivity of the two disciplines and the overlapping of interests which are the main contributors to the methodological approach adopted for this thesis.

Our daily lives are constituted of what Christian Norberg-Schulz calls "concrete phenomena" (Norberg-Schulz, 1980, p6) and these are people, animals, trees, stone, earth, wood, houses, towns, etc... Literally everything that has a material substance and occupies a space in our environment can be considered as a concrete phenomenon. On the other hand, "intangible phenomena" (Norberg-Schulz, 1980, p6) such as feelings contribute a great deal to the formation of the environment around us. It is crucial to state the importance of the oscillation of interrelations and connections between the concrete and intangible phenomena that constitute our life. Dermot Moran in 1999 described this oscillation as the interrelation between the objective and the subjective (Moran and Mooney, 2002, p2). Furthermore, he emphasises the role of phenomenology in explaining the process of this conspicuous oscillation between objectivity and subjectivity by stating:

"Phenomenology aims to describe in all its complexity the manifold layers of the experience of objectivity as it emerges at the heart of subjectivity. It is critical of all forms

of objectivism that attend only to what appears and not to the relation of the appearing to the subject" (Moran and Mooney, 2002, p2).

Maurice Merleau-Ponty refers to this relationship as experience where he states:

"To experience a structure is not to receive it into oneself passively: it is to live it, to take it up, assume it and discover its immanent significance. Thus an experience can never bear the relation to certain factual conditions that it would bear to its cause" (Merleau-Ponty, 2002, p301).

Gilles Deleuze links this relationship back to the knowledge of being which lies between the two forms of subjectivity and objectivity, which he evolves into a third relationship, the idea of the fold. Deleuze blurs the boundaries between subjective and objective relationships and furthermore, he emphasizes the emergence of a third relationship out of their interactions.

"Everything is subject to variables and variation: the variables of knowledge (for example, objects and subjects as immanent variables of the statement) and the variation in the relation between forms; the variable particularities of power and the variations in the relations between forces; the variable subjectivities, and the variation of the fold or of subjectivation" (Deleuze, 1988).

Deleuze's ideas were first initiated by the philosophy of Husserl, Foucault, Heidegger and Bachelard. Gaston Bachelard refers to this exact relationship as the phenomenology of roundness. It is where he speaks of a metaphysical and a metapsychological dimension, a hidden truth of being which requires phenomenological meditation and interpretation which he found vivid in poetry as a form of being. Where images of being should retain their primitivity and those which are worked over lose their initial virtues (Bachelard, 1994, p235).

"If we submit to the hypnotic power of such expressions, suddenly we find ourselves entirely in the roundness of this being, we live in the roundness of life, like a walnut that becomes round in its shell" (Bachelard, 1994, p233-234).

Husserl, the founder of phenomenology wrote in 1936 about the thresholds between objectivity and subjectivity. This was followed by his discovery regarding the effect of constitutive subjectivity on phenomenology.

"Husserl was concerned with the problem of how objective truth could be constituted in and through subjective acts of consciousness, what Husserl called 'the enigma of subjectivity'" (Moran and Mooney, 2002, p61).

Husserl explains the meaning of objective truth as opposed to objective sciences, where he states:

"The idea of objective truth is predetermined in its whole meaning by the contrast with the idea of the truth in pre-and extra- scientific life. This latter truth has its ultimate and deepest source of verification in experience which is 'pure' in the sense designated above, in all its modes of perception, memory, etc. These words, however, must be understood actually as prescientific life understands them; thus one must not inject into them, from current objective science, any psychophysical, psychological interpretation" (Husserl, 1970, p124-125).

However, later on Husserl's interest shifted to studying the emergence of intersubjective processes within human communities. This is when he supplemented the notion of the static constitution of objectivity with a genetic component, which is based on the objective sciences that emerge from cultural contexts (Moran and Mooney, 2002, p61). At the same time, friction between Deleuze's and Merleau-Ponty's interpretations of phenomenology began to emerge, however, its boundaries remain unclear as both philosophers developed their thinking across the timescale of their writings. Merleau-Ponty believed in a two-world ontology where essence is separated from appearance (Lawlor, 1998, p15). Deleuze, however, confronted this

belief with two challenges, the challenge of immanence and another of difference, as he believed on one hand, that immanence eliminates transcendence and combines both essence and appearance where being is the phenomenon, and on another that difference is viewed as articulation and connection at the same time (Deleuze, 1991). However, and despite this friction, Deleuze and Merleau-Ponty both relate phenomenology back to consciousness in the essence of their definition.

Merleau-Ponty defines phenomenology in the *Phenomenology of Perception* as:

"A study of the appearance of being to consciousness" (Merleau-Ponty, 2002, p61).

While Deleuze states:

"[...] the cogito makes it possible to treat the plane of immanence as a field of consciousness. Immanence is supposed to be immanent to a pure consciousness, to a thinking subject" (Deleuze and Guattari, 1994, p46).

This evolution in the thinking of philosophers of phenomenology sheds a light onto its relation to complex systems and the emergence of life processes and phenomena. The complex nested structure of this thesis required a highly structured methodological model that combines both aspects of behaviour of the complex system of the observer's consciousness with the experience and expressions of architecture being perceived and conceived, not only in sequential time but also through memory. The oscillation between aspects of second order cybernetics and phenomenology is, in itself, an active dynamic model of analysis in process to produce a speculative model of architectural experience as a system. This is evident through the analysis of interdisciplinary accounts of contemporary theories of representation and

interpretation in architecture which will be unpacked in chapter two. This is a novel approach to the integration of generations of representation and experience in architecture through a cybernetic and phenomenological model of analysis.

This thesis represents an interdisciplinary research based on the understanding of the influences from principles and processes of complex systems, current cutting edge technological advancements of this age, and active perception. These influences contribute towards new imperatives and endeavours of representational, experiential and experimental architecture. Furthermore, they suggest a conspicuous instability in the representation of architectural representation, reflected in its experience through generating dynamism in the architectural system as a whole, which in return emerges as behaviour.

The objectives and the hypotheses of this chapter shift and slide between architectural *representation and its experience based on three main key players, throughout this* research, these are: the architectural forms and spaces, the active observers that interact with their environment, and finally, the responsive environment. The methodological approach of the cybernetic phenomenological model adopted for this research acts as the main structure of the thesis where the narrative and the contributing parts of its complexity will emerge. This model considers architecture as a behavioural system where its characteristics are derived from the hypothetical links and unstable thresholds of its non-dualistic notions of materiality and immateriality, reality and virtuality, and finally, intentionality and interpretation.

Below is a diagram that extrapolates the main strands of the thesis and their overlapping and intertwining effects on each other which will be expressed throughout the narrative of the thesis (Figure 15).

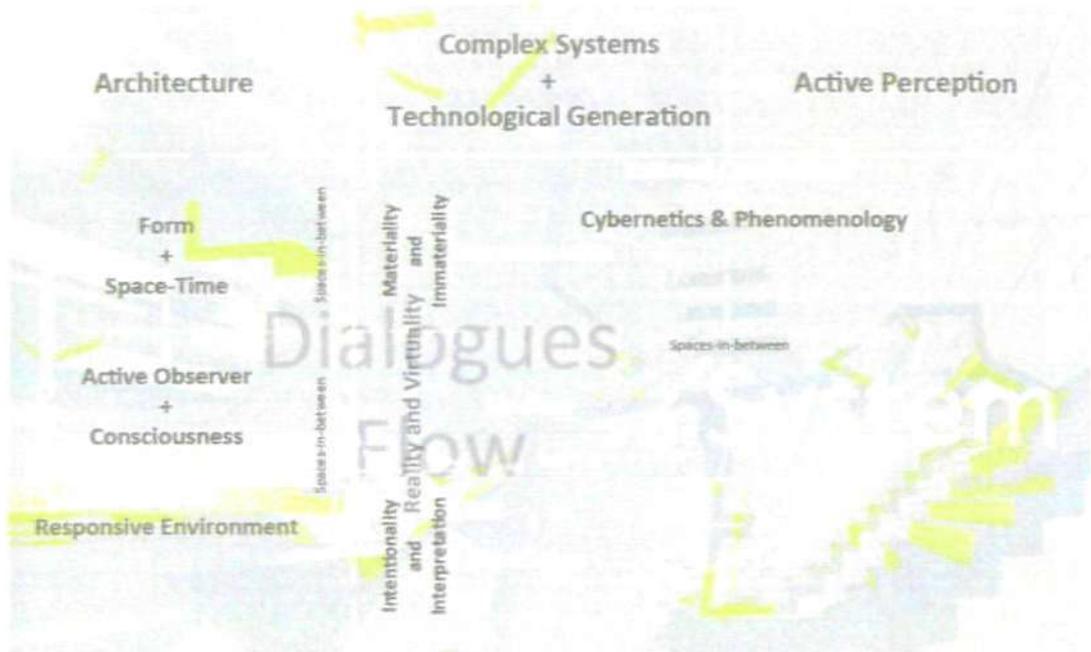


Figure 15: Diagram of the main strands of the thesis.



CHAPTER TWO: GROUNDING ARCHITECTURE

6. The Re-humanisation of Architecture and its Representation

According to the definitions of the word *representation* put forward at the beginning of the thesis, it was established that representation, for this research, means an action and a depiction of architectural relations of materiality and immateriality in a real and virtual context. To reiterate:

"Presentation to the mind, as of an idea or image. A mental image or idea presented; concept. The act of portrayal, picturing, or other rendering in visible form. A picture, figure, statue, etc. The production or a performance of a play or the like, as on the stage. Often, representations. A description or statement, as of things true or alleged"
(Dictionary.com, 2010).

However, from the above quote the reader might discover that all definitions listed above can be linked back to the observer's experience and consciousness in a certain space in time. Hereafter, this section is marked by the reappearance of the influence of the human body on architecture from the mid 20th century until the present day, providing insights into new methodological imperatives, shifts in paradigms, and unconventional implementations in the creation, representation and experience of architecture. All examples from architecture, particularly the ones used in this chapter, are of an experimental and experiential nature.

Conventional and orthodox media of representation attempting to connect the human body to architecture stretch back in time to the first civilizations of *Mesopotamia*, passing through the *Egyptians* and the *Greeks*. *Ten Books on Architecture* by Vitruvius identifies the symmetrical relationship between the human body parts and the

proportions of what Vitruvius calls “*the perfect building*”. These were the first documented writings (dating to the 1st century B.C.) that unpacked any kind of relationship between the human body and architecture (Vitruvius Pollio, 2005).

“[...] in the human body there is a kind of symmetrical harmony between forearm, foot, palm, finger, and other small parts; so it is with perfect buildings” (Vitruvius Pollio, 2005, p73-74).

The history of architecture confirms the analogies used to connect nature and specifically the human body to architecture, this is evident in the drawings and sketches of Leonardo Da Vinci and the *Vitruvian Man* in relation to the inhabited space which later on in the 1950s were recalled by Corbusier when he introduced the *Modulor Man* and the notion of modularity in architecture (Le Corbusier, 1980). This extends further into the ideology of the humanisation of architecture as at that time the overall understanding of the impact of the notion of humanisation was to:

“[...] uphold those aspects of design and construction that directly relate to promoting the comfort and well-being of people” (Michel, 1995, p246).

This link is also highlighted in the writings of Bloomer and Moore in their *Body, Memory and Architecture* book, in the late 1970s, as they described this relationship:

“The landscape of the human inner world of landmarks, coordinates, hierarchies, and especially boundaries serves, we believe, as the only humane starting point for the organization of space around us, which, more than being perceived, is inhabited by us” (Bloomer and Moore, 1977, p77).

However, the shift in the thinking regarding this relationship in the late history of architecture has had a greater impact on the interpretation and the emergence of new media of representation in architecture. This is evident in the work of Cedric Price and

the incorporation of cybernetic principles in the development of the design process, passing by the technological and the bio-technological and later on the interactive influence on the development of the media used not only to represent architecture but also to experience architecture. The account of this work discusses the shift in the meaning of representation in architecture from the actual and literal to the more conceptual and experimental, from the individual human body and its relations to the multifaceted ecosystem of multi cultures, collectivity and connectivity on different levels whether physical and real or digital and cyber. Juhani Pallasmaa links representation to experience through the primary feelings of architecture when he says:

"The quality of architecture does not lie in the sense of reality that it expresses, but quite the reverse, in its capacity for awakening our imagination" (Pallasmaa, 1996, p452).

In the second phase of the modern movement there was a reflection of change in the focus from the practical aspects of living (embodiment of the first phase), to notions of *"monumentality and regionalism"* through *"constancy and change"* (Giedion, 2003). Christian Norberg-Schulz explains the impact of this change on architectural theory and history when he relates that by monumentality Giedion meant, *"the memory and the symbols that serve to root humanity to time"* and by regionalism he meant the need to sink these roots in space and place (Norberg-Schulz, 2000, p8). Norberg-Schulz had noticed that *"constancy and change"* and the notions of *"monumentality and regionalism"* contribute directly to ideas of *"survival"* and by which these ideas shed a light on the emergence of the first glimpse of *"re-humanization in architecture"* in the early 1950s (Norberg-Schulz, 2000).

Starting from this particular phase, a discussion of modern and current anxieties in architectural theory and practice influenced by digital and biological technology will be presented in what may seem to be a chronological order. However, these theories and practices influenced each other in a non-linear way and therefore, the reader might observe the overlapping and intertwining of certain theories and practices which reflects the effect of architectural representation on its experience and vice-versa.

Nevertheless, these new paradigms and theories drew upon elementary and fundamental principles in representation; this was achieved by acknowledging the human body as part of a larger system. This system was represented in society, city and life on all levels and dimensions. Therefore, it was crucial to shift the focus of attention from the individual to the principles and processes of the social, material and immaterial networked systems to which not only the individual but also architecture contributes a great deal. Hence, architectural representation and its medium shifted towards a new paradigm as a response to the urge for networked, interconnected, interactive spaces, forms and eventually living architectures. This shift blurred the boundaries between architecture and its representation, and integrated the architectural experience through its media of expression. Pallasmaa emphasizes the relationship between representation and experience in architecture to the human body by saying:

"Architecture is a direct expression of existence, of human presence in the world. It is a direct expression in the sense that it is largely based on the language of the body of which neither the creator of the work nor the person experiencing it is aware"
(Pallasmaa, 1996, p451).

As mentioned earlier, this section is orientated around the body, mechanizing the body and architecture, and then re-humanising architecture. Moving on to the idea of Deleuzian connotations of the body, the idea of the boundaries between body and form merging into one entity becomes evident in Andrew Ballantyne's writings about the shift in the use of the body in architecture. Ballantyne draws on experiences of others such as Samuel Butler, Deleuze and Guattari as they suggest a boundary-less body and form relationship where the body extends, connects and blends with its surroundings (Ballantyne, 2007).

"Renaissance drawings show grids of squares with human figures superimposed across them, which turn into the ground plans of churches, and in doing so embody divinely ordered proportion. The body in the Deleuze-and-Guattari-world is utterly different. It shits and fucks, is engaged in processes of production and consumption, has an interior as well as an exterior (or, rather, the interior and exterior are indistinguishable) and it connects in multifarious ways, within itself and with its surroundings. In its most elemental state it is the 'body without organs' – a term which Deleuze and Guattari adapt into an abstract concept, re-territorializing it in many contexts – but its origin is in a concrete example" (Ballantyne, 2007, p34).

Catherine Ingraham talks of the asymmetrical condition and relationship between life and architecture which parallels, in a way, the same asymmetry between life, biological organisms for example, and any ecological milieu with the addition of a *"motivated connection between artifice and artificer"* (Ingraham, 2006, p8). Ingraham stresses the constant change in such connections between the artifice and the artificer due to the *"relative status and values of human life and the relative status and value of architecture"* (Ingraham, 2006, p8). In other words, such connections are dependent on each other, interlinked, and feed back into one another any changes or developments that happen between our consciousness and the environment around us. Ingraham builds her arguments upon established contemporary philosophies by Deleuze and Guattari, as she continues:

“Architecture designs the space, environment, and context within which most of biological/social human life passes. [...] insofar as architecture is a spatial and technical practice that responds to forces in the world, it, like a biological milieu, is governed by laws indifferent to the intrinsic needs of living beings” (Ingraham, 2006, p9).

These shifts in the ideologies of architecture, firstly inspired by body proportions, later migrating into merging the body and form, eventually reaching the mechanisation of architecture, all are not unprecedented notions. However, moving into the realm of understanding biological principles, processes of complex systems and behaviour in particular, makes it possible to attempt to create architecture that will exert an influence on the behaviour of the human body through both its representation and experience. This later transformation creates a fresh point of view into architecture.

7. Positioning Architecture through its Representation in Space and Time

For generations, representation in architecture has been the subject of a multiplicity of theories and movements. The dynamic complex interactions between these theories support the notion of architectural creation, existence and experience as a milieu. Almost all claim that creating architecture is a living process in one way or another but few have embodied aspects of the principles of living processes necessary to theorise about the changing experience of architecture at the deepest level of its elementary structural representation which manifests itself as a living entity rather than one composed of static matter. The territorial elements of this context depend on existing work such as Archigram’s *Living City* (Cook, 1999), Cedric Price’s *Generator Project* (Price et al., 2003), Peter Eisenman’s autonomous houses (Eisenman, 1999), Neil Spiller’s *Velazquez Machine* (Spiller, 2005), Greg Lynn’s *Embryonic House* (Lynn, 2000),

passing by the recent involvement of interactivity in NOX's *Machining Architecture* (Spuybroek, 2004a) and Michael Hensel's differentiated structures and morphogenetic designs (Hensel et al., 2006a), and others, where the relation to the body was created through extensive use of cutting edge technology and media of representation in order to generate ideas and/or execution.

Architecture has always been considered a very important part of a bigger umbrella, art. As part of nature itself, architecture has always been inspired by nature through ideas, forms and forces which are represented in architectural forms and spaces that are related to human activities and the environment. This thesis defines architectural forms and spaces as actions represented by relationships of everything that composes the environment around us that we encounter in time. Norberg-Schulz explains that the components of these ensembles are dynamic entities, where he states:

"[...] things are not static objects, but rather ways of being with infinite and countless forms of being made present" (Norberg-Schulz, 2000, p137).

Different architectural media, discussed in this thesis, are meant to represent an amalgamation of forces, structures and patterns which are represented and experienced in spaces and environments around us in time as an extension of our own bodies and consciousness which we cannot isolate from one another. Thus in a way, architectural forms and spaces could be seen as a representation of representation, a medium that uses different media to allow the observer to experience his or her own environment.

The development of *Modernist, Post-Modernist, De-Constructivist, and Post-Structuralist* imagery in architectural theory has led to an approach which identifies and seeks to promote hypothetical and actual links between forms, spaces and living structures. An account of such models will be introduced in this chapter which sheds light on capturing the fundamental essence of representation in living structures that are dynamic and self-organized, and furthermore, connects these models of representation to the observer's consciousness and his or her own experience of architecture. This historic and theoretical account bridges a gap that was left unaddressed in order to explore the relationship between the imagery representation of architecture on one hand, and advances in technology and biology as well as the influence of the observer on another. Therefore, this section focuses on different accounts of architectural forms and spaces and their representation and acts as a fragmented literature review to the narrative and the structure of this thesis.

The account presented in this section illustrates a brief history based on architects' anxiety, be it theoretical or practical, shaped around the impact of the technological generation onto different media of representation in architecture which, in return, has been reflected on its experience as a whole. Examples can be seen in the work of the experimental sculptor Richard Wilson as well in the work of the architect Gordon Matta-Clark. In Wilson's famous *20:50* installation (Figure 16) of the Saatchi Collection, London 1987, half a room was filled with sump oil. Wilson used the oil surface and metal with light reflection in the design of this room, creating a gangway for the viewer to walk over. This gangway is positioned above the lake of oil where the latter mirrors the space around it. On the other hand, Gordon Matta-Clark's work titled *The*

Splitting House 1974 (Figure 17) became a political statement in response to the American city's decay of the mid 1960's and early 1970's and at the same time his work carried another embedded connotation, which was to reveal the hidden architectural practice within the usual experience of architecture by deforming it (Walker, 2004, p130). Matta-Clark used derelict housing estates as the medium to communicate his ideas and carved them with a power saw to open up the spaces and reflect on the reasons behind their dissection. Stephen Walker describes the whole experience of "*Splitting*" as an "*operative viewing*" by stating:

"This movement through the building, horizontally and vertically, in plan and section, would have been interrupted by the presence of the cut, the section, which would begin to call into question the tacit assumptions that architecture makes on our behalf, and to counter any claims that the architecture might make toward attaining a 'whole-object' object quality that can be understood once and for all" (Walker, 2004, p131).

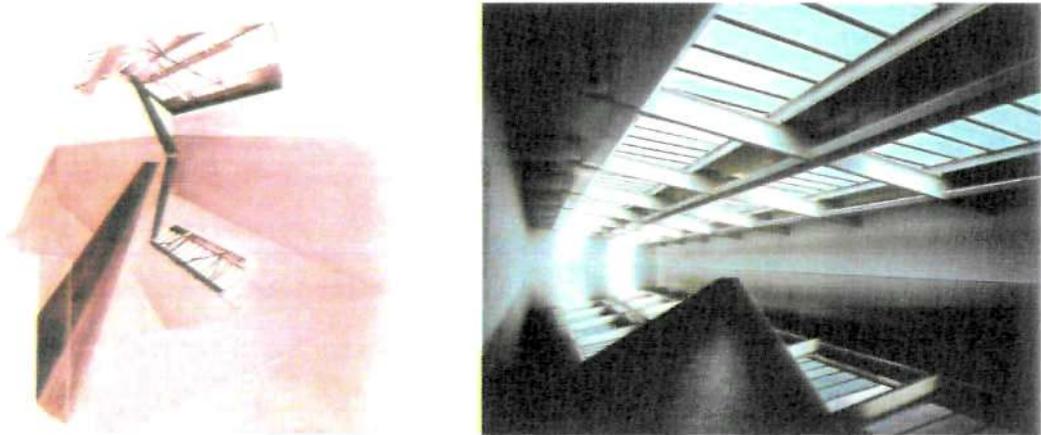


Figure 16: *20.50* installation by Richard Wilson, the Saatchi Collection, London 1987 (Left: Kovats, 2005, p173) and (Right: http://www.saatchi-gallery.co.uk/artists/artpages/richard_wilson_2050.htm).

Wilson's and Matta-Clark's pieces as well as others such as Rachel Whiteread's work (Figure 18), however different in the medium of technology used nevertheless, all contribute to the transformation of the ordinary perceptual experience of architectural spaces and their impact on the development of such experimental practices on

architectural theory and the dynamism of our perception. In addition, they all used architecture as a medium or a tool to enable them to expose a certain statement.



Figure 17: *Splitting House*, Gordon Matta-Clark 1974 (http://photocentricfsu.blogspot.com/2010_02_01_archive.html).



Figure 18: Rachel Whiteread's work, Left: http://www.artofthestate.co.uk/london_photos/tate_modern_rachel_whiteread.htm and (Right: Kovats, 2005, p194).

Three generations of representation of architectural forms and spaces are identified as physical/analogue, digital/interactive, and theoretical, or in other words, conceptual/experimental. These three generations will be discussed separately and collectively as it is misleading to suggest that they are separated completely. They share principles and qualities of materiality and processes; they overlap each other in the making and the regeneration of new spatial and temporal entities. However, for the sake of explaining the historical and theoretical account of these three

generations, the reader might observe separation and discontinuation in some of the discussions but these will be reconciled towards the end of this chapter.

7.1. Physical/Analogue

The physical and analogue forms and spaces dominate our environment. The work of many architects falls into this category; the pieces of architecture selected for discussion in this section have a consciously growing perceptual complexity as well as multifaceted meanings of representation. One of the most influential examples can be seen in the *Barcelona Pavilion* designed by Mies van der Rohe (Figure 19). This building and its furniture carried notions of beauty and perfection in the creation of architectural spaces. It succeeded to the extent that it was regarded as too singular to be used for its original intended purpose. Therefore, it was left non-functional as it became an iconic piece of rich perceptual experiences. The *Barcelona Pavilion* became a statement of singularity in architectural representation and its significance lies in the media used for its representation, i.e. in books, journals and so on and so forth, rather than in the mere quality of its architectural spaces. This is one of the most powerful examples of architecture becoming a representation of representation. The history of this pavilion has contributed to the assumption of it becoming a representation of representation. The pavilion was originally designed and built by Mies van der Rohe in 1929 for the Barcelona International Exhibition. After the end of the exhibition in 1930 the pavilion was demolished, and later on in 1986 was rebuilt to its original design by architects Ignasi de Solà-Morales, Cristian Cirici and Fernando Ramos, and since then has been open daily to the public. The decision to rebuild the exhibition came as a

reaction to the iconic presence of the building in the history and theory of *Modern Architecture*. Its singularity emerged as a reflection of its creator's reputation as well as the number of times the building has been considered as an example to illustrate various concepts in the history and theory of architecture over the past five decades or more. Therefore, the building itself resembles a representation of the original representation created by Mies van der Rohe.

Kester Rattenbury, an architectural journalist and an educator explains the ideas above in her book, titled *This Is Not Architecture* (Rattenbury, 2002), a statement written on the cover of the book under an image of the *Barcelona Pavilion* (Figure 20). She starts her introduction explaining the reasons behind this controversial statement on one of the most iconic buildings in architectural history, where she states:

"Of course this is not architecture. This is a picture. This is a book. Yet it is almost impossible to conceive that a photo of the Barcelona Pavilion, on the front of an architectural book, is not architecture... It is hard to accept the construct – that what you're looking at is a representation and not the thing itself" (Rattenbury, 2002, pxxi).



Figure 19: *Barcelona Pavilion*, Mies van der Rohe, Barcelona 1929 (<http://fineartpublicity.com/2009/04/10/villa-grisebach-photography-exhibition-and-sale/>).



Figure 20: *This Is Not Architecture* book cover, Kester Rattenbury, 2002 (Rattenbury, 2002).

Rattenbury reiterates the fact that this statement of the image of the *Barcelona Pavilion* is not architecture is not entirely true and this image which is a representation of the actual building is almost more definitive than the building itself (Rattenbury, 2002, pxxi). This is one side to representation, a drawing, an image, a picture, however, there is another side to representation which is embedded within the architecture itself, be it material or immaterial, real or virtual. The architectural experience that is at the core of this thesis depends on two faceted sides of representation, representation of the actual and representation of the representation of architecture.

“Architecture’s relationship with its representation is peculiar, powerful and absolutely critical. Architecture is driven by belief in the nature of the real and the physical: the specific qualities of one thing – its material, form, arrangement, substance, detail – over another. It is absolutely rooted in the idea of ‘the thing itself’. Yet it is discussed, illustrated, explained – even defined – almost entirely through its representations” (Rattenbury, 2002, pxxi).

Le Corbusier draws attention to this link between architecture and “man” in an attempt to explain the relationship and the influence of the observer onto architecture:

*“Plans are not politics.
Plans are the rational and poetic moment set up in the midst of contingencies.
Contingencies are the environment: places, people, culture, topographies, climate.
They are, furthermore, the recourses liberated by modern techniques. The latter are universal. Contingencies should only be judged as they relate to the entity – ‘man’ – and in connection with man, in relation to us, to ourselves: a biology, a psychology”* (Le Corbusier, 1964).

In 1930 Le Corbusier tried to shift his thinking from machine aesthetics to connect man with his environment and enable him to live in a united organism (Menin and Samuel, 2003, p64). He imagined building the perfect cell – the *Biological Unit: The Cell* (Figure 21) (Le Corbusier, 1964, p143) where he allocates fourteen-square-metres per

occupant which could be duplicated to make a community; this is the first starting point for an evolution towards a more humane architecture that is not simply based on the proportions of the human body. He strived in his theory and work to create a city as an organism where the centre is the heart and the open public spaces are the lungs, etc. These ideas of his marked the birth to the *Radiant City* 1935 (Figure 22), where he imagined communities evolving around patterns of his biological cells (Le Corbusier, 1964, p143). The *Radiant City* carried the notion of a collective organism that breathes and permits life. But it was not until further development of his ideas to reach standardization of perfection and the impact of human proportion that architecture turned to humanism (Le Corbusier, 1980). His interest in the synthesis of proportion and harmony sparked his devotion for a humane measuring tool for design, the *Modular* (1943-1947). The reappearance of the *Modular Man* (Figure 23) is thought to have sparked the comeback of the relation between the body and architecture that faded away for centuries after the *Vitruvian Man* (Figure 24) (Hight, 2008, p6-7).

The Greeks believed that everything in nature evolved around the *Golden Section* which is a figure of ratio of approximately 1.618. The *Golden Section*, the *Vitruvian Man*, the *Fibonacci series* and the *Modular Man* all fall in the same grounding notion of proportion, harmony in unity and verity that exists in patterns of natural organisms. The *Modular Man* was created as a measuring tool based on the human body and mathematics, not to explain proportion in natural organisms but to assist in the evolution of design. Le Corbusier believed that creating architecture around the *Modular Man* would mean designing and adapting for user's requirements, which he

believed to be the closest to nature and life and led his work, in a way, away from the Cartesian illusion (von Moos, 1979, p252). His first building that portrayed the use of the *Modular* was *Unite d'Habitation* (Housing Unity) Marseille, France, between 1947-1952 (Figure 25) followed by an identical version built in Berlin in 1957 *Unite d'Habitation* (Figure 26).

Le Corbusier's attempt at implementing the *Modular Man* on an urban scale was in fact an embodiment of his ideas of the *Radiant City*. Ideas of the *Modular* were also embedded in the design of *Chapel of Ronchamp* (1955) also known as Notre Dame du Haut (Figure 27). Many thought that *Ronchamp* marked a turning point in Le Corbusier's work as it appeared far from the conventional work of the *Modern Architecture* (von Moos, 1979, p254). Yet *Ronchamp*, despite its unconventional look, was a continuation of Le Corbusier's healthy obsession in grounding architecture to nature. This singular sculptural building represents *genius loci* in the urban suburbs of France and in architectural history. Le Corbusier's theory and work marked the starting point of this chronological history of biologically/perceptually inspired architecture; however, representation of the media of architecture was still rather directly inspired by the body proportion at this stage.



Figure 21: *Biological Unit: The Cell*, Le Corbusier, 1930s (Le Corbusier, 1964, p143).

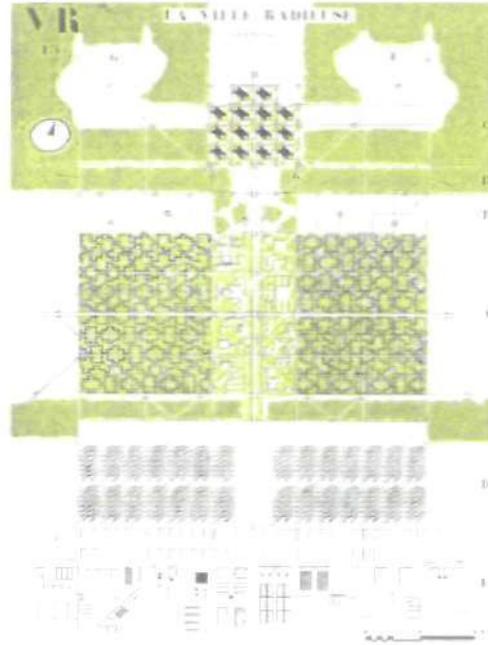


Figure 22: *The Radiant City*, Le Corbusier, 1935 (Le Corbusier, 1964, p170).

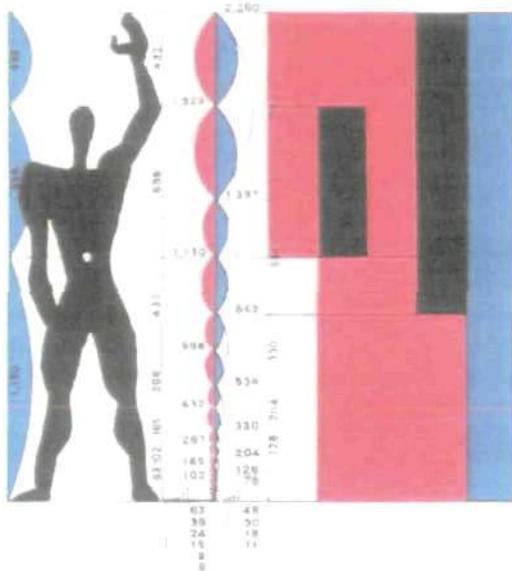


Figure 23: *Modular Man*, Le Corbusier, 1943-47 (<http://www.rb-architectes.com/nos-projets-d-architecte-10.html>).



Figure 24: *Vitruvian Man* drawing, Leonardo da Vinci, 1487 (<http://www.davincibio.org/vitruvian.jsp>).



Figure 25: *Unite d'Habitation (Housing Unity)*, Le Corbusier, Marseille, France 1947-1952 (<http://www.essential-architecture.com/IMAGES2/unite-dhabitation-marseille.jpg>)



Figure 26: *Unite d' Habitation*, Le Corbusier, Berlin 1957 (http://www.e-architect.co.uk/berlin/corbusier_building.htm).



Figure 27: *Chapel of Ronchamp or Notre Dame du Haut*, Le Corbusier, Ronchamp, France 1955 (<http://www.galinsky.com/buildings/ronchamp/>).



At this stage architecture and its representation were linked literally and directly up until the appearance of the Archigram group in the 1960s. Drawings, models, sketches, or any other imagery and pictorial expressions of an idea were translated literally into physical built architecture, for example, the famous Ronchamp sketch by Le Corbusier. The reader might wonder why the Archigram group work is in this section, which is marked by the physicality and the analogousness of its architecture and not in the conceptual and experimental section. The reason is that the Archigram group and their work came as a serious reaction to the physicality and rigidity of the practiced built architecture and its technologies at that time. Simon Sadler carries on this reasoning by explaining:

"Archigram's historical significance was as an origin of combative neo-avant-garde attitudes and techniques that became stock-in-trade to practitioners keen to rethink architectural spaces and architectural technology" (Sadler, 2005, p4).

Archigram's work collectively, from the beginning of the 1960s until the mid 1970s, has influenced architectural representation in a new direction. The use of collage, bold colours, montage and sequential diagrams that are heavily populated with people within the architectural forms and spaces they are creating, as well as the comic political messages implemented with large type sprouting out of the multiple perspective points, has diverted attention from the architecture itself into the people that are using it and experiencing it (Figure 28). Drawings and situations experienced in time by people were key factors in the Archigram group's work. Peter Cook talks about drawings in the development of his work from paper architecture to *"making buildings"* through ideas and drawings. Cook questions the completion of the cycle between the drawings and the finished built object and whether it exists within the drawn end of the process or at the handing over of the finished object, where he contemplates:

"Needing to push the conceptual range further and further on and needing to constantly complete the cycle between ideas and forms, forms and arrangements, arrangements and motives, motives and content, content and ideas" (Cook, 2008, p200).



Figure 28: Archigram use of representation (Left: Cook, 1999, p78-79) and (Right: Cook, 2008, p165).

While Warren Chalk, one of the founders of the Archigram group, highlighted the importance of people's experience when he wrote in 1965 an essay originally published in *Arena*, Journal of the Architectural Association, titled: *Housing as a Consumer Product*. In this essay Chalk reflected on the misconception held about the Archigram work as not being concerned with people. He adds, that this is directly linked to the type of imagery they use, which if looked at closely:

"[...] there will be found traces of a very real concern for people and the way in which they might be liberated from the restrictions imposed on them by the existing chaotic situation, in the home, at work and in the total built environment" (Cook, 1999, p16).

He continues by saying:

"Human situations are as concerned with the environmental changes and activity within the city, as with the definition of places. Important in this is the percept of situation as an ideas generator is creating a truly living city. Cities should generate, reflect and activate life, their structure organized to precipitate life and movement. [...] Situation can be caused by a single individual, by groups or a crowd, their particular purpose, occupation, movement and direction" (Cook, 1999, p16).

To some extent, through representation, the Archigram group's work had a special concern for ideas of change and survival of both people and the built environment at the same time, therefore, some of the material discussed in this section forms an extension of these concerns, and the emergence of change and life processes in architecture are attributes of that.

Drawing on a few of the ideas described in the previous examples is the work of Christopher Alexander, which is deeply concerned with the development of natural physical forms, but in this case rather static ones constructed with conventional building materials. In his most recent set of four books entitled *The Nature of Order*, a theory of design for living architecture through natural processes is detailed throughout Alexander's career starting with the *Notes on the Synthesis of Form* in 1964 (Alexander, 1964) and the *Timeless Way of Building* in 1978 (Alexander, 1978). Alexander's way of thinking provides helpful context for a deeper understanding of the relationship between the human body and architecture, which is however concerned with technological aspects, unplanned outcomes, and the embodiment of intelligent behaviour rather than with the design and analysis of fixed structures.

In book 1 titled *The Phenomenon of Life: The Nature of Order*, Alexander discusses various examples of buildings, gardens, paintings, tiles and other artefacts from around the world. He attempts to illustrate the artefacts that possess the greatest life throughout describing the structure of these artefacts (Alexander, 2004a). In book 2 titled *Process of Creating Life: The Nature of Order*, he discusses the process that these artefacts have in common; where he claims that all truly living works are created by

unfolding – a continuous structure-preserving process (Alexander, 2004b). This led to book 3 titled *Vision for a Living World: The Nature of Order*, where he describes the kind of process that is capable of creating life in buildings and in towns (Alexander, 2004c). Then in book 4 titled *The Luminous Ground: The Nature of Order*, he attempts to explore the same artefacts from a different angle; from the cosmology in which these works were created, and the concepts of our relatedness to matter (Alexander, 2004d). These ideas are not unprecedented, Deleuze talks extensively about the fold and the extension of the body in relation to its surroundings (Deleuze and Guattari, 2004, p157), however, Alexander's approach to overlaying these imperatives and attempting to analyze and synthesise architecture accordingly has contributed a great deal to our understanding of the influence of living processes and folds on architectural forms and spaces.

"The more one understands the idea of unfolding, and the more one understands the key role which sequence plays in the unfolding process, the more it becomes clear that the process of design and the process of construction are inseparable" (Alexander, 2004b, p322).

Alexander's ideas of dynamic thinking for static buildings can also be found in the theories of Stewart Brand. In his book titled: *How Buildings Learn: What Happens After They're Built*, a layered taxonomy is developed in which buildings may be classified according to their rate of change; for example the most radical and rapid changes are those undergone by commercial premises. The adaptation in these different layers is analyzed in order to extract the optimum strategy, this analysis leads to the conclusion that:

"Doing it right requires an intellectual discipline that doesn't exist yet" (Brand, 1995, p11).

Brand's book goes on to define an *ecopoiesis*³ in which the new system comprises both the building and its occupants. He calls this new method of analysis the "*scenario planning strategy*" (Brand, 1995, p178). Where a plan is based on predictions, this strategy ensures that there will always be room for manoeuvre. The motivation for this approach is given succinctly:

"All buildings are predictions. All predictions are wrong" (Brand, 1995, p178).

A bottom-up approach is suggested for the establishment of the building's hierarchy:

"[...] a building 'learns' only through people learning, and individuals typically learn much faster than whole organizations" (Brand, 1995, p188).

Brand's theory as presented in his book was built on many years of experience which resulted in crucial points addressed in this thesis. Allowing for prediction and change to explain the system of analysis and synthesis of architectural forms and spaces, results in a bottom-up approach not only from a learning point of view, but more fundamentally, from a representational point of view. This is where architectural forms and spaces will be driven by different media of representation which are initiated by different predictions and interpretations depending on the learning, the cognitive experience, and the consciousness of the individual experiencing these spaces in time.

Steven Holl's work is one of the most influential examples of mediating different media of representation from the earliest sketches to the built form and beyond. Most architects do have the same pattern of work, but Holl is conscious, with every step of

³ *Ecopoiesis* originally means the process of a system making a home for itself (Brand 1995, p178).

the development in any of his projects, of the impact of the perceptual field by manipulating it through the use of different media of representation to allow the experience of architecture to unfold gradually.

“Perception and cognition balance the volumetrics of architectural spaces with the understanding of time itself. An ecstatic architecture of the immeasurable emerges. It is precisely at the level of spatial perception that the most powerful architectural meanings come to the fore” (Holl, 2000, p13).

Holl argues that alongside perception there must be intent. He talks of the tension between the two sides of perception, the intent or the mental inside and the physical phenomenon or the outer perception. To Holl, this tension stimulates the phenomenological field and heightens the architectural experience while simultaneously expressing meaning (Holl, 2000, p42). *Chapel of St. Ignatius* in Seattle, USA 1994-1997, was one of the most expressive examples of Holl’s approach in design and production. He started the design with his famous sketch of the *Seven Bottles of Light in a Stone Box* using watercolour as a medium to convey his ideas of transparency and translucent connections between the spaces within the chapel (Figure 29). The ideas within his drawings of the chapel were translated into architectural spaces with clear connotations of tensions between the inner and outer sides of perception, intentionality and the perceptual phenomenological field (Figure 30).



Figure 29: *Seven Bottles of Light in a Stone Box*, water colour by Steven Holl (Holl, 2000, p155).



Figure 30: *Chapel of St. Ignatius*, Steven Holl, Seattle, USA 1994-1997 (Holl, 2000).

Moving from the static physical forms and spaces into the dynamic, the Dutch artist Theo Jansen creates giant animated structures powered by wind called *Strandbeests* (Figure 31) (Jansen, 2008, p22-27). The materials used to create these sculptures are basic plastic tubes and adhesive tapes and the like. Jansen followed one of nature's most important rules, simple components interacting together to create complex structures. These creatures represent one of the first examples of animated kinetic structures without the need to use electronic devices or digital technology. However, due to this fact, the creatures display a limited range of behaviour embedded in their motion.

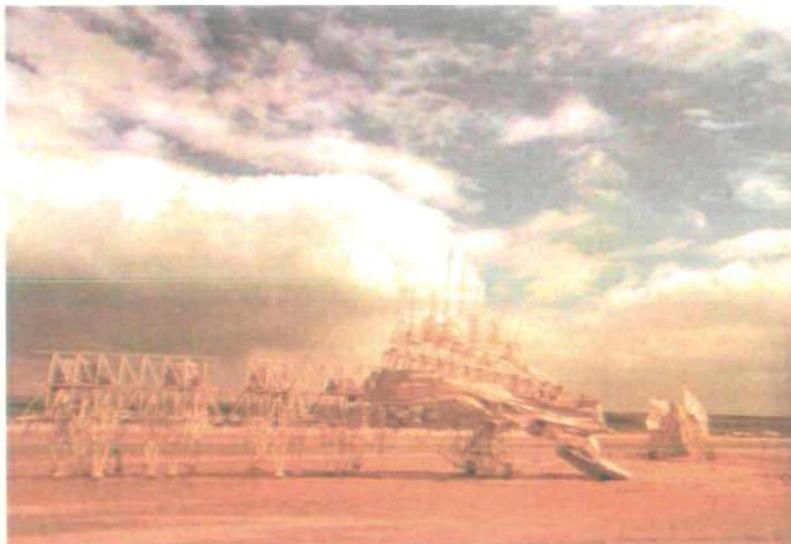


Figure 31: *Strandbeests*, Theo Jansen (Jansen, 2008, p22).

This section described a variety of architectural interventions that come together under the scope of physicality and analogousness. However, the importance of the section lies in their tendency towards experimentation that is embodied in their representation, and developed in all stages of the process of being and becoming of such architectures.

7.2. Digital/Interactive

In 1965 Reyner Banham wrote an influential essay titled: *A Home is not a House* where he argued that the services of a house, which he calls “hardware”, had become a crucial and important part of life. Mechanical technology had begun to replace the traditional components of architecture, and in this period architects did not know how to shift their design paradigms and imperatives to incorporate this technological invasion. As Banham noted:

“Services are a topic on which architectural practice has alternated capriciously between the brazen and the coy - there was the grand old Let-it-dangle period, when every ceiling was a mess of gaily painted entrails, as in the council chambers of the UN building, and there have been fits of pudicity when even the most innocent anatomical details have been hurriedly veiled with a suspended ceiling” (Banham, 1965).

This has led Banham to suggest the *Environment-Bubble* (Figure 32), a giant transparent plastic dome inflated with an air-conditioned output created as an acknowledgment of the invasion of mechanical technology into architecture (Banham, 1965).

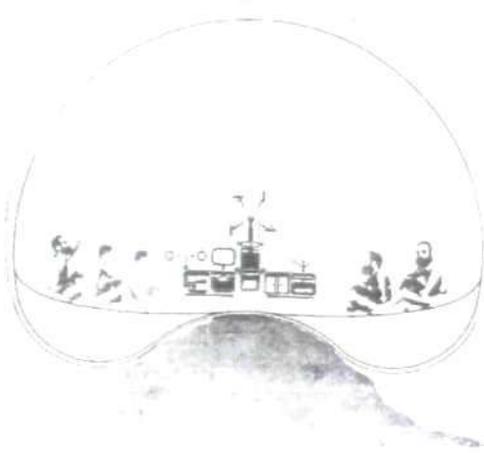


Figure 32: *Environment-Bubble*, illustration by Francois Dallegret of Reyner Banham concept of the Environment-Bubble, 1965 (Banham, 1965).

Buckminster Fuller, Frei Otto and others have taken the idea of inflatable, invisible shelters further to grander scales. Many such futuristic projects have been realised such as Nicholas Grimshaw's *Eden Project* in Cornwall, UK 2001 (Figure 33). Moreover and in recent years this mechanical and technological shift has moved on from the technically mechanical to the digital and the influence of yet another invasion of new architectural paradigms in representation and production of forms and space in architecture has affected the spatial and temporal existence of architecture.



Figure 33: *Eden Project*, Nicholas Grimshaw, Cornwall, UK 2001 (<http://www.wikiwak.com/image/Eden+Project+geodesic+domes+panorama.jpg>).

This new digital technology, then, facilitated a new medium of representation in architecture, not only creating the potential for new paradigms and imperatives to

emerge but also making it possible for the so-called paper architecture projects submitted by architects such as Peter Eisenman, Frank Gehry, Zaha Hadid, Coop Himmelblau, Rem Koolhaas, Daniel Libeskind, and Bernard Tschumi to be realised or at least considered. In 1988 an exhibition was held at the Museum of Modern Art (MOMA) named *Deconstructivist Architecture* (Figure 34), directed by Philip Johnson and Mark Wigley (Wigley, 1988). In this exhibition, the above-named architects exhibited their work and projects which were later criticised and labelled as paper architecture or academic architecture. This movement was greatly related, at that time, to the emergent interest of architects in principles and processes of fractals and chaos theory which gave birth to non-rectilinear forms and distorted and dislocated structures and envelopes in architecture. The new *Deconstructivist Movement* aimed to embrace the freedom of spatial expression by moving away from the constraints of the *Modern Movement* rules where form must follow function and materials and forms must be pure and truthful. Wigley described the way Deconstructivist architects' work presented in the MoMA exhibition in 1988 embraced the connection between theory and practice by saying:

"Architectural theory generally preempts an encounter with the object. It is concerned with veiling rather than exposing objects. With these projects, all the theory is loaded into the object: propositions now take the form of objects rather than verbal abstractions. What counts is the condition of the object, not the abstract theory. Indeed the force of the object makes the theory that produced it irrelevant" (Wigley, 1988).

Later on Wigley goes on to describe how Deconstructivist architects release different inhibitions to fragment form in radically different ways.

"In so doing they produce a devious architecture, a slippery architecture that slides uncontrollably from the familiar into the unfamiliar, towards an uncanny realization of

its own alien nature: an architecture, finally, in which form distorts itself in order to reveal itself anew" (Wigley, 1988).

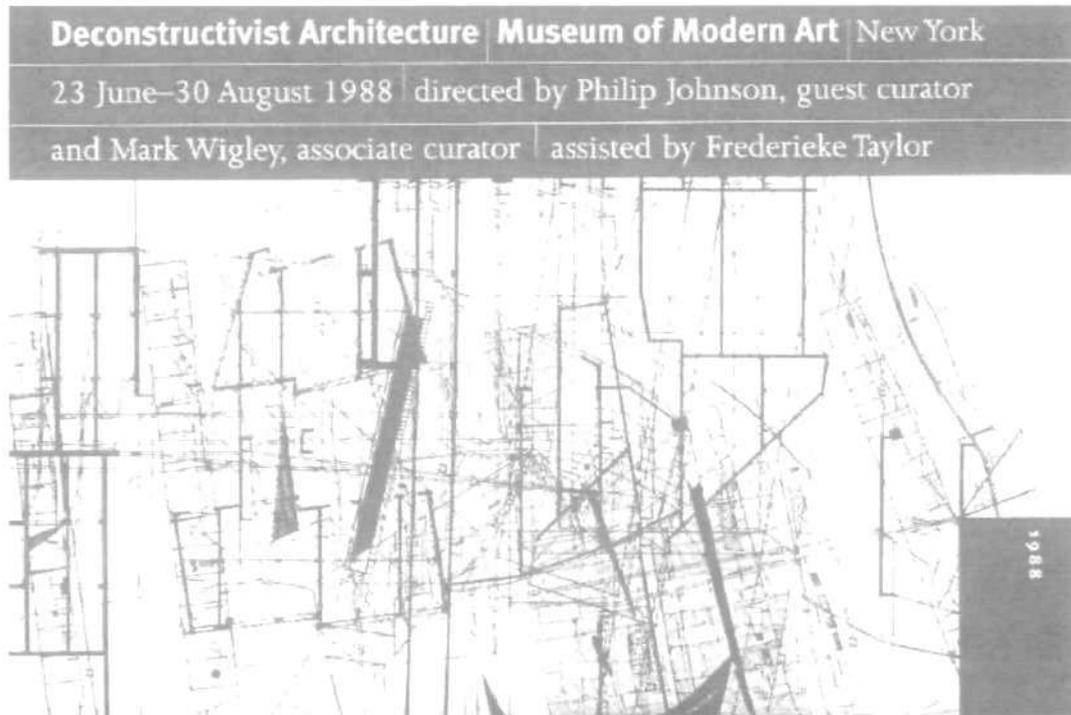


Figure 34: *Deconstructivist Architecture* exhibition poster, MoMA, New York 1988 (Wigley, 1988).

The *Deconstructivist Movement* has played an important part in the history of *Postmodern Architecture* and provoked the search for new media of representation and experimentation as well as addressing the need for trans-connectivity of interdisciplinary theories in architecture. This was partly due to the invasion of Computer Aided Design (CAD) applications and software which facilitated the creation of digitized two-dimensional, and most importantly, three-dimensional environments. Malcolm McCullough, the first architecture product manager for Autodesk (1985), wrote an article in *Architectural Design (AD)*, *Programming Cultures* titled: *20 Years of Scripted Space*, stating:

"The more kinds of representation that software lets us manipulate, the more opportunity we have to take design to a higher level. After all, the very essence of software is to represent problems abstractly, through the use of variables, conditionals, iterations and procedures" (McCullough, 2006, p12).

Architects that have taken an interest in the creation of digital forms and spaces have almost always striven to achieve some degree of transformation or adaptation in space, if not necessarily through the use of biological systems. Marcos Novak is one of the most active figures in this field. In his work, algorithmic techniques are used for the design of actual, virtual and hybrid environments such as cyberspaces. Novak introduced the expressions “*Liquid Architecture*” and “*TransArchitecture*” (Figure 35) (Novak, 1998a), meaning architecture which is no longer a static given but a flexible, transmittable epistemological space based on topology. Furthermore, he defines clearly the difference between topology and simple curved surfaces by clarifying the meaning of the word topology as:

“[...] simply the study of those relations that remain invariant under transformations and deformations. A notion of continuity is indeed implied in this definition, but the continuity is abstract” (Novak, 1998a, p84-93).

Further examples that sprouted out of the same inspirations are NOX’s *Whispering Gardens* (Figure 36) and Michael Fox’s *Robotecture* movement that stemmed from an early interest in Kinetic architecture in the mid 1990’s (Fox, and Kemp, 2009). These ideas were developed further to reach a degree of interactivity, when architecture begins to respond to human needs and psychological states of mind, to calm or relax its users and observers. Through changes in form, sound and/or light, such environments are in constant conversation with their users. Such conversations were the basis for the concept of NOX’s *Whispering Gardens*. Set as a public artwork next to Hotel New York in Rotterdam, this installation induces interactions between structure, light, sound and the human body through feedback effects registered from the

environment reflected as computer-generated female voices projected as vowels creating a polyphonic forest of sound (Spuybroek, 2005).

"All the possible wind properties (direction, force, duration) are used to have computer-generated female voices continuously singing vowels splitting into other vowels, making overtones proliferate, creating a polyphonic forest of sound. The steel structure brings the whirls from Mucha's hair-arabesques into a systemacy of crossings and mergings supporting green glass panels. The faceted glass shatters the light into many directions, and with every step we take there will be a new flicker, a new variation of emerald shading. Whispering Garden is a synaesthetic node, short-circuiting all elements and forces that are present: connecting the wind to light, light to structure, structure to sound, sound to architecture, architecture to bodies, looping all the loops, making everything sensing everything, making everything sensuous" (Spuybroek, 2005).



Figure 35: *TransArchitecture*, (Novak, 1998a, p84).

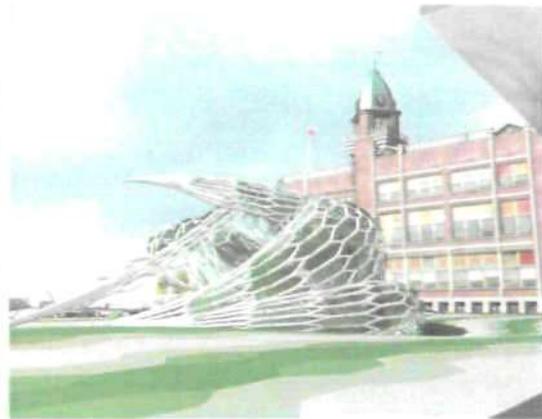


Figure 36: *Whispering Gardens*, Lars Spuybroek of NOX, 2005 (Spuybroek, 2005).

This type of architecture elevates its relationship with its users and observers, from a human-computer level to a much closer relationship to the human-human level (Fox and Kemp, 2009, p153). Fox attempts to achieve such a relationship in his *Bubbles* project, set in Silver Lake, California, exhibited at the Materials & Application Gallery. On an urban site, Fox created an interactive landscape of giant bubble-like objects with LED lights and sensors (Figure 37), that inflate and deflate according to their interaction with the public who are walking around and through the installation (Figure 38) (Fox and Kemp, 2009, p154-155).

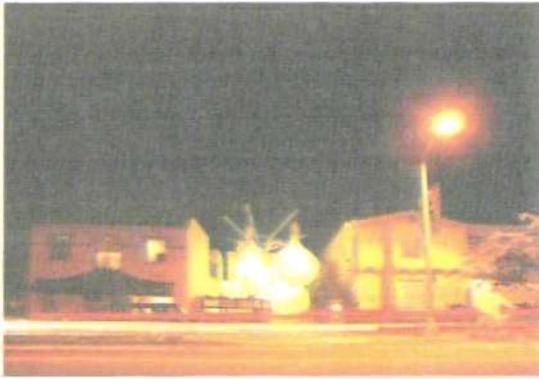


Figure 37: *Bubbles*, Michael Fox, exhibited at the Materials & Application Gallery, Silver Lake, California (Fox and Kemp, 2009, p154).

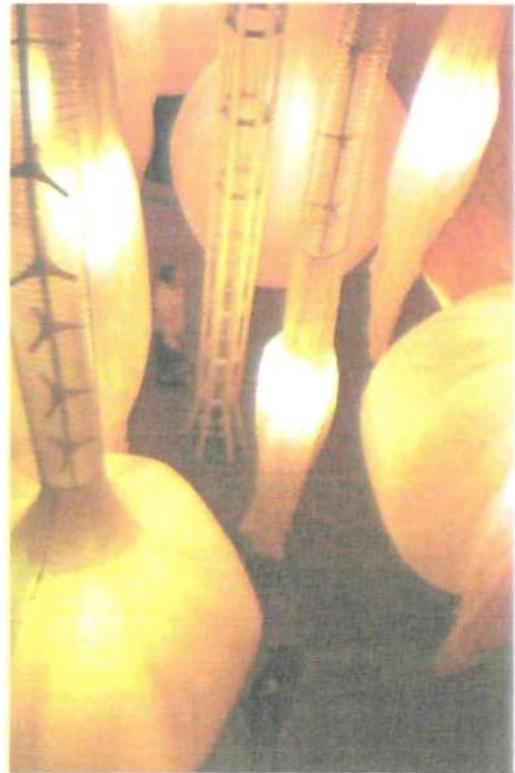


Figure 38: *Bubbles* interacting with its users, Michael Fox, exhibited at the Materials & Application Gallery, Silver Lake, California (Fox and Kemp, 2009, p155).

Interactive forms and spaces occur when a flux of physical, digital matter with data and information flow and sensors produces an environment capable of responding to external effects, whether this is a human interaction or environmental effect. Perhaps some of the first attempts can be seen in the work of Lars Spuybroek and Kas Oosterhuis; the main interest here lies in building programmable environments. Oosterhuis argues that virtual reality is more real than natural reality on the basis that we know every “bit and byte” of the components that make up the former, while the latter still holds unknown secrets of its complexity (Oosterhuis, 2002b, p5). Kas Oosterhuis outlines the use of the phrase “Swarm Architecture” (SA) as a metaphor to indicate the running process of complex systems such as urban environments where there is information flow between the buildings, users, cars, and all other objects

within some context. On that basis, everything we see in an urban environment is in fact interrelated, and we can no longer see isolated objects (Oosterhuis, 2006). This is due to the notion of swarm intelligence, of the complex relations and interactions between the components of any swarm, such as a flock of birds, or a school of fish, etc., which will be unpacked in chapter three.

This work posits that more interesting results will be seen if the outcome of the process is not preconceived. By not focusing on outcomes, we gain the ability to concentrate on the processes that create such environments and by doing so we are unfolding layers of overlapping media of representation that constitute these environments or spaces. This certainly has contributed another layer to the complexity of representation of forms and spaces in architecture. This layer is heightened by changes in information flow that result in a vivid effect on our experience and sense of place (Fox and Kemp, 2009, p153). Thus it is a layer of animated processes of becoming, a layer of life, which Spuybroek supports by saying:

"Everything that is static is condemned to death. Nothing that lives can exist without transformation" (Nio and Spuybroek, 1996).

In an article titled *Soft Office*, (published in *Digital Tectonics* by Neil Leach in 2004), Spuybroek describes the non Cartesian approach to design that he adopts in the generation of the *Soft Office* project combining a shop, interactive playground and headquarters office for an anonymous client in Warwickshire, UK, 2000-2005 (Figure 39) (Spuybroek, 2004b, p50-61). The design started with a sketch-like non-volumetric whole made from rubber tubes attached to two separate rigid wooden rings. This whole was dipped into a liquid lacquer and was later on left to harden (Figure 40).

"The separation of the wooden rings during a three-hour procedure is analogous to the splitting of floor and ceiling. So, while calculating programmatic forces, mental states, we are also calculating structural forces. Complete vagueness: never fully column, never fully wall, never fully floor. The system is negotiating everything with everything without resorting to equalization" (Spuybroek, 2004b, p61).

Spuybroek's work gave rise to new connotations to the medium of representation used which is portrayed in the sudden impact and the happy accident that he refers to as the *"in-between that becomes operative"* (Spuybroek, 2004b, p61).



Figure 39: *Soft Office*, Lars Spuybroek, Warwickshire, UK 2000-2005 (Spuybroek, 2004b, p45-55).



Figure 40: Sketch models of *Soft Office*, Lars Spuybroek (Spuybroek, 2004b, p56-57 and 60).

Greg Lynn certainly makes use of a similar sudden impact on his design strategies; his interest in *Blobs* then in rapid prototyping and laser cutting machines had a significant effect on the development and change in his ideas about architectural production and representation. The tools and the medium of such machines leave trails of in-between

or leftovers of elements which Lynn refers to as ornaments in a conversation with Neil Leach (Lynn, 2004, p63). However, Lynn refers to his connotations of the use of the word ornament to the texture and pattern which strengthens the structure and details of the design through process and organization, rather than an applied decoration.

"My recent interest in ornament (since we brought a CNC machine into the office) comes primarily from the method of crafting surfaces using CNC technology⁴. The process of converting a spline mesh surface into a tool path can generate a corrugated or corduroy-like pattern of tooling artifacts on surfaces. The decoration emerges from both the design of the spline surfaces and the conversion into a continuous tool path" (Lynn, 2004, p63-65).

Digital forms and spaces are material forms consisting of data and information flow which were originally presented on a computer screen or the like, however in recent years this has developed and the computer screen is no longer the threshold between the observer and the architecture presented. This development is due to interests in interdisciplinary studies and inspirations from fields such as biology, as well as advancements in the technological machinery that has made it possible to represent architecture in unprecedented ways. Greg Lynn's work is one of several examples of process led architectural forms and spaces at the start of the digital age, whether they are digitally produced physical forms and spaces or just digitally presented. Yet since the beginning of the late 20th century scientists and engineers, and later on, artists and architects, sparked an interest in biotechnology and nanotechnology. One of the first architects to experiment with designs based on materials developed from such technologies was John Johansen.

⁴ CNC: Computer Numerical Controlled machine tools that are highly automated using CAD/CAM programs.

John Johansen was one of the Harvard Five *Modern Movement* architects in America. After his retirement from a long career spanning over half a century, he turned his interest to the creation of architecture for the speculative future with the aid of nanotechnology, magnetic levitation and materials science. Johansen believed that biological processes could be the future building code for architecture.

"The molecular building process is not biological, but mechanical; living cells are replicated by dividing, assemblers replicate mechanically, by building others. Assemblers are robots, or "nanobots", with communicative powers that in collaboration can build anything they are programmed to build" (Johansen, 2002, p154).

Johansen used inflated "living membranes" – balloons (Figure 41). Such inflatable membranes have been in use for some time, though a cluster of air chambers of this complexity had never been realised. The primary difficulty is the equalisation of air pressures sustained in the various spherical volumes. Here, this process is controlled by monitors connected to a control computer that activates air pumps that stabilize the various bubbles. Johansen also used inflatables in a developing technology of electromagnetic levitation "mag-lev" in sliding contact systems (Johansen, 2002, p68-87). He went on to develop this idea in his *Metamorphic Capsule* (Figure 42), an enclosure where form, opacity and colour are controlled by electromagnetism. An object is suspended in space by the application of repulsive and attractive electric forces acting between nodes on the object and those of a surrounding field. This surrounding field is formed by a system of nodes, attached to a structural framework, with corresponding nodes placed on the outer surface of a fabric capsule placed within this field. Continuous air pressure from within is necessary to sustain the form of the capsule. Changes in the power sent to the nodes, cause the capsule to undulate (Johansen, 2002, p90-95).



Figure 41: *Living Membranes – balloons*, John Johansen (Johansen, 2002, p33).

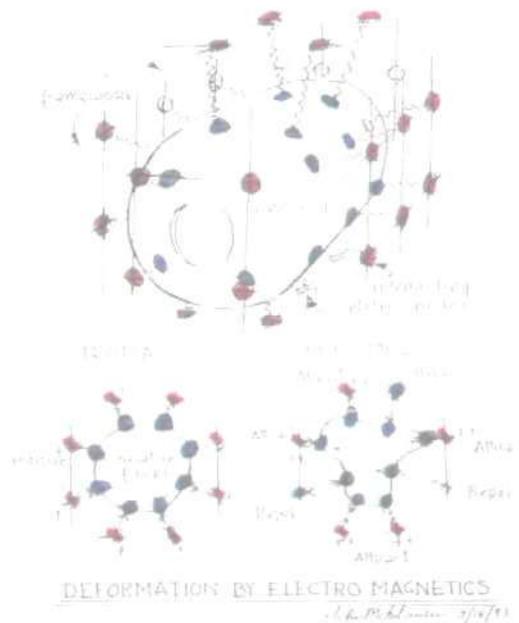


Figure 42: Sketch of the *Metamorphic Capsule*, John Johansen (Johansen, 2002, p90).

All these speculative examples contributed a great deal to the validation of the idea of a biologically grown house in the near future. However, Johansen’s vision for the speculative future of architecture was understated, and to some extent unconvincing, by the quality of his own design proposals and their representation. This is partly due to the physicality, materials, and media of representation that were used to convey such complex ideas. Thus, the medium of architectural representation plays a great part in the success of the architectural intentions and interpretations, and furthermore, this success will have an effect on our own perceptions, conceptions and experiences.

Contrastingly, different and more appropriate media of representation which include many aspects of natural complex systems can be seen in the work of John Frazer and his team at the Architectural Association (AA). Frazer introduced the concept of

evolutionary architecture. His work emphasizes the natural sciences of cybernetics, complexity and chaos. In the well-known book *An Evolutionary Architecture*, Frazer describes a set of rules for form generation in a genetic language and encodes these as a computer program. These computer models simulate the development of prototypical forms which are evaluated on the basis of their performance in a simulated environment through natural selection. He emphasises the idea of a hierarchical process-driven program; in contrast to the beliefs of this thesis Frazer's hierarchy demonstrates a well-defined direction of influence in which one process drives the next.

Frazer's work is concerned more with evolution than development which can be seen in the *Universal Constructor* project (Figure 43).

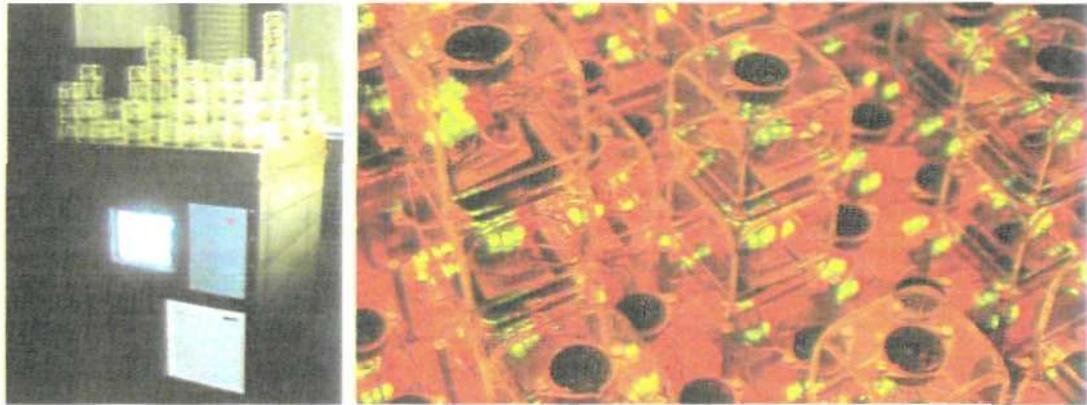


Figure 43: *Universal Constructor*, John Frazer and Unit Eleven group in the Architectural Association (AA) in 1990 (Frazer, 1995, p49).

The *Universal Constructor* is a working model of a self-organizing interactive environment, as Frazer describes it. The project was constructed by the Unit Eleven group in the Architectural Association (AA) in 1990. The whole system was a three-dimensional array of identical cubes. Frazer and his team had chosen cubes for their

universality and self-similar geometry, which meant that they could represent anything. In the system, there are two-hundred-and-fifty-six states only and each cube can have any of these states, which are displayed by means of eight light emitting diodes (LEDs).

"The eight-bit code could be used to map the state of the cell to any form or structure; to environmental conditions such as wind; to sound, or even to dance" (Frazer, 1995, p44).

The 12x12x12x256 logic space consists of a baseboard of 12x12 cells with the same electronics as the cube, and cubes that were vertically stacked on top of each other to a height of 12. Each cell had the ability to display its identifying state through changes in the LEDs.

"Messages could be passed between any two units by streaming data in serial form down one stack of cells and up another. The flow of logic in the model was thus made visible by slowing down the system. The array could be used as an input or output device. For input, the exact configuration, location and identifying code of every cell could be deduced by a controlling processor interrogating each location and prompting for a possible neighbour above. As an output device, each cell could display 256 messages with the eight LEDs. Interaction with the observer was made possible by two red LEDs – one flashing light meant "take me away"; two flashing lights meant "add a cube on top" (Frazer, 1995, p45).

The *Universal Constructor* was designed with a computer program for interrogation, message-passing, and a screen display. Each member of the development team had his or her own individual application, program and mapping. This project represents a significant leap in architectural representation where architecture became a medium for mapping the thoughts of interacting individuals. Additionally, this project marked the transition from the digital screen into a hybrid of both digital and analogue forms and spaces for interaction.

A much more architecturally defined from a representational point of view and potentially highly speculative approach can be seen in the work of Neil Spiller, professor of architecture at the Bartlett School of Architecture, University College London (UCL). Spiller introduced in 1995, through a series of illustrated work, the term “*Architects in Cyberspace*”. The series attempts to unpack research which incorporates the virtual realm into architecture. This term was developed to respond to the reflectivity and feedback of the virtual media onto architecture and in particular, architectural theory. In the third contribution to this series, titled “*Reflexive Architecture*”, Spiller explains the potential of the term for the future of architecture through his essay titled: *A Provisional Taxonomy of Slamhounds*:

“My slamhounds are schizoid, neurotic, highly sensitive, eroticised, often have fleshly biotechnological protuberances and are benevolent, more or less” (Spiller, 2002b, p22).

Spiller then goes on to give examples of such alien conceptions in architecture. One *slamhound* was fitted to the wall of the Dali Museum at Figueras in Spain which senses the variation of “*Freudian slits*” (the old arrow slots) in the museum’s “*goose-flesh-façade*”. Another *slamhound* was inserted into the waters of the River Stour in Kent to sense the river turbulence (Spiller, 2002b, p24). Spiller used the conventional method of drawing with black ink on white paper to convey his notions of such complex ideas (Figure 44). His drawings are very seductive and reflect connotations of futuristic implications and evolution in the process of his designs.

“My drawings of these slamhounds must be read in this manner. They are homuncultic drawings⁵. Therefore the drawings almost ‘balloon’ towards the viewer over time, elements expanding and contracting as if inflated by the ‘air’ of responsivity” (Spiller, 2002b, p25).

⁵ “Nearly everyone has seen the human body mapped according to the number of touch receptors in each part. This creates a representation of a human being with large hands, lips, and genitals – a homunculus” (Spiller, 2002b, p25).

Spiller's drawings of the *slamhounds* were not an actual representation of such devices, but a representation of the complex processes engaged in the functions of such devices. Hence, he soon realised that in order to reflect the dynamic power of such drawings, they needed to be represented using a medium with the potential to express the full complexity of such dynamism.

"This new diversely contextual architecture might use nanotechnology or the newly invented aero-gel⁶ to weave these architectures" (Spiller, 2002b, p27).

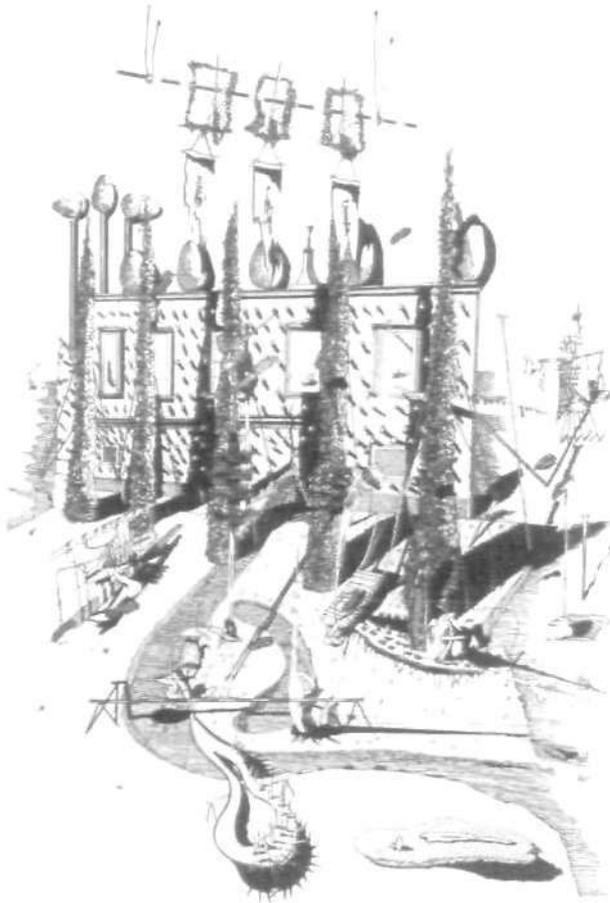


Figure 44: Slamhound "Partial landscape: imaginary drawing of slamhoundian landscape showing some slamhounds yet to come and hinting at their probable interactions" (Spiller, 2002b, p22-23).

⁶ Aero-gel is a type of tubular fog of mostly empty space.

Despite the controversies that such projects sparked in the recent history and theory of architecture and especially regarding their representation, Spiller's projects are intended to work in conjunction with nature and landscape ecologies. In the early 2000s, Spiller teamed up with Rachel Armstrong, a biologist with a vision towards technologically advanced sustainable futures in architecture. Her preconceptions of the future of architecture were considered to be science fiction even in her own words until the recent development in their research on neo-plasmatic⁷ materials for architecture. She wrote in 1999 speculating:

"An evolutionary transition in architectural design will replace classically scientific fossils with intelligence, responsive, fluid interfaces that both inform and learn from their organic inhabitants" (Armstrong, 1999, p21).

In 2008 Armstrong and Spiller's cooperation and research has led to a newly designed material which is biologically and artificially modified operating on a nanotechnological scale to create a sustainable environment, sustainable in the sense of its dependence and reflection on nature. Armstrong suggests metabolic material⁸ to be the building unit for sustainable architecture and by this architectural forms and spaces will respond to their environment through direct interaction and exchange with nature where architecture becomes part of the ecosystem rather than insulated away from it (Armstrong, 2009). Such materials open up new horizons in the design and representation of architecture and certainly will change the way we perceive and conceive architecture.

⁷ The term 'neoplasmatic' in architecture was originally used and developed by Marcus Cruz in his doctoral thesis titled: 'The Inhabitable Flesh of Architecture' at the Bartlett School of Architecture, supervised by Peter Cook and Jonathan Hill between the years 2000-2007. Meaning partly designed object and partly living material (Cruz and Pike, 2008, p6).

⁸ Armstrong refers to the metabolic material as protocell (Chen, 2006).

"The future implications for architecture in terms of nano-scale modifications to living processes are exciting in that they will form the properties that will have a broad range of applications in our experience of the built environment" (Armstrong, 2008, p89).

Another digital ecologically sound approach to design can be seen in the work of Dennis Dollens and his group in the Genetic Architecture Program at the International University of Catalunya, Barcelona, Spain. Dollens explains the meaning of Biomimetic as derived from the Greek words *bio* meaning life, *mimetikos*, imitative (Dollens, 2004).

Dollens advocates biomimetic architecture, an architecture that is inspired, observed and extrapolated from natural forms especially botanic ones, calling this architecture "*visual biomimetics*". He argues that this method for design thinking will help architects to create aesthetically and mechanically more advanced buildings in terms of environmental and sustainable technologies that make use of less toxic botanically derived products. In his research he uses software as a tool for digital biomimetic extrapolation. The software is called *Xfrog* and is generally used for landscape architecture (Figure 45).

"The software has the ability to produce forms based on botanic algorithms that impart to the digital, 3D design, the essence of a growing plant" (Dollens, 2004, p2).

"Natural and digitally grown (Xfrog) tumbleweeds as an example of biomimetic observations that can then be edited/developed and used for 3D visualization and CAD/CAM manufacturing Biomimetic process of studying plant morphology and applying observed properties to digital forms leading to the development of a series of icons that are used like a form-lexicon (right) for the development of structures, surfaces and spaces" (Dollens, 2009).

Dollens's digitally and algorithmically grown structures took inspiration from early work done by a Celestino Soddu, a Milan-based architect and professor of generative

art. In 1988 Soddu described generative artificial intelligence software called *Argenia* which produces endless variations of artificial DNA for the generation of design species (Figure 46) (Soddu and Colabella, 2005). Soddu's work has given architects insights into the ability to design software that manipulates form into several generations and selects the ideal based on notions of natural selection, and by which he presents a new medium of representation for the generation of architectural forms and spaces (Soddu and Colabella, 1997). This development in Milan had a parallel movement here in the UK with the work of Michael Hensel of the AA School of Architecture, London.

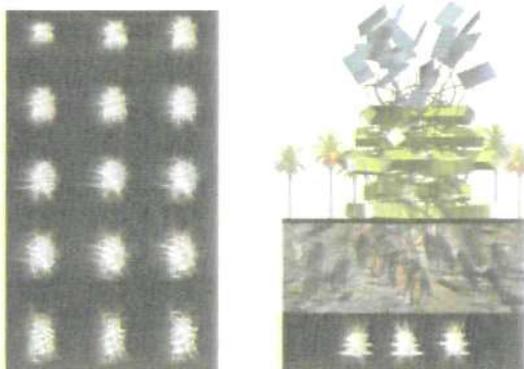


Figure 45: *Xfrag project*, Dennis Dollens (Dollens, 2004, p2).

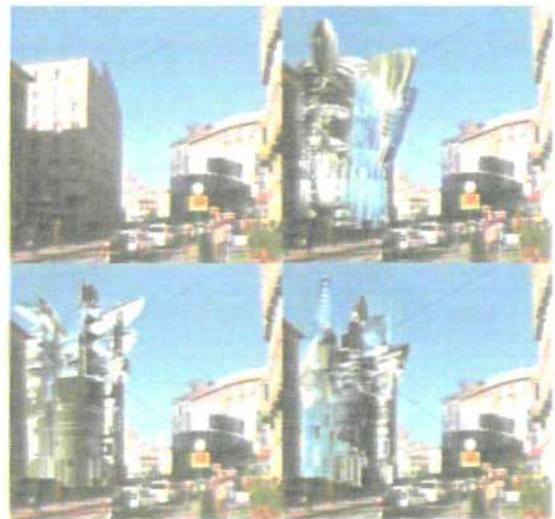


Figure 46: *Argenia project*: 1 real + 3 generated variation of Milan with the New Museum of Futurism, Celestino Soddu (Soddu and Colabella, 2005).

Hensel's ideas extend back into the mid and early 1990s. OCEAN North was an interdisciplinary research network established in 1994 in Norway, where Hensel was one of the key contributors. Several projects emerged out of OCEAN North's research network, which were based on the dynamic relationship between the built environment and the human subject using computational and analogue media with articulation of material geometries (Hensel, 2006b, p105). The *Extraterrain* furniture

project in 1996 was one of these projects; it aimed to create heavily charged, simple material surfaces, with multiple potential interpretations for their inhabitation and social formation, while at the same time avoiding any connotations to an object-specific proper use (Figure 47) (Hensel, 2004b, p122). Unlike the soft surface environments of the sixties and seventies, Hensel used hard fibreglass produced through the use of computational modelling which enabled the rapid re-assembly of the *Extraterrain* furniture. This implies a shift in the focus from the instant user's comfort to the frequent change of positioning in order to acquire negotiation and adaptation, where a conversation between the surface and the human body emerges.

"Geometry and positioning trigger in this way incidental individual use, with the array of individual use accumulating to collective interaction. The latter constitutes an unfolding field of social interaction that is yielded by the geometric and material articulation of the surface" (Hensel, 2004b, p123).

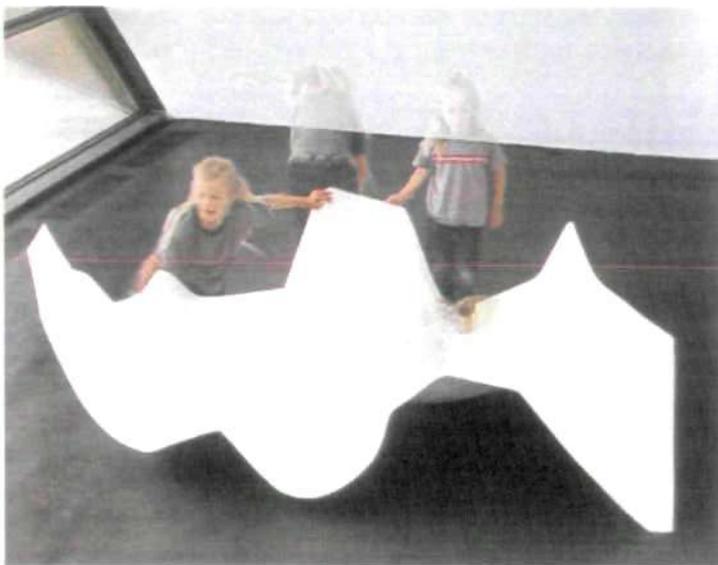


Figure 47: *Extraterrain* furniture, Michael Hensel, 1996 (Hensel, 2004b, p122).

This elevates Hensel's work to a level beyond the dichotomies between the digital and the analogue world and further to the respective repercussions of modifying the environment in which anticipated interactions between its users collectively emerge.

Imdat As and Daniel Schodek in their book titled *Dynamic Digital Representations in Architecture: Visions in Motion* convey the depth of the use of digital media in architectural representation along the lines of Hensel's research and projects by saying:

"Architecture generated with the help of computer graphics, animations, physical models, immersive interactive environments, or digital fabrication methods can expand traditional projective geometry. If we see architectural representations as momentary, dynamic, and endowed with shadows, we may generate and represent an architecture that transcends the limits of abstract graphics conventions and convey a multitude of sensory experiences" (As and Schodek, 2008, p25).

Rodrigo Alonso expresses his definition of the "spatial expansion" that accompanied the information revolution:

"An architecture of data, composed of routes and accesses, nodes and information highways, has emerged" (Alonso, 2005).

After the appearance of cyberspace architects did not stop speculating about the future of architecture, its forms, its environment and the societies it will create. Architects such as Peter Anders talk extensively about the design of on-line communities in *Envisioning Cyberspace* (Figure 48). At the time he coined the word "Cybrids" to describe the hybridization of physical and cyber space environments and explained the natural extension of creating environments in cyberspace, where he states:

"Space is the medium by which we understand our world, ourselves and each other. And cyberspace is its electronic extension. [...]. Cyberspace will continue to grow parallel to its technology. [...]. Modelling the interaction and design on our innate use of space is a first step in converting information to knowledge and extending ourselves to others. Space is the language we all share" (Anders, 1998, p217).

During the last three decades in the history of architecture and its representation, new speculative and hypothetical scenarios and environments appeared on the Internet,

and in cyberspace. Leading architects such as Novak, Anders and Spiller (to name just a few) have speculated, in form and space, social interaction, and theoretical agendas in anticipation of the existence of such elaborate, ludic, mercurial, and hyperspace environments.

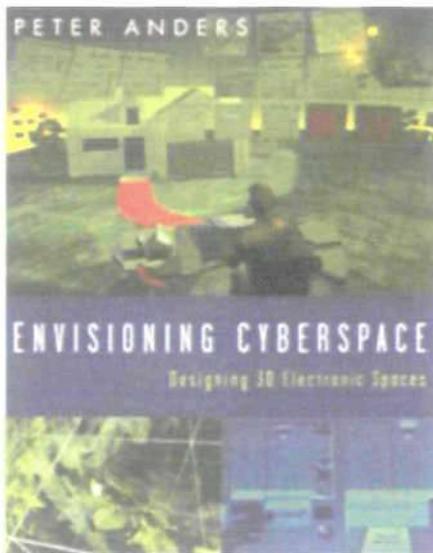


Figure 48: *Envisioning Cyberspace*, Peter Anders, 1998 (Anders, 1998).

An article on the ArchVirtual blog written by Keystone (username), an online blog about *Architecture and Design in Virtual Environments*, criticises, three decades later, and in an era of cyber existence, the lack of theoretical and indeed experimental existence of the cyber architectural dream in social network environments such as *Second Life* (Figure 49) (Keystone, 2010). In order to answer the question posed in the article, an account of what virtual space actually means in theories and critiques of architecture is required. Virtual space conditions the experience of the observer and user by confining their interactions to surfaces and spaces that are not linked to their context. Surfaces where joints, thicknesses, materials, grounds, and the laws that govern their relationships to their bodies are gone. William J. Mitchell elaborates on these thoughts, stating:

"With this technology, you can walk or fly through virtual landscapes and virtual architecture, crash through enclosing surfaces without feeling a thing, and even encounter inhabitants represented by their virtual bodies. Because there is no material to transform, there is no weathering of surfaces with the passage of time. And the forms and relationships of the spaces are not necessarily stable; they can be programmed to shift and reshape themselves in whatever ways the designer wants" (Mitchell, 1998, p207).

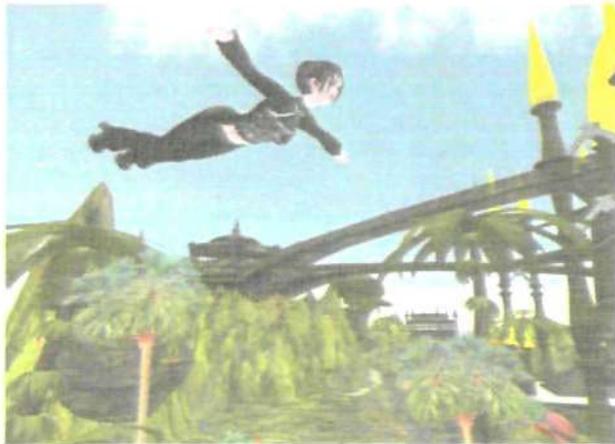


Figure 49: Image of the online interactive environment *Second Life* (http://blog.case.edu/lev.gonick/2007/03/19/cleveland_in_second_life_and_the_launch_of_cleveland_20_the_view_from_the_cleveland_plaindealer).

Therefore, to return to answering the question put forward by the article through what Mitchell was attempting to demonstrate here, the reasons are endless. Its essence lies in the lack of rules that govern the game. This is evident in the lack of relationships between one virtual space and another designed just next to it, the lack of context, the lack of the relationships between its components, and the lack of constraints between the designed and the body that is experiencing it as well as its irrelevant relation to time, to list a few. This ultimately will lead to the absence of the elemental existence of the meaning of architecture. That said, it is not the purpose of this discussion to diminish the role of virtual spaces and environments as they have contributed a great deal to the development of new imperatives and paradigms for design in architecture. However, this contribution is in the form of speculation about

the representation of explorations and experimentations of this hyper reality, which once realised and experienced, is then exhausted.

Digital and interactive technology facilitated the creation of new generations of forms, spaces and transient environments utilizing digital representational techniques and media. However, this rapidly changing face and image of architecture has contributed to the anaesthetization of architecture, where the seduction of the image overrides the ability to critically acknowledge the depth of the projects, and where the criticality of the projects limited their extensions and impact to the immediate users rather than the society. Neil Leach expresses his concerns regarding the anaesthetization of architecture through seduction where he states:

"When meaningful discourse has been absorbed and rendered impotent with the depthless, aestheticized world of the image, seduction remains the only viable strategy for winning over the viewer. In a culture of aestheticization, all that is left is seduction" (Leach, 1999, p85).

Despite the strong critique of the programmable image that Leach expresses, digital and interactive environments have contributed greatly to interdisciplinary research in the field of art and architecture in particular. The emergence of interactive cyberspaces in particular has impacted our thinking about social space and furthermore, the construction of networked societies. Such networks have led to a significant radical critique of the effects of such architectural environments on our collective behaviour and consciousness. Architecture and its representation are seen as a medium for political and social impact on cultural change rather than a means for *inhabitation and use, and this marks a breakthrough in the history and theory of contemporary architecture, which is explored in the following section.*

7.3. Conceptual/ Experimental

Conceptual and experimental architecture consists of preconceptions, notions and processes which are realised entirely through the use of media of representation. The relevance of such architectural forms and spaces to this thesis lies in the fact that they convey the collectivity of the experiment or the concept in their means and tools of representation and by this they participate in a powerful never-ending process of preconception and interpretation every time they are mentioned, experienced and represented. One of the most powerful examples, charged with expressions of representation was Constant's *New Babylon* project (Figure 50). A vast array of tools and media were used to convey the ideas behind this project which spanned two decades and produced countless drawings, architectural models, etchings, paintings, lithographs, audiovisual displays of slide projections, films, and video screenings as well as maps, photographs, catalogues, manifestos, etc. A selection of these were exhibited in The New York Public Library's exhibition titled, *Utopia: The Search for the Ideal Society in the Western World* 1999 (de Zegher and Wigley, 2001, p9).

This visionary architectural project ran between 1956 and 1974; at the time its founder, the Dutch artist Constant Nieuwenhuys was concerned with issues of unitary urbanism and the role of art in an advanced technocratic society (de Zegher and Wigley, 2001, p9). To Constant the *New Babylon* project is:

"[...] the worldwide city of the future for a society of total automation, in which the need to work is replaced by a nomadic life of creative play, a modern return to Eden. The homo ludens whom man will become once freed from labour will not have to make art, for he can be creative in the practice of daily life" quoted in (de Zegher and Wigley, 2001, p9).

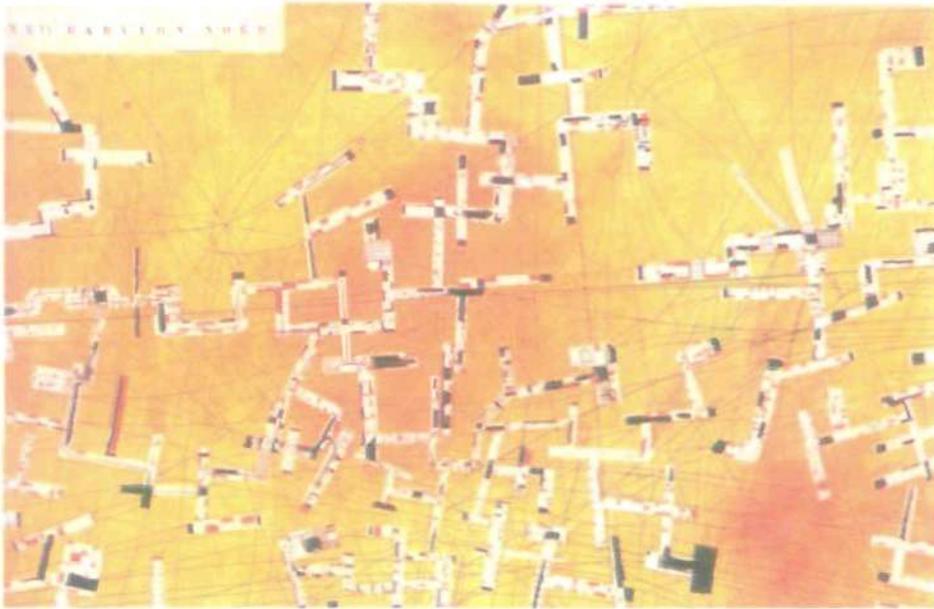


Figure 50: *New Babylon*, Constant Nieuwenhuys, visionary project 1956-1974 (de Zegher and Wigley, 2001, p59).

The power behind this project is not limited to the ideas behind it, but rather it extends to a complex debate questioning the role of architects, and most importantly for this thesis, the role of the media used in representing a process for a complex open ended project rather than a fixed outcome. In a way, Constant's vision for this project influenced his selection of the media of representation he used to portray the dynamism of such ideas. Constant, who was originally a painter, produced a number of drawings to represent the project. The paper that Constant used for his drawings ranged in size from a few centimetres to two or three meters long. These drawings truly reflected the process of their making as they were covered in ink, chalk, crayon, and pencil marks. They had splashes of watercolour, fragments of tourist maps, text, photographs, newspaper, and Zip-a-tone (Figure 51) (de Zegher and Wigley, 2001, p28). However, he soon realised that he needed a much more dynamic medium to represent the infinite and creative freedom of the automation of the *New Babylon* project and this is when he began building models and photographing them from

different angles, using different lenses, lighting, and backgrounds. Mark Wigley described this process as an orchestrated production of the desired effect of kaleidoscopic transformation (Figure 52) (de Zegher and Wigley, 2001, p28).

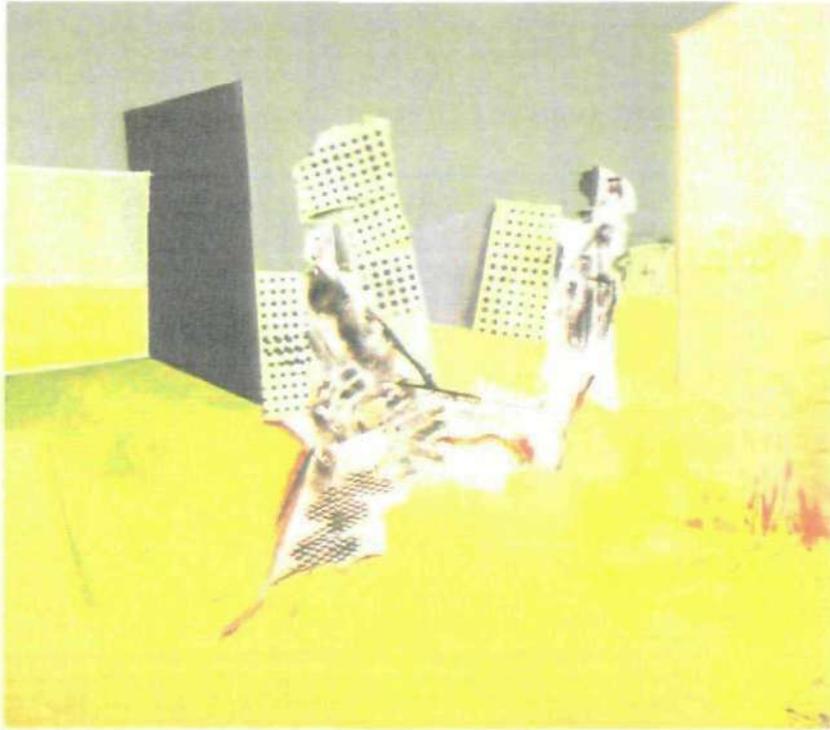


Figure 51: Collage of *New Babylon*, Constant Nieuwenhuys (de Zegher and Wigley, 2001, p120).



Figure 52: Photograph of orchestrated model of the *New Babylon*, Constant Nieuwenhuys (de Zegher and Wigley, 2001, p108).

"New Babylon is a vast machine, a mechanism that repeats itself endlessly, automatically, yet allows people to collectively realize their ever-changing fantasies. Again, this could easily be drawn using the architect's standard techniques. But the mechanism is not meant to be experienced as such, only the sensuous fantasies it makes

possible. To represent the structure of New Babylon accurately would be to misrepresent New Babylon. The role of the drawing is therefore torn between the undesirability of fully representing the collective automation of resources and the undesirability of fully representing collective self-expression. The tension is quite visible in Constant's drawings. Most are neither images of the mechanism nor images of the life going on within it" (de Zegher and Wigley, 2001, p29-30).

The tension created in the drawings, draws the viewer or the observer to enter the dynamism of the drawings in an attempt to complete one or other of these images described by Wigley. Such is the kind of play that Constant envisioned for the people that he imagined inhabiting his project. Many architects followed in the footsteps of Constant in putting forward narratives and processes of dynamic interactions between forms, spaces and people, rather than a finished product to be explored. In a Wordpress blog written by Lebbeus Woods about the influence of the Situationist Constant and his vision of the *New Babylon* project, Woods begins by relating the story of a young Peter Cook and Mike Webb attending a lecture given by Constant about his *New Babylon* project in 1960, where Mike leaned over to Peter whispering "*we can do it better!*" and a couple of years later the Archigram group founded by Peter Cook and Mike Webb emerged. In Woods's words:

"[...] setting off a revolution in architecture that reverberates to the present day. What both Constant and Archigram did was imagine architecture as a leading instrument of social change, through the making of ideal or utopian architectural projects. The difference between them is that the projects and the ideals they expressed stand on opposite sides of a cultural divide" (Woods, 2009).

What Lebbeus Woods meant by the cultural divide was multi-layers of change and divisions between the East and the West. A historic divide started in the late 1950s between the communist East and the capitalist West. This was followed by the most influential of all, the technological divide, which is marked by the 1960s where the digital computation replaced the typewriters and the telegrams. Woods emphasizes

the fact that the technological divide or change facilitated the boom of the Archigram Group where he says:

"The contemporary world was born. Archigram, founded in 1964, quickly became a global phenomenon, in a way that New Babylon never did" (Woods, 2009).

Finally came the architectural divide, where the early 1960s saw the end of the *Modern Movement* and the beginning of new ideologies in design and architecture of the *Post-Modern* with an emphasis on imagery over structure.

The formation of the Archigram group in the late 1960s was a sign of revolutionary young architects going against the orthodox mainstream architecture that was the norm at that time; moreover, it was one of the most significant architectural movements that concentrated on following narratives and processes of interaction between people and architecture. This took place at a time when architectural representation was restricted to the orthogonal projections of plans, sections, and elevations, etc. The Archigram group, led by David Greene, Peter Cook, and Michael Webb, introduced a new way to present architecture through creative writing and graphics in their publications. In the words of the movement's creator, Peter Cook:

"It was as important to break down real and imagined barriers of form and statement on the page as in built form on the ground" (Cook, 1999, p8).

Also seen here in this poem by David Greene:

*"The love is gone.
The poetry in bricks is lost.
We want to drag into the building some of the poetry of countdown, orbital helmets,
discord of mechanical body transportation methods and leg walking
Love gone" (Cook, 1999, p8).*

One of the most significant projects which laid the foundation of the Archigram group was the *Living City* project (1963) exhibited at the Institute of Contemporary Arts in London. The projects' brief was to empower and invigorate the expression of city life rather than to suggest a master plan for one. Peter Cook in a statement extracted from the *Living Arts Magazine* no.2 June 1963 (referred to in his book *Archigram*), defines the *Living City* as a complex structure by saying:

"Living City is not a blueprint for a city. Architecture is not in evidence here... Living City takes the form of a complete structure, an organism designed to condition the spectator by cutting him off from the everyday situation, where things are seen in predictable and accepted relationships. This city stimulator is a conditioning chamber, like the corner of some giant brain or analogic computer, and has compartments we have called 'Gloops'³. Each gloop defines an area of basic constant and reasonably predictable fact. Man, Survival, Crowd, Movement, Communication, Place, Situation: all contributing and interacting one on another and sum totalling to Living City" (Cook, 1999, p20).

The *Living City* project was expressed through a series of collage and montage drawings with comic text and diagrams, newspaper cut-outs and plans; all to illustrate the complexity of the vast network of human interactions within a city (Figure 53). The ideas behind the *Living City* project at the time were not unprecedented. William H. Whyte in his book *The Exploding Metropolis* (Whyte, 1993) and Jane Jacobs's writings in *The Death and Life of Great American Cities* (Jacobs, 1993), have expressed their concern regarding the cities' right to an existence before focusing on their regeneration. However, what was unprecedented about the *Living City* was the power behind the media of representation used to express those notions particularly in architecture at that time. It was bold, different and connected with the pop culture that was expressed through the art of that era, and moreover introduced architecture

³ "The term 'Gloop' was coined to define an area of the exhibition; it derived from the idea of a loop-enclosure of a soft profile and was one aspect of the original intention to build the exhibition structures from spray plastic" (Cook, 1999, p20).

as a complex process of becoming rather than an end product. The focus on process in creating architecture was also evident in the work of Cedric Price.

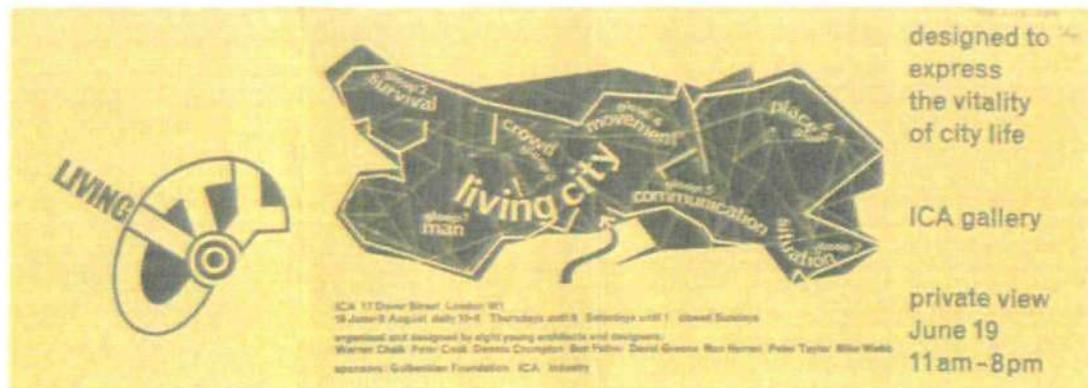


Figure 53: *Living City*, Peter Cook, exhibited at the Institute of Contemporary Arts in London 1963 (http://www.digitalmediadesign2009.com/nusa/blog/wp-content/uploads/2009/01/60s_livingcity_large.jpg).

The radical thinking behind Cedric Price's projects, the *Fun Palace* (1960) for East London and *The Generator* (1980) in Florida led to the creation of a platform for a visionary, cybernetic and intelligent architecture. The idea of "*form as process*" (Price et al., 2003) was one of the most important aspects of Cedric Price's thinking about architecture. Though he did not realise many buildings, his way of thinking has influenced generations of architects. In his architecture, Price aims to negotiate and adapt to the constantly shifting cultural climate. Stanley Mathews describes it as an "*improvisational architecture*" (Mathews, 2005, p73-91), in which Price introduced a novel synthesis of contemporary discourses and theories, such as cybernetics, information technology, game theory, and theatre. Price imagined his buildings would never look the same twice, but instead would blend with the context and adapt to survive in it. One of the most famous and radical buildings of his – never built – was the *Fun Palace* (mid 1960s). The *Fun Palace* is one of the most famous unbuilt buildings.

"Price thought of the Fun Palace as an instrument of social improvement, primarily social: The emancipation and empowerment of the individual" (Mathews, 2005).

Ranulph Glanville's background as a cyberneticist and architect has led to an individual way of thinking about design in general which echoes Price's thoughts about the outcome of design. Instead of concentrating on the material outcome of his design research, he emphasizes the circularity of the system, and observation of the interaction of processes. He says:

"What matters is the principles of the mechanism rather than its embodiment" (Glanville, 1995).

Glanville presents a compelling idea about *"the self and the other"*. This idea represents a radical alternative to conventional thinking about form design. Here what matters are the forces and the attractors of the system that help the observer to analyse, synthesise and design the form without thinking of its materials, designing a form with the power of control over the whole system. He argues that:

"For circle and line are complements. They derive from the difference between the view within the system and that from without: the wheel and the track, the self and the other" (Glanville, 1995).

Gordon Matta-Clark's work resembles in its essence the same system of interaction between the parts and the whole that Glanville describes. In 1975 Matta-Clark created a cut-out in two town houses in a derelict area of Paris called Les Halles during its period of regeneration. The cut-out took the shape of a twisting cone of four metres in diameter. This project was called the *Conical Intersect* (Figure 54). The *Conical Intersect* project functioned from within the building as a periscope while the observers from

the outside connected the two houses to a glimpse of the centre of Pompidou beyond (Kovats, 2005, p25). Gordon Matta-Clark refers to his cut-out projects as multidimensional spatial drawings of which the viewers form a significant part as they are the architects that construct the scene. He tied in his cut-out buildings with his cut drawings in an attempt to convey an understanding of the structural cut in architecture as analogous to the structural cut of a heap of paper where the cut in a page seems to alter the composition of the drawings on that page in the same way as can be seen in a cut-out building.



Figure 54: *Conical Intersect*, Gordon Matta-Clark, Les Halles, Paris 1975 (<http://www.batchprocess.org/2009/10/15/infante-arana-gorunova-matta-clark-clang/>).

In her essay titled: *Drawing in Between*, Pamela M. Lee attempts to analyse Matta-Clark's drawings. She questions the validity of calling the heap of paper cut outs a drawing where she says:

"No doubt the cut line is not a graphic line, but its structural operations coincide seamlessly, if paradoxically, with the foundations of drawing as they have been classically formulated. ... For if the line has been conventionally regarded as a mediation of sorts – a mediation between the artists sense perception and an abstract judgement – Matta-Clark's line particularly literalizes this mediation, as something which cannot wholly secure the form for perception" (Lee, 1997, p29).

Lee refers to this mediation between Matta-Clark's drawings and perception as the "in betweenness" where she says:

"The mediating function of drawing, and its endless indeterminacy of form, is expressed at the level of the thing depicted" (Lee, 1997, p29).

Such projects and many more by Lebbeus Woods and most recently by Neil Spiller, Rem Koolhaas, and Peter Eisenman reflect another dimension for architectural representation, not just the physical inhabitation but rather the theoretical challenges of the experiential and perceptual experiences of processes of becoming in architecture. Eric Lum proposes a different way to perceive and conceive experiential architecture in his article, *Conceptual Matter: On thinking and making conceptual architecture*, Lum discusses:

"[...] when so much rides on the perception that what one is seeing and walking in is not so much a building as an idea, the building as constructed object needs to disappear, replaced by something not quite a building" (Lum, 2003, p3).

Projects such as Peter Eisenman's serial houses and Neil Spiller's *Velazquez Machine* and *Dee Stools*; carry on Lum's notions of experiential spaces. The two projects are very different in concept and representation. Eisenman's work embeds messages that promote notions of process and decomposition over the tectonics of the buildings themselves, for example the grid of columns and voids in *Houses VI* and *X* which

appear in the middle of the dining table and bedroom. Eisenman intended for these houses to be treated as objects rather than functional spaces, therefore the initial design processes that Eisenman adopted were form/object orientated (Figure 55) rather than spatially or experientially motivated (Moneo, 2004, p165). However, Spiller's projects evolve conceptually over time, for example the *Dorian Gray Column* (Figure 56) which was to be placed in the foyer of an architecture school for generations of students to deface it or reassemble it over time just like the self-portrait of the original Dorian Gray created by Wilde (Spiller, 2005). Spiller refers to his projects as:

"[...] time capsules moving between the history of art and architecture, the virtual and the actual and the challenge of the future with all its magical potential" (Spiller, 2005).

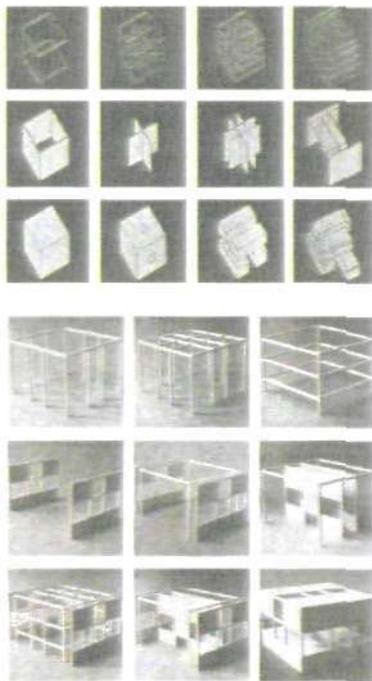


Figure 55: *Houses VI and X diagrams*, Peter Eisenman (Moneo, 2004, p162).

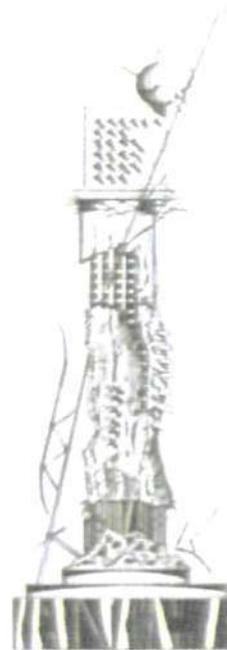


Figure 56: *Dorian Gray Column*, Neil Spiller (Spiller, 2005).

It is crucial to state that conceptualising architectural form is not only concerned with de-materialising it per se, as some of the examples mentioned above were realised as

physical buildings. However, this endeavour deals with forms that extend further than their material world and encapsulate a coded process of becoming, developing and learning from their environment, users, observers and the spaces in between. Kester Rattenbury emphasises the importance of such processes on the development of new design processes in architecture as she refers to the media of representation of the inbuilt and imaginary projects of Italian Futurism, the Avant-garde, and the work of Archigram. She continues to describe architecture in general as a construction, or a way of understanding the relationship between parts of the inhabited world as being different to others, when she states:

"It's to do with a constructed understanding of quality, class, interpretation, intention, meaning. And this seems to be not just conveyed but actually defined by this complex system of media representations, by an elaborate construct of drawings, photographs, newspaper articles, lectures, books, films, conferences, and theoretical books whose subject matter is often the representations rather than the things themselves"
(Rattenbury, 2002, pxxii).

In the next section of this chapter, Rattenbury's vision of representation in relation to architecture is developed further to reach a collective overlapped series of events in recent architectural history and theory which lead to further development and shifts in the complexity of this thesis.

8. Architecture, a Living Apparatus

Peter Cook describes representation in architecture through the act of drawing, whether jotting on paper or digitized drawing, where he argues that it is a spontaneous notion of summarising immediate intentions, which he refers to as the motive forces of architecture (Cook, 2008, p9). Cook suggests a creative oscillation

between a challenge to the familiar means of representation and the assurance of the familiar in contemporary architectural imagery; is a vital means to the field of speculation in the process of experiencing architecture. He further explains that the unfamiliar can be a result of something inexperienced before such as the experimentations of inbuilt architecture of the *Avant-garde* or indeed the many components of the virtual world which are invisible (Cook, 2008, p177).

“Many architects might resist this even if the general public will have a ready taste for it. [...] It is even conceivable that there will be a period of creativity around a kind of faux reality. If architecture no longer needs to depict or even reflect real functional parts (because these are virtually invisible), then the discipline might escape into a form of ‘theatre’ whereby a satisfying elegant or complicated set of visible things is made available, almost none of which have any operational meaning: but they are fun anyhow. Consider a situation where nearly all architecture is a folly?” (Cook, 2008, p178).

By envisioning such a world, Cook is not encouraging one or opposing another, however, he is more interested in allowing for inventions and creativity which push the boundaries of the known to the unknown and by which, pushing our perceptual experiences and consciousness to new fields of speculations and interpretations. Cook speaks highly of the *Temple Island* project (Figure 57) (1988) by fellow Archigrammer Michael Webb, where Cook explains the success of this project which lies in the fact that it was a major essay in observation, geometry and perception. However, its most unique feature lies in its location and context in Webb’s hometown of Henley-on-Thames and is dedicated towards a special event that centres around rowing on the river. This project is one of the few Archigram works that followed a specific context. The project was presented using oil on prepared illustrated boards and conveyed three parallel narratives which were: the map, the Romantic Island and the vehicle (Figure 58). Cook elaborates:

"The movement of a boat along a straight stretch of that river is the key to his proposition regarding the space behind the trees. The tantalisation of the unseen. The constant reconfiguration of this unseen as you move forward. [...] That he should then wish to celebrate two special objects was admissible. The temple on its island is a romantic nod towards an unavoidable link between the Romantic and the Classical. By contrast, the other celebrated object, the submarine, is the creation of the geometrical hypothesis itself. The submarine must lie prone and observe through a small porthole, having the perfect conditions for observing the spatial denouement" (Cook, 2008, p30-33).

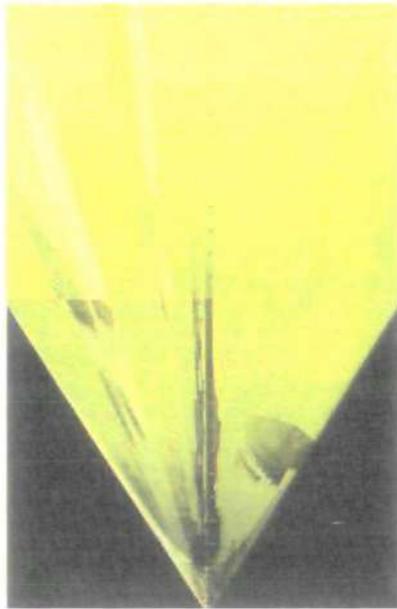


Figure 57: *Temple Island*, Michael Webb, Henley-on-Thames 1988 (Cook, 2008, p32).

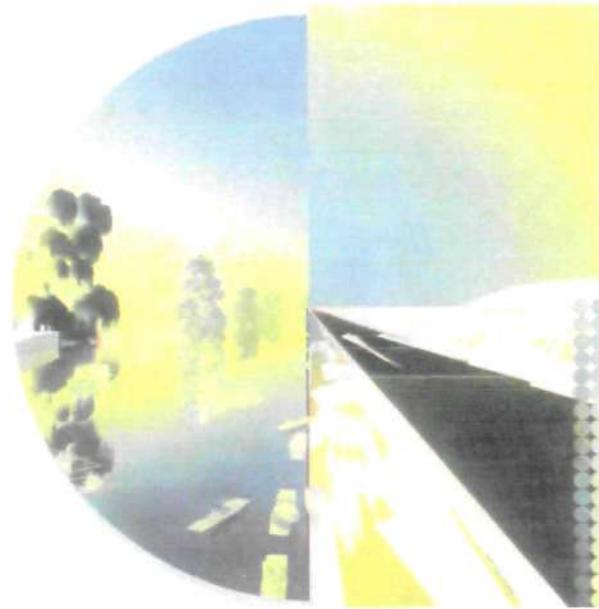


Figure 58: Three parallel narratives of *Temple Island*, Michael Webb, Henley-on-Thames 1988 (Cook, 2008, p31).

Conceptual and experimental architecture, digital, analogue and/or hybrid forms, spaces and their representation, have dramatically transformed under the influence of technological change in the last half a century or so. In particular, these developments have motivated a radical re-thinking and re-conceptualization of contemporary architectural theory evident in the writings of Lucy Bullivant, Neil Leach, Juhani Pallasmaa and Andrew Ballantyne. Architecture is no longer regarded as a straightforward matter of design, construction and use; instead it is now seen as a system, influenced by inter-disciplinary fields of science, technology and perception,

which provoke issues of life, survival and complexity. However, Juhani Pallasmaa argues a fundamental difference between technological and scientific facts on the one hand, and mental and perceptual facts on the other. He goes on to add that architecture as a form of art is primarily connected to the mental and perceptual fields that relate back to individual experiences of the world (Pallasmaa, 2005a, p202-203).

“Architecture, as with all arts, structures and articulates our experience of the world by providing us with horizons of perception and understanding. In my view, the essence of all artistic expressions, including architecture, is the existential experience; art is primarily about life and the human confrontation with the world. Pure utility and rationality, or even the most advanced technologies, cannot grant entry into the artistic realm. The realm of art is approached through metaphysical, existential, and poetic concerns” (Pallasmaa, 2005a, p202-203).

The thesis extends Pallasmaa’s position of the relationship of technology and biology to architecture by focusing on its impact on collective as opposed to individual experiences in order to explain the components of this complex apparatus of representation in architecture and its feedback effect on a social context. Such components stretch beyond the material aspect of the media of representation to reach unstable and immaterial territories, such as changes in our perception, cognition, consciousness, and later on our social and cultural change. Technological and biological means are mediating the advances used as tools and media of representation to express architecture in a more experimental and instrumental medium. At the same time, architecture is emerging through these media of representation, and also through the individual’s and later on collective experiences of this unfolding process by intentions and interpretations of their unfolding surrounding perceptual fields on one another. And hence, the materiality and condition of architectural forms and spaces whether they are physical, analogue, digital or interactive, are not critical to this thesis, but the process in which such forms and

spaces can be represented and experienced is at the heart of its discussion. Moreover, the importance lies in the hybridised environments of such forms and spaces, and in the ways they provoke our perception and experiences and furthermore our expectations and interpretations.

Some of the origins of conceptualisation and experimentation in architecture, for whichever new media and design processes it has given rise to, emerged out of political as well as cultural pressures. Walter Benjamin has observed that artists and architects always strive to politicise their work (Woods, 1996, p1). Simultaneously, architects started questioning architecture's dedication to functions, simple rectilinear plans and sections, as well as, on an urban level, questioning its restrictions of urban zones within cities (Spiller, 2006, p41). Several architectural movements fall into this category of political activism that gave rise to nearly all the examples of the experimental form and space generation in architecture and their representation discussed in this chapter of the thesis. One of the first was the 1957 Situationist International, a revolutionary movement founded by Guy Debord in Paris which fought against the superior passional living of the capitalist order at that time. They advocated the construction of active situations¹⁰, of freedom of choice, responsibility and self-consciousness of existence within a specific environment, to be their central purpose (Ford, 2005, p50). Debord, who believed in life as a chief power over the infinite wealth of the unconscious imagination of the surrealists, wrote the key text *The Society of the Spectacle*, where he says:

¹⁰ The term *situation* has its links back to Jean-Paul Sartre's existentialism theories (Ford, 2005, p50).

"A science of situations is to be created, which will borrow elements from psychology, statistics, urbanism and ethics. These elements have to coincide in an absolutely new goal: the conscious creation of situations" (Debord, 1992, p14).

This was evident in the work and projects that this movement gave birth to throughout the period between 1957 and 1972, for example *The Naked City* (Figure 59) 1958 by Guy Debord. This project was a result of several experimentations which provided the precise definition of the word *Psychogeography* and later on coined the word 'derive' which became a mode of experimental behaviour linked to the conditions of urban society (Debord, 1996, p22). The Situationist International movement impacted the political mood at the time when their work influenced the wildcat strikes in May 1968 in France. They also influenced the work of several artists, painters, graffiti artists, film makers, and produced comic strips (Figure 60), films and artwork which concentrated on the collective influence of the individuals on their society and context. Most famously they influenced Constant Anton Nieuwenhuys, who was one of its members, and his famous *New Babylon* project. In their work they used media of representation which communicated directly with the lives and behaviours of people within the society. Their artwork was accessible and spontaneous, eventually expressive of all the messages they tried to portray. Parallel to the Situationist International movement in France, and the Archigram group in Britain, a group of new graduates in Florence called Superstudio formed in 1966. They believed that:

"[...] architecture served to indoctrinate society into an irrelevant culture of consumption, and therefore sought to extract out of architecture all that encumbered on man's ability to live a free life" (Lang and Menking, 2003, p13).



Figure 59: *The Naked City*, Guy Debord, 1958 (Ford, 2005, p35).



Figure 60: Situationist International comic strips (Ford, 2005, p131).

Despite their attempt in the late 1960s to subvert the system of consumer objects, they in fact, seemed to fuel it with designs and objects that were overloaded with symbolism and poetic content; this was later admitted by Cristiano Toraldo di Francia, one of the Superstudio founders during an interview with Peter Lang conducted on the 7th December 2002, Filottrano:

"[...] we initiated a new level of consumerism, and consequently another level of poverty" (Lang and Menking, 2003, p19).

However, this period in the life of the Superstudio project was followed by extensive research into the architecture of the monument in 1966, and later on the architecture of the image and technomorphic architecture in 1967 which represented a continuation of Francia's university thesis. This had set the stage for a scientifically-based research project utilizing technology as an interface medium for architecture

(Lang and Menking, 2003, p16). Peter Lang and William Menking wrote extensively about the history of Superstudio's research and practice, but most importantly they shed light on the architecture of the image phase which they referred to as the period that provoked a vast number of visual techniques and experimentations utilising pop art, storyboard, collage, cinema and data presentation techniques (Lang and Menking, 2003, p16). Perhaps the most elaborate project regarding total urbanization is the *Continuous Monument*. The authors give an example of this type of architecture, the *New New York* (Figure 61), where a superstructure of grid-like forms is sufficient to hold the entire built-up form of Manhattan preserving some skyscrapers "in memory of a time where cities were built with no single plan", in an attempt to create a singular utopia where architecture is created by a single act and design.

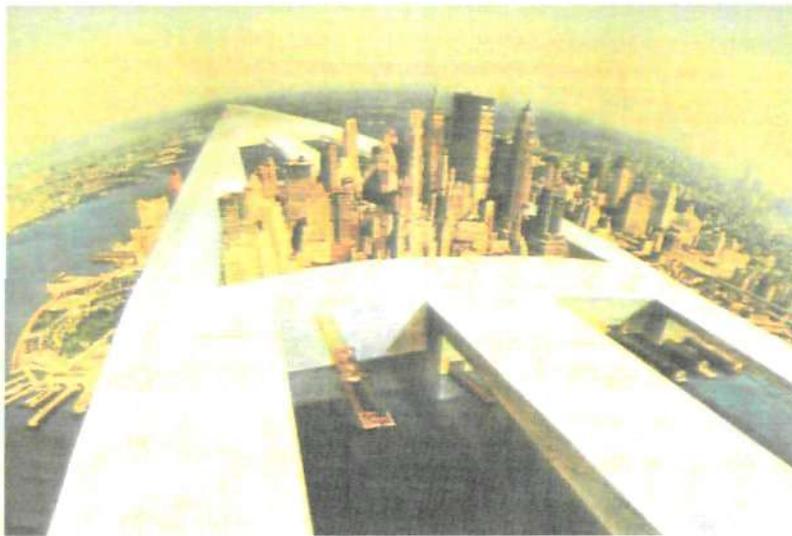


Figure 61: *New New York*, Superstudio, Manhattan 1971, Book Cover (Lang and Menking, 2003).

Superstudio published a statement regarding their ideology of urban utopianism and the *Continuous Monument* in a special issue of *Archizoom* and *Superstudio* magazine titled: *The Distraction of the Objects* (Issue no. 3) where they stated:

"The square block of stone placed on the earth is a primary act; it is a testimonial that architecture is the centre of technology, sacredness, utilitarianism. It implies, man, machines, rational structure and history. The square block is the first and ultimate act in the history of ideas in architecture. Architecture becomes a closed, immobile object that leads nowhere but to itself and the use of reason" (Lang and Menking, 2003, p122).

A similar but slightly different ideology was adopted by the 1980s new architects of the Soviet Union; this came as a protest against the stagnation and standardisation of design production in the state at the time. The Paper Architects, so called due to the fact that their projects were only conceived on paper, emerged in Moscow confronting official Soviet architecture and the ideology of socialist realism by winning international competitions with work that rejected principles of modernity (Sokolina, 2002, p3). The ideologies of the *Paper Architecture Movement* of the Soviet Union were different to the ideologies of the *Superstudio* and others in Europe in its beliefs in fantasy over utopianism. Alexander G. Rappaport has studied the distinction between fantasy and utopia in an attempt to understand the work of the *Paper Architecture Movement* stating:

"A utopian project is based on a universal perception of space which results in a general possibility of realization; the specific spatial conditions 'geographical as well as human' may in fact influence the project but cannot fundamentally change it" (Klotz and Rappaport, 1990, p13).

However and on the other hand he explains that: *"fantasy proceeds from the principles of a pluralistic work and the variety of the spatial conditions of human life"* and therefore, it is subject to human will as opposed to utopia which subjects the human to its will (Klotz and Rappaport, 1990, p13).

Some of the movement's simple execution yet complex connotations and imagination can be seen in the work of Alexander Brodsky and Ilya Utkin, pioneers of the *Paper Architecture Movement*. One of their most controversial works is the *Crystal Palace* (1989/1990, 32 7/8" x 23 1/4" etching) (Figure 62) which achieved first prize in the 1982 Crystal Palace Japanese competition, Japan Architects, in Tokyo. This project launched the breakthrough of Brodsky and Utkin's means of visual and verbal expression that continued to thrive throughout the 1980s starting with etching techniques and passing through three-dimensional physical installations in New York, Paris and Japan as well as Russia (Nesbitt, 1991).

Brodsky and Utkin describe their *Crystal Palace* project themselves in their competition entry piece:

"Crystal Palace is a beautiful but unrealizable dream, a Mirage which calls you always, seen at the edge of the visible. But as each dream is seen in close examination, it will prove the other thing than it seemed from afar. It stands on the edge of the city. A person who wants to visit it will make a long way through the town borderland, blocks of slums and dumps but coming at last to the palace find neither roof nor walls – only the huge glass plates, stuck into the huge box of sand. A Mirage remains simply a Mirage, though it can be touched. Passing from one glass chink to another, a visitor will walk through the palace... and find himself at the border of a small square, where the landscape commences... Did he learn the very essence of the Crystal Palace? Will he have a desire to visit it once more? Nobody knows..." (Nesbitt, 1991).

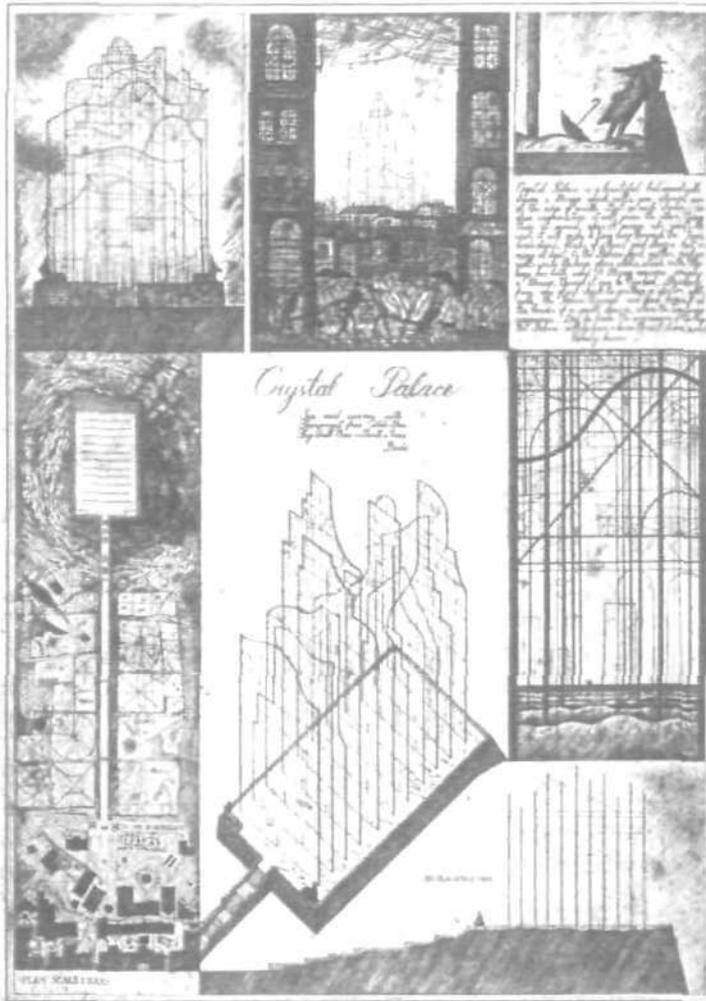


Figure 62: *Crystal Palace*, Alexander Brodsky and Ilya Utkin, 32 7/8" x 23 1/4" etching, 1989/1990, achieved first prize in the 1982 Crystal Palace Japanese competition, Japan Architects, in Tokyo (Klotz and Rappaport, 1990).

The *Paper Architecture Movement's* work was the spark of the *Deconstructivist Movement* in the architecture of the West, which was marked with the MoMA exhibition in 1988 mentioned earlier. Moreover, it has become clear that architecture, not just as a field but a social active medium in itself, is transient as well as being a living ecology of hybridised environments of multiple representations and experiences revealed in time and space. This becomes evident as we attempt to unpack the influence of the Archigram group's futuristic vision, Constant's *New Babylon* multilayered project, Cedric Price's consideration of "*form as a process*", passing

though Rachel Armstrong's "metabolic protocells" and speculating beyond the current effect of science and technology on architectural representation. Therefore, it was no surprise that thirty years on from the utopia of the Situationists' vision which was only achievable on paper, physical models, films and other tangible and physical means of representation, Marcos Novak, a young architect at the time, created *Soft Babylon* in 1998 in cyberspace (Figure 63) (Novak, 1998b, p21).

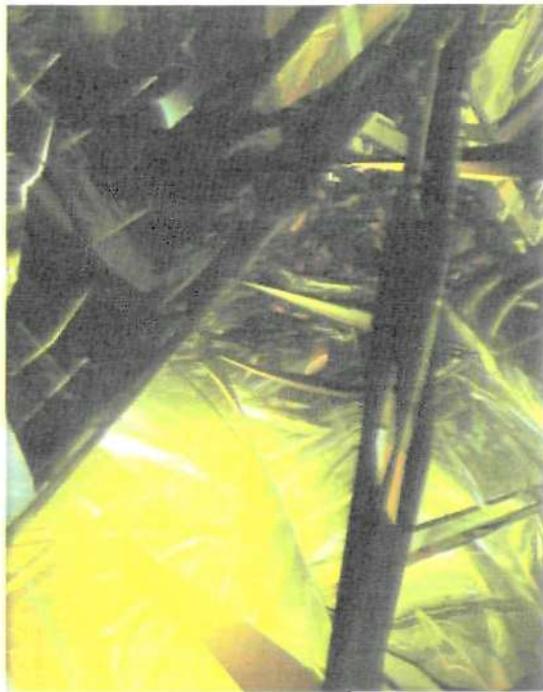


Figure 63: *Soft Babylon*, Marcos Novak, Cyberspace 1998 (Novak, 1998b, p20).

Novak explains the similarities in the vision of both Constant's *New Babylon* environment and the virtual environment, by stating:

"The megastructural framework that was to cover the entire planet has been replaced with the infrastructure of the global internet, the cellular telephony grid, and the constellations of low-earth orbit satellites that bring the whole earth within wireless electronic reach. Multiple layers of artificial landscape are inherent in virtual spaces, where three-dimensional motion is a given and landscape is synthetic by definition. The lack of contact with the earth, and the emphasis on interiority are the inherent conditions of immersion in virtual environments. [...] The lack of personal possessions and the sharing of common goods is already the case in multi-user environments, where spaces are built using found shareware components" (Novak, 1998b, p23).

Neil Spiller acknowledges the similarities between Novak's *Soft Babylon* and Constant's *New Babylon*, however, he realises that the new virtual city of the Situationists on the Net is charged with contemporary spectacles embodied in the computer. As Spiller explains, the power of the computer can aggregate an already hyper-fragmented world:

"It can be used to trace and survey; it can be used as a tool of mechanistic imperialism and as the time-keeper in a twenty-four-hour global sweat shop. Anyone who deals in the amazing opportunities of the computer and its virtual spaces battles constantly with the sticky web of spectacular fragmentation as geography is condensed and choice is limited and perverted into societal dislocation" (Spiller, 2006, p53).

This oscillation between the real and the virtual in terms of media for representation has contributed to the nonlinear and circular feedback effect between each of the eras of representation. Thus, the emergence of new tools and media of representation in architecture follows the development of a living hybridised system of becoming, the living apparatus of architecture. This meant that forms and spaces in architecture needed to be thought of continuously in a collective and dynamic way, in a process of becoming rather than a process of being; hence the need to investigate the means in which complex life processes and natural systems impact our built environment, which are explored in depth in the following chapter. This chapter attempted to reflect the reality of the unstable anxiety of the current state of architectural representation under the development of biotechnology and the generation of dreams boosted by the electronic revolution. On the other hand, it also acted as an introduction to the effect of conventional tools of representation onto instrumental media of representation that involve biotechnology, digital and interactive means on the architectural experience. Dalibor Vesely talks of the new generation of dreams and possibilities of instrumental representation stating:

"In the new generation of illusions and dreams, the traditional unity of representation and what is represented is seen no longer as resulting from a dialectical process of reevaluation, but as indicating the direct presence of reality" (Vesely, 2004, p308).

On the other hand, well-established researchers in the field of instrumental representation in architecture adopt a more optimistic view of the involvement of technology in architectural representation. William J Mitchell wrote extensively about such a relationship, once stated:

"We are entering an era of electronically extended bodies living at the intersection points of the physical and virtual worlds, of occupation and interaction through telepresence as well as physical presence of mutant architectural forms that emerge from the telecommunications-induced fragmentation and re-combination of traditional architectural types and of new, soft cities that parallel, complement and sometimes compete with our existing urban concentration of brick, concrete and steel" (Mitchell, 1995, p167).

Vesely criticises and in a way challenges our experimental and productive mentality which he assumes is linked and limited to our understanding, explaining:

"This is a logical fulfilment of the experimental productive mentality, which assumes that we can understand only what we can make. Therefore only what can be produced is real" (Vesely, 2004, p308).

However, our cognitive system is highly complex and always pushing the boundaries of as Peter Cook once put it, the unknown and the unfamiliar of instrumental and experimental representation in architecture, which is never limited. This thesis follows the footsteps of Cook in support of experimentation in architecture for the sake of inventing new imperatives for the experience and representation of architecture. Cook first introduced *Experimental Architecture* as a field in the 1970s with the publication of a book having the same title (Cook, 1970). Experimentation in architecture came as

a rejection of the old principles of architecture at a time where design was limited to the Cartesian forms and spaces, and when institutionalised building blocks were emerging everywhere in the landscape. Lebbeus Woods founded a similar movement in the USA in 1988, The Research Institute for Experimental Architecture (RIEA) where research and practice of new territories of concept and perception sit at the heart of experimental design in architecture. Since then experimental practices have flourished. This is evident in the work of Diller Scofidio + Renfro led by Elizabeth Diller and Ricardo Scofidio, Morphosis, Foreign Office Architects (FOA), MVRDV, Office for Metropolitan Architecture (OMA), Architecture and Urbanism (CHORA), Stan Allen Architect, and UN Studio, among others such as the Archigram group and all active members of RIEA. The interdisciplinary New York based practice of Diller + Scofidio is one of the most controversial and experimental practices to exist in recent architectural history. Their projects span from physical buildings to artwork, installations, and theatre performances all of which carry elements of technological experimentation and play between the perceptual and the representational in architecture. The 1987 performance of *The Rotary Notary And His Hot Plate* (Figure 64), a multimedia theatre work exhibited in the Philadelphia Museum of Art, combined elements of technology, perceptual and representational play, and analysis of experiential space. Diller + Scofidio describe the piece as a constant exchange of spatial dialogue between the characters:

"It consists of an opaque pivoting panel that splits the stage in two, half for the Bride, half for the Bachelor— front is revealed, back is obscured. A rotation of 180 degrees exchanges Bride and Bachelor domains. A mirror suspended at 45° above the stage reveals what the audience cannot see yet reoriented 90°. Thus, one character is always in the physical space of the audience, the other is present in mediated form. The characters constantly exchange locations, physical states, and sexual identities in a game of temptation and denial" (Diller and Scofidio, 1987).



Figure 64: *The Rotary Notary And His Hot Plate*, Diller + Scofidio, multimedia theatre performance, exhibited in the Philadelphia Museum of Art 1987 (Diller and Scofidio, 1987).

Spiller maintains that the work of Diller + Scofidio with its surreal nature focuses on the relationship between the technologically enhanced body and the modern conditions of our society (Spiller, 2006, p36).

Forty years on, Cook's beliefs that acted as the drives that generated the sense of experimentation in architecture still apply to this current time. Cook spoke, at that time, of the influence of science, technology and the human sense and freedom of exploration, which are still the main causes and contributors to the explosion of the meaning of architecture, practically, and theoretically (Cook, 1970, p11). Therefore, a clear account of the understanding of such influences requires their existence to be established in this thesis.

The following two chapters will focus on unpacking the influences suggested above by Cook, of science, technology and the human sense with their impact on architecture.

The first of these explores extensively research into complex systems and technological advancements of the current age. The chapter to follow will unpack the philosophical grounding of the significance of the active perception and ideologies of in-between.

CHAPTER THREE: INTERWOVEN FIELD ONE - LIFE PROCESSES & TECHNOLOGICAL GENERATION

Nature builds *architectures* composed of trillions of moving components; the number of interactions between these components increases exponentially with the number of the components themselves and so these *architectures* are inevitably complex. 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. 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 thesis focuses on obtaining relevant knowledge from natural systems, analysing it, reconstructing it, and using it to build a new hypothesis, a hypothesis of interpretation and experience evoked by experimental representation in architecture.

Attempts at reaching some levels of investigation in this field of semi-natural systems can be seen in the work of designers such as, Marcos Cruz and Steve Pike as well as artists such as Oron Catts and Ionat Zurr, etc. Cruz and Pike's projects deliver a degree of integration between biological entities and design practices on a conceptual and experimental level. In their own words they describe this new bio-architecture as composites that sometimes appear as constructed entities and other times as living beings, where they explain:

"A notion of design is emerging in which interdisciplinary work methodologies, traded between physicians, biologists and engineers, as well as artists and designers, are

increasingly occurring, giving rise to hybrid technologies, new materiality and hitherto unimaginable potentially living forms. The results of these conditions, defined here as 'neoplastic' are partly designed object and partly living material. The line between natural and artificial is progressively blurred" (Cruz and Pike, 2008, p6).

Living processes are difficult to unpack and interpret because they are non-linear dynamic phenomena. Unpacking the dynamics of such a process will only result in distorting our understanding of its collective nature. However, it is vital to endeavour to unfold its complexity in order to interpret it 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*. Each temporary form or space is a product of emergence that is unleashed after phases of transformation in the process of becoming. In architectural terms, this translates into the spatial and temporal representation of form and space as experienced by the observer(s). This phenomenon is dynamic and constantly in flux. Christopher Alexander echoes much the same observation when he argues that process embeds transformations from one moment to another which govern order in any system (Alexander, 2004b).

This thesis suggests that such processes in architecture run through phases – considered the transformational periods – that form and guide the coherent whole resulting in the creation of a series of distinct folds and thresholds for the forms and spaces. These periods of fold and threshold leaps of a certain system influence emergence and confusion in the course of the system. Hence, they become the main generator for the dynamic continuation and change in any system. These folds and

thresholds are temporary forms and spaces of transformations, or “*living centres*” as described by Alexander (Alexander, 2004b, p21). They may be a shape, a function, a movement or a force. The combination of a number of folds and thresholds in one phase of the process of becoming leads to the formation of a certain form/space. This form/space will change if another fold or threshold is added or changed. A change in their arrangement creates a dynamic tension state. This is why architectural form/space is a thought and artefact with changing relations and transforming connections. Alexander similarly argues that the emergence of new structure in nature is brought about by a:

“[...] sequence of transformations which act on the whole, and in which each step emerges as a discernible and continuous result from the immediately preceding whole” (Alexander, 2004b, p19).

Alexander refers to these transformations as a living process until they reveal the form: the outcome. He calls them living centres because they interact with the context where they belong in a conceptual way, his centres do not transform physically but conceptually (Alexander, 2004b).

This representational phenomenon is therefore born after a number of processes drive the system through transformational periods and phases eventually reaching a near-equilibrium. Yet this phenomenon begins to change in order to attain another near-equilibrium and all this is accompanied by a formalistic multiplicity and reaches its aim in a non-linear manner. This process as Kas Oosterhuis describes it, is in action; it never stops because it is part of a greater action, which is life (Oosterhuis, 2002a). Lebbeus

Woods describes the process in a more radical way when he refers to it as multi-transformations in architectural form where:

"[...] composition is gone, because the process continuously recomposes itself within an almost infinite range of possibilities. Furniture is gone, because it is unknown in advance. Structure is gone, because it is entirely fluid – dynamic, nonlinear, even mathematically chaotic" (Woods, 2001).

All that remains is an intimate and unpredictable interaction between the experience of the observers, the representation of architectural forms and spaces, and the components of the folds and thresholds that generate this system. A living process always embeds the temporary – the state of what exists – and is always anxious to push itself forward to preserve the structure of what exists, growing and adapting itself as it creates change, evolution or development. This is the creative process: the living process.

The increasing interest in living spatial form has yielded many new and important facts, but only relatively minor advances in architectural design theory have followed. One of the most fascinating aspects of living structures is the pattern of organization found at each level of description. On a molecular level, a highly ordered pattern of geometry can be seen, which takes different configurations: linear, cylindrical, and helical structures, plane membranes etc. These highly organized and geometric structures nonetheless transform and adapt in the course of development; a rather striking paradox (Whyte, 1968).

"There is no doubt that at the deepest levels organic structures combine rather strict forms of geometrical ordering with variety, mobility, cyclic changes, and the tendency to maintain, and when necessary restore, organic coordination" (Whyte, 1968, pxiv).

These levels of geometry follow a structural hierarchy, which governs the whole and its relation to the parts in each living structure. Thus mobility, variety, cyclic changes, and the tendency to maintain, restore and coordinate are all characteristic of processes of formation, also known as "*morphic processes*". Whyte describes the "*morphic process*" as:

"I have given them a scientific name: morphic. This is defined to mean 'displaying a movement towards greater three-dimensional spatial order, or form'" (Whyte, 1968, pxxvi).

These processes generate new order in new forms in space and time. However, while the processes of formation build up the hierarchy of a living structure, the entropy process breaks it down through feedback loops that are essential to each complex system. The interest of the thesis in such processes lies in the emergent behaviour that such processes generate in each form/space. In this context, form can be defined as any behaviour, structural configuration, pattern of organization, or system of relations that occupy a physical or a virtual space. However, in biological terms this definition takes on specific attributes of patterns and pattern formations in a certain physical space. At the same time, it is hard to maintain a clear distinction between form and pattern (Ball, 2004b, p9). Ball explains that a pattern is not necessarily a regular repeated array of identical units but can also include arrays of similar units, not necessarily identical, which repeat, not necessarily regularly or symmetrically (Ball, 2004b, p9). Regular units with regular array patterns can be seen in designed wallpaper or carpets, etc., whereas, similar and irregularly repeating patterns can be seen in sand ripples, waves, clouds, etc. Most such irregular patterns are formed out of

equilibrium; i.e., they are not in their most thermodynamically¹¹ stable state (Ball, 2004b, p254). 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.

Architects, engineers and designers have always been fascinated by nature's various patterns and their formation on multiple scales and levels of sophistication (Senosian, 2003). Nevertheless, there is a single aim; it lies in learning techniques that can be taken into another field, such as architecture, which have been tested in nature. Thus nature is the medium of all interim stages of experimentation and exploration on different scales, relating to technology and potentiality of materiality, principles and processes of formation and existence, or meta-perception and cognition of its innovative speculations. A wide range of explorations in this field have been attempted and this has had a great impact on the development of the architectural theory of design in general and representation in particular. From the geodesic dome of Fuller's invention to the re-humanisation of dwelling places in *Bio-Architecture* by Javier Senosian (Senosian, 2003, p159), to the interpretation of algorithms in architecture by Benjamin Aranda and Chris Lasch which is described by Cecil Balmond as follows:

"What we choose depends on materiality linked to scale. At the infinite, the proposals may hint at cosmic organization; at the micro and realm of compact densities, they intuit biological process. In between is a world of inventive speculation, where the imperative of a particular pattern drives the response towards a choice dictated purely by local features" (Balmond, 2006, p7).

¹¹ Thermodynamics, "the science of change that developed initially as an engineering discipline in the nineteenth century, was intended to describe the equilibrium state of systems" (Ball, 2004b, p254).

Aranda and Lasch unleash in architecture that which Ball established in biology regarding materiality in non-equilibrium states and its effect on pattern formation or organization at a later stage in the process of formation where they suggest:

"if architecture is an extended process of formation, then before ideas coalesce into a definitive form there must exist some undifferentiated state free of any organization. The moment any sort of development is imposed onto this formless matter it begins to enter the realm of substance, organization and material" (Aranda and Lasch, 2006, p8).

The particular moment of development was envisioned by Aranda and Lasch through seven natural processes of formation that enabled pattern formation in architectural design and representation and were expressed under the umbrella of tooling. These tooling processes are spiralling, packing, weaving, blending, cracking, flocking, and tiling (Aranda and Lasch, 2006). Lessons from such tooling processes were used in the creation of new materials such as the biomimetic¹² system *Sonomorph*¹³ by Natasa Sljivancanin. Sljivancanin invented an intelligent kinetic system that responds to changes in the environment (Figure 65). This kinetic building system is constructed from an aluminium outer panel, a glass reinforced plastic inner panel, sensory devices/wiring/circuit boards, and light emitting diodes (LEDs) (Brownell, 2008, p56).

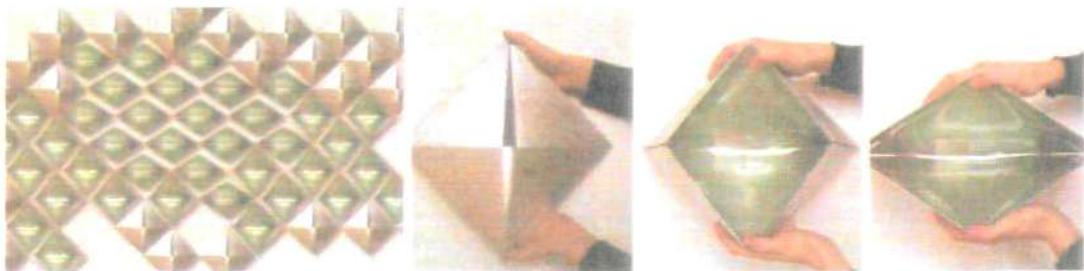


Figure 65: *Sonomorph*, Natasa Sljivancanin, sound responsive wall (Brownell, 2008, p56).

¹² Professor Julian Vincent, director of the Centre of Biomimetics and Natural Technologies at the University of Bath identifies Biomimetics which is also referred to as "bionics, biomimicry, bioinspiration or bioinspired design", as "the implementation of design principles derived from biology" (Vincent, 2009, p76).

¹³ "A research collaboration with Cornell University, Sljivancanin's sound-responsive wall comprises cellular components that react to various stimuli by opening and closing cells that absorb sound and emit light" (Brownell, 2008, p56).

Sljivancanin's system is biomimetic; unlike the biomorphic approach where principles of biology are applied literally to design such as copying directly from animal architecture, (Rudofsky, 1973) a biomimetic system is built upon abstract systems derived from biological principles and processes. Julian Vincent supports abstraction in building such biomimetic systems, stating:

"The more abstract the derivation, the more one relies on the recognition of pattern in the data rather than the shapes of physical objects. Abstraction thus simplifies technology transfer by emphasising the main principles to be used and so makes the technology more powerful and pervasive: powerful because it introduces techniques from biological systems in a more adaptive manner; pervasive because this adaptive manner makes it easier to blend the biological approach with conventional engineering" (Vincent, 2009, p76).

On a theoretical level, powerful and pervasive abstractions of biological principles lead to recognition of patterns in which the distinction and the relation between organization and articulation is at the heart of their formation. Patrik Schumacher of Zaha Hadid Architects echoes much the same, identifying that:

"Organization is concerned with the spatialisation of the social order via objective distances/proximities and via physical divisions/connections between domains. Articulation is concerned with the subjective comprehension of the spatialised social order" (Schumacher, 2009, p31).

Later on he continues stating:

"Only on the basis of articulate organizations will users be enabled to navigate, and collectively utilise, the built environment to its fullest potential. [...] Architectural patterns are a potent device for architectural articulation" (Schumacher, 2009, p31).

In their book titled: *Autopoiesis and Cognition: The Realization of the Living*, Humberto R. Maturana and Francisco J. Varela define living systems as units of interactions that

follow the structure of their organization while maintaining the circularity of their interactions with the observer (Maturana and 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 and Varela, 1980, p9-10).

This indirectly leads to the assumption that the cognition of spatial architecture is dependent on the articulate organizations recognized in patterns that can be derived from abstractions of biological 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 architectural patterns are potentially transient too. 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 in particular.

Philip Ball put forward insights into the development of irregular patterns in systems in general. This field of study was founded in the 1970s when the French mathematician René Thom founded *Catastrophe Theory*, which promised to explain through mathematics the reasons behind the sudden changes in society when provoked by small effects, but eventually failed to deliver useful predictions. Later on in the 1980s *Chaos Theory* emerged to explain the unpredictability of the outcomes of complex and dynamic systems even when their initial states and inputs are known in detail. This

theory later on developed into *Complexity Theory*, which came to explain how order and organized stability can emerge out of interactions between many agents guided by simple rules (Ball, 2004a, p4).

Pierre von Meiss in *Elements of Architecture* explains the notions of *chaos theory* in an urban context where he introduces what could be elemental to understanding complexity in architecture by referring to the architectural occupation, where he states:

"Urban chaos is a state of instability. On one hand, it tends to become organized by signs of occupation. On the other, being accustomed to a city helps us to learn about its more secret order" (von Meiss, 2006, p49).

One of the leading architectural critics, the first to write extensively about the effect of the complexity of natural systems on architecture, is Charles Jencks. In 1995 Jencks wrote a book titled: *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 in architectural influences at the time, from the idea of the static universe to the mechanical of the *Modernist Era*, eventually reaching a *Cosmogensis Era* in which development is constant (Jencks, 2002, p207). Jencks explains the nature in which the cosmogenesis universe operates, and eventually influences a new paradigm in architecture:

"To capture its essentially dynamic quality, we might emphasize the creativity and surprise of a universe that evolves in phase changes – sudden jumps in organization. [...] The history of the cosmos over some thirteen billion years [...] can now be conceived as progressing from perfect super-symmetry to more organized and differentiated states. 'Symmetry breaking' is itself a new concept of the new paradigm and its importance for

a profession founded on symmetry 'making' cannot be overemphasised" (Jencks, 2002, p207).

Many architects such as Peter Eisenman, Rem Koolhaas, Greg Lynn and others, have written and practiced the extensions of a cosmogenesis 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, p159).

Therefore, it is vital, for the progression of this thesis, to unpack the complexity of natural systems with its principles and processes, in order to take one step closer to understanding the impact of such complexity on architecture. However, before *developing the notion of complex systems in architecture or embarking on unpacking its principles and processes*, it must be mentioned that the sole reason for doing so is to reveal the relations that link these principles in the *process of becoming*, or in other words, the relations that reveal the system's functionality. Here, functionality is not used to mean mere utility, but rather the relations between the different states of complexity, which depend on each other. Such processes collectively formulate and are generated by the *process of becoming*, starting from the growth and development of an entity. Max Bill writing in the fifth series of *Architectural Words* published by the Architectural Association (AA), London, distinguishes between two different kinds of functions that relate to each other, explaining:

"The first one reveals the relations between the object and the people as individuals (and as a society). The second one reveals the relations between the components that make up the object and the processes by which it is produced" (Bill, 2010, p108).

Here in this chapter the latter type of functionality that relates to principles and processes of becoming is of primary interest while the former relation between objects and people will be the focus of the following chapter.

9. Principles of Complex Systems: Growth, Development, and Behaviour

It is important to start this section by differentiating between complicated systems and complex systems, stating a definition for both. Bernard Pavard and Julie Dugdale differentiate between complicated systems such as planes or computers, and complex systems such as ecological or social or economic systems by acknowledging:

"The former are composed of many functionally distinct parts but are in fact predictable, whereas the latter interact non-linearly with their environment and their components have properties of self-organisation which make them non-predictable beyond a certain temporal window" (Pavard and Dugdale).

A complex system is fundamentally non-deterministic and behaves in a non-linear way and therefore, it is difficult to define a related starting point; at the same time, it is impossible to define an end point to the dynamics of its complexity. Therefore, complex systems are irreducible and far from chaotic always striving to reach an unreachable equilibrium due to changes in the environment. Despite its dynamic nature and for the sake of understanding its deeper influence on our lives, the thesis attempts to begin the process of unpacking complex systems from what John Holland calls *"the very embodiment of emergence"*, the seed (Holland, 1998, p1).

Holland speaks of the seed as a small capsule that encloses a specification that produces sophisticated and complicated structures through a growth process (Holland, 1998). The growth process starts from a seed. A seed, whether it is matter or non-matter, such as information and data flow, is the starting point for anything to take place in a *process of becoming*. The development of a growth process was argued until 1917 when D'Arcy Thompson described the origins of biological form as a necessary result of biological growth (Thompson, 2005). He showed again and again by examples, that biological form could only be understood as a part of the "*growth process*". Thompson based his theory of analyzing biological processes on mathematical and physical aspects, drawing particularly from the Fibonacci sequence, and the hybrid theory of Pythagoras and Newton (Thompson, 2005). One of the most relevant ideas due to Thompson is that physical forces shape organisms directly; surface and volume ratios must influence the organism as it grows in size and as it inhabits different realms of forces. As a consequence of this, small creatures are influenced primarily by surface forces while large creatures receive stronger influences from volumetric or gravitational forces (Thompson, 2005).

Although Thompson has been criticised for his views on natural selection, some of which have been contradicted by modern evolutionary and developmental biology, many of his ideas remain highly relevant to this day. One of the most compelling of these is the theory that the growth and form of an organism have two tendencies: the first consists of the genes which are responsible for producing proteins which in turn

produce structure or form, and the second tendency consists of factors which limit the role of the genes.

"Those limits are due to the nature of the very structures for which they provide the assembly instructions" (Thompson, 2005).

This idea supports the new view of molecular biology, in which it is argued that the genes are not acting alone and that they are governed by:

"[...] physico-chemical rules which severely limit what shapes, what morphologies are possible" (Bonner, 2005).

Thompson exhibits a wide range of examples in his book, and through these examples, explains extensively the development and growth of form in relation to the developmental processes of the embryo. This thesis asserts that such processes are crucial to the emergence of new representational and design thinking in architecture, be it conceptual, instrumental, virtual or physical.

The formation of the embryo begins with the fertilisation of an egg followed by rapid cell division, followed by pattern formation, and morphogenesis which is a process of three dimensional differentiation and growth. These processes overlap and interact with each other in the course of creation (Wolpert, 1993). Cell division and differentiation reveals a very interesting aspect of morphogenesis which is tree structures. During a phase of rapid division the cells follow tree like shapes to form the limbs, and the limbs follow further tree structuring; legs and arms grow further into fingers and toes. This segmented branching process is accompanied by chemical gradients which enable the whole to guide the parts (Wolpert, 1993). Steve Grand

argues that if cells consume the chemical as they grow along it, they will leave trails, and such trails can alter the behaviour of other cells as they follow. What is interesting about these principles is that they all share one feature: different permutations of combinations of modules in a growth process arise out of complexity and interaction through feedback loops (Grand, 2001).

We may see some of these processes and aspects such as replication, coordination, and pattern formation, but rarely differentiation in creating artificial complex systems using nanotechnology. Differentiation is not possible using current technologies in artificial systems even if using living materials such as tissue and cell culture. Thus, in order to control the growth of living culture, experts use moulds and leave the tissue to grow. Artists as well as scientists have experimented with this idea. This can be seen in the artwork of Oron Catts the director of SymbioticA¹⁴ and Ionat Zurr at the *Tissue Culture & Art Project* at the University of Western Australia in their attempt to grow a semi-living jacket to create “*victimless leather*” (Catts and Zurr, 2008, p31). This project highlights the possibility of wearing leather jackets without killing an animal. Catts and Zurr grew a living tissue into a leather-like material and had it mature in the form of a miniature, stitchless, coat-like shape (Figure 66). However, the intention is cultural rather than catering for consumption, Catts explains:

“The intention is not to provide yet another consumer product, but rather to raise questions about the exploitation of other living beings. The role of the artist is to provide symbolic yet tangible examples of possible futures, and research the potential effects of these new forms on our cultural perceptions of life” (Catts and Zurr, 2008, p34).

¹⁴ SymbioticA: The Centre of Excellence in Biological Arts, The School of Anatomy and Human Biology at the University of Western Australia.

Such experimentation in arts and cultural studies is vital for progression and development in the awareness and familiarisation of societies with such processes and their influences on other disciplines such as art and architecture as opposed to merely biology.

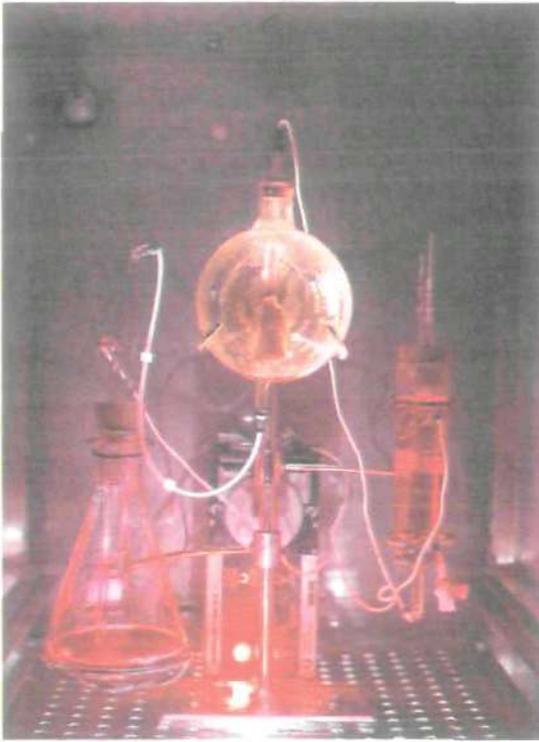


Figure 66: *Victimless Leather Jacket*, Oron Catts and Ionat Zurr, Tissue Culture and Art Project, University of Western Australia, Perth (Catts and Zurr, 2008, p34).

Returning to D'Arcy Thompson's examples of analysis of pattern formation in nature, all of these were examples that we can encounter and see around us. Among these examples are the famous spirals of snail shells, or the ones seen in sunflower heads, the stripes of a zebra, and the perfection of the orderly honeycomb (Thompson, 2005). All of which are complex, however, Thompson's examples stopped at, although forming the basis for, explanations of even more complex and irregular patterns in nature such as the designs of butterfly wings, the branching of trees and rivers, the ripples of sand dunes, etc. (Ball, 2004a, Ball, 2009a, p7). Ball explains that such

complex patterns and the structural formation behind them are both surprising and inspiring, where he states:

"Many of the most striking examples that we encounter around us are evidently the products of human hands and minds – they are patterns shaped with intelligence and purpose, constructed by design" (Ball, 2009a, p7).

Such complexity in patterns was first viewed as the work of God until the late 19th century when Darwin's theory of evolution by random mutation and natural selection explained such complexity without the need for a designer. Later on, Darwin's theory of evolution was pushed forward with new investigations into the development of patterns and forms in living organisms carried out by the pioneer of computer science and the founder of the field of Artificial Life (AL), Alan Turing. Turing wrote in his 1952 article titled: *The Chemical Basis of Morphogenesis*:

"It is suggested that a system of chemical substances, called morphogens, reacting together and diffusing through a tissue, is adequate to account for the main phenomena of morphogenesis. Such a system although it may originally be quite homogenous, may later develop a pattern or structure due to an instability of the homogenous equilibrium, which is triggered off by random disturbances" (Turing, 2004, p519).

Mathematically and with the aid of digital computers Turing establishes a theory of morphogenesis where he 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, Turing develops a non-linear theory of instability due to differences in reaction rates as functions of concentrations in patterns, later known as *Turing Instability* (Turing, 2004, p560). 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 pattern formation and experimentations in art and architecture.

Sanford Kwinter echoes much the same when he recalls Alan Turing's breakthrough of algorithms, where "*numbers could be automated within functions*" in order to explain the complexity of nature (Kwinter, 2006, p93). Kwinter continues describing the benefit of algorithms and the way they function in design, where he states:

"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, p93).

Among the wide range of designers and architects who have attempted the use of algorithms in their design are, Celestino Soddu founder of the Generative Design Lab in Milan Polytechnic University, and others such as Benjamin Aranda and Chris Lasch who in their architectural pamphlet titled: *Tooling* explored principles of morphogenesis in design by utilizing an algorithmic language for each process they suggested, creating, at the basic level, the first seed for the growth and development of patterns and later on forms. It seems 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 and Lasch, 2006, p9). 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, p93).

Due to the transient nature of such processes and the effects appearing on architectural representation, the exploration of phrases that could be coined to describe such outcomes were developed throughout this research, such as *Transphorms, and Temporary Forms/Tempforms*. *Transphorms* are forms that are observed while interacting with their environment in space and time. The word *transphorm* is the combination of transformations of the phenomenal form. This phrase has evolved to the phrase *temporary form* or *tempform* which also carries the meaning of circularity and change that takes place in a certain time; however the latter is used within a context that emphasises the process of feedback, which is a crucial element of the creation of each *tempform* in its wider context. The term *temporary form* or *tempform* is used in an experiential context and the same word translates into *frozen behaviour* when used in a representational context. *Frozen behaviour* is a term used by biologists to refer to artefacts. Artefacts leave an enduring record of the behaviour which resulted in their creation as Hansell argues, while acknowledging that:

"The life expectancy of this behaviour record varies very much with the builder and its habitat" (Hansell, 1984, p159).

This idea of a *frozen behaviour* in architecture is very much like describing a completed origami design, the outcome of manipulating a sheet of paper through a sequence of foldings. Describing the final form of the paper in detail is very difficult due to the complex relationships between its features, but the sequence of instructions that yields this form is relatively easy to formulate. The reason behind that is that simple instructions about folding the paper have complex spatial consequences.

In the origin and history of the word behaviour, which appeared in the late 15th century:

"From BEHAVE, on the pattern of demeanour, and influenced by obs. haviour from HAVE" (Soanes and Stevenson, 2009, p122).

Behaviour usually refers to an action or reaction of an object or organism in relation to its context. Different types of behaviour are important in each field of research; the most important for this research are those that relate to biology and computer science and are used in the field of psychology as well as social and cultural contexts.

Most important for this thesis in terms of the development of its argument and methodology is to understand the collective influence of its trajectories on architecture. Collective behaviour is a term used in sociology to refer to social processes and events which do not reflect existing social structure (laws, conventions and institutions), but rather emerge in a spontaneous way. For example, a religious revival, a panic caused by a sudden effect or emergency, or a passing fad for a particular fashion style; these are all instances of crowd behaviour. However, there are other types of collective behaviour such as mass, public, and social movements. A *frozen behaviour* is a caption for a single state of a collective behaviour of multi-individuals or agents in space and time. The relationships between sequences of *frozen behaviours* will explain the complexity of the collective behaviour in a system.

Sociologists have invested an extensive amount of time and research dedicated towards defining types of collective behaviour in society. Among those sociologists was Herbert Blumer who suggested a new methodology for defining social interaction between people in a certain society, coining the phrase: *"Symbolic Interactionism"*

(Blumer, 1986, p1). Blumer explicitly identifies three premises on which this methodology is based, stating:

"The first premise is that human beings act toward things on the basis of the meanings that the things have for them. Such things include everything that the human being may note in his world-physical objects [...]. The second premise is that the meaning of such things is derived from, or arises out of, the social interaction that one has with one's fellows. The third premise is that these meanings are handled in, and modified through, an interpretive process used by the person in dealing with the things he encounters" (Blumer, 1986, p2).

These premises if true, confirm the validity of the nested structure of the hypotheses, objectives and the research questions of this thesis. However, before attempting to relate this to architecture, vital questions must be asked: Why living forms? What is so special about living processes that current architecture needs? Despite the complexity of the effect of such questions in architecture, this thesis takes the position that the answer is *survival*. If any form in nature has the ability to survive, it can then be considered a living form. In natural forms, change entails making multiple transitions between different transformational phases in the *process of becoming*; having the ability to negotiate such transitions means that the form can adapt. Adaptation in turn leads to survival, up to some limit in space and time. Architects have frequently taken inspiration from nature, motivating new structures, forms, materials and more recently, processes of creation (Hensel et al., 2006a). We often wonder whether man-made architecture is part of nature and to some extent, it is. Any piece of architecture is part of the environment, the context, which is in turn part of nature. This observation, as Frazer envisioned, gives rise to an important and pressing question: whether architects can achieve in the built environment the *"symbiotic behaviour and the metabolic balance that are characteristic of the natural environment"*? (Frazer, 1995).

Many architects refer to architecture as a form of artificial life, which means it should be subject, like the natural world, to principles of morphogenesis¹⁵. Architectural concepts can be expressed in space as structures and forms in a context. However, can there be generative rules that develop and interact with each other and, later on, grow into models in an environment which will have an input on the process? Can architectural form be designed to have emergent behaviour? A study of the folds and thresholds that generate transience in the *process of becoming* in any system therefore becomes essential. Hence, it is crucial to unpack, in order to study, understand and interpret the folds and the thresholds of the principles of complex systems as they reveal their effective impact on the thinking, the structure, and the development of arguments in this thesis, not only in a linear and direct manner, for example the use of such principles in architectural design, but also in a collective social and experiential way embedded within the creative narrative and unfolding/folding of events of this thesis.

10. Properties of Complex Systems

10.1. Emergence: Self-organization and Adaptation

Emergence in the Oxford English dictionary is a –noun and means: “*the act or process of emerging*”. When related to philosophy it means: “*(of a property) arising as an effect of complex causes and not analysable simply as the sum of their effects*” (Soanes and Stevenson, 2009, p466). We can also explain the idea of emergence through a

¹⁵ Morphogenesis means the biological processes that take place in the early stages of the development of an organism causing changes and development in its form, i.e. change in the form in the early embryo (Wolpert, 2002, p253).

board game such as chess. Holland explains that in essence, emergence is embedded within the rules of the game. The simple set of a small number of rules that governs the game can lead to extraordinary complex games with endless possibilities due to mathematical interactions (Holland, 1998, p1). Steven Johnson, from a different angle, identifies emergence as:

"The movement from low-level rules to higher-level sophistication is what we call emergence" (Johnson, 2002, p18).

In 2002, Johnson argued that the study of emergence has entered a new phase in the last decade or so, one that is more revolutionary than the other two phases.

"In the first phase, inquiring minds struggled to understand the forces of self-organization without realizing what they were up against. In the second, certain sectors of the scientific community began to see self-organization as a problem that transcended local disciplines and set out to solve the problem, partially by comparing behaviour in one area to behaviour in another. [...] but in the third phase, we stopped analyzing emergence and started creating it" (Johnson, 2002, p20-21).

Creating emergence requires decentralised thinking, which is not achievable without bottom-up behaviour. By this scientists mean organization from below in the hierarchy of any system - an ant colony or a slime mold for instance - where the agents work together to generate a flow of information guided by simple locally applied rules. They self-organize their structure according to changes in their context, thus they are adaptive, they learn from their environment to solve a problem and to survive. These systems are complex and exhibit emergent behaviour. Johnson continues by stating:

"Emergent complexity without adaptation is like the intricate crystals formed by a snowflake: it's a beautiful pattern, but it has no function" (Johnson, 2002, p20).

One of the most striking features of the universe and its phenomena is that complex systems are always anxious to push themselves to the threshold between order and chaos. This threshold is unstable and it gives, at the same time, a formalistic multiplicity that generates dynamism in the system. The inability to predict the outcome is associated with the cyclic nature of the phenomenon. Self-organization is one of the properties of dynamic complex systems, which push themselves to the threshold between order and chaos in an attempt to organize their complexity so as to optimize energy flow. In an insightful observation, Nikos Salingaros refers to this organization as a kind of *"learning process"* where,

"The system uses internal forces to influence its own structure or growth" (Salingaros, 2004).

The most significant feature of a living process is that it grows, unfolds and adapts gradually to allow the temporary form to emerge from the coherent whole with the help of feedback processes. Without feedback at each step, a process cannot be complex and living; this is the secret of biological evolution. Ross Ashby equally argues:

"During the course of evolution, the adaptation of the thousands and millions of variables that must occur to make one successful organism happens gradually" (Ashby, 1960).

Richard Dawkins echoes much the same observation when he notes that cumulative adaptation is the only possible way for evolution.

"It would be impossible for nature to 'design' a system as complex as an organism all at once" (Dawkins, 1989).

Furthermore, Steve Grand describes what may develop in a system that unfolds gradually:

"When populations of interacting structures become arranged in certain configurations, and new and surprising comes into existence, we call this an emergent phenomenon" (Grand, 2001).

Some excellent examples of this principle can be seen in the field of cellular automata. The most well-known example is *Conway's Game of Life* (Figure 67), where each unit follows a straightforward rule that produces emergent behaviour in the system as a whole. All the cells in *Conway's Game of Life* follow simple rules, which capture coordination between the cells to form a certain pattern (Gardner, 1970). It is in fact an autopoietic system¹⁶ as it exhibits self-production behaviour through interactions between its constituting agents or components, *"a network of component-producing processes"* (Beer, 2004, p310).

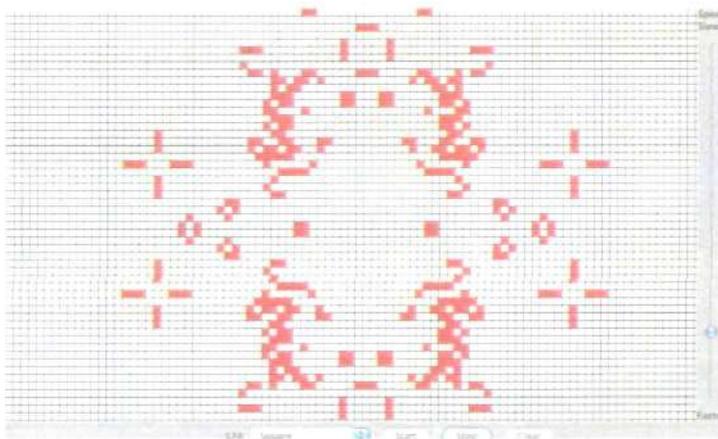


Figure 67: *Conway's Game of Life*, cellular automaton, John Horton Conway 1970 (<http://psych.hanover.edu/JavaTest/Play/Life.html>).

"A cell can be alive or dead. A live cell is shown by putting a marker on its square. A dead cell is shown by leaving the square empty. Each cell in the grid has a neighbourhood consisting of the eight cells in every direction including diagonals" (Callahan, 2000).

¹⁶ The term *Autopoiesis* was first coined by Maturana and Varela in describing the processes of living machines.

"An autopoietic machine is a machine organised (defined as a unity) 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 and Varela, 1980, p78-79).

By counting the number of live neighbours for each cell, we can tell what will happen

next. Callahan explains:

"A dead cell with exactly three live neighbours becomes a live cell (birth), A live cell with two or three live neighbours stays alive (survival), in all other cases, a cell dies or remains dead (overcrowding or loneliness)" (Callahan, 2000).

The Game of Life is an excellent example of emergent complexity and/or self-organizing systems. However, it does not explain the complexity of the dynamics of complex systems and the thresholds of its transience. Michael Weinstock explains:

"Critical thresholds are those where the effect produced by a small change in one or more variables, such as the addition of a few grains of material, is disproportionately large or 'non-linear', producing a rapid and substantial collapse and a subsequent cascade of other changes, or a reorganization from which new forms emerge" (Weinstock, 2010, p254).

For the purpose of unpacking the main principles of complex systems in architectural terms, a model was created and developed in stages throughout the period of this research. Described below is the progression of the development of this model which acts as a tool of exploration and interpretation of ideas of complex systems in architecture. As a starting point, the use of magnets as a controlled force which embed simple set of rules of attraction and repulsion was adopted. Following this, different possible forms for the elements of the system were researched to reach the most suitable form. The rhombic dodecahedron was selected as a space-filling form which can be used as an efficient module for the creation of nanomachines (Figure 68).

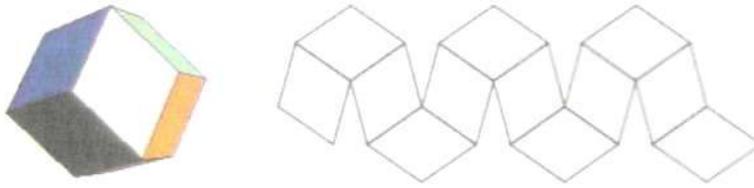


Figure 68: Rhombic Dodecahedron, space-filling form
(<http://mathworld.wolfram.com/RhombicDodecahedron.html>).

If the module is replicated then a whole form may be constructed from multiple modules. Rearranging the modules yields another form. When a number of these modules are placed in a container and shaken together, they can arrange themselves in a compact form purely as the result of a large number of random interactions between them as they are agitated. To control the modules, we can suppose that each side will have four electromagnets +, -, +, - to be placed in the middle of each line (Figure 69). Changing the polarity of a magnet from (+) to (-), causes it to push itself away from the side that was previously attached to it and roll onto another side. With coordination between the modules a surface can be built which can take different colours or shapes as required.



Figure 69: Photograph showing the Rhombic Dodecahedron with magnets.

Steve Grand provided some comments on this model in which he suggested an improved design. Grand suggested the use of electrostatic forces that change their sign as opposed to magnetic faces that reverse their polarity.

The above model was further developed as part of a publication¹⁷ and was also submitted as a design challenge for a workshop¹⁸ at the University of Westminster in London. This further development of the model exhibits an attempt to grow forms from seeds that contain a genetic code to provide a novel approach to the creation of unpredictable designs that are able to adapt to their context. For the time being, the behaviour displayed is pre-programmed and as such does not yet constitute a true simulation¹⁹. The model is theoretically structured on the principles of development and the cutting edge technology of nanotechnology and cellular automata.

In the early stages of the model process there is one cube which is a space-filling polyhedron (Weisstein, 1999). If we assume that the cube is able to replicate itself (through a nanotechnological implementation, for example), then after several replications, we can go on to code all faces on each component with a codon from a complete sequence of DNA (Figure 70)²⁰. Then by placing the components randomly in a glass box and shaking it to disturb the sequence, each face of a component will try to look for the matching face that completes its sequence, just like what happens when two strands of DNA join together. They will all settle after a while to form a certain form: a *temporary form*. If there will be another attempt at manipulating the code by changing one or two or even more of the sequences on the faces of one of the components; the cubes will try again to push one another to form a different pattern

¹⁷ Paper published in Altered States Conference Proceedings, Plymouth, UK: Liquid Press (Murrani, 2005).

¹⁸ Designing for the 21st Century, University of Westminster, London 2005.

¹⁹ This aspect will be evolved at a later stage of the development of this model.

²⁰ For further details see movie: Division and coding throughout time and space.

<http://sanamurrani.me.uk/july05/movie1.mov>

to match the new sequence, and this is pattern formation (Figure 71)²¹.

Simultaneously, the cubes are displaying similar tendencies of natural systems in their striving to reach equilibrium, which is never a static process.

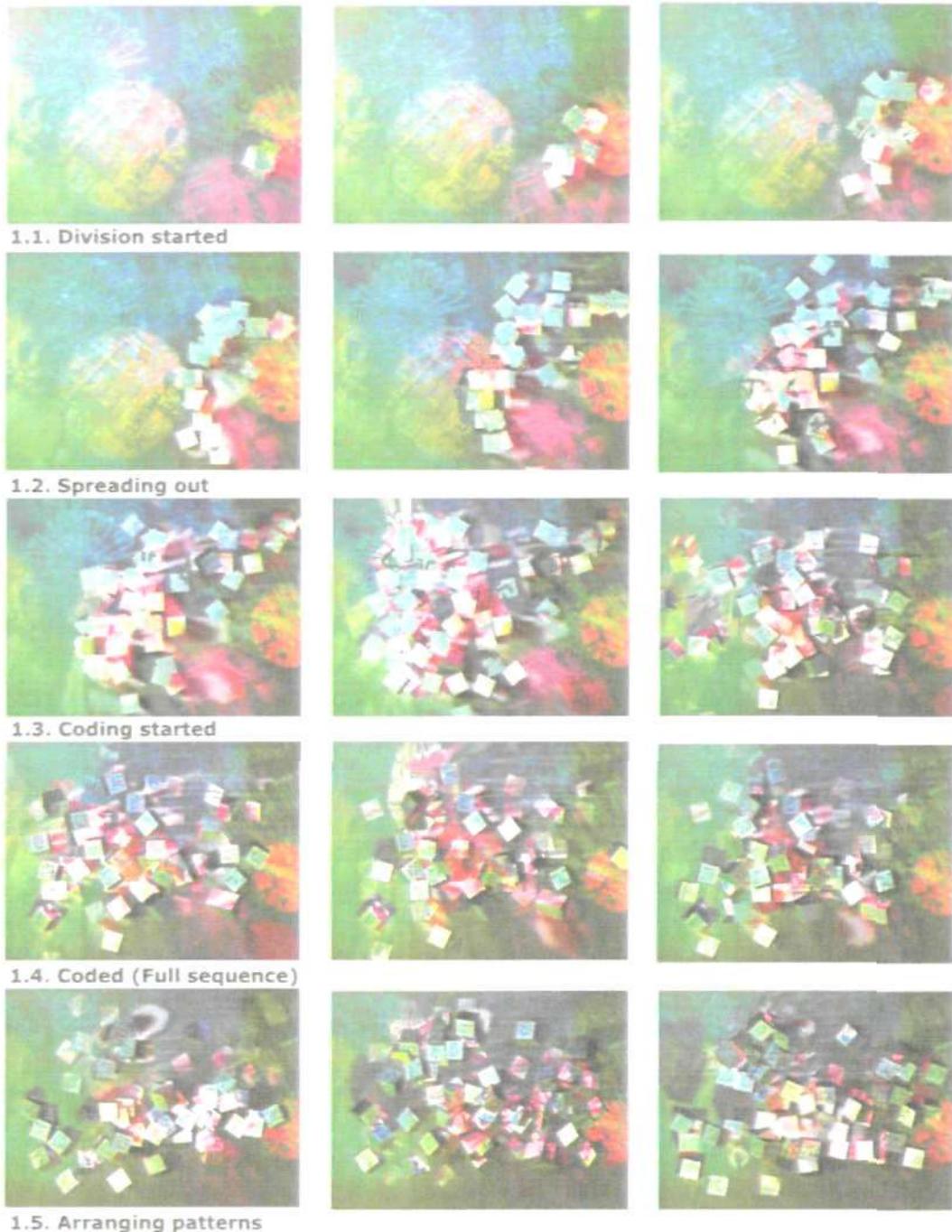


Figure 70: Division and coding throughout time and space.

²¹ For further details see movie: Three examples that show pattern formation and manipulation of code <http://sanamurrani.me.uk/july05/movie2.mov>

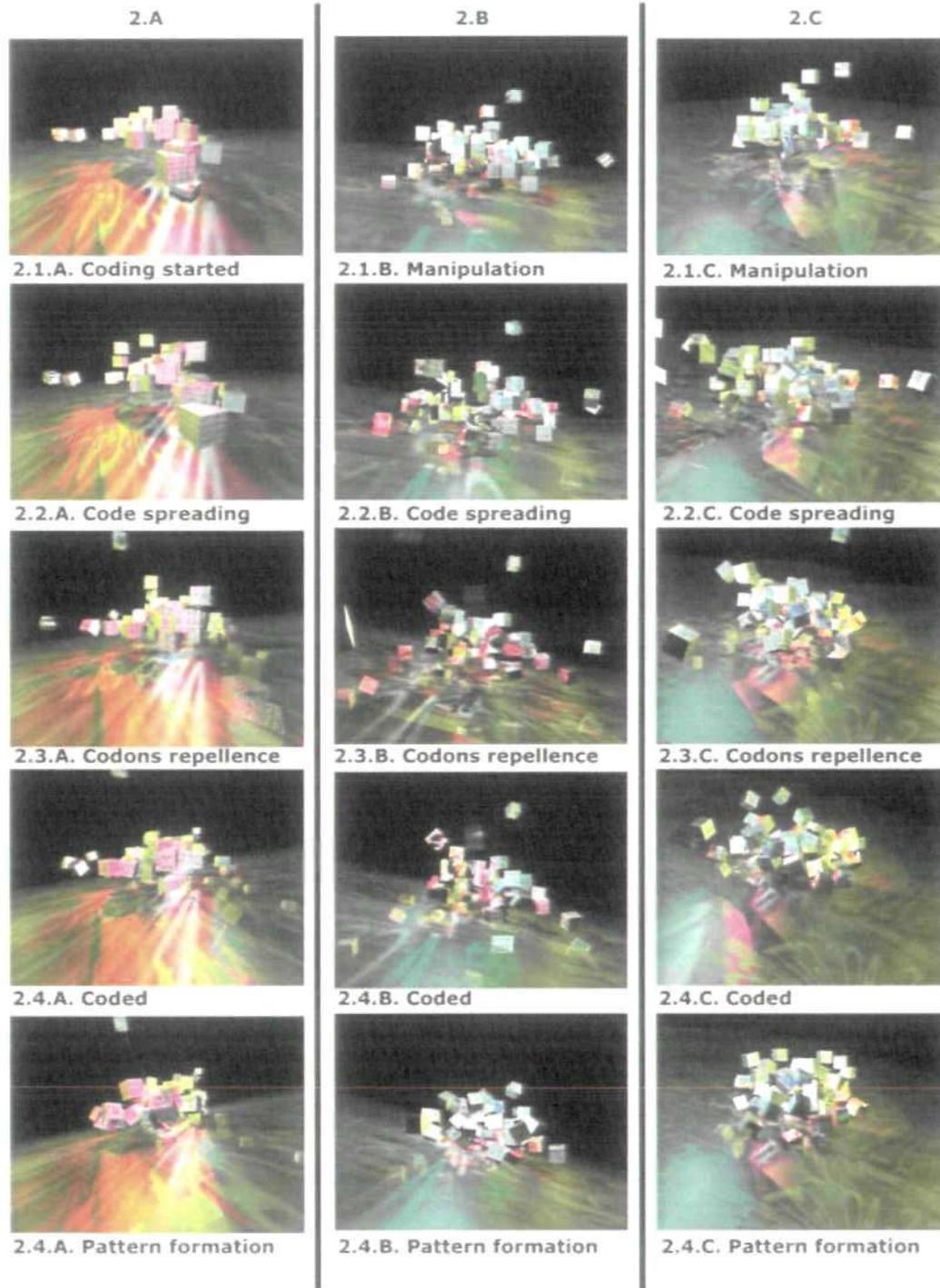


Figure 71: Three examples that show pattern formation and manipulation of code.

There are simple rules guiding the way. These three-dimensional components need to follow one main rule which is: every face on the component must find its matching face to complete the sequence of the code, and if the code changes then the forms

established will change accordingly. This reflects high coordination in the system. The ability to grow generative structures comes from their self-organization that is guided by the internal effects induced by the rules, whereas the change in the sequence represents the external effect, resulting in the potential for adaptation. There is high geometry on the individual level and on the coherent whole. There is simplicity in this generative complex system, thus the model exhibits an emergent behaviour on all levels and scales. Steve Grand reflects on the same idea:

"When populations of interacting structures become arranged in certain configurations, and new and surprising comes into existence, we call this an emergent phenomenon" (Grand, 2001).

It is vital to mention here that the idea of the model works on larger systems with millions or even billions of components and this is where it can involve nano-forms in order to achieve smoothness on a functional or operational level as well as aesthetics on its surface/form/space level. Changing the sequence is equivalent to an external effect and if the system has the ability to adapt to this change then it will run through gradual phases of transformations and feedback, exactly as happened with the components when the original sequence of code was manipulated. A coherent whole of complex systems arises out of simple interactions between the components: the *temporary form*, the living fractals that grow to a coherent living architecture.

There are some similarities between the *Universal Constructor* project that Frazer and his students produced and the cube model that was described here. The theoretical model that was presented here has no limitations on form generation as to how many forms can result from the process because more than one rule shapes the outcome.

The other important point is that the degree of interaction is higher in the cube model due to the changes occurring on all faces of the cube if needed, which increases the potentiality for creating different forms. However, one can draw some similarities between Frazer's model and the cube model, such as the use of cubes as a sign for universality and their self-similar geometry as well as the intention to generate behaviour in architectural forms and spaces. Of course, an important difference is the fact that Frazer's model has a physical implementation; the model presented here is theoretical (a variation on the model was later produced as a digital simulation).

A modified version of the previous digitally produced model was later programmed with assistance from Justin Roberts, a research assistant at The Institute of Digital Arts and Technology (i-DAT) at the University of Plymouth. The model was evolved and developed out of an understanding of the previous theoretical/digital proposal. Below is the description of the original design of the model, which was later altered in ways that will be described shortly:

Cube Colony (description of the initial design):

The main aim is to implement local rules and create emergence from self-organization in a system that will exhibit bottom-up as well as top-down behaviour.

Phase one: Growth, division and formation

- Data to be created out of a number of the possible connections between simple rules derived from the full DNA of an e. coli genome.
- The DNA sequence will begin to be displayed on the screen while cubes start to emerge, grow and float in space (anti-gravity).

- The sequence is continuously generated on the display while the cubes divide and grow to a certain size. This division will cease once the entire DNA sequence has been displayed.
- At this stage, the code immediately begins to appear on the cube faces, one by one, until the entire code is distributed on all the faces.
- Each face on the cube will have a codon. This is a combination of three of the main four amino acids: Adenine (A), Cytosine (C), Guanine (G) and Thymine (T).
- The cubes' faces will attract and repel each other according to a set of simple rules which are guided by the combination of each 3 amino acids on each face (codon). E.g. CTA matches GAT. Most importantly is to know that G always matches C and T always matches A, and vice versa.
- Codons can come in all combinations of 3 and only 3 amino acids: repetitions and rearrangements are allowed, e.g. CCC, TTA, GCT, TTG, GCC, and so on.

Phase two: Gravity power (feedback)

- If the cubes will come to compose a single form, when all the cubes have become attracted to each other to reach a stable state of equilibrium, after a few seconds an algorithm will scan the form to check for repeated pairs of matching codons. This algorithm will report back to the colony (the form) where it will become the centre of gravity.
- If the cubes will form a number of distinct individual forms then the same algorithm will scan each individual colony to identify repeated matching pairs and the form (individual colony) carrying the most repeated codon matches will be nominated as the main colony that will become the centre of gravity and remain in place. As for

the others, they will be influenced by the gravitational attraction exerted by the main colony.

Phase three: Energy flow (local rules – self-organization)

- Each cube will hold energy which is shared when combined with other cubes.
- The energy inside each cube will be at a maximum until the cube finds other cubes and start combining with them to create forms; then energy will be shared.
- Energy levels will drop to zero when all cubes have formed one coherent form, then immediately the strength of the repulsive force will be increased and the form will forcefully repel and break all bonds.

The rules given above were too numerous and the resulting simulation lacked sufficient control leading to erratic behaviour. A reduced model with alterations to these rules was developed to ensure that its characteristic behaviour could be clearly identified.

The description of the reduced model (Cubeolony)²² is as follows:

Phase one: Growth, division and formation

- This phase was limited to generating cubes on the screen according to a given number, which can be altered by the user of the model.

²² The simulation provides the ability to control the number of cubes to be generated, the speeds at which cubes and springs are created, as well as the strength and damping of the springs. The display can be rotated using the W, A, S, and D keys and zoomed using the up and down arrow keys. The expand button temporarily causes all springs to be extended, which causes the forms to become unstable; they will be regenerated in different configurations when the button is released. The simulation can be found at: <http://sanamurrani.me.uk/cubeolony/Cubeolony.htm>

- Each face of the cube will have six amino acids instead of just three, as when it was limited to three (as in the original case) the model did not exhibit the required stability.

- In this initial phase, the cubes are not attracted to each other. It is merely a generation process.

Phase two: Gravity power (feedback)

- The simulation begins to identify matching pairs of faces as described in the original model. As each pair is identified, the faces become connected by a virtual spring which draws the cubes towards each other with a strong attractive force proportional to the distance between them where the force at a greater distance is higher than at a lesser distance.

- As a consequence of this process, small clusters of cubes begin to appear. At this stage the interactions between the elements of the system are simple and stereotyped.

Phase three: Energy flow (local rules – self-organization)

- In phase three, the simulation continues to progress according to the above rules; however, the resulting dynamics are very different due to the increasing level of organization of the system.

- Clusters of cubes begin to merge together to form bigger clusters. Larger clusters contain more faces which are targets for potential connections to other cubes and so have a greater ability to attract smaller clusters and single cubes.

- The system reorganises itself when the larger clusters are hit by a small cluster as the strength of the impact of the collision is higher than the strength of the springs

holding the cluster together which are relatively relaxed due to the small distance between the cubes.

The simulation exhibits generative behaviour for some time²³, however, it will eventually reach a stable state. Although this is a greatly simplified version of the original design, it still exhibits a complex relationship between the rules of the simulation and the physics of the environment leading to highly dynamic and unpredictable behaviour (Figure 72). A cube within a cluster exhibits collective behaviour in relation to the other cubes in the same cluster, at the same time, any cube can exhibit powerful individual behaviour when it becomes attracted to a cube outside its own cluster. Simple rules guide the whole system which results in the generation of different forms. This simulation²⁴ can work as a model for further projects to assist in the creation of emergent interactive architectural spaces and forms.

²³ This depends on various parameters of the simulation, most importantly the number of cubes given at the start of the simulation.

²⁴ Simulation formed part of a paper published in 13th Generative Art Conference. 2010. Politecnico di Milano University, Milan: Italy: Domus Argenia Publisher (Murrani, 2010).

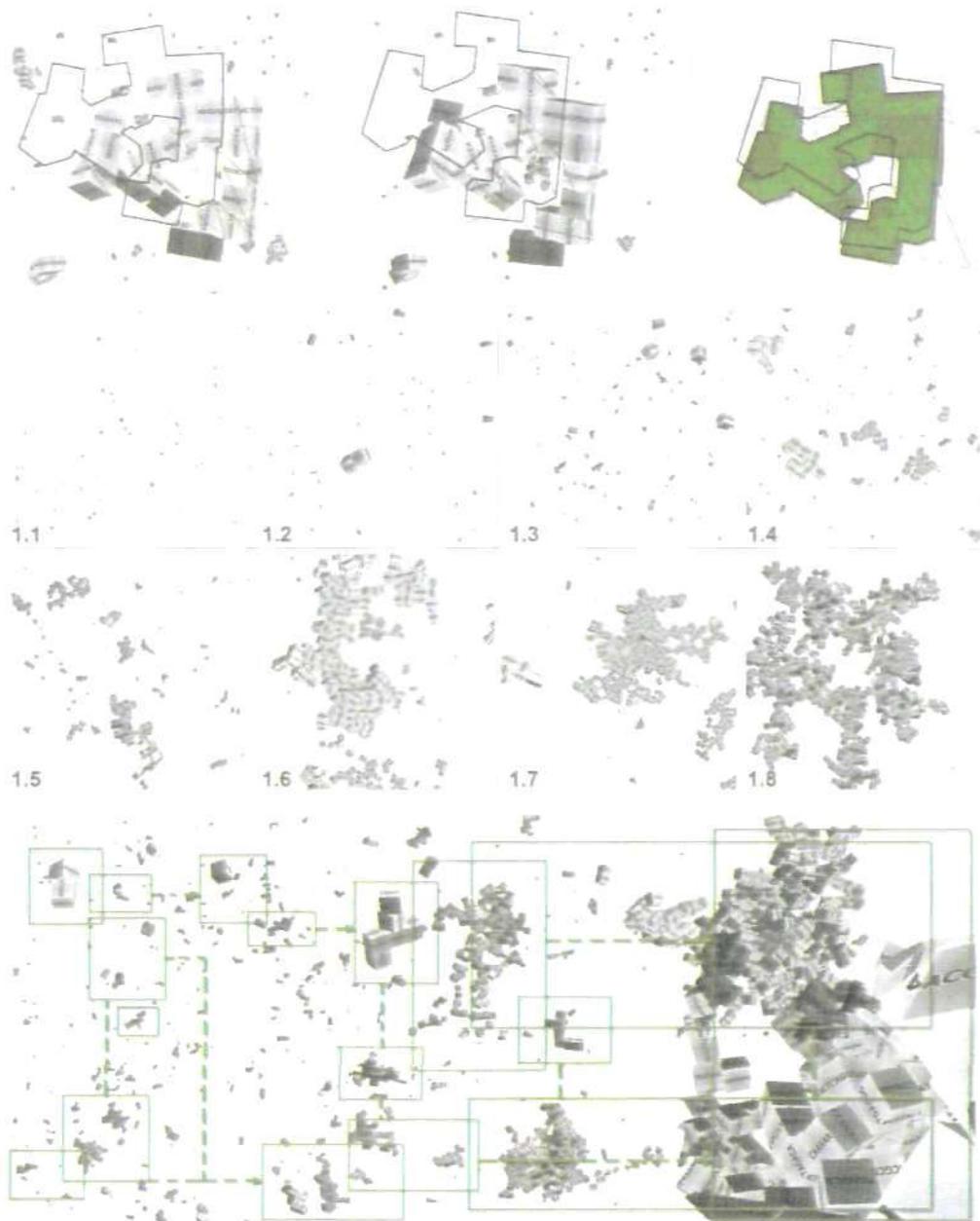


Figure 72: Details of the simulation (*Cubeolony*).

10.2. Communication: Hierarchy, Circularity, and Feedback

The endless fascinating phenomena of nature have inspired researchers and architects to create new approaches in design and solve difficult construction and/or design problems. Buckminster Fuller's geodesic dome is one of the most influential examples in design for autonomous forms. In an era of booming complexity, where not only

nature but even governments, economies and societies have become impossible to understand, the study of social insects and the construction of uncommunicative, simple creatures that are responsible for epic feats of organization and creativity such as termites, ant colonies and their individual and collective behaviour can do more than just pave the way to new approaches of representation and design in architecture.

"It turns out that not only might we, as multi-cellular organisms, be composed of swarms, but so could our societies, economics and perhaps even our minds" (Gordon, 2003).

"A swarm is simply a set of self-organizing agents capable of performing distributed problem solving, the body of a multicellular organism can be seen to constitute such an entity" (Hoffmeyer, 1994).

This research attempts to extend the notion of swarms to our cities and architecture which can be composed of swarms with local rules for construction. Here by construction it is not simply meant the sense of building construction and technology, but rather the *collective rules of communication in architecture*. These rules embody an amalgamation of social, representational, experimental and experiential interactions.

Communication is a vital process for generating collective behaviour in decentralised and self-organized systems. Although, generative systems are composed of simple individuals, that follow patterns of indirect interactions developed through experience rather than a pre-designed pattern, the *frozen behaviour* or the *tempform* is vastly more complex than the individuals themselves which sometimes behave randomly on an individual level in time. This field is known in computer science and robotics as

swarm intelligence (SI), an artificial intelligence technique found in some insects such as ant, bee and wasp behaviour. In nature *swarm intelligence* means the indirect interactions of a population of simple agents, such as ants, bees or wasps, school of fish, or flock of birds, which communicate locally with each other and their environment. A specific kind of swarm behaviour where the individual agents depend in their communication on feedback from their environment is referred to as "*stigmergic behaviour*" (Benzatti, 2002).

Stigmergy meaning "*incite to work*" is a tool of communication in emergent systems, where the individual parts of such a system communicate with one another by modifying their local environment. The term was introduced by French biologist Pierre-Paul Grassé in 1959 to refer to termite behaviour. He defined it as:

"Stimulation of workers by the performance they have achieved" (Grassé, 1959).

The richest natural example of *stigmergic behaviour* can be seen in ant colonies. The discrepancy between the complexity of the anthill and the complexity of the individuals that construct it is, to say the least, striking.

"A single ant has no global knowledge about the task it is performing. Ants' actions are based on local decisions and are usually unpredictable" (Benzatti, 2002).

Scientists describe the collective behaviour of the ants as a complex system that provides intelligent solutions to problems, but in fact, these problems only exist as a consequence of the drive to survive in their environment. There are simple rules of construction that these simple creatures follow that represent their collective

behaviour. These rules were first documented by the father of *stigmergy* the French biologist Pierre-Paul Grassé in his 1959 study of the construction of termite mounds (Grassé, 1959):

- First, they simply move randomly, dropping pellets of chewed earth on any elevated patch on the ground. And soon small heaps of moist earth form.
- These heaps of moist earth encourage the individuals to concentrate their pellet-dropping activity and soon the biggest heaps develop into columns, which will continue to grow while others with less height are increasingly ignored.
- Finally, if a column has been built close enough to another, one other behaviour develops; the individuals will climb each column and start to build diagonally towards the neighbouring columns.

These basic rules for construction (which cannot be separated from other rules of communication explained earlier) collectively contribute to the survival of the coherent whole. All these rules are based on patterns of interaction and changes in the environment as well as the needs of the colony. The individuals are not explicitly coordinated at any point from the start of the process until the finish. Every single time in a certain space yields a different frozen behaviour which is revealed, depending on the state of its immediate environment, as *stigmergic behaviour*. As a consequence of the interaction between those individual parts and their environment, the system begins to encode learning through feedback loops. Feedback loops can be negative or positive depending on the input or the output of information of a system. Negative feedback tends to oppose change and positive feedback reinforces it.

These performances in time represent indirect communications between the ants in their environment which will lead to an organized emergent behaviour that reveals an ordered pattern of interactions. Therefore, and on an individual level, the behaviour of the ant is simple while at the level of the colony the behaviour is cooperative and self-organized without any preconceived or designed plan. Ants communicate indirectly by laying down pheromone trails while foraging. Pheromones are hormones produced by ants that influence the behaviour of others from the same species. Accordingly, they are altering their environment around them, or in other words, encoding it. Other ants from the same colony will automatically follow the trail and by this they are responding to indirect interactions with each other through their environment and thus exhibiting *stigmergic behaviour*.

“An isolated ant moves at random, but when it finds a pheromone trail there is a high probability that this ant will decide to follow the trail” (Benzatti, 2002).

Hierarchy is certainly in evidence in ant colonies, and is achieved in a very efficient way. It follows a bottom-up rather than a top-down system which depends heavily on communication. The adaptation seen in such structures is very much functional, as the main drive of the inhabitants – an emergent drive rather than a designed one - is to exploit food sources through communicating with each other, but the end product is vastly more complex than just a giant storage room for food. Each ant colony maintains a multifunctional complex system providing an environmentally controlled mass, with solar and defence systems, rooms for storing food, housing, and even areas for cultivating fungi which are fed and maintained on stored food and water.

Circularity is a very important aspect of such complex systems through which the system is defined as a coherent, organized, and functional entity. This appears within the context of the anthill through the ways in which ants interact with the structure and each other, and also in the way the combined system of structure and ants interacts with its environment. Circularity within a system pushes the parts to learn through repetition (experience), reminiscent of activity within the neural networks of the human brain, where each flash of brain activity triggers an array of neural circuits; while a large number of possible neural circuits go unrealised over a very long period of time, certain circuits repeat themselves again and again. These circuits are feedback loops and all decentralised systems rely on these loops for both growth and self-regulation. In such systems, negative feedback is crucial as a way of indirectly driving a fluid changeable system towards a goal and a way of transforming a complex system into a complex adaptive one as Steven Johnson further argues:

"Negative feedback is a way of reaching an equilibrium point despite unpredictable – and changing – external conditions. The 'negativity' keeps the system in check, just as 'positive feedback' propels other systems onward" (Johnson, 2002, p138).

While Héctor Sabelli explains that:

"Whereas positive and negative feedback mechanisms have found a wide range of applications in engineering, natural and human processes invariably include both. If positive feedback processes were to predominate, there would be no check to exponential growth in which plants become weeds, animals become pests, beliefs become self-fulfilling prophecies, and ideas grow enthroned by bandwagon effects. Conversely, if negative feedback were to predominate absolutely, there would be little change, and no evolution. The creation of organization requires a combination of positive and negative feedback" (Sabelli, 2005, p80).

The pattern of interactions that develops over time contributes to the dynamics of the system and its behaviour, where such behaviour results in task allocation in terms of top-down hierarchy in ant colonies.

“Colonies perform various tasks, such as foraging, care of the young and nest construction. As environmental conditions and colony needs change, so do the numbers of workers engaged in each task” (Gordon, 2003).

Interactions between ants provide both negative and positive feedback according to specific environmental circumstances which play an important role in creating the pattern of interactions. Deborah M Gordon echoes this fact saying:

“It appears that what matters to an ant is the pattern of interactions it experiences, rather than a particular message or signal transferred at each interaction. Ants do not tell each other what to do when they meet; hence, the pattern of interaction each ant experiences influences the probability it will perform a task” (Gordon, 2003).

After a thorough investigation of the behaviour of ants through some key specialists in the field, it was evident that a need for a personal observation of that area would be of direct importance to architectural insights. A small colony of British garden ants was put in an ant farm containing gel substance. The gel substance is a non-toxic transparent material especially formulated for the nutritional needs of ants. This gel farm was developed by NASA in 2003 to survive Space Shuttle launches. It was part of an experiment to study tunnel formation in microgravity. The gel does not collapse during launch, and besides the nutrients also contain antibiotics and anti-fungal agents. A trial was attempted with twenty workers, larvae and eggs as well as a queen ant (Figure 73). As soon as they were deposited the workers were in defence mode. They gathered their eggs and larvae in a pile and surrounded this pile and did the same

for the queen ant. At this stage they were on the surface of the gel substance (Figure 74).



Figure 73: Photograph taken of specimen.



Figure 74: First photograph taken of the experiment.

After two days of starting the trail, a few worker ants began to tunnel vertically, digging for approximately two centimetres before halting. No horizontal digging took place. No significant change took place until a week later where they were found to be immobile. No movement was registered for that day which marked the failure of the initial reasoning behind the experiment. Placing the ants in an alien environment to the standard British garden as well as adding the queen and the eggs to this environment has contributed to pressuring the worker ants' behaviour on many levels:

- The gel substance contains all the nutritional needs for the ants besides anti-fungal agents therefore; there was no need for the worker ants to follow their natural behaviour of excavating pockets and tunnels for storing their food or cultivating fungi.
- As soon as they were deposited on the surface of the gel substance, the ants were behaving in a crisis mode; their attention was divided between acclimatising to the new environment and protecting their queen and eggs.
- The results of the experiment suggest that the ants have committed a mass suicide as a reflection of their highly sophisticated, collective behaviour. This is proven

scientifically in some social insects as a result of failure to defend their colony from either an external predator or during combat. They commit their mass suicide by violently dissecting their abdominal muscle (Hölldobler and Wilson, 1994, p67).

Regardless of the outcome, this experiment is evidence of ordered patterns of coordination and communication between simple agents, such as ants, which result in complex decisions and outcomes (Figure 75).

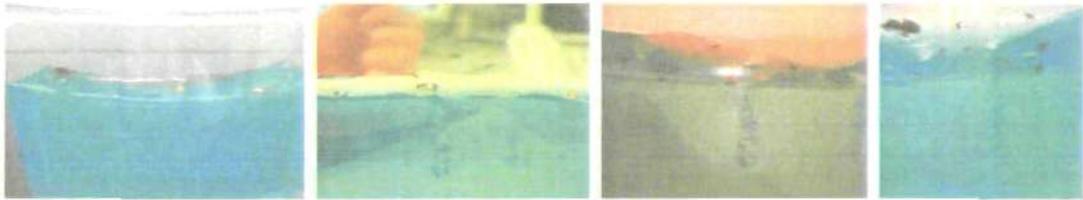


Figure 75: Photographs taken of the Ant Farm experiment.

As an extension of this experiment, a pre-programmed model has been designed to illustrate the ideas behind *stigmergic behaviour* in architecture²⁵. The theoretical model incorporates principles and processes that have been discussed earlier beginning with sequential growth from seeds and the forces that shape a form depending on the level of sophistication and involvement in the process following Thompson's notions of development. The first stage of the model concentrates on the idea of *frozen behaviours* and especially on the individual sections that construct these behaviours in time as well as their level of engagement with their environment (Figure 76)²⁶. The second stage of the model involves *stigmergy* as a tool of communication between several colonies of individuals. In this stage the model exhibits another dimension where patterns of interaction between two or more swarms will develop.

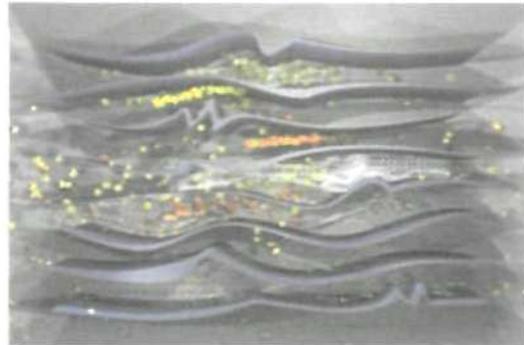
²⁵ Paper published in the 8th International Consciousness Reframed Conference Proceedings, Plymouth, UK: Liquid Reader (Murrani, 2006).

²⁶ For further details see movie: Frozen behaviour: <http://sanamurrani.me.uk/july06/movie1.mov>

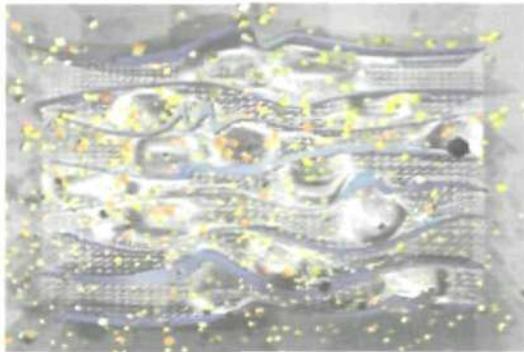
This represents the emergence of *stigmergic behaviour* between more than one colony and the environment (Figure 77)²⁷.



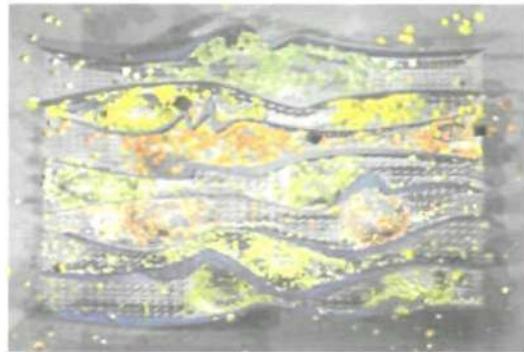
01 Seeds



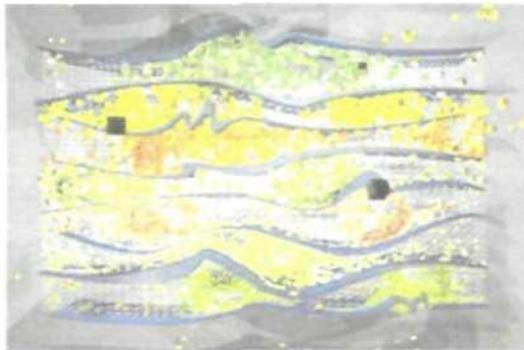
02 Growth



03 Environmental change



04 Pattern of interaction



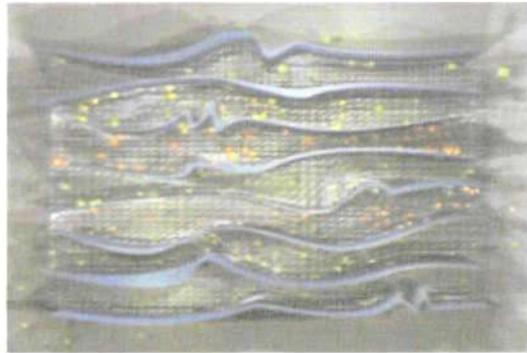
05 Creating environments



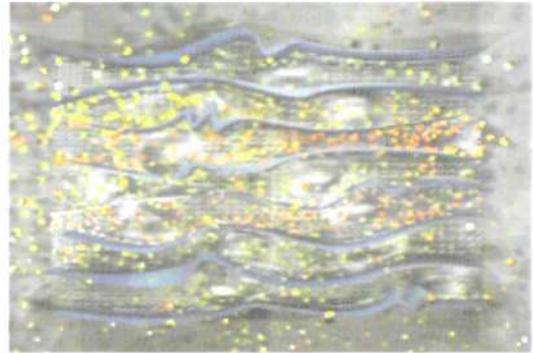
06 Frozen behaviour

Figure 76: Sequence of Frozen Behaviours.

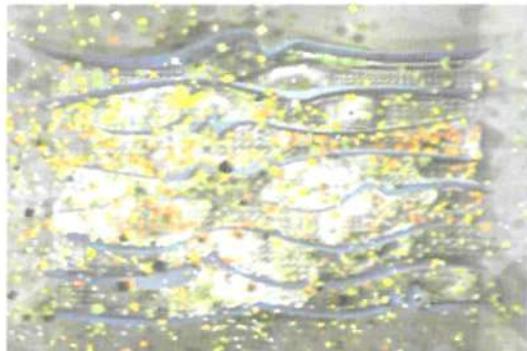
²⁷ For further details see movie: Stigmergy: <http://sanamurrani.me.uk/july06/movie2.mov>



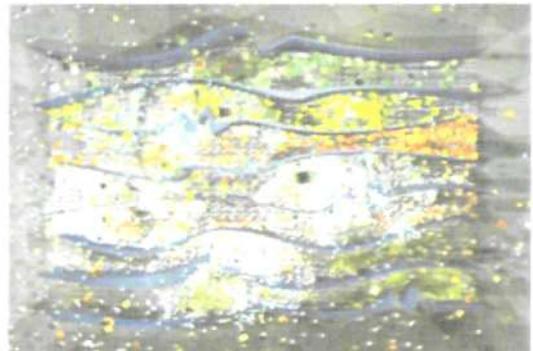
01 Multiple colonies



02 Random interaction



03 Stigmergic behaviour



04 Modifying the environment



05 Communication



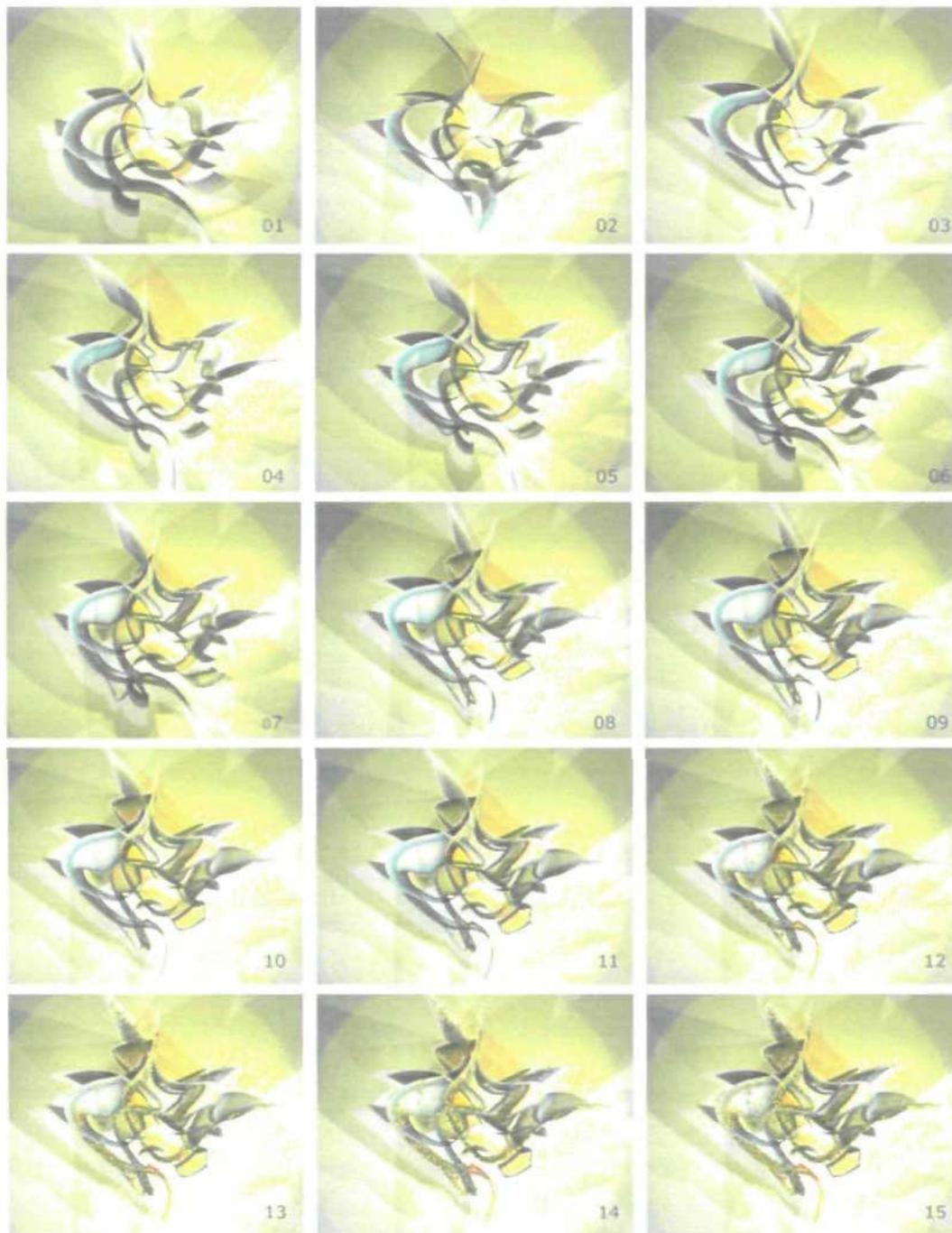
06 Emergence of new colonies

Figure 77: Stigmergic Sequence.

Colonies of theoretical architectural forms and spaces of *frozen behaviours* interact with each other and their environment to survive in their continuously changing context, like swarms of simple individuals communicating through patterns of interaction (Figure 78)²⁸. The study of the behaviour of such colonies may then be used as the basis for a taxonomy. This taxonomy could be later used in a theory of

²⁸ For further details see movie: Architectural Colony: <http://sanamurrani.me.uk/july06/movie3.mov>

interpretation for the creation and growth of architectural forms and spaces. This theory would be based on architecture's representations and experiences that can survive within a dynamic and volatile context.



Architectural Colony

Figure 78: Architectural Colony.

This model proposes the development of theoretical forms/spaces of architectural behaviour that are able to communicate with each other through interactions with their environment; the form is abstracted away from its material instantiation and encoded as a system of rules and principles working fluidly together. This section of this chapter investigates the *stigmergic behaviour* of ant colonies in natural systems, and the forces and attractors that influence the creation of any spatial form, which can be demonstrated as any behaviour, structural configuration, pattern of organization, or system of relations that can occupy a space in time.

11. Interim Stage: Unpredictable Generations

This section focuses on presenting evidence of current examples of the interim stage of unpredictable situations, generations, representations and designs. The aim of this section is to pave the way towards reinforcing the notion of architecture as a system that behaves. The previous sections have exhibited some examples which relate to the core of this section, such as the *Tissue Culture and Art* projects. The *Tissue Culture and Art Project* represents new possibilities and alternative futures for innovative materials and at the core of its work is the *BIOFEEL*²⁹ project and the symposium *The Aesthetics of Care*, part of the Biennale of Electronic Art Perth (BEAP), in which art mingles with bio-medical science and technologies. All work presented in the symposium deals in one way or another with the relationships the artists form with manipulated living systems. The resolution of the work shifts from the protein through the chromosome, the cell and the tissue, to the whole organism; at the same time, it offers challenging

²⁹ The BIOFEEL artists expressed the importance of their involvement in genetic manipulation and animal experimentation and that such fields should not be left solely for scientists and bio-engineers, etc (Jones, 2002, p12).

interactions to create new paths in investigating our biological future (Jones, 2002, p12).

BIOFEEL, part of *The Tissue Culture and Art Project* initiated in 1996 by Oron Catts, is an on-going artistic research and development project into the use of tissue culture and tissue engineering as a medium for artistic expression; it utilises biological technologies as a new form for artistic representation to focus attention and challenge perceptions regarding the fact that these technologies exist, are being utilised and will have a major effect on our future (Catts and Zurr, 2008, p30-35). One example highlighted by the *BIOFEEL* project was the *Worry Dolls* (Figure 79) which are sculptures still in the realm of a symbolic gesture representing a new class of objects or beings.



Figure 79: *Worry Dolls*, *BIOFEEL* project, Oron Catts and Ionat Zurr, *Tissue Culture and Art Project*, University of Western Australia, Perth (http://www.tca.uwa.edu.au/ars/main_frames.html).

These objects are partly artificially constructed, consisting of both synthetic materials and living biological matter from complex organisms. They were exhibited in small sample jars filled with formalin. The installation was accompanied by a computer where visitors could interact with the *Worry Dolls* by posting their worries on the website³⁰. These entities, or sculptures, blur the boundaries between what is

³⁰ The *Worry Dolls* website can be found at: http://www.tca.uwa.edu.au/ars/main_frames.html

born/manufactured, animate/inanimate and further challenge our perceptions and our relations towards our bodies and constructed environment.

In other contexts, researchers looking to apply adaptive materials to specific design problems are turning to the natural/biological world for inspiration, giving birth to new sciences such as *Biomaterials*: the study of how processes and organisms in nature can provide a model for scientific advances. Dr. Julian Vincent and Colin Humphreys from Bath University have created materials which do not exist naturally. They experimented by adding one atom to another and built materials/polymers up often literally atom-by-atom to create a wide range of structures (Vincent, 2009, p78). The Centre of Biomimetics and Natural Technologies CBNT at Bath University indentified a set of control parameters that depend on the control of energy and the synthesis of the starting materials used for investigation. This is done via the identification of patterns in a wide range of sizes from the nanometre to the kilometre scale, as Vincent explains:

“At the nanometres to millimetres level, the observations are equated with the synthesis and processing of materials; from millimetres to metres we are mostly concerned with structures and mechanisms; and from metres to kilometres and beyond the concern is more with populations and ecosystems” (Vincent, 2009, p78).

From an architectural context such investigations and interventions of biotechnology for new materials and design practices have flourished in the last half of this decade. Rachel Armstrong, an active researcher in this field has endeavoured to create materials with living properties, meaning materials that grow, self-organize, repair, and interact with their environment. Such materials can be the basis for new

architecture to grow in any environment and for living properties of materials alike to blend with nature, for a sustainable approach in design (Armstrong, 2008, p86-89).

This can be seen in the work of Steve Pike and Marcus Cruz in their publication *Neoplasmatic 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 and that of invited guests stretching between *Comfo-Veg Club* (1970s) by Peter Cook (Figure 80) to *Density Fields in Viscous Bodies* (2008) by Tobias Klein (Figure 81) (Cruz and Pike, 2008).

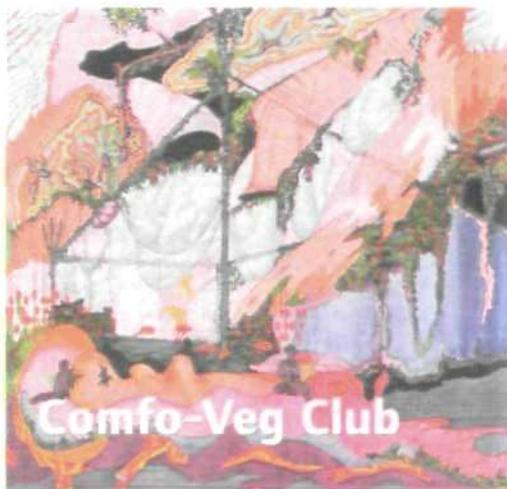


Figure 80: *Comfo-Veg Club*, Peter Cook, 1970 (Cruz and Pike, 2008, p60).



Figure 81: *Density Fields in Viscous Bodies*, Tobias Klein, 2007-2008 (Cruz and Pike, 2008, p45).

Contaminant by Steve Pike is an installation designed and structured around monitor cells which act as contamination pockets, monitoring vessels for access to help develop locally present microbes (Figure 82). Pike identifies two kinds of common microbes in our environment which are *Aspergillus* from the fabric of our environment and *Micrococcus* which lives on the surface of our skin. However, there are other types of microbes which have played a big role in creating different emergent visual

transformations and morphological aesthetics on the monitor cells (Figure 83). Pike explains, people interacted with the installation by introducing particular matter which acted as catalysts for the transformations of monitor vessels. Pike elaborates that *Contaminant* exhibits an emergent and morphological aesthetics dependent on the context in which it flourishes and the interactions it receives (Pike, 2008).

Michael Weinstock, an architect, lecturer at the Architectural Association (AA), and the founder of the Emergent Technologies Masters Programme at the AA, has written extensively about the emergence of new forms in nature, linking this to architecture. His latest publication on this topic is titled: *The Architecture of Emergence: The Evolution of Form in Nature and Civilization*. This book contributes a great deal to architects', and indeed students' understanding of the close relationship between the emergence of natural and architectural forms (Weinstock, 2010). All the above examples of experiments and theoretical grounds are evidence of investigations of new paradigms and the integration of interdisciplinary fields into architectural practice.



Figure 82: *Contaminant* installation process, Steve Pike (Cruz and Pike, 2008, p25).

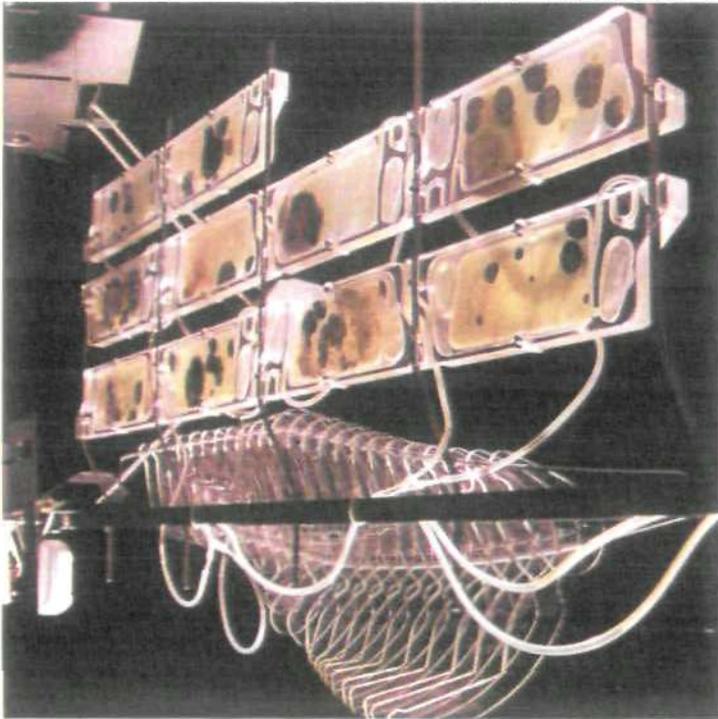


Figure 83: *Contaminant* installation in exhibition, Steve Pike (Cruz and Pike, 2008, p26).

Andy Clark suggests that such investigations and experimentations did not appear all of a sudden. Knowledge based electronics, software and semi-intelligent devices have been operating deep below the level of our conscious awareness; they are blending and integrating seamlessly with our biological brains. Clark argues that those particular integrations are blurring the boundaries between the users/observers and their rich, *“responsive, unconsciously operating electronic environment”* (Clark, 2003, p34), where he states:

"We are already primed by nature to dovetail our minds to our worlds. Once the world starts dovetailing back in earnest, the last few seams must burst, and we will stand revealed: cyborgs without surgery, symbionts without sutures" (Clark, 2003, p34).

In his book *Natural-Born Cyborgs*, Clark unpacks, in a logical, historical and critical manner, the way our minds seek out to incorporate and exploit non-biological resources which later become extensions of our own bodies. Such extensions act as tools of integration within our experiences. Due to the changes and development in our technologies, biotechnological tools such as wearable computers, intelligent and augmented environments, sensory devices, etc, have become tools that are rapidly overlapping the territorial presence of their users. Clark points out that the plasticity of our brains and the growth and development of increasingly responsive technological tools will create opportunities for closer kinds of human-machine merger, which he argues is an entirely natural merger (Clark, 2003). Clark continues describing the future of such mergers by stating:

"The drive toward biotechnological merger is deep within us - it is the direct expression of much of what is most characteristic of the human species. The task is to merge gracefully [...]. If we are to succeed in this important task, we must first understand ourselves and our complex relations with the technologies that surround us. We must recognize that, in a very deep sense, we were always hybrid beings, joint products of our biological nature and multilayered linguistic, cultural, and technological webs. Only then can we confront, without fear or prejudice, the specific demons in our cyborg closets. Only then can we actively structure the kinds of world, technology, and culture that will build the kinds of 'people' we choose to be" (Clark, 2003, p194).

Steve Grand, an inventor and self-taught scientist, followed Clark's vision with the creation of Lucy (Figure 84), an artificially intelligent robot baby orangutan designed to exhibit all the qualities of a natural being, even self-awareness (Grand, 2003, p1). Grand asserts the importance of understanding natural as well as artificial intelligence in order to reach a true exploration of the building block as an entity (Grand, 2003,

p191). Grand suggests that attempts and experiments with linking the natural to the artificial are already evident in science fiction novels and films as well as military research, notions that Drexler shares with both Clark and Grand.

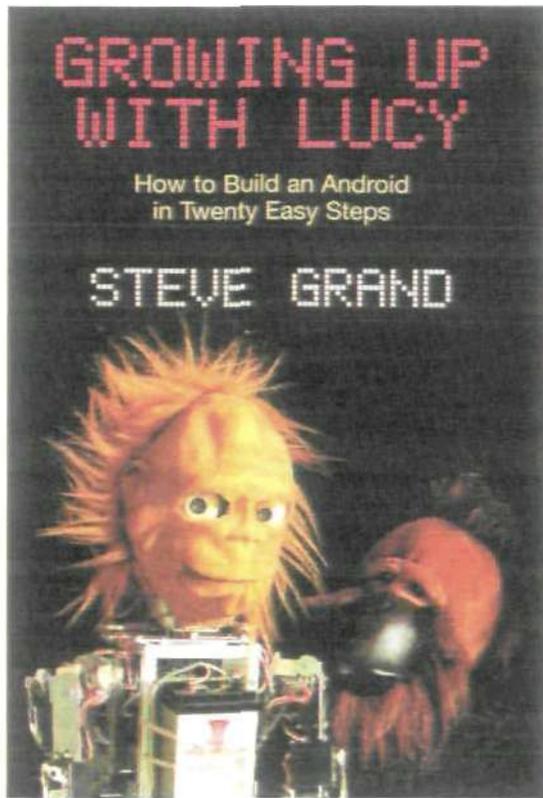


Figure 84: Lucy, artificially intelligent robot baby orangutan, Steve Grand, 2003, Book Cover (Grand, 2003).

Similarly, nearly a decade earlier than Clark's vision of natural integration between human and machine, Eric Drexler the leading expert in the field of nanotechnology called, in his book *Engines of Creation*, for collaborative knowledge, understanding, and hypertexts that combine collectively the dangers and opportunities of the possibilities of nanotechnology (Drexler, 1996, p239). Drexler explains the basic facts and reasoning behind the behaviour of everything around us in an attempt to get closer to establishing a similar vision to Clark's, where he suggests:

"The things around us act as they do because of the way their molecules behave"
(Drexler, 1996, p5).

Drexler gives tangible real-life examples such as the contrast between air and water: air does not retain its shape or volume because of its freely moving molecules, however, water molecules stick together and therefore, water holds a constant volume as it moves about. Similarly, copper and plastic behave differently due to the different degrees of regularity of their atom patterns. He continues suggesting:

"These simple molecular patterns make up passive substances. More complex patterns make up the active nanomachines of living cells" (Drexler, 1996, p5).

The more complex such patterns become, the more complexity can be seen in the way their molecules operate in relation to each other. This process is assisted by proteins whether hormones or enzymes which adhere to molecules selectively (Drexler, 1996, p8). Thus for a system of the future to be developed and seen as a cohesive, collaborative, interlocking, and collective growth process, there is an urgent need for an acceptance of the integration of technology within our lives, its influences on our experiences and its overlaying and merging behaviour, Drexler writes:

"[...] the idea of long life, when unaccompanied by the expectation of abundance and new frontiers, will seem perverse. Abundance, when imagined without space development or controlled replicators, will sound environmentally damaging. [...] Unless they are held together by book covers or hypertext links, ideas will tend to split up as they travel. [...] The World Wide Web is a major step in this direction, and software developers are working to add the remaining necessary abilities to move it far beyond mere publication, to support discussion, criticism, deliberation and consensus-building" (Drexler, 1996, p239 and 242).

To accept the notion of the influence of the machine onto our lives is something that architecture came to terms with during the Industrial Age and later on the Second

Industrial Age of control mechanisms. However, it was not until Banham's book titled *Theory and Design in the First Machine Age*, that architectural critics began to notice the influence of the integration of machine and architecture on architectural theory (Banham, 1982). Banham's vision was a historic account rather than a speculation concerning future events. Although, it was not made completely explicit, Banham christened the *First Machine Age*, where the last decade of the 19th century saw the appearance of the power grid and the introduction of human scale machines such as cars, vacuum cleaners, typewriters, etc. Banham considered the *First Machine Age* to be the time for theories about fitness for purpose and new materials as opposed to his own ideas of the *Second Machine Age* which he thought to be built around the assumptions of Le Corbusier's notion of a "pure type" of machine evolution which increasingly failed to fit the transience of material culture (Powley, 1990, p1-2).

Martin Powley followed Banham's book with a sequel titled: *Theory and Design of the Second Machine Age* referring to the impact of the information technology onto architectural design and the cultures emerging in this age. With regard to the vital impact of Archigram's work and projects onto late theories of representation and design speculation in architecture, Powley admits their interdisciplinary techniques and methods of experimentation. However, he denies their power in steering architectural design and representation into the *Scientific Age* and later on the *Digital and Interactive Age*, etc. (Powley, 1990, p84). This is due to the clear distinction in defining architecture that Powley draws between built architecture and experimental/theoretical architecture, where the latter played a significant role in architectural history on a conceptual level. Kostas Terzidis extends this later link

between experimental and conceptual to a computational approach in architecture for new aesthetics, where he states:

"A challenging point is the fact that this new aesthetics is about the unknown, the unpredictable, and the unforeseeable. It requires the cooperation of two brains: that of the human and the computer, for without one another it is impossible to plan or execute imaginary design spaces. Most of all, they lead to the creation of computational schemes, which are available for experimentation, analysis or play across disciplines. Dynamic design space contributes to our understanding of aesthetics and creates a new dimension of how it may change our perception" (Terzidis, 2003, p63).

Many art and architectural critics have speculated about a world of integrated machines and humans, but the most vital for this thesis are those who have managed to extrapolate principles and processes from other disciplines and fields to be intertwined with art and architecture in order to create new worlds and environments, new hyper-realities and in-between spaces. Roy Ascott is a leading figure in this field; he coined the phrase "*Moistmedia*" which he describes as the amalgamation of:

"The silicon dry world of interactive media with the wet biology of living systems, that the emergence of a new substrate and vehicle for art can be detected, which I identify as moistmedia, and which may lead to the evolution of a moist art. Moistmedia involves bits, atoms, neurons and genes (the big B.A.N.G) co-existing in new configurations of form and meaning" (Ascott, n.d.).

Ascott speculates on such a future based on currently emerging evidence in the world of cyberspace, telepresence, virtual reality, and artificial life, etc. with the active interaction of the observers' and viewers' perceptions, interpretations and consciousness, going on to state a manifesto for *Moistmedia*:

"THE MOIST MANIFESTO

*MOIST SPACE is where dry pixels and wet molecules converge
MOIST ART is digitally dry, biologically wet, and spiritually numinous
MOIST REALITY combines Virtual Reality with Vegetal Reality
MOIST MEDIA comprises bits, atoms, neurons, and genes
MOIST TECHNOLOGY is interactive and psychoactive*

MOIST LIFE embraces digital identity and biological being
MOIST MIND is technoetic multiconsciousness
MOISTWARE erodes the boundary between hardware and wetware
MOIST MANUFACTURE is tele-biotic, neuro-constructive, nano-robotic
MOIST ENGINEERING embraces ontology
MOIST DESIGN is bottom-up, seeded and emergent
MOIST COMMS are bio-telematic and psi-bernetic
MOIST ART is at the edge of the Net" (Ascott, n.d.).

One highly experimental artist, working in the field of the hybridised media of the moist and dry is Stelarc, an Australian artist who integrates technology into his body to be utilised as a medium for exhibiting an artist's expression. Stelarc exploits and uses his body as an extension to the world around him rather than to define his territory in space. His work pushes the boundaries of what is a norm or as Marquard Smith, the editor of *Stelarc: The Monograph* puts it:

"Working in the interface between the body and the machine, employing virtual reality, robotics, medical instruments, prosthetics, and the Internet, Stelarc's art includes physical acts that don't always look survivable" (Smith, 2005).

Stelarc's early work was built around the notion of experimentation with the boundaries of the body. The Suspended body in *Street Suspension* (Figure 85) was a sculptural landscape piece where the artist was hooked into his skin in several places and suspended over a particular place in a landscape. Later on his work became more elaborate and moved to the physiologically hybrid integration of machine and human body when he surgically had an artificial ear with a microphone inserted into his arm (Figure 86). This was followed by the stomach sculpture and later on the robotic arms that were attached to the artist's body while being controlled over the Internet in three different parts of the world (Figure 87) (Stelarc, n.d.). Brain Massumi describes Stelarc's intentions:

"Stelarc applies instrumental reason – careful, calculated, medically-assisted procedure – to the body, taken as an object, in order to extend intelligence into space" (Massumi, 1998, p335).



Figure 85: *Street Suspension*, sculptural landscape piece, Stelarc (<http://v2.stelarc.org/images.html>).

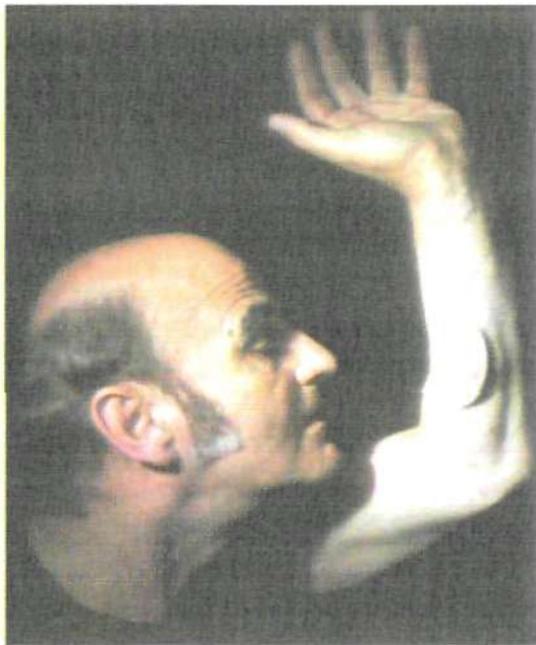


Figure 86: *Ear on Arm*, Stelarc (<http://v2.stelarc.org/images.html>).



Figure 87: *Exoskeleton*, Stelarc (<http://v2.stelarc.org/images.html>).

Stelarc's experimentations with his body, while intriguing as well as explorative in their nature are more or less limited to proving the plasticity, and not only in the literal sense, of the body, but in the sense of becoming the medium of communication between information and forces, between the hollowness of the body and its environment and context. However, his installations, if seen in the context of Ascott's

moistmedia world, will extend out to new imperatives to assist in the creation of innovative responsive environments in architecture.

So far, this section (and previously in this thesis, particularly in chapter two) has exposed examples of the emergence of new worlds and environments, and explored their parallels and contrasts. This investigation began on the material level, which can be seen in the extensive work of Catts, Vincent, Pike, and Armstrong among others. Later on, the focus moved to theories of integration between human and machines, which are manifested in Clark, Drexler, and Ascott's visions. The notion of the body as an entity and medium in such worlds was explored, as experienced in Stelarc's work, and this will be unpacked in more detail in chapter four. There is certainly scope for further explorations of the relationship between the body as an entity or medium and experimentations on a *moistmedia* level within a representational and experiential environment.

In the last few decades architecture has been lingering in between spaces, the physical and the digital, the natural and the artificial, in an attempt to create responsive environments. Lucy Bullivant suggests that for such spaces and environments to coexist, architects will need to work as system designers:

"If architects want to create a responsive environment, they need to think like designers of operating systems. A system or framework is still needed, but it is subordinate to the means of expression provided by the software" (Bullivant, 2006, p11).

Lars Spuybroek of NOX has always striven to expose the physical forces of human interaction with his or her environment. Between the years 1993-1997 *FRESHH²O*

EXPO was created as an interactive water installation and a pavilion, located in Zeeland, southwest of the Netherlands (Figure 88). The pavilion did not act as an exhibition in the conventional sense, however, Spuybroek saw it as “*a complete fusion of body, environment, and technology*” (Spuybroek, 1998, p265). The form itself was crafted out of metal, concrete and devices combining interactive electronics and water. It was shaped fluidly by fourteen ellipses spaced for the length of over sixty-five yards. Inside the pavilion there was a deliberate elimination of any relation to the horizon, i.e. no horizontal walls or floors, although, the fluidity of the form itself can be seen as an extension of the environment and the context where the pavilion is situated. Spuybroek explains further:

“Next to non-interactive events – ice, spraying mist, water on the floors, rain, and an enormous well – there are seventeen sensors connecting different visitor actions to fluidity. Light sensors for crowds, touch sensors for individuals, and pulling sensors for groups create, respectively, waves, ripples, and blobs in real-time projections and sound manipulations” (Spuybroek, 1998, p266).

By looking at each response of the installation’s sensors, one can interpret such reactions as passive; just like the automatic revolving doors that we see everywhere in buildings around the world nowadays. Nevertheless, *FRESHH²O* demands to be critiqued collectively. Individual responses or interactions, although novel and original for its time, could be seen as commonplace and familiar in a few years time. However, the variety of such interactions, if the seventeen sensors will influence each other according to interactions with their observers/users/players, can elevate this project to be, not a mere interactive environment but an ecosystem with all the complexity implied by that term. However, Lucy Bullivant suggests that *FRESHH²O EXPO* and Kas Oosterhuis’ *Salt water Pavilion* (Figure 89) (another example of a similar nature), have both reached the hybridised worlds of the natural and the artificial, by stating:

"Both multimedia exhibitions of water are ludic, yet hermetic environments, driven by desire and subjectivity, organisms so synthetic that they close the distinction between the artificial and the natural" (Bullivant, 2006, p10).

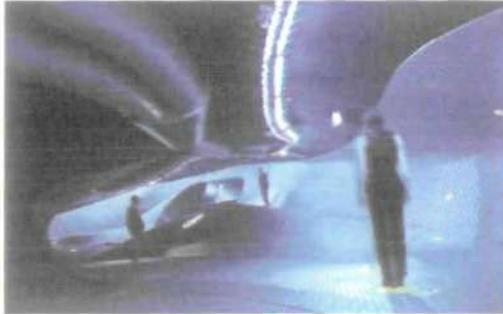


Figure 88: *FRESHH²O EXPO*, interactive water installation and a pavilion, Lars Spuybroek of NOX, Zeeland, southwest of the Netherlands 1993-1997 (Rattenbury, 2002, p11).



Figure 89: *Salt water Pavilion*, Kas Oosterhuis (Oosterhuis, 2002b, p52-53).

Both Spuybroek's and Oosterhuis' pavilions are collaborations between private and public sectors, ministries and art councils requiring substantial funding. The young British designer Usman Haque endeavours to utilise everyday interactive systems, such as mobile phones and the Internet. He has proven that complexity and interactivity can emerge out of simple, low budget components; and produce similarly complex and interactive spatial environments. His work varies in the applications used and systems integrated however, it always depends on integrating systems from various fields, and especially cybernetics, with human interaction. Haque believes that architecture is moving away from mere interactive skins and building interfaces and into a world of spatial interactivity of operating systems (Bullivant, 2006, p62). One of his simple yet highly systematically embodied works is *SKY EAR*, Greenwich (2004). In this piece Haque utilises mobile phones, which are the most common devices for interactivity nowadays, and can be seen almost as an extension of our bodies. Central to the project are hundreds of glowing helium balloons in the form of a non-grid cloud contained in a carbon-fibre net structure twenty-five metres in diameter. Suspended

from this cloud were mobile phones, coloured light emitting diodes (LEDs), and electromagnetic sensors (Figure 90). The sensors were to detect levels of electromagnetic radiation at a variety of frequencies. As these sensors are activated, they cause the LEDs to illuminate.

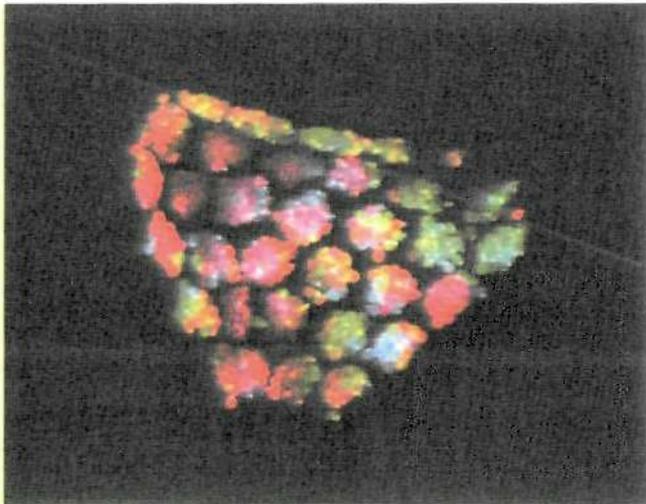


Figure 90: *SKY EAR*, Usman Haque, Greenwich 2004 (Rattenbury, 2002, p63).

Bullivant quoted Haque speaking about the behaviour of this project while it floats over a variety of radio and microwave spaces, stating:

"When an audience member uses a phone during the cloud flight, they are not using it just as a remote control device: the cloud is actually responding to the electromagnetic fields created by the phones in the cloud. [...] like a glowing jellyfish sampling the electromagnetic spectrum rather like a vertical radar sweep" (Bullivant, 2006, p63).

Haque develops his designs similarly to the growth and development of an organism based on sophisticated observations and experiments, where matter and energy are equivalent. Donna Haraway maintains that in modern physics and biology the connotation of the word matter has shifted, where she argues:

"[...] it is ridiculous to maintain that organisms contain unique matter, the meaning of the word 'substance' has changed for both biology and physics. It is common knowledge

that the matter of modern physics posits organization and motion at its core" (Haraway, 2004, p196).

The shift in the understanding of the word *matter* to include organization and motion is at the heart of computational approaches to design and representation in current architecture. Neil Leach, David Turnbull and Chris Williams extend this idea further by suggesting the application of digital tectonics to the practice of computational, algorithmic, material complexity and representations emerging from process orientated approaches to design with recognition of "*structural forces and material composition*" or in other words patterns of organization that translate into forms and spaces in time (Leach et al., 2004, p5).

Kostas Terzidis, an architect, professor and computer scientist currently working at the UCLA Department of Architecture has defined a spatial kind of form, which he calls "*expressive form*". In his book titled: *Expressive Form: A Conceptual Approach to Computational Design*, Terzidis defines expressiveness as existential, expectation, and suggestive rather than merely dynamic, animated and in-motion (Terzidis, 2003, p1). He goes on to describe the forms and spaces that emerge expressively, stating:

"Form is not always conceived literally as made out of matter. In fact, form is rather an abstract entity that possesses certain geometric characteristics. The attachment of material quality constrains the behaviour of form and restricts the designer's imagination. In contrast, the lack of materiality liberates form from its constraints and introduces behaviours closer to intuition rather than perception. Furthermore, skilful omission or deliberate inclusion of partial information creates patterns of interpretation that engage the viewer to participate in the visual composition by 'connecting the dots'" (Terzidis, 2003, p2).

Arguably most architects and designers endeavour to engage the viewers and users of their projects for whom they create their designs to allow for participation and

interpretation to take place. However, it is most important to ask: how can such states of participation be achieved? And furthermore, how to master the skill of omission, or inclusion of partial information, in other words, abstraction? In order to answer such complicated questions we need to understand the limitations of our perception, if existing, and speculate beyond our current dynamic environments, which is the task of the following chapter.

The essence of this chapter lies in both its explanation of the trajectories of the folds and thresholds of life processes and principles of complex systems in their collective states, as well as its examination through several models of the possibilities of generating behaviour in architectural forms and spaces. Thus, the influence of the field of biology and the technological generation has affected architecture directly and indirectly, through both bottom-up and top-down trajectories. Several of the terms established in this chapter such as *frozen behaviour*, *collectivity*, and *emergence* will be used throughout the thesis. This chapter has exposed another side to representation in architecture that is embedded through the process of design and is evident at the early stages of laying out the rules of the game. This link between representation and the process of design will be developed further in the fifth chapter of this thesis.

CHAPTERFOUR: INTERWOVEN FIELD TWO - ACTIVE PERCEPTION & THE DYNAMIC CULTURE

The main aim of this chapter is to introduce the structural elements of the architectural experience: the observers, their own impact upon the system, their consciousness, the fields and folds of forms and the spaces in between, as well as the collective dynamic culture and the responsive environment.

In order to explain the process through which the architectural experience is unpacked, an acknowledgment of the close relationship between perception and conception is vital and elementary. This chapter discusses the influence of the individual haptic experience of perception on architecture, pioneered by Juhani Pallasmaa, passing by notions of active perception and cognition through to the collectivity of the process of perception, its impact on cultural change and its dynamism. The latter point forms the greater part of this chapter. Historical developments in the study of perception from psychology into art and architecture are initially introduced in a linear way but towards the end of the chapter, are shown to collectively overlap and feed back into each other. Also associated with the text, is a model developed to introduce concepts of perception discussed in this chapter regarding the emergence of architectural forms and spaces.

In his book *The Thinking Hand* Juhani Pallasmaa highlights the importance of the haptic senses, especially touch and vision, to the architectural experience stating:

"As we look, the eye touches, and before we see an object, we have already touched it and judged its weight, temperature and surface texture. The eye and the hand constantly

collaborate; the eye carries the hand to great distances, and the hand informs the eye at the intimate scale. Touch is the unconsciousness of vision, and this hidden tactile experience determines the sensuous qualities of the perceived object” (Pallasmaa, 2009, p101-102).

This approach to the relevance of hapticity to the experience of forms and spaces, as much as it is supported by widely known figures in philosophy, is still limited in its relevance to the understanding of the architectural experience in the sense of the cogitative conceptual interpretation of meaning through representation. Architecture is experienced through the collective users’ experiences and interpretations of its forms, spaces and environments. These users vary from the passive to the active and creative, their changing consciousness is transient due to their different backgrounds, experiences and memories as well as their history (Hill, 2003). The architect is no longer the mastermind and the creator of the architectural experience; however, he or she is the facilitator of the collective representations and interpretations of the active and creative observers and users.

The architect is considered in this thesis to be the designer of the seeds and rules of interaction of the game which are portrayed in forms, spaces and environments through the medium of representation. Sir Ernst Hans Gombrich wrote extensively on the subject of art criticism and interpretations of expressions. In his book: *Art and Illusion* Gombrich explains the importance of habitual interpretations to the process of perception with an example from language:

“To me, at least, the cock says not ‘cock-a-duddle-doo’ as he calls to the English in the morning, nor ‘cocorico’ as he says in French, nor ‘kiao kiao’, as in Chinese, but still ‘kikeriki, as he says in German. My percept of the throaty noise of his call is distinctly coloured by habitual interpretation... Put it this way, the difficulty, or perhaps the absurdity, of the problem becomes apparent. There is no reality without interpretation” (Gombrich, 1972, p306-307).

Gombrich goes on to describe how interpretations are in fact composed of different stimuli sectioned and grouped in a particular way. By trying alternative interpretations, i.e., sectioning and grouping stimuli in a different manner, an alternative reading is imposed on reality. Gombrich suggests that *"the adventurous artists"* might be the solution to succeed in *"exploring the dazzling ambiguity of vision"* (Gombrich, 1972, p307).

"The personal accent of the artist is not made up of individual tricks of hand which can be isolated and described. It is again a question of relationships, of the interaction of countless personal reactions, a matter of distribution and sequences which we perceive as a whole without being able to name the elements in combination" (Gombrich, 1972, p310).

On the other hand, Henri Lefebvre unpacks the elements in combination of what he calls the dynamic underpinning of the social relationship between the senses and the material elements, between the body and the drives of subjective and objective articulation of the social relationship:

"In analysing the social relationship, it is impossible simply to dub it a form, for the form as such is empty, and must have a content in order to exist. Nor can it be treated as a function, which needs objects if it is to operate. Even a structure, whose task it is to organize elementary units within a whole, necessarily calls for both the whole and the component units in question. Thus analytic thought finds itself returning, by virtue of its own dynamic, to the very entities and 'substantialities' that it had originally banished: to 'subject' and 'object', to the unconscious, to global praxis, and so on" (Lefebvre, 1991, p401).

This oscillation between the relationship and distribution of a sequence of elements of social space and its perceptual analysis is heightened with the introduction of the digital and interactive media in architecture through cyberspaces and augmented reality spaces, etc. This in turn has pushed the boundaries and rhythms of analysis of the social space from the body to a meta-level and back. Lefebvre explains this relationship between the body and the production of space:

"The whole of 'social' space proceeds from the body, even though it so metamorphoses the body that it may forget it altogether – even though it may separate itself so radically from the body as to kill it" (Lefebvre, 1991, p405).

This chapter attempts to unveil the ambiguities surrounding issues of the orthodox and unorthodox connotations of perception of the architectural experience. It also strives to explore the complex processes in which new modes of perception operate in relationship to the body and the collective dynamic culture. However, before embarking on such an intricate task, it is essential to relate some of the attributes discussed in this chapter to the part of the methodological approach that focuses on phenomenology and consciousness. In an attempt to explain this relationship, Edward Winters articulates the following:

"[...] it is an intrinsic feature of sensation, experience and imagination, that they have a phenomenology. Whereas for propositional attitudes – belief, hope, fear, intention and knowledge – they need not. It would seem, then, that propositional attitudes are not sensitive to whether or not they are conscious states. Whereas the group of experiential states we have mentioned have consciousness as an essential feature" (Winters, 2007, p113).

Later, Winters continues to explain the construct of our experiences:

"Our experiences are constructed out of the sensations we receive via our sensory apparatus and our internal nervous system" (Winters, 2007, p113).

In this thesis, the focus will be on the experiential states and their relation to our consciousness, nevertheless, intention does play an important role in the creation of experiential states, which will be discussed in the fifth chapter.

12. Active Perception

The word *perception* in Concise Oxford English Dictionary, is identified in psychology as:

"The neuropsychological processes, including memory, by which an organism becomes aware of and interprets external stimuli" (Soanes and Stevenson, 2009, p1063).

In agreement with the above definition, Edward Winters explains that perception does not depend only on the haptic senses but also on the conceptual construction of their meaning as interpreted by the cognitive process:

"[...] that is to say, there is something it is like to perceive something – perception essentially involves a phenomenology – and that in representing the world, perception is conceptually structured; and is thus constitutive of the propositional attitudes that we take up toward the world represented" (Winters, 2007, p115).

The process of perception then requires a subject-matter (body-form/space) in an environment, and an observer with his or her own consciousness or conceptual knowledge. And, as mentioned above, this does not only depend on the haptic senses in a given environment, but rather, on the extension of connections and patterns of interpretations between our pre-experiences, our memories, history, transient consciousness, and our active creative self. Many architects are still locked in the "direct" interpretation of perception, the Gibsonian perception, which believes that senses and their stimuli are the only way to interpret perception. Juhani Pallasmaa is one of many architects who believe that the perceptual architectural experience is a multi-sensory experience:

"Sensory experiences become integrated through the body, or rather, in the very constitution of the body and the human mode of being. Our bodies and movements are in constant interaction with the environment; the world and the self inform and redefine each other constantly. The percept of the body and the image of the world turn into one single continuous existential experience; there is no body separate from its domicile in

space, and there is no space unrelated to the unconscious image of the perceiving self" (Pallasmaa, 2005b, p40).

Despite the complex close interrelation between the body and the perceptual experience of architecture, John Hendrix has managed to describe two different relations between the body and perception:

"Perceptual experience has evolved in two ways affecting art and architecture – the embodiment of vision in perception, and the disembodiment of the subject as punctiform object in perception. The combination of these defines the body in the theory of making" (Hendrix, 2003, p221).

He goes on to establish that the subject as body is not the definition of the field of experience but rather the interrelation between the embodiment and disembodiment of the object/subject and the projection of spatial construction as a representation of the experience of life.

"Vision is embodied in the subject and cannot be separated from body experience; the body is experienced by the subject in other ways than as orthopaedic and logocentric form" (Hendrix, 2003, p230).

One way of relating the body pre-experiences to the subject of the perceptual field is through the process of conception. Richard L Gregory believes that perception, especially vision related, requires intelligent problem-solving based on knowledge which is an active as opposed to a passive process (Gregory, 1997). He continues to give a description of perception:

"Perceptions are hypotheses, predicting unsensed characteristics of objects, and predicting in time, to compensate neural signalling delay, so 'reaction time' is generally avoided, as the present is predicted from delayed signals" (Gregory, 1997).

Gregory established that perceptual and conceptual knowledge are both vital to the overall cognitive experience and at the same time are largely separate as each process occurs in time on a different schedule to the other. Perception works faster, in a fraction of a second, to aid survival; on the other hand conception might take minutes, or sometimes years (Gregory, 1997, p2).

"Perceptions are of particulars, rather than the generalities of conceptions. We perceive a triangle, but only conceptually can we appreciate triangularity. Also if knowledge of belief determined perception we would be blind to the unusual, or the seemingly impossible, which would be dangerous in unusual situations, and would limit perceptual learning" (Gregory, 1997, p2).

The background of theories of perception has contributed greatly to the involvement of the current "indirect" theories of perception pioneered by Hermann von Helmholtz and Richard Gregory who were interested in explaining "errors of perception" or in other words, the phenomenon of illusion (Gregory, 1997).

The construct of illusion depends heavily on the organization of the subject that is being perceived. Gestalt theory was one of the first psychological theories of perception to be implemented in art and architecture that was concerned with the property of organization of the subject-matter (body-form/space) of natural things and their perceptual influence on our understanding of the world around us (Arnheim, 1968, p196). In this case the subject-matter was found not only to be the outer envelope or form but rather the manifestation of these forms as forces. Moreover, the act of perceiving through the senses of the observer will then lead into the act of conceiving by the observer's consciousness and later on reflected in his or her own interpretations of the world around them. Thus art and particularly architecture can be

seen as a psychological experience; and the forces which generate such experiences are the objects of our intrigue, attention and perception. Throughout the history of perception, these forces have been interpreted differently in relation to the body in architecture.

Julian Hochberg (Hochberg, 1983) in his article *Visual Perception in Architecture* divides these theories of perception into: the *Classical theory*, the *Gestalt theory*, and the “*Direct*” theories of perception (Hochberg, 1983, p37-39). Classical theorists in the 17th and 18th century believed that our perceptions of objects and forms represent a complex experience which is built up through learning to associate structures in our physical world out of simpler psychological elements or in their words “*sensations*” (Hochberg, 1983, p37). However, these sensations fail to give us the positioning and the properties of the objects/forms around us. Robert Schwartz and Merleau-Ponty echo much the same idea:

“Sensations serve only as signs or the initial building blocks upon which full-blown perceptions are constructed” (Schwartz, 2004, p67).

“Sense experience is that vital communication with the world which makes it present as a familiar setting of our life. It is to it that the perceived object and the perceiving subject owe their thickness. It is the intentional tissue which the effort to know will try to take apart” (Merleau-Ponty, 2002, p61).

In the early 19th century the Gestalt theory emerged out of criticism of the critical theory of the time. Theorists such as Max Wertheimer and Kurt Koffka intended to discover the principles that govern how the configurations of whole patterns determine what we perceive, and to provide a theory of brain organization (Hochberg, 1983, p38). Early principles of the field of Gestalt psychology aimed at explaining

perceptual experiences as a relation of figures to space through the laws of proximity, connectivity and relativity to its components in its space or environment. However later on, it was established that for each unit or entity in space, there might be a behavioural environment and/or a geographical environment (Koffka, 2004, p50).

The idea of the behavioural environment or the behavioural field was first introduced by Kurt Koffka in 1935. Koffka established that some entities exist in the geographical environment but would not necessarily also have behavioural fields of existence, and vice versa. The behavioural field is the reflection of the actions, sensations, and meaning of an entity on the observer, while the geographical environment is the actual positioning of the unit in space in a certain time. Koffka explains the independence of the two environments through examples. In the first, he states that by looking at a fragmented figure, our behavioural field will establish that it is a unit, for example a cross, but in reality and in the geographical environment, there is no cross and instead there are eleven dots arranged in a certain geometrical way and there is no connection between them that makes them a unit (Koffka, 2004, p53). On the other hand, Koffka establishes that the existence of real unity is neither a necessity nor an important cause of behavioural unity, in his second example. He adds, if a gun is covered with paint in three different parts to blend with the background that it is placed on (in this case the background is made out of a tree, leaves and ground), then the gun will no longer appear to the observer as a unit but rather as a multiplicity of much less important objects (Koffka, 2004, p53).

These two examples explain the move from perception into cognition; this was when Gestalt psychologists believed that a new theory of brain organization might emerge. In reality Gestalt theorists managed to explain the figure/ground phenomenon as well as some of the laws of organization but they struggled to establish reasons for illusion and other major problems of perception. And this was the beginning of the “direct” theories of perception, which initially followed in the footsteps of the classical theory in that our visual system responds to wavelengths and the intensity of light falling on the eye rather than the properties of the objects being observed such as, size, colour, form, etc. However in addition to this, the perception psychologists established that this is then added to our memories and past experiences to generate complex perceptions of objects and spaces, which in turn, hold that the notion of the perception of the world is “direct” (Hochberg, 1983, p40). James J. Gibson is one of the pioneers of the “direct” theories of perception. He considered the senses to be channels of sensation which can be considered as systems of perception (Gibson, 2004, p71).

Kurt Koffka believed that light waves coming from an artificial or natural light source, are not geographical objects, and are in fact the direct causes of our complete perception (Koffka, 2004, p55). Steven Holl, however, argues that subjective and objective qualities form the basis of “complete perception”:

“The architectural synthesis of foreground, middle ground, and distant view, together with all the subjective qualities of material and light, forms the basis of “complete perception”. The expression of the originating “idea” is a fusion of subjective and objective. That is, the conceptual logic which derives a design has an inter-subjective link to the question of its ultimate perception” (Holl et al., 1994, p45).

Gibson adds to the above, the preconceptions, conceptions and beliefs of the existence of the external objects are produced by means of the senses, and this is what he calls complete perception (Gibson, 2004, p72). Gibson believes that the perceptual system involves two different senses or levels of sensitivity which he refers to as passive receptors and active receptors. He explains:

"[...] the passive receptors that respond each to its appropriate form of energy, and the active perceptual organs, better called systems, that can search out the information in stimulus energy. The receptors have measurable thresholds below which they are not excited; the organs and systems do not have fixed thresholds except as they depend on receptors" (Gibson, 2004, p73).

He refers to different levels of stimulation or the stimulus energy of optics, machines, and chemistry which he considers as variables. These vary according to frequency and intensity and other complex dimensions (Gibson, 2004, p73). Therefore, the perceptual system is far more complex than the laws of gestalt and the first *Classical theory of perception* have established but nevertheless current theories of perception would have never existed without previous findings. Moreover, the conception of "*complete perception*" in this complex and constantly variable perceptual world is difficult to sustain. Gombrich and Gregory add to this complexity the ambiguity of the phenomenon of illusion, or errors of perception as it was previously called, while Gibson generally denied its existence (Gregory, 1997); (Gregory, 2000); (Gombrich, 1972).

Despite their disagreements on the way the information taken from the environment is perceived and interpreted, perception psychologists and theorists seem to support the existence of the dualism of the factual environment and the conceptual, or a

physical image/environment as opposed to a mental or conceptual one. The physical environment being closely related to Koffka's ideas of the geographical environment (Koffka, 2004) and the haptic and mental environment being a reflection of Gibson's "direct" notions and beliefs (Gibson, 2004), while the conceptual one is an interpretation of von Helmholtz's "indirect" theory (von Helmholtz, 1962).

Therefore, a dualist process, temporally and spatially connected and collectively transient could be established between the physical and the sensory as well as the conceptual in order to explain perception.

"We use our visual information to create, qualify, and modify our understanding of the visual world and in turn use perceived patterns to direct new explorations. This cycle admits no disjunction between perceptual and creative thinking, for vision is meaningful only within an existing framework. Percept and concept turn as one, spinning the fabric of experience, looking always ahead and always back, 'there is no vision without thought'" (Merleau-Ponty, 1964, p175).

Alice G. Read and Peter C. Doo write of the use of the word "image" to describe the distinction and yet the relationship between physical and mental environments where they state:

"The eye could never see an object whole or know the ideal forms, prototypes, and fantasies abounding in the imagination, nor would a percept ever be confused with an image made in the mind. This distinction suggests that the mental image is a phenomenon more akin to a proposition or analogy than to anything purloined from the physical world" (Read and Doo, 1983, p9).

This confirms the collectivity, connectivity and circularity of the perceptual system which brings the field of perception even closer to notions and principles of cybernetics. Arnheim states that our perceptual experience is far from boring, regardless of the object or environment being observed due to the openness of the

system (Arnheim, 1968, p203). These active interactions between the three main elements of a perceptual field; being the object/form, the space and environment around it (its context), and the observer's consciousness, are confirmations of the perceptual experiences being an active open system. And accordingly Arnheim explains:

"For our purposes, 'objects' can be defined as processes that have been temporarily arrested on their way to final equilibrium. The images of all objects show the partial success of that process, namely, some regularity, some symmetry, some simplicity of form. But they also show the marks of striving and growing, of segregation and independence. Thus the form of objects allows us symbolically to envisage the nature of life in its restless striving towards rest" (Arnheim, 1968, p203).

Then he continues dwelling on the notion of active as opposed to passive perception (an example of passive perception being the mechanism of a photographic camera), by stating:

"[...] our visual apparatus copes with the incoming images in active struggle. It is upset by the intrusion and animated by the stimulation. It seizes upon the regularities of form, which allow comprehension, and tries to subject the bewilderingly accidental agglomeration of objects in space to whatever order is obtainable. Every-day vision initiates and anticipates the duel of the artist with the image" (Arnheim, 1968, p203).

Despite establishing that the perceptual field and the visual apparatus in general are active processes, it is not enough to explain the dynamics of the perceptual experience as a system. The observer and the context or environment being percept and concept are both very important variables in this system. According to Jonathan Hill there are three types of users or observers, the passive, the reactive and the creative (Hill, 2003, p28).

"The passive user is predictable and unable to transform use, space and meaning. The reactive user modifies the physical characteristics of a space as needs change but must

select from a narrow and predictable range of configurations largely defined by the architect. The creative user either creates a new space or gives an existing one new meanings and uses. Creative use can either be a reaction to habit, result from the knowledge learned through habit, or be based on habit, as a conscious, evolving deviation from established behaviour” (Hill, 2003, p28).

The environment or context, being perceived and conceived by the observer, plays a very important part in determining the role of the observer: passive or active. This environment could be physical, digital, interactive or a hybrid of all these spaces and forms, furthermore, this difference and collectivity could play an important role in the observers’ interactivity, interpretations and consciousness. Jonathan Hill mentions flexibility and spatial redundancies, for example in open plan spaces (Hill, 2003, p36), while Stan Allen talks of the field condition where in a matrix-like context, both agree that the spatial or formal layers involved can retain their own integrity while remaining capable of “*unifying diverse elements*” if overlapped and interacted with each other (Allen, 1999, p92).

Others such as Lucy Bullivant propose the responsive environment as a result of the penetration of new technologies in the field of architecture (Bullivant, 2006). Responsive and interactive environments that can adapt to our desires and needs can also shape our experiences, and if that occurs then we will be faced with new design and representational imperatives, which in return we will respond to (Fox and Kemp, 2009, p153). Consequently, our environment evolves around us and as a result of this evolution, our consciousness changes and thereafter our behaviour transforms. This confirms that the effect of the observers/users on architecture is complemented by the ability of architecture to transform its observers and their environments.

"[...] perceptions change according to the particular place and historical moment, and just as intellectual history is characterized by differing styles of thought, visual thinking is tied to cultural change" (Read and Doo, 1983, p7).

What we perceive and conceive is affected by our memories, history and culture but most importantly by our consciousness. Philosopher Edward S Casey has written extensively about place, memory and imagination in relation to the body, where he states:

"Body memory is [...] the natural centre of any sensitive account of remembering... There is no memory without body memory" (Casey, 2000, p148).

This is eventually and directly linked to our body as the immediate entity that makes of each one of us a participant in this world physically, mentally or telematically. The word *Telematics* was first introduced by Simon Nora and Alain Minc in 1978 to describe a world of interconnectability between computers, telecommunication and society (Nora and Minc, 1980). Roy Ascott coined the phrase "*Telematic Art*" in describing the networking system in art. He describes networking as "*a shared activity of mind and a form of behaviour that is both a dance and an embrace*" (Ascott, 2003a). He opposes the need for the centrality of the existence of the body in the system of perception going on to suggest that networking takes the physicality of the body out of the system by linking the mind to a kind of timeless sea (Ascott, 2003a, p187) and by doing so, the focus moves onto the transformation of the artwork, or as Ascott calls it "*creative data*", which appears in a constant process of becoming and perceptual motion:

"In this sense, art itself becomes, not a discrete set of entities, but rather a web of relationships between ideas and images in constant flux, to which no single authorship is attributable, and whose meanings depend on the active participation of whoever enters

the network. In a sense, there is one wholeness, the flow of the network in which every idea is a part of every other idea, in which every participant reflects every other participant in the whole... The observer of the 'artwork' is a participator who, in accessing the system, transforms it" (Ascott, 2003a, p199).

However, the relationship between the body, the creative data and perception is in constant oscillation. Merleau-Ponty in his book the *Phenomenology of Perception* confirms the relationship of the body to a theory of perception:

"We have learned to feel our body; we have found underneath the objective and detached knowledge of the body that other knowledge which we have of it in virtue of its always being with us and of the fact that we are our body. In the same way we need to reawaken our experience of the world as it appears to us in so far as we are in the world through our body, and in so far as we perceive the world with our body. But by thus remaking contact with the body and with the world, we shall also rediscover ourselves, since, perceiving as we do with our body, the body is a natural self and, as it were, the subject of perception" (Merleau-Ponty, 2002, p239).

Therefore, in order to understand our space around us we need to understand the relations of our body to its space. This can be seen in the dichotomy between the proportions of Le Corbusier's *Modular Man* and the *Sensory Homunculus*³¹ (Figure 91) in relation to the space and form illustrated around them.



Figure 91: Three-dimensional clay model of the *Sensory Homunculus* (http://scienceblogs.com/neurophilosophy/2008/08/wilder_penfield_neural_cartographer.php).

³¹ *The Sensory Homunculus* is a representation of the human body illustrating the effects of psychological characteristics upon physiological functions.

This dichotomy is one of the most effective demonstrations of the lubricious and multiple representations of the relationships between body, space and perception. Moreover, this relationship between body and space or place has been the most important topic in philosophy since it was initiated by Aristotle's *Physics* argues Edward Casey in his inquest for the *Fate of Place* where he states that:

"Aristotle himself posits a rigid material body in place by virtue of its sheer contiguity with the inner surface of what immediately surrounds it – a strictly physical intimacy that works by close containment" (Casey, 1998, p331).

Continuing, Casey states that even though Aristotle believed in this rigid relationship, he however ignored the existence of any body other than the physical body. Not until Kant, Husserl, Merleau-Ponty and later on, Foucault, Deleuze and Guattari were the changing human experience and the perception of place and space accounted for (Casey, 1998, p332).

Deleuze and Guattari suggest different connotations to the relationship between the body and place. With this relationship they coined their theory of the *"Body without Organs"* (Deleuze and Guattari, 2004, p165-184). They describe the *Body without Organs* as the egg before the extension and development of the organism, being defined by gradients, thresholds, axes, vectors, dynamic tendencies and energy transformation, where the organs appear and function out of intensities (Deleuze and Guattari, 2004, p170). By intensities Deleuze and Guattari mean fundamental abstraction, where matter equals energy, and when both equal zero. In biological terms this means when a hypothetical equilibrium pushes form and space into the

edge between order and chaos, and where emergence starts its non-linear loop again.

For them, the *Body without Organs* or *BwO* is:

"A BwO is made in such a way that it can be occupied, populated only by intensities. Only intensities pass and circulate. Still, the BwO is not a scene, place, or even a support upon which something comes to pass. It has nothing to do with phantasy, there is nothing to interpret. [...] It is not a space, nor is it in space; it is matter that occupies space to a given degree – to the degree corresponding to the intensities produced" (Deleuze and Guattari, 2004, p169).

Similar to different ideologies of the body in relation to space, there are multiple ideologies of space itself, for example, the physical space, the cyber space, the virtual space, and the interactive space. There are parallels that can be drawn between Deleuze and Guattari's *Body without Organs* and the empty space that Perec identifies in Lewis Carroll's *Map of the Ocean* in *Hunting of the Snark* (Figure 92). Georges Perec identifies and lists different species of space which he then summarises under one definition, explaining:

"In short, spaces have multiplied, been broken up and have diversified. There are spaces today of every kind and every size, for every use and every function. To live is to pass from one space to another, while doing your very best not to bump yourself" (Perec, 2008, p6).

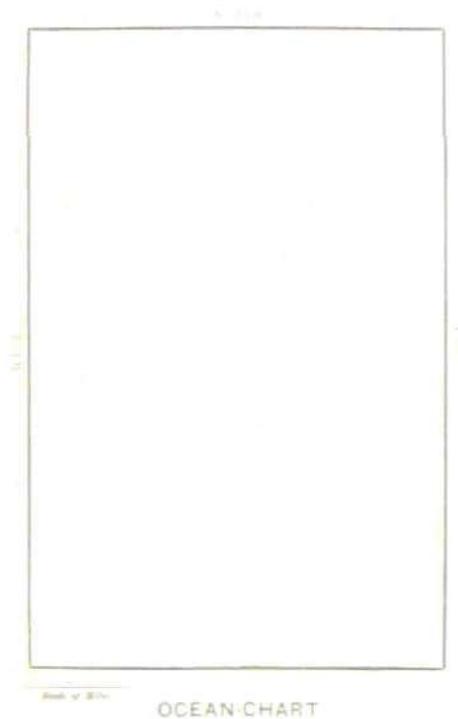


Figure 92: *Map of the Ocean* in *Hunting of the Snark (An Agony in 8 Fits)*, Lewis Carroll, 1874 (<http://www.gutenberg.org/files/29888/29888-h/29888-h.htm>).

It is not the core purpose of this thesis to explore different kinds of space as well as different kinds of body; however it is necessary to build a clear hypothesis of dependence established between body and space in relation to their representation as well as the overall collective cognition experience.

The escalation of events around the relationship between the body, form and space in this section is a proof of the complexity of the subject of perception. There are several variables involved in the system which act individually and collectively at the same time within this complex system. These main elements are, the sensations (the haptic senses), the perceptual field (the environment whether it is a geographical or behavioural one), the body/observer with his or her own consciousness and conceptual constructive knowledge and the medium in which the system takes place.

These elements follow principles and processes within the perceptual field, such as connectivity, collectivity and circularity between each other through certain media. The observer and the environment on the other hand carry a different status being passive and/or active, present or absent, depending on preconceptions, conceptions and beliefs as well as different environments.

Finally, it seems that the complexity of the perceptual field is similar in its nature to the principles of complex systems discussed in chapter three. This discovery does not come as a surprise. It is expected that the principles and processes of biological systems will apply to any other complex system, whether it is cultural, perceptual, or a physical network. This gives further evidence to the connection between the cybernetic and phenomenological paradigms as the methodological approach adopted for this thesis. After exhibiting the complexity of active perception, it is important to note that our main interest in this complexity lies in the connections and feedback loops between the elements involved in the perceptual system and moreover, the focus is on the *spaces-in-between* these elements which are the subject of the next section.

13. Energy Fields and Folds: Spaces-in-Between

In her well-known book titled: *Crystals, Fabrics and Fields*, Donna Haraway attempts to unpack one of the most complicated words in the English language, *form*:

"Form is about shape, number, figure, beauty, making, ritual, image, order, cause, relationship, kind, conduct, and character. 'To have good form' describes a way of doing

something that is at once about ethics, technics, and practice. 'Simply, 'to have form' is more likely to call to mind a criminal record'. Meanings, communities, persons, organisms, landscapes, and artifacts are configured, constituted, brought into being-formed-in the relentless emergent relationality that is the world. Far from connoting a fixed type, form is formative process" (Haraway, 2004, pxvii).

Following Haraway's ideology this thesis takes the position of considering form and the *space-in-between* to be a collective relational formative process of becoming spatially and temporally. Furthermore, this can also be described as a metaphysical relation as characterized by Mary B. Hesse when attempting to answer the main question of her thesis on physics, "*How do bodies act on one another across space?*"

"Matter acts only by contact, so, faced with matter attracting at a distance with no apparent material medium, subtle matter of dubious status and properties has to be postulated. [...] So the medium is described in terms of stresses and tensions, in such a way that energy is the only material property which is located in it, and this is said to show that action is after all continuous" (Hesse, 2005, p293).

In an attempt to articulate what Hesse refers to as medium in architectural terms, Jane Rendell describes a "*place between*" in spatial and temporal terms when she states:

"A place between is spatial, it is a mapping of the geographies between here, there and elsewhere. A place between is temporal, it pays attention to time, to the ways in which we locate the then from the now, the now from the yet-to-come, for in our writings history, our placing of the past in the present, we are already positioning possibilities for the future. A place between is social, it is an articulation of the place of dialogue, ongoing discussion, between one and another" (Rendell, 2007, p221).

Rendell extends her vision regarding place between from her predecessors, such as Arnheim and Portoghesi. Arnheim suggests, when examining the perceptual experience of architecture that spaces surrounding buildings cannot be considered empty (Arnheim, 1978, p28-30). Instead these spaces are packed with energy determined by visual forces generated by architectural structures, bearing in mind that emptiness is not meant to relate to the absence of matter, but rather, to the contours

that either define surrounding objects to be structurally unorganized or do not define a certain pattern.

"Emptiness and the ensuing sense of forlornness do not come about only when the visual objects needed to determine the field of forces in an open expanse are missing. A similar effect results when such determinants are present but do not add up to an organized structure and thereby cancel one another out" (Arnheim, 1978, p24).

One of the earliest to acknowledge this idea was the architect Paolo Portoghesi, who in 1974 adopted the notions of perceptual and social fields from physics. He emphasized the origin of the surroundings of architectural form as a consequence of fields of visual forces which can be illustrated as patterns.

However, and more to the point, the discussion moved to the dynamic perceptual relationships and boundaries between objects/forms and the spaces that surround them. In an attempt to visualise these boundaries, the forms and the spaces around them become inseparable entities, meanwhile, the forces and energy around these forms can be interpreted as visual forces within a perceptual field (Arnheim, 1978). Proposing such boundaries will initiate tension in the perceptual field as a result of hypothetically resisting belonging to either the form or the space surrounding it. Moreover, and as a result of this interplay and tension, it will be difficult to define a fixed boundary for any form in particular space and time. Therefore, this interplay of *space-in-between* confirms a continuous dynamic perceptual experience of architecture. The notion of the *space-in-between* has been referred to as "*interspace*" by theorists and architects such as Arnheim, Portoghesi and others.

Christian Norberg-Schulz emphasises this notion by framing architecture by forces of interaction of vertical tension and horizontal rhythm between two main hypothetical lines of perception, earth and sky. This relation is expressed in space and form as a figure of gestalt (Norberg-Schulz, 2000, p133-134). Arnheim and Norberg-Schulz were the first architects to attempt to implement the principles of the theory of gestalt in architecture. Furthermore, Norberg-Schulz discusses the flexibility and the dynamics of the idea of gestalt:

"All of the things that configure the environment are found both on the earth and under the sky. These two relationships entail a horizontal extension and a vertical elevation or, as I have previously said, 'rhythm' and 'tension'. These are expressed in space and form, and despite the flow of changes, they are manifested in the figure as something durable, that is to say, as a Gestalt" (Norberg-Schulz, 2000, p133).

In order for a "thing" to be conceived as a gestalt, the form, its context and the spaces in between should be expressed as an organized structure that generates animated patterns. There are two ways of perceiving and conceiving the *space-in-between* which places architecture in constant oscillation between being seen as a whole in space and alternately as an ensemble of actions experienced in time which creates dynamics in the perceptual experience. The importance of the discrepancy between form in space and its structure lies in the dynamic of the notion of the gestaltian figure as a representation of a whole and as an abstract pattern at any moment. The experience of a sequence of overlapping urban perspectives that unfolds according to motion, angle and speed as well as a fusion of subjective and objective expressions, develops our perception (Holl et al., 1994). Collectively these experiences in time will form multiple unstable states of consciousness which will contribute to the formation of architecture as a system of fields derived not only from the architect's will but also from observers' and users' interactions.

The best examples of gestaltian figures in art can be seen in the work of M. C. Escher, a Dutch graphic artist. His work was mathematically inspired and he also had a great fascination with explorations of infinity, gestalt and architecture. Aspects of growth and development can be seen in his piece *Metamorphose* which demonstrates transitions, layering, and patterns that transform and evolve. *Metamorphose II* manifests the dynamism of the gestaltian figures in both its transition from one gestalt to another within the pattern and also in its suggestion for continuation beyond the boundaries of the piece (Figure 93) (Escher, 2006). This dynamism is captured in motion in the work of director and film critic Sergei Eisenstein who provided great insight into the idea of the gestaltian montage in film. The 1925 film *The Battleship Potemkin* by Eisenstein is a great example of complex ideas relating to the manipulation of perceptual spaces through gestaltian representation (Figure 94). Scenes develop through simple interrelations and connections between two gestaltian patterns which are presented in black and white. The transitions from parts into the whole and back in certain scenes were developed gradually to allow the perceptual immersion of each part of a scene to be fully experienced with the aid of positive and negative spaces of geometry.

"Painting has remained incapable of fixing the total representation of a phenomenon in its full visual multidimensionality. (There have been numberless attempts to do this). Only the film camera has solved the problem of doing this on a flat surface, but its undoubted ancestor in this capability is – architecture" (Eisenstein and Bois, 1989).

Although Escher's and Eisenstein's works are based on the gestaltian perception influenced by the sequential juxtaposition of pictures, phrases, and/or elements and despite the element of montage and motion in Eisenstein's films that separate the

elements of their sequential juxtaposition to expose an emerged image (Eisenstein and Bois, 1989), their work still exhibits a pre-designed complexity rather than an emergent complexity. For a long time, the focus of perceptual studies was the simplest case of the *"figure-ground"* relationship in which the figure has an articulated form and the ground appears shapeless and endless and is sometimes considered empty (Arnheim, 1978). However, in the context of this thesis, spaces surrounding forms are not considered to be empty; but rather to be charged with vectors of generated fields of forces that spread in space. Under such conditions, these spaces are conceived as ground in the overall context but they are not endless or empty. They rather act as negative spaces with a shape of their own that contributes to the whole pattern. Forcing the structure of the whole pattern to invert itself, where positive spaces exchange places with their negative surroundings and figure becomes ground for a moment, will assist in analysing and controlling the influence of such negative spaces to reach a state of perceptual antimatter.

"Space is therefore not some pure extension, lacking all qualities or forces, but is rather a kind of primordial atmosphere, endowed with pressure and tension and bounded by the infinite void" (Arnheim, 1978, p71).

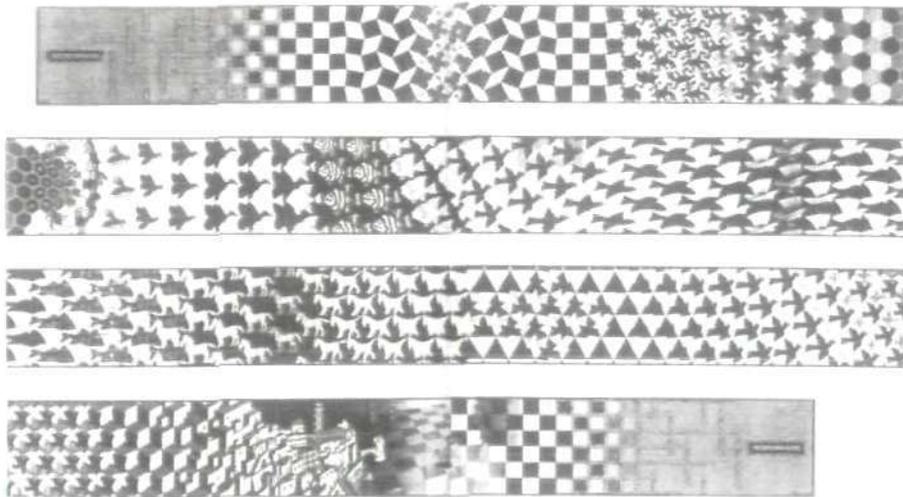


Figure 93: *Metamorphosis II*, woodcut print measures 19.2 by 389.5 centimetres, M. C. Escher, 1939 – 1940 (Escher, 2006, p32).

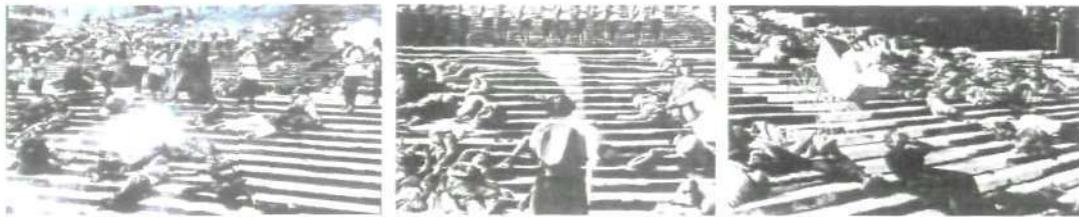


Figure 94: Snap shots of *The Battleship Potemkin* film, Sergei Eisenstein, 1925 (Eisenstein, 1925).

The boundary between the positive and the negative space is a dynamic multifaceted state in time striving to create a balance within one part or another of the system at any moment. However, this has left us with a distorted image of a two dimensional relationship of vertical tension and horizontal rhythm, which might be interpreted to mean that architecture has a linear impact on the context. This was the case until the Deleuzian theory of the fold was introduced (Norberg-Schulz, 2000). In this theory, Deleuze establishes that these forces and fields of energy exist collectively, not as a single event, but rather as a multiplicity of folds. And by a fold he meant an ontology of becoming, and a differentiation of forms, spaces and environments while maintaining a continuity (Deleuze, 2006). Therefore, these energy fields and forces emerge and evolve within a transient process of becoming which embeds non-linearity.

"Folding-unfolding no longer simply means tension-release, contraction-dilation, but enveloping-developing, involution-evolution... the simplest way of stating the point is by saying that no unfold is to increase, to grow; whereas to fold is to diminish, to reduce, to withdraw into the recesses of a world. Yet a simple metric change would not account for the difference between the organic and the inorganic, the machine and its motive forces. It would fail to show that movement does not simply go from one greater or smaller part to another, but from fold to fold. When a part of a machine is still a machine, the smaller unit is not the same as the whole" (Deleuze, 2006, p9).

Thereafter, and going back to the hypothetical unstable borders between the form and its surrounding space, the potentiality of figure/ground only presents one dimension of consideration which acts by the orthodox Cartesian rules of space. However, a simple example of what Deleuze calls the theory of the fold can be seen in moiré figures, which are effects emerging out of the superimposition of two regular fields; these can be seen individually as a representation of two dimensional forms or figures. They exhibit unexpected complex effects by following simple mathematical rules of shifting, repetition in patterns, scale, etc. These figures have been used to analyse the architectural urban context. Stan Allen describes the effects emerging out of these figures as field combinations, and the impact of these field combinations onto the context by saying:

"What these field combinations seem to promise is this context is a thickening and intensification of experience at specified moments within the extended field of the city" (Allen, 1999, p98).

The field conditions in any context act as overlapping regular patterned layers that produce complex and perceptually challenging emergent effects. Nature consists of a multiplicity of moiré figures scattered around us which the observer unpacks by perceiving and conceiving fragments of this context in a certain space in time. Therefore, it is essential to consider an alternative multidimensional context with

different scales of folds and *spaces-in-between* in time. Eisenman echoes much the same when he refers to the fold as an aspect of singularity (Eisenman, 2007, p31).

“Singularity is not something that emerges from a ground or from a figure form. It is the quality of unfolding in time that allows the possibility of singularity. Thus the fold can never be a neutral datum; it will always be a moment if not a specific object or place in time. As such, it can be an unstable or nonstatic being in time as well as in place. The fold in this sense is neither a frame nor a figure as ground, but contains elements of both” (Eisenman, 2007, p30).

Eisenman’s *Rebstockpark* competition in Frankfurt, Germany, 1991 (Figure 95), exhibits a good example of the idea of the fold in architecture. The ground of the *Rebstockpark* competition carries a condition of singularity – in the sense of the Deleuzian fold – that is portrayed in its groundlessness. This is where the design inhabits in-between spaces and conditions of folds; and where it becomes infinitely extendable and repeatable.



Figure 95: *Rebstockpark*, design competition, Peter Eisenman, Frankfurt, Germany 1991 (Eisenman, 2007, p16).

Eisenman’s resolution of *Rebstockpark* and the urban fabric of Frankfurt as a fold of time event is not just a call for a radical intervention against the gridded urban space,

but rather an extension to the possibility of singularity under the current interdisciplinary debates of the electronic paradigm.

"A time-bound place has lost its placeness. It has moved to a kind of placeless, timeless condition. The fold attempts not to return place and time to what they were formally, but to bring them into the fold" (Eisenman, 2007, p32).

Greg Lynn adopted the Deleuzian idea of the fold in architecture, realising that its foreground is *"a more fluid logic of connectivity"* (Lynn, 1980) as opposed to the logic of conflict and contradiction of the *Deconstructivist Architecture*. This shift which occurred between the Derridean 1980s and the Deleuzian 1990s configured the relationship between the conceptual and the perceptual dimension in architecture (Buchanan and Lambert, 2006, p36). As a result of this shift, architects such as Greg Lynn and Peter Eisenman began implementing the singularity notion of continuity between site and structures, embedding conceptual design which in turn entices perception to follow patterns of connectivity between the inside/outside both on a physical/actual level and a psychological one. Lynn carries this notion of the fold further and into the virtual world through his collective essays of *Folding in Architecture in Folds, Bodies and Blobs* 1998 and later on *Animate Form* 1999. Lynn's fold carried notions of multiplicity, motion and a new adaptation to the relationship between body and space through time.

"The form of dynamically conceived architecture may be shaped in association with virtual motion and force, but this doesn't mandate that architecture change its shape. Actual movement often involves a mechanical paradigm of multiple discrete positions, whereas virtual movement allows form to occupy a multiplicity of possible positions continuously with the same form" (Lynn, 1999, p10).

Time and motion play a great deal in this rapidly changing perceptual world between the real/actual and the virtual. Thus, an isolated experience of any image in time has far less effect on the observer than a collective experience in motion of a space, building or form. Therefore, perceptual experiences of architectural spaces and forms embed several layers of overlapping complexity. However, a virtual experience can be more complex and unique than a physical one, as the former is always under the process of collectivity passing through one complex event in order to emerge differently within another, while the latter resembles a preformed and pre-existing moment-event. Sanford Kwinter describes the tension between the virtual and the actual:

"The relation of the virtual to the actual is therefore not one of resemblance but rather of difference, innovation, or creation 'every complex, or moment-event, is unique and new'. Thus the following should be clear: realization 'of a possible' and creation 'through actualization-differentiation' are two intrinsically distinct and irreducible processes. The first programmatically reproduces what was already there, formed and given in advance, while the other invents through a continuous, positive, and dynamic process of transmission, differentiation, and evolution" (Kwinter, 2002, p8-10).

The architectural forms and spaces most relevant to this part of the thesis are constantly affected by the tensions of the changing dialogues between their embodiment in a spatial and temporal context, and the cognitive and perceptual influence of the observer on the system as a coherent whole. The *spaces-in-between* arise from interactions between the form and its environment on one level, between the environment and the active perception of the observer on another level, and between this dynamic perception and the cognitive experience as a whole on a further level. Within this nested structure of complexity the allocation of the *space-in-between* remains always incomplete under the influence of the unstable states that confirm the importance of architecture as an experience in a transient ecology.

Below is a model which attempts to demonstrate the representation of the dynamic complexity of the relationship between form, space and their environment. This model was developed as part of the *SlidingScales* workshop³². Thereafter, it was presented as part of a lecture in February 2007 (Architecture Week) to i-DAT (Institute of Digital Art and Technology, Plymouth, UK) as part of an architect's experience between theory and practice. Since then the model has developed further³³ to embed discussion about the behavioural characteristics of architectural form which are discussed in chapter five.

The workshop focused on the idea of scale in the relationship with our view of the peculiar landscape of digital technology as an ecology. The three-day workshop entailed selecting an item to be scanned under the electron microscope (SEM); the resultant image was then to be interpreted as a *process of becoming*. In the next stage of development, this process was decomposed into a set of folds to act as a set of rules, which, at a later stage, formed the basis for the design of a three-dimensional virtual model, which was manufactured using a rapid prototyping (RP) machine.

A piece of umbrella fabric was chosen to be scanned by my team. The connotation of the use of the umbrella represents a dividing layer between the user and the environment which later became the main idea for generating the form. Despite the workshop's aim of translating the virtual into the physical, this project emphasises the

³² Workshop took place in December 2006 at the University of Plymouth, organized by i-DAT [Institute of Digital Art and Technology] at the University of Plymouth and The Bartlett School of Architecture at University College London.

³³ Paper published in *Technoetic Arts: a Journal of Speculative Research*, Volume 5:3 (Murrani, 2007, p133-149).

process of development as opposed to the specific properties of the object which emerged out of the process.

At the start of the process an image was selected from a collection taken in different nano-scales with the aid of the scanning electron microscope (SEM) mechanism. Its potential complexity lies in its multidimensional effect through interpretations of gestalt and the transitional effects from order to chaos (Figure 96).

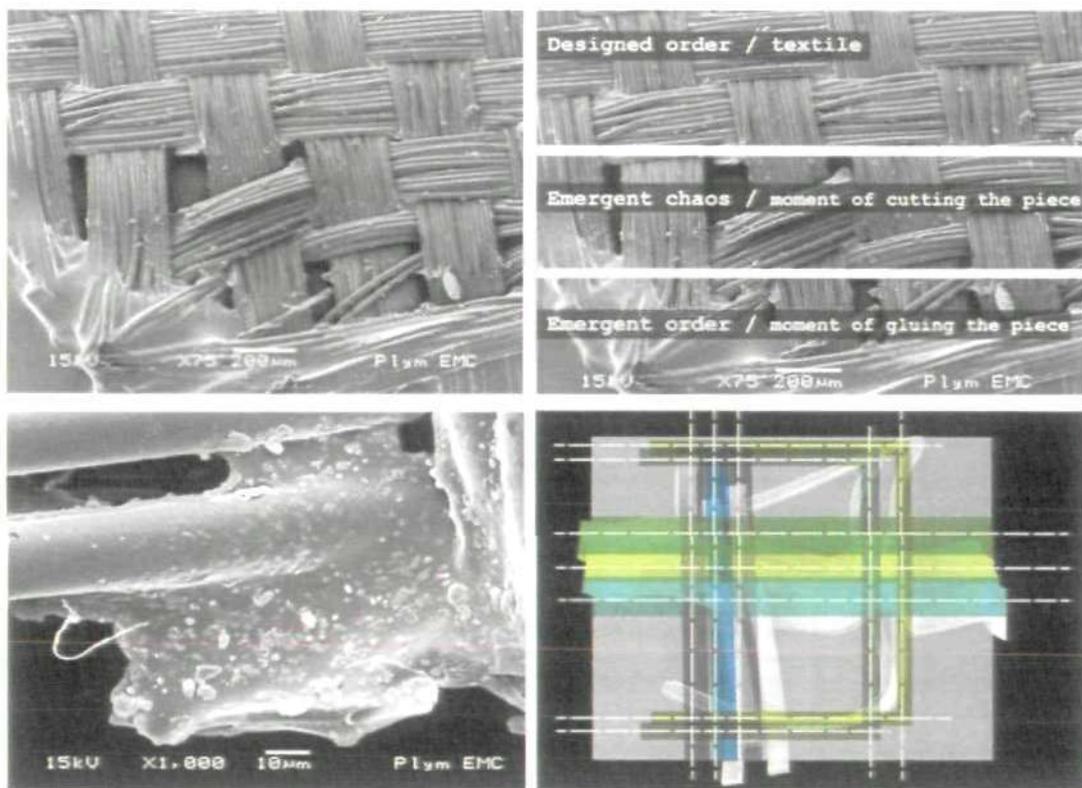


Figure 96: Selected image of the SEM and initial sketches.

This is reflected in the hypothetical borders and the effect of time on the properties of the fabric between the moment of cutting of the piece and the moment of attaching it to the stud which was placed under the microscope. These hypothetical borders can be seen as a designed order (evident in the pattern of the textile), emergent chaos (the edge where the cut went through the textile), and emergent order (the edge where

the textile was glued to the stud) thresholds. Each of these thresholds represents an action within the *process of becoming*. The designed order is the ordered action of the mechanical weaving of the fabric, while the emergent chaos represents the action and the resulting threshold of cutting the fabric, and finally the emergent order representing the effect of gluing the edge of the fabric to the stud for placement under the electron microscope.

Before further details of the development of this model are provided, it should be made clear that this model represents a particular moment in the process of development and becoming of the form which could be referred to as *frozen behaviour* that captures one instant in time from a dynamic and transient process. In order to begin the design process, some fundamental starting points or seeds must be provided to enable the process to grow and develop. The concept for the early sketch of the model was derived from the following considerations:

- The SEM image of the weaving of the textile.
- The workshop theme of scaling in between processes and systems.
- The concept of the umbrella as the dividing layer between the user and the environment.
- The three levels of complexity of the fold and the hypothetical borders and thresholds mentioned earlier.

This initial concept was refined through a sequence of stages of growth and development; the improved model illustrates aspects of articulation and perceptual

effects, such as figure/ground, solid/void, influence of parts on the whole and the relationship between form/environment and the *space-in-between*. And at the same time, it reflects notions of singularity and continuation of the *process of becoming*. (Figure 97) represents the first level of complexity (growth and development) over selected generations. (Figure 98) proposes the idea that perception of the whole form does not only depend on the material/immaterial representation of its parts but also on the relationships between the *spaces-in-between*. (Figure 99) identifies the fields and forces of energy in the form that induce further seeds to grow and emerge in the environment. (Figure 100) illustrates sections in time while the form is changing and transforming in an attempt to map the transient fields of forces that exist around the points of tension located close to the melted boundaries between the form and the environment. This visualisation revealed that the idea of continuous change and transformation could be seen as multiple patterns. Each static image of these sections represents a stage in the development of the form or a *frozen behaviour*. Eventually, the process of collectivity of these frozen behaviours will represent one of the multifaceted outcomes of the entire form in a certain time (Figure 101).

Further development of the model was undertaken to illustrate deeper complexity in the form's self perception; this emerges after the observer enters the system and starts perceiving and conceiving the form in space. (Figure 102) illustrates the reaction of form to the perceptual influence of the observer – reflecting the observer's collective experience pictorially.

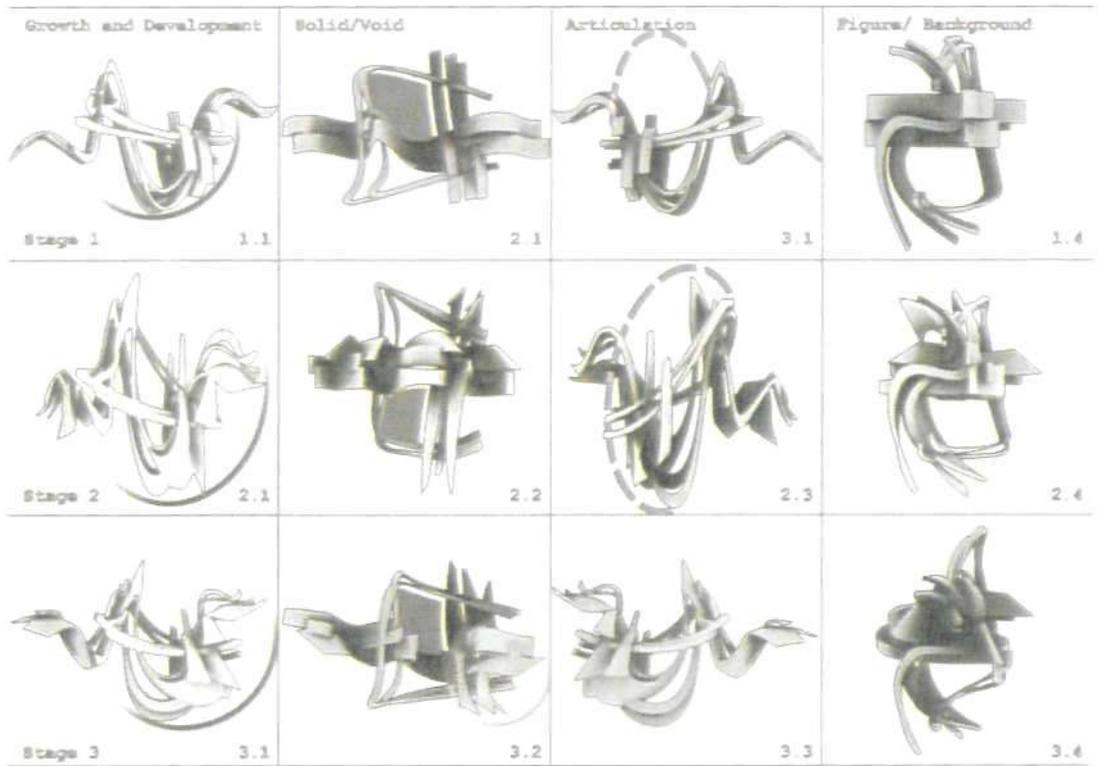


Figure 97: Illustration represents the first level of complexity (growth and development) over selected generations.

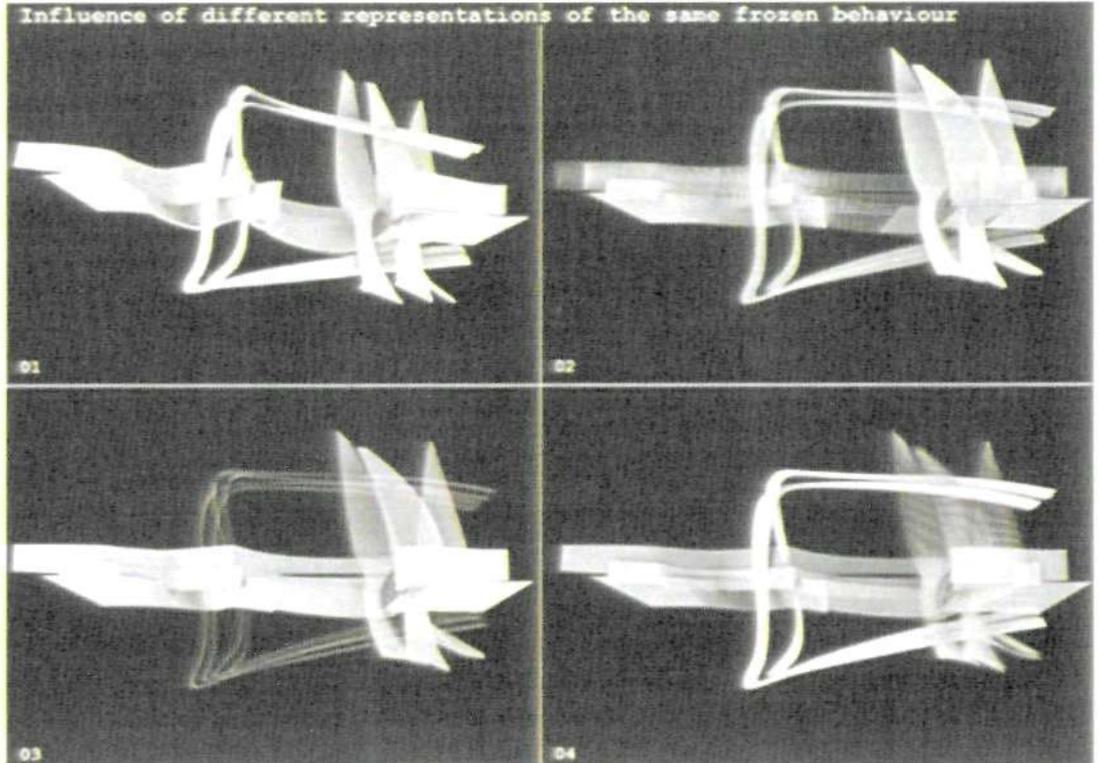


Figure 98: Illustration of *spaces-in-between*.

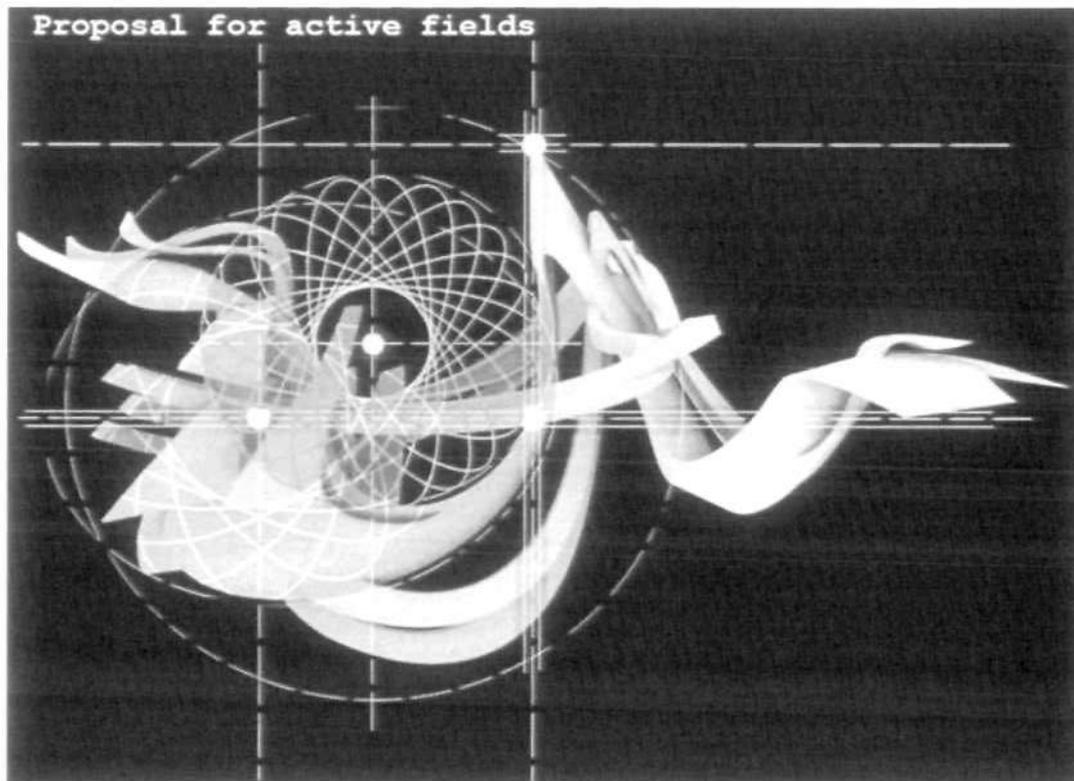


Figure 99: Illustration of the fields and forces of energy in and around the form.

In this model, visual forces and fields have the potential to create and shape active spaces and allow new forms to emerge. The dynamic perceptual system between the observer and the *space-in-between* will provide assembly instructions consisting of various properties of perception such as figure/ground, solid/void effects, exaggeration of parts over the whole, the influence of missing subjects/objects, the layering of patterns, as well as the singularity and the continuation of the *process of becoming*. These gestaltian properties along with the conspicuous instability between the *spaces-in-between* create different dynamic states in the perceptual system of the architectural experience. The proposed environment, presented here, encompasses fields of forces that influence the emergence and growth of new forms. The potential energy inside each form could have a great impact on the fields of forces in the environment. Hypothetically, architectural forms and spaces can emerge out of multi-

dynamic states of visual fields in the environment, their internal energy feeding back into the environment to create the potential for the generation of seeds and their growth into new forms and spaces. The dynamics of this process are always transforming in time in a certain space. Such processes not only influence dynamism in our perception but they contribute to changes occurring in the social and cultural environment. These transformations are referred to as behavioural patterns in forms and spaces, which will be explained in detail in Chapter five.

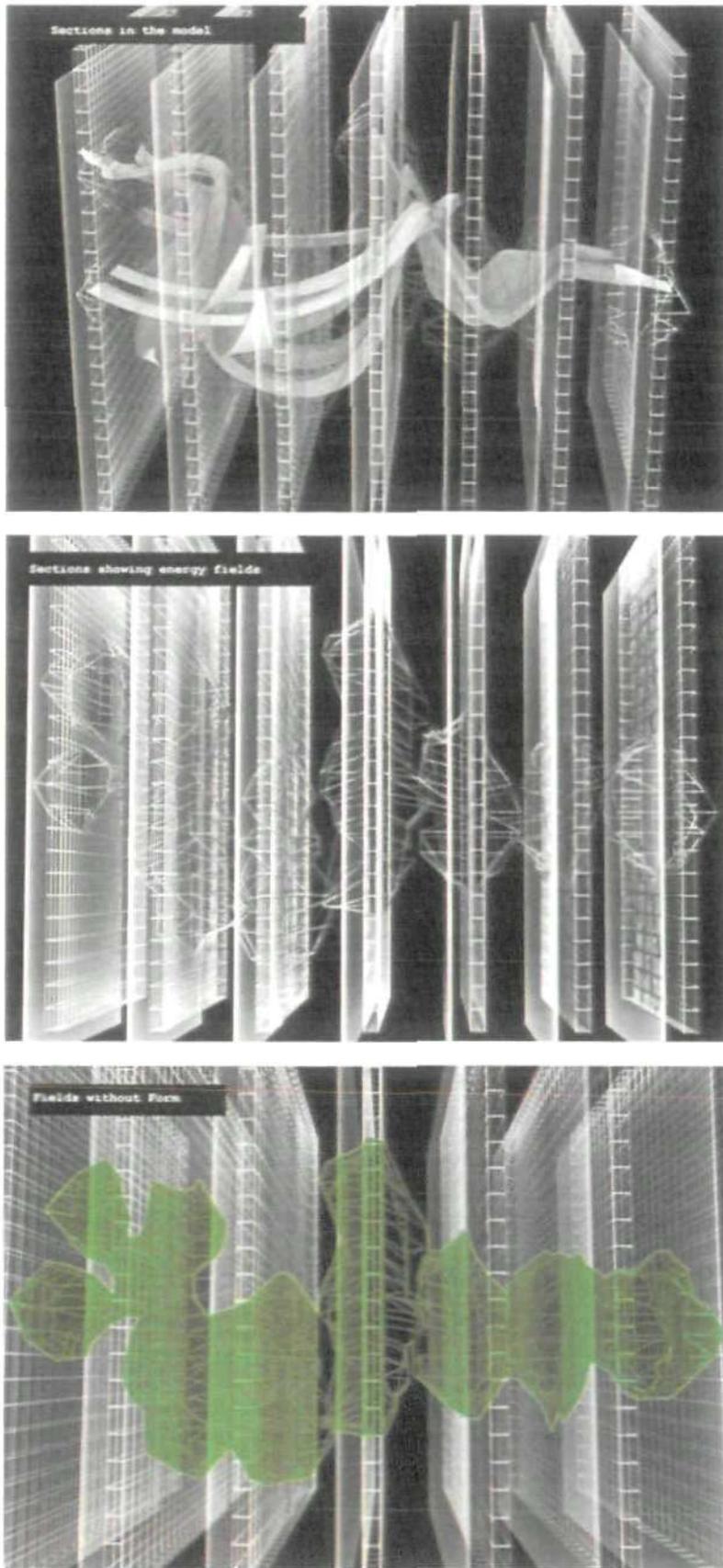


Figure 100: Illustration of sections in time of the model.

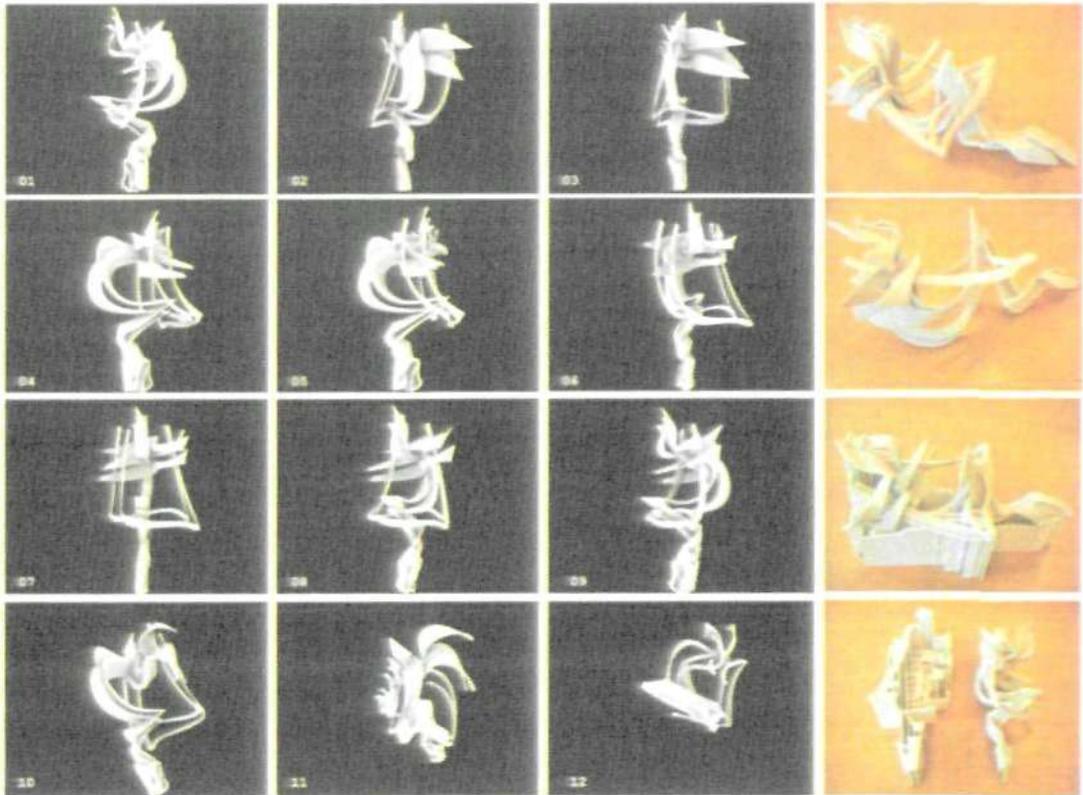


Figure 101: Illustration of a *frozen behaviour* of the model.



Figure 102: Illustration of the form's self-perception.

14. Responsive Environments and Dynamic Cultures

Whenever the active user/observer will interact with the environment around him or her, a new understanding of the environment's geometry, the way it operates, the way it adapts, and its components' interactions may be attained. Such interactions contribute a great deal to the emergence of new imperatives in our experiences of the forms, spaces and environments around us. In Fox's terms, our experiences happen as a consequence of our understanding of the potential of space, or even our understanding of the interactions between its parts that take place over time (Fox and Kemp, 2009, p156). Fox and Kemp later explain:

"Architecture can play a more active role in suggesting new ways for its inhabitants to use the environments based on real-time information exchanges. The experience can change depending on how a group of users interacts, whereby the rules are learned or the rules are completely dynamic and evolving" (Fox and Kemp, 2009, p156).

Accordingly, the influence of the leaps in the media used in architectural representation has changed the way we perceive and conceive architecture; most importantly this has transformed architectural environments, theoretically and practically. No doubt this change has influenced dynamism in current cultures which in turn have urged new discoveries in architectural representation towards responsive and emergent environments. In this context the word responsive means dynamism that implies behaviour, change or transformation and active response effects. After establishing the closely related loops of interaction between the body and the surrounding environment in the previous sections, it must be said that implications of responsiveness and dynamism in the environment on one hand and the social culture on the other, are in fact extensions of the idea that was established in the previous

sections regarding the collectivity of the architectural perceptual experience as a system.

Michael Weinstock distinguishes between two systems, one that emerges in nature which is called *the biological system* and one that emerges out of social collectives which is called *culture*. He points out that natural forms take place due to their spatial and temporal arrangements that emerge out of dynamic interactions between energy and matter in complex systems through time. Social collectives provide another system to transform information through time (Wienstock, 2010, p245). Both systems overlap and influence each other; they inhabit and modify our environments around us, however most importantly, they allow change to occur, which eventually paves the way for the emergence of new forms and representations. This can be seen through time in the form of new paradigms, new technology, or new media of representation, such as the evolution of the use of sketchpads and pencils to digital pads and *interactive pens through advancements in spatial and experiential as well as experimental technology*.

Nevertheless, developments in digital and interactive technology were not limited to digital pads, but have been evolving from being a mere medium of representation to being the core contributor to the development of interactive spaces and cultures.

Artists and architects as well as research groups such as AVATAR founded by Professor Neil Spiller of the Bartlett School of Architecture, OCEAN Design Research Network led by Michael Hensel of the Architectural Association, London, and small practices such as Haque Design + Research by Usman Haque, all strive to create responsive

environments. From giant electronic billboards, to the responsive skin of the building for example Jean Novell's *Islamic Arab Centre* in Paris, and Mark Goulthorpe's interactive wall, to the hybridised architectural environments of digital and analogue that have become the focus and inspiration for artists, architects as well as scientists in the last two decades or so. Such active processes did not emerge to fill the interest in technology of smart spaces for the sake of it, but rather to examine environments that act as "*mediating devices for a new social statement*" (Bullivant, 2006, p7).

Manuel Castells in his book the *Rise of the Network Society* establishes that spaces are expressions of society and culture (Castells, 2000, p440). He emphasises that spaces are expressions rather than reflections of society:

"Space is not a photocopy of society, it is society. Spatial forms and processes are formed by the dynamics of the overall social structure. This includes contradictory trends derived from conflicts and strategies between social actors playing out their opposing interests and values. Furthermore, social processes influence space by acting on the built environment inherited from previous socio-spatial structures" (Castells, 2000, p441).

Castells limits the definition of space to the material world on the assumption that:

"[...] space is a material product, in relationship to other material products – including people – who engage in 'historically' determined social relationships that provide space with a form, a function, and a social meaning" (Castells, 2000, p441).

However, the consideration of the extension of materiality of space to conceptual immaterial expressions is becoming more plausible under the current practices of creating responsive and interactive environments. Therefore, pinning down the complexity of the construction of space and thereafter society and culture becomes a significant part of this argument. It has been established, earlier in this chapter and

previously in the thesis, that our perceptual and conscious experiences of our surrounding environments strive towards some kind of order or equilibrium (Arnheim, 1968, p203) in reaction to the human mind and the mechanism of vision which are governed by the tendency to simplify the connections and relations between spatial forms. Mihaly Csikszentmihalyi in his book *Flow* discusses the relevance of the principle of ordered structural organization that is shared by the construction of space and the processes by which our perceptual experiences are interpreted:

"Cultures are defensive constructions against chaos, designed to reduce the impact of randomness on experience. They are adaptive responses, just as feathers are for birds and fur is for mammals. Cultures prescribe norms, evolve goals, build beliefs that help us tackle the challenges of existence. In so doing they must rule out many alternative goals and beliefs, and thereby limit possibilities; but this channelling of attention to a limited set of goals and means is what allows effortless action within self-created boundaries" (Csikszentmihalyi, 1991, p81).

Csikszentmihalyi's book *Flow* was dedicated to finding the ultimate conditions for optimal experience and concurrently he establishes that there is a vital condition affecting experience: our *"individual's ability to restructure consciousness so as to make flow possible"* (Csikszentmihalyi, 1991, p83). Although Castells' discussion of the importance of the notion of flow was not seen as a direct explanation of our experience of the surrounding space but rather of its implications on network society; his argument remains very closely related to Csikszentmihalyi's point of view, and both are relevant to the subject at hand.

"[...] our society is constructed around flows: flows of capital, flows of information, flows of technology, flows of organizational interaction, flows of images sounds, and symbols. Flows are not just one element of the social organization: they are the expression of process dominating our economics, political, and symbolic life" (Castells, 2000, p442).

He continues proposing the space of flows which he defines as:

"[...] the material organization of time-sharing social practices that work through flows"
(Castells, 2000, p442).

Castells describes it in relation to the network society as a:

"[...] new spatial form characteristic of social practices that dominate and shape the network society" (Castells, 2000, p442).

Advanced contemporary architectural practices such as Foreign Office Architects, MVRDV, Stan Allen Architects, OMA and UN Studio, among others, have always striven to link their design projects to multiple communication networks and patterns of flow of information in a given site or city, whether it is physical or digital. Maria Fedorchenko talks of the diagrammatic balance between forms and flows in contemporary architectural practices, where she states:

"Reflecting the pragmatic turn in design practice, projects are treated as local parts within larger dynamic systems of organization. Processes of flow, change and integration take priority over compositions of static objects and staged appearances. Faced with the need to negotiate the instability of their project sites, designers redefine the conceptual treatment of the production of space" (Fedorchenko, 2008).

This intertwined notion also applies when attempting to define a performative environment or interactive environment. Bo Stjerne Thomsen identifies the vital importance of the flow of performative technologies onto architecture. Such performative technologies are different to those of pre-determined digital results such as Computer Aided Design (CAD) programs. Performative, interactive and pervasive technologies are those that constantly create outputs from changing inputs, involving feedback processes and bi-directional communication, as well as making active responses to changes around them (Thomsen, 2008a).

"As these technologies slowly weave into the domain of urban space and architecture as integrated processes, it becomes architecture that performs the role of a complex extension of both people and networks" (Thomsen, 2008a).

In addition to consideration of the external conditions of the surrounding space, there are internal conditions that make flow possible which are the negotiations and meanings generated between the mind of the observer and the objects being perceived and conceived. These internal conditions are results of our ability to control consciousness, which is explored widely in psychology and also in the interactive arts.

One of the best examples in interactive arts can be seen in the work of Ulrike Gabriel's art installation titled *Terrain 01*. *Terrain 01* is an interactive Artificial Life (AL) art installation of a colony of robot components which depend for their energy on the intensity of a number of light projectors (Figure 103). The light projectors are connected to sensors which are placed on the head of the observer or participant. These sensors read the brain activity of the participant and register this activity in a code which feeds back into the system to alter the light intensity of the projectors. Several participants could connect and communicate together to intensify the light differently, which in turn alters the behaviour of the robots' movements (Gabriel, 1993). Such projects have elevated the field of interactive arts and perceptual experience into a different level, into a level of control of consciousness rather than just a direct, one-way transmission of content to be observed (Ascott, n.d.).



Figure 103: *Terrain 01*, an interactive Artificial Life (AL) art installation, Ulrike Gabriel, 1993 (<http://www.medienkunstnetz.de/works/terrain/>).

Architectural theory and critiques in the last decade or so have focused on redefining the forms, spaces and functions as well as the purpose, processes and systems of architecture. The space of flows started blurring the relationship between architecture and culture. Architectural appearance and representation is no longer the focus of current theories but rather the impact of the changing medium, technology of representation and materiality of architecture on the architectural experience as modified by our consciousness. Conventional architectural forms and spaces have evolved towards the end of the 20th century and the beginning of the 21st century from physical and analogue into kinetic, to digital and interactive. Lucy Bullivant states:

"Technology is deployed as a means of understanding and commenting on paradoxes within our culture, especially the unquestioned ubiquity of corporate technologies, as well as make visible or to translate invisible phenomena ranging from sounds to pollution, electromagnetic waves and the paranormal. Human desires are a fundamental part of this list" (Bullivant, 2006, p17).

The environments have shifted from real to virtual to hybrid, spaces have evolved from physical to augmented realities, new social nodes have appeared in cyberspace, and

new interactive worlds have emerged such as Second Life where new architectural experiences became an extension of our bodies and consciousness. This confirms the blurring boundaries between architecture and culture, and confirms a shift towards a dynamic and responsive environment and culture. The responsive environments that are most relevant to this thesis are the ones that carry active rather than passive responses which are not pre-determined, the ones that interact with their users' and observers' experiences, adapting and learning through time. Bullivant echoes much the same when she uses the word "*alloplastic*" originally coined by Mark Goulthorpe, meaning "*a malleable and reciprocal relationship between the self and the environment*", saying:

"The perception of architecture as relational and alloplastic has great implications for the built environment, provided that new propositions in this field fulfil their potential. This is a conceptual, technical and programmatic issue" (Bullivant, 2006, p21).

Fascination in programmable spaces, forms and environments has been of interest to architects since the mid 1980s, its leading advocate being Malcolm McCullough, the first architecture product manager for Autodesk. In his essay *20 Years of Scripted Space*, McCullough establishes the motives behind the emergence of programming culture in architecture.

"Advances in digital fabrication... there is now far more incentive to express design in terms of a few variables based on the machining process... rapid prototyping and computer-numerically controlled (CNC) machining have become competitive necessities. Second the theoretical basis of cultural expression in form is increasingly informed by a domain of knowledge that appears relatively comfortable with notions of generative algorithmic beauty: namely biology... In addition, more people know that information technology and organizational change are just two sides of the same coin. And finally, and perhaps most widespread culturally, the crafts of personalising one's workspace and scripting one's intellectual pleasures have become far more distinct in the generation of designers who grew up with computing" (McCullough, 2006, p15).

McCullough's motives emphasize the interrelation between architecture and culture which in turn brings us closer to realising the validity of this thesis' objectives. Furthermore, they establish on a deeper level, links between these objectives. These links in fact are feedback loops and oscillation processes between the availability of the technological advancements of the age; their theoretical underpinning in biological, technological, perceptual and experiential systems; as well as the emergence of interactive forms, environments and space. These processes and systems collectively influence dynamism in the culture, and furthermore, will generate instability and incompleteness in the representational and experiential system.

Lefebvre echoes much the same as he describes the transformation of any society which is based on "*collective ownership*" that is "*founded on the permanent participation of interested parties*", with their differences and varied backgrounds. Therefore, Lefebvre presupposes "*confrontation*" within an environment which could lead to either "*co-operation or division*" (Lefebvre, 1991, p422). These processes are vital for the existence of any social system; Lefebvre explains their circularity and feedback by stating:

"It is an orientation that tends to surpass separations and dissociations, notably those between the work 'which is unique: an object bearing the stamp of a subject, of the creator or artist, and of a single, unrepeatable moment' and the product 'which is repeatable: the result of repetitive gestures, hence reproducible, and capable ultimately of bringing about the automatic reproduction of social relationships'" (Lefebvre, 1991, p422).

Deleuze emphasises repetition over generality. Repetition is where no particular change appears in the object but rather change occurs in the mind that is contemplating it (Deleuze, 2004, p90). Change occurs in the perceptual interpretation

of relations between the repeated objects that are being observed in time. Hence they differ from one another as they occupy a specific space in a particular moment in time.

Technological advancements of the current age play an important role in the creation of new experimental representational tools in art and architecture. This has been a debate among many philosophers, historians and artists/architects on to what extent this technological and experimental representation is allowing for new perceptual experiences and conceptual imaginations to be unveiled. Below are just a few of such conflicts presented in the form of quotes that can be seen as constructed dialogues within the narrative of the thesis:

"We are entering an era of electronically extended bodies living at the intersection points of the physical and virtual worlds, of occupation and interaction through telepresence as well as through physical presence of mutant architectural forms that emerge from the telecommunications-induced fragmentation and re-combination of traditional architectural types and of new, soft cities that parallel, complement and sometimes compete with our existing urban concentration of brick, concrete and steel" (Mitchell, 1995, p167).

Dalibor Vesely questions the difference between experimental and traditional representations, and more importantly their creative imagination, where he argues:

"There is no doubt that even the most advanced forms of representation are ultimately only tools, because they contribute to the representation of the given reality and only indirectly to its transformation. They are certainly not independent. They are more involved with, and reflect more clearly the conditions and limits of, our imagination and thinking than any earlier modes of representation" (Vesely, 2004, p310).

One of the first philosophers of sociology, Jean Baudrillard, focused for the major part of his life in philosophy on the effect of cultural theories of consumerism and the media society on emerging representations. This led him to label situations of "more

information and less meaning", "culture of the copy" with the term "ecstasy of communication" (Baudrillard, 1988). Baudrillard was mainly discussing the media and the mass media in terms of news, televised, newspaper, and radio on the appearing image as opposed to art or architecture projects. Where he argues that the media:

"[...] pressures an irresistible destruction of the social... Thus information dissolves meaning and dissolves the social, in a sort of nebulous state dedicated not to a surplus of innovation, but, on the contrary, to total entropy" (Baudrillard, 1994, p80-81)

Similar to Baudrillard were the writings of Guy Debord in his book titled: *Society of the Spectacle*; the effect of dazzling images of representation on societies and cultures in general could be looked at in terms of architectural projects presented in glossy magazines.

"In societies dominated by modern conditions of production, life is presented as an immense accumulation of spectacles. Everything that was directly lived has receded into a representation" (Debord, 2009, p24).

According to Baudrillard and Debord, in such societies every object turns into information which is reduced to a presentation or an over aesthetised image which is detached from its original complex cultural situation and by doing so it is emptied of its meaning (Gane, 1991, p101). Neil Leach draws on the lines of Baudrillard and adds to this debate his concerns of the impact of the inevitable cultural condition of aesthetisation due to developments in technology and particularly Computer Aided Design (CAD) software on a discipline that relies heavily on the use of images, referring to the field of architecture.

"This privileging of the image has led to an impoverished understanding of the built environment, turning social space into a fetishized abstraction. The space of lived experience has been reduced to a codified system of signification, and with the

increasing emphasis on visual representation there has been a corresponding reduction in other forms of sensory perception” (Leach, 1999, p10).

Lefebvre echoes some of Leach’s concerns about the future of an architectural practice that seems to be trapped in the processes of representation; Lefebvre identifies this as the elementary cause to the aesthetisation of design:

“As for the eye of the architect, it is no more innocent than the lot he is given to build on or the blank sheet of paper on which he makes his first sketch. His ‘subjective’ space is freighted with all-too-objective meanings. It is a visual space, a space reduced to blueprints, to mere images – to that ‘world of the image’ which is the enemy of the imagination” (Lefebvre, 1997, p144).

Leach also paints a grim, however to some extent true picture of the society of the image:

“A society awash with images will experience a consequent reduction in social and political sensibilities, as the intoxication of the image leads to a lowering of critical awareness. The saturation of the image will therefore promote uncritical acceptance of the image. [...] Aesthetization leads to anaesthetization leads to further aesthetization in a dizzying spiral whose only apparent respite lies in the total collapse of the system under its own intoxication” (Leach, 1997, p55).

Leach’s anxiety about the effect of the depth of our involvement in the digitised world has been the concern of many scientists and psychologists. It is the spark of debate with still no concrete evidence of its harm to our brains, and learning processes. Steven Pinker, professor of psychology and cognitive science at Harvard University, argues in an article published in the *New York Times* titled: *Mind Over Mass Media*, that such anxieties appear with the emergence of any new medium, he lists for example the arrival of the printing press, television and the Internet. Pinker believes that according to the way we are built, our brains have the plasticity to rewire

themselves as we learn new things in life. He argues that the new media have made us smarter, where he explains:

“The new media have caught on for a reason. Knowledge is increasing exponentially; human brainpower and waking hours are not. Fortunately, the Internet and information technologies are helping us manage, search and retrieve our collective intellectual output at different scales, from Twitter and previews to e-books and online encyclopaedias. Far from making us stupid, these technologies are the only things that will keep us smart” (Pinker, 2010).

With the invasion of the digital technology and Computer Aided Design (CAD) programmes into the discipline of architecture, dazzling computer generated images (CGI) have simultaneously inspired and affected the new generation of young architecture graduates and students. However, on the other hand, advancements in the technology have not only contributed to new software for graphical ends or for understanding the behaviour of structures and the creation of new materials but also are shedding light on the effects of the emergence of new theoretical paradigms of perception, conception and, most importantly, the experience of architecture. This has happened through the exploration of new tools and media of representation not only visual but also mental and conceptual which have contributed a great deal to our behaviour and interaction as well as the evolution of our consciousness.

Neil Leach’s ideas, now a few years removed from his earlier concerns of the anaesthetisation of architecture, have evolved to consider the other side of the coin which concentrates on the influence of studying biological models to reveal structures of behaviours for architectural design ends as opposed to using digital means for representational purposes. Leach is predicting that a “*biophilosophy*” era will take place stemming from philosophical debates attempting to understand the impact of

the relationship between structures of behaviour in nature and emergent generations of new design tools in architecture. He explains the potential of computer-generated structures lies in the possibility of experiencing the whole design operation as a process (Leach et al., 2004, p71). Furthermore, Leach concludes that a new paradigm in architecture, which he calls "*Swarm Tectonics*", is developing due to advancements in computational techniques used in the design process. It is not meant for the computer to be used for representational means only but rather as a "*generative instrument*" for the design process in architecture. In other words, the computer has redefined the role of the architect, from the sole creator of architecture to the controller of the rules that govern the process of formation in architecture (Leach et al., 2004, p75).

One of the most recent and fascinating immersive and interactive environments created for Venice Biennale 2010 titled: *Hylozoic*³⁴ *Ground* was created by Philip Beesley, professor of Architecture at the University of Waterloo, Canada, in collaboration with Rob Gorbet, an engineer, and Rachel Armstrong from the Bartlett, University College London, UK. The installation considers, to a great deal, 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 (Figure 104).

³⁴ Hylozoism is the philosophical doctrine of the belief that all matter has life (Soanes and Stevenson, 2009, p699).



Figure 104: *Hylozoic Ground*, immersive and interactive environment created for Venice Biennale 2010, Philip Beesley (<http://www.hylozoicground.com/>).

The piece is combined of lightweight rapid prototyped components fitted to microprocessors, sensors and light emitting diodes (LEDs) that react to human interaction producing gentle waves and movements in a forest-like environment (Figure 105). It 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 (Beesley, 2010). Potentially, such expressive, instrumental and experimental architectural environments will eventually transform our environment around us to a more responsive and dynamic one. Due to the example in practice above, and the theories of Leach and others, it seems that the study of the behaviour of experimental architecture is at last attainable.



Figure 105: Components of the *Hylozoic Ground*, immersive and interactive environment created for Venice Biennale 2010, Philip Beesley (<http://www.hylozoicground.com/>).

Leach's attempts to define "Swarm Tectonics" can be seen as an extension to the notion of the networked societies, which in their essence are nothing but biological models of structural behaviours in the collective and dynamic sense. Ilya Prigogine states the parallels between the emergence of the networked society and self-organization in biological systems:

"I feel that there is some analogy between the present evolution toward the networked society and the processes of self-organization I have studied in physics and chemistry. Indeed, nobody has planned the networked society and the information explosion. It is a remarkable example of spontaneous emergence of new forms of society. Complexity is moreover the key feature of far-from-equilibrium structures. The networked society is of course a non-equilibrium structure which emerged as a result of the recent developments in Information Technology" (Prigogine, 2000, p893).

Technology on the other hand is considered to be the material culture and at the same time it is a fundamental dimension to social culture and more importantly to social change (Fischer, 1992, p1-32). Castells adds that "informationalism" acts as the material basis for the technological paradigm of 21st century society (Castells, 2004). He goes on to draw a parallel with industrialism as the dominant era of the 20th century society, however, "informationalism" depends on different kinds of energy to operate. According to Castells, this energy is based on the human ability to communicate and process information which was made possible by the revolution of

microelectronics, software and computing in general, where computers and digital communications are direct expressions of this revolution (Castells, 2004).

"Because information and communication are the most fundamental dimensions of human activity and organization, a revolutionary change in the material conditions of their performance affects the entire realm of human activity" (Castells, 2004).

Castells and Prigogine's vision of information technology and social networks which were investigated and discussed through projects in art and architecture in this chapter, emphasise a vital point in the development of this thesis which focuses on the necessity of advancements in technology and communications in networked societies in order to sustain the nature of the evolving culture to new dimensions, meta and hyper. The second point that emerged out of the chapter's discussions is in its essence in defining the elementary existence of the *space-in-between* and its role in creating thresholds for critical debates in architectural theory of representation and perceptual as well as conceptual experiences. *Spaces-in-between* came in the form of, Lefebvre's singular and unrepeated moments, Deleuze's fold, Csikszentmihalyi's flow, and Castells' network, such connotations represent evidence of the dynamic culture in general and the circularity of the perceptual experience and social space specifically. More importantly, their transitional processes and hypothetical thresholds define the in-between, and presuppose transience, instability, and incompleteness in the *process of becoming* between spatial and social interaction. Simultaneously, their theories paved the way for a new theory of architectural experimentation to be established. This theory will be based on the relationships between both the responsive environment and the dynamic culture as well as the body and our consciousness, through the ludic and mercurial thresholds of the *spaces-in-between*.

CHAPTER FIVE: INTERRELATION & INSTABILITY OF THE ARCHITECTURAL SYSTEM

As this chapter concludes the narrative of this research, it is important to state here that this is not meant to be a finalisation to the issues discussed in the previous four chapters. However, it combines the interrelations between the previous chapters leading to the culmination of all hypotheses of this work. The result is an open-ended collectively theoretical, philosophical and to some extent experimentally based thesis. This chapter will concentrate on the conclusions that have emerged from each of the previous chapters in an attempt to develop the architectural system with all its connotations and notions of tensions and instabilities. All such connotations will be derived directly from the fields of influence of biotechnology and perception, as well as from the narrative of architectural representation.

Firstly, to consider the notion of systems in architecture, a clear definition of the origins and the properties of the word *system* is urgently needed. Originating in the early 17th century, the simple abstract sense of the word is defined as:

"A complex whole; a set of things working together as a mechanism or interconnecting network" (Soanes and Stevenson, 2009, p1462).

Therefore a system is a whole consisting of several parts in action; however, the nature of this action may be open or closed. In *The Theory of Open Systems in Physics and Biology*, Ludwig von Bertalanffy explains the difference between the two states of a system:

"A system is closed if no material enters or leaves it; it is open if there is import and export, and therefore, change of the components. Living systems are open systems,

maintaining themselves in exchange of materials with environment, and in continuous building up and breaking down of their components” (von Bertalanffy, 1950, p23).

Identification of examples of both kinds of systems is important before pursuing a deeper level of understanding. Closed systems are virtually mechanical systems with a clear input and a designed output. They can exchange energy with their environment but not materials. Examples of such systems are a greenhouse, or prescribed software such as Microsoft Word. Contrastingly, open systems can exchange heat and materials with their environment and therefore, are affected by it; this category includes all natural and living systems, which are the main concern of this research. By drawing this distinction, Ludwig von Bertalanffy has summed up the main elements that are vital for the continuation of the development of this chapter. The characteristic property of open systems — constant exchange with the environment through crossings of hypothetical equilibriums, thresholds, and instabilities — dictates that open systems are always described through the notion of states, as Rosen explains:

“Central to the notion of natural system is the attendant notion of state. [...] System and state have become essentially coextensive; systems are described in terms of their possible states, while their environments are not and indeed, cannot be” (Rosen, 1991, p67).

Extensive investigations into the general principles and properties of natural and complex systems have been discussed in chapter three; this chapter will focus on identifying the elemental characteristics of the architectural system in particular. Having established that architecture constitutes an essential part of our collective and dynamic environment, it is now crucial to characterise its system and sub-systems before reaching a theory of experimental and experiential behaviour in architecture. Furthermore, it is even more critical to discuss the hypothetical territories and links

between its sub-systems on one level and between the components that these sub-systems are made from on another level, i.e. to identify its states. The first sub-system is defined by the influence of the interwoven fields of biology, technology and perception on architecture, while the second sub-system is embedded in the dialogues initiated between the influential notions of representation, medium and experience in architecture. These particular notions have been identified due to their direct relationship to the components that constitute the *elemental behavioural characteristics of architecture in its process of becoming*. The collision of the two sub-systems will give rise to a clearer understanding of the main hypothesis of this research, where behaviour in architecture is established. Furthermore, this chapter will conclude with an open-ended discussion of the speculative future of architecture and further research possibilities and interventions.

15. The Sub-Systems

15.1. Defining the Territorial Instability between the Interwoven Fields and Architecture

In its essence, the first sub-system is embedded within the thresholds, links and connections between the interwoven influential fields of biology, technology and perception on architecture. This thesis' interest lies in the transient states of the links and hypothetical boundaries between these fields, which are even more dynamic than the actual fields themselves. This is due to their territorial belonging which is not located in any one field but lies at the heart of the definition of the *spaces-in-between*. These states of hypothetical links, borders and territories, in fact, are the *spaces-in-between* the two sub-systems and can be seen at times in one or the other. This

irregular oscillation in the positioning of the *spaces-in-between* forms the constant tension and dynamism in this system: *the system of architecture*.

Before beginning to unpack the characteristics of these unstable territories, it is crucial to explain their nature with a practical example, such as the boundaries of the market within a city, or the bedroom within a house. Pierre von Meiss explains the influence of limits and thresholds on the architectural practice of building, defining them as the boundaries in which the interior and the exterior are determined (von Meiss, 2006, p148). Von Meiss suggested multiple aspects of dependence and belonging that drive the relationship between the interior and exterior:

"It provides both separation and connection, or, in other words, differentiation and transition, interruption and continuity, boundary and crossing. Thresholds and spaces of transition become 'places' in their turn. [...] It is the threshold which reveals the nature of the limit" (von Meiss, 2006, p148).

Throughout this thesis, aspects of separation and connection form the essence of each of the chapters, all of which follow the methodological approach of the cybernetic phenomenological model of analysis which is built on notions of circularity, feedback, and communication with all their connotations in one field or another. Another fundamental part of the methodological approach is vividly seen in the involvement of the human body and its consciousness as an active and elemental part of the model of analysis of the thesis. This involvement can carry different connotations, literal as seen in the *Vitruvian Man* and the *Modulor Man*, representational as in a medium or tool of expression and extension for forms and spaces, or experimental and theoretical as in the Deleuzian *Body without Organs*, as well as of course as an active observer. All of

which are states and thresholds or shifts in the understanding of the territorial body in relation to its surrounding context, or in other words, architecture.

The thesis takes on Von Meiss' connotations of the relationship between the exterior and the interior in comparison to Arnheim's reference to the *interspace* between figure and ground or positive and negative figures. Thus, we can establish that these thresholds and territories created between the interwoven fields exchange positions through their intensities within their context, through Deleuze's fold, and Csikszentmihalyi's flow as well as Castell's network, and therefore, can be declared unstable. The boundaries are limitless and therefore it is more challenging to define its stability. However, in any dynamic system, elements of control are essential to distinguish between open and chaotic systems. Therefore, defining the elements of control for the architectural system becomes a fundamental part of that system. This can be explored through dialogues initiated between representation, medium, and experience in architecture, which will be explored in detail in the following section.

15.2. Initiating Dialogues between the Non-Dualist Notions

At the beginning of this section, it is paramount to explain the use of the word *dualist* or *dualism*. According to the current philosophical definition, it means the dual state of irreducible existence defined by Descartes as the mental and the material, or mind and matter (Descartes, 1964). Descartes elaborates on the complex dualist state of being as he gives examples of being able to conceive oneself or our body through faculties of

imagination and perception by relating those faculties to an intelligent substance or the mind. He states:

"I am only a thinking and not an extended being, and since on the other hand I have a distinct idea of body is so far as it is only an extended being which does not think, it is certain that this 'I' – that is to say, my soul, by virtue of which I am what I am – is entirely [and truly] distinct from my body and that it can [be or] exist without it" (Descartes, 1964, p132).

There can be no doubt that the connotations of the word *dualist* for this thesis are based on Descartes' thoughts on dualism, however, it can also be seen as an extension of the meaning of the word in a biological context. Robert Rosen stems his interpretation of the word *dualist* from a biological context derived from Descartes' line of thought to be; the dualism of "*self*" and "*ambience*" (Rosen, 1991, p40-41). Rosen explains self as the "*inner world*", being our own subjective view of ourselves; we are contained within it, our perceptions, imaginings, ideas and actions. Thus, everything outside oneself is the "*external world*", the "*ambience*" which contains the world of objective reality; the world of phenomena and most importantly our bodies and our selves (Rosen, 1991, p41).

"Science, in fact, requires both; it requires an external, objective world of phenomena, and the internal, subjective world of the self, which perceives, organizes, acts and understands" (Rosen, 1991, p41).

The "*self*" and the "*ambience*" is a dualism that cannot be separated; each of the contributing parts is vital for the existence of the other. Rosen extends this dualism to a second branching of the first. The second dualism is concerned with the way we "*manage*" our perception of the world, i.e. managing or partitioning our ambiances (Rosen, 1991, p41). In attempting to move from a macro to a micro level of understanding our ambience or external world it is vital to consider the second

dualism of systems and their environments. Rosen explains the relationship between the first and the second dualism:

"A system in the ambience is a collection of percepts that seem to us to belong together" (Rosen, 1991, p41).

He continues later stating:

"[...] system gets described by states, which are determined by observation; environment is characterized rather by its effect on system" (Rosen, 1991, p42).

This approach above of the explanatory scientific account of the relationship of systems to observation lies at the heart of the phenomenological description of Husserl. Husserl defines the phenomenological description in terms of the dualism between objects and subjects as *"paradox" or "mystery of subjectivity – as the site of appearance of objectivity – is its theme"* (Moran and Mooney, 2002, p2). Dermot Moran explains:

"It focuses on the structure and qualities of objects and situations as they are experienced by the subject. Phenomenology aims to describe in all its complexity the manifold layers of the experience of objectivity as it emerges at the heart of subjectivity" (Moran and Mooney, 2002, p2).

The thesis takes the philosophical, scientific and phenomenological interpretation of the word dualist to another level where the focus is not only on the relationship between the dichotomies, but also on the influence that actuates the *process of becoming* between these dualist notions of body and mind, self and ambience, objective and subjective, etc. Sanford Kwinter in representing the world as a complex dynamical system and fluid manifolds identifies two kinds of influence that occur in time during the *process of becoming*. Kwinter distinguishes 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, p24-25).

Kwinter builds his idea of *singularity* on the existing knowledge of the field of computer science and in particular the promise of ultra-artificial intelligence which will be marked by the development of machines or robots that achieve superhuman intelligence. Those machines will later be capable of building still more sophisticated intelligences creating what is known as “*intelligence explosion*” (Good, 1965). This hypothetical event in time is called “*The Singularity*”; the term was originally coined in the 1950s by John von Neumann as he described the impact of technological advancements on societies, cultures and their consciousness. In his book titled: *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. Jean Baudrillard in a conversation with Jean Nouvel expresses his way of understanding singularity in architecture as the definition of the uniqueness of the object that can carry different interpretations but at the same time cannot be exhausted while being interpreted, aesthetically, sociologically, politically, or spatially (Baudrillard and Nouvel, 2002, p67). Similarly, Eisenman expresses his understanding of the word *singularity* in terms of singular objects (Eisenman, 2007,

p23-24); however, this thesis uses Kwinter's connotations of the word as in the active situations, events and thresholds in the *process of becoming* as opposed to its meaning in terms of final forms, objects and spaces.

In this thesis such active situations, events and thresholds of *singularity* in architecture actuate dialogues between the dualisms of materiality and immateriality relating to the states of its representation, virtuality and reality relating to the states of its medium, and finally intentionality and interpretation relating to the states of its experience. All of which will be established in the following sections of the thesis, based on Rosen's explanation of the two systems of dualisms. Rosen asserts that the dichotomies of each dualism are dependent on the other, and therefore cannot be separated. Thus materiality depends on immateriality — and vice versa — in its contribution to representation in architecture, in the same way that virtuality and reality depend on each other in their contribution to meditating the medium in which representation can take place, to be experienced through overlapping layers of intentionality and interpretation, as in the observer's interpretations of what is being perceived and conceived in time. Therefore, the dualist notions expressed here are in fact non-dualist notions because they rely on each other's existence to emerge, as Baudrillard puts it:

"For duality can be neither eliminated nor liquidated – it is the rule of the game, the rule of a kind of inviolable pact that seals the reversibility of things" (Baudrillard, 2009, p69).

15.2.1. Materiality and Immateriality (Representation)

Baudrillard believes that we live in a world that is increasingly defined “as” and “by” representation (Baudrillard, 1994). On a specifically architectural note, Alberto Pérez-Gómez has written extensively about the subject of representation in architecture. Pérez-Gómez speaks of the vital influence of the tools of representation; he considers these to never be neutral as the tools determine the conceptual endeavours of architectural projects and deliberately elaborate the process of generation of form in general (Pérez-Gómez, 2002, pp3). Historically, architecture was preoccupied with the tectonics of its materials and the way they were crafted as a mere expression of those material properties, whether for representational or expressional means. Matter was the driving force of architecture. Interviewed by Andreas Ruby, Paul Virilio once stated that centuries ago matter was known to have two dimensions: mass and energy; he continues on to assert that today a third dimension has been added: information (Virilio and Ruby, 1998, p180).

Recent inventions of new material properties have contributed, to a great extent, to the development of new forms and spaces that are mutable and unstable. A selection of these *Transmaterials* is evident in the content of a three-volume catalogue of materials, collected by Blaine Brownell, that have the potential to redefine our physical environment (Brownell, 2006), (Brownell, 2008), and (Brownell, 2010). Materiality in architecture, according to this thesis, is not limited to the physical world of objects, forms, and spaces, but rather extends to the digital, the interactive and furthermore to the hybridised environment of the two. Jonathan Hill asserts that:

"Architectural matter is not always physical or building fabric. It is whatever architecture is made of, whether words, bricks, blood cells, sounds or pixels" (Hill, 2001, p3).

Drawing on Hill's position, the thesis posits that matter can be physical (represented in glass, brick, concrete, etc.), digital (represented as data and information flow) or even conceptual and experimental (represented through ideas, new imperatives, and thoughts). Examples of each type of architectural form and space and their connotations of representation have been extensively discussed in chapter two, from the physical to the digital and interactive, as well as the experimental and theoretical.

Materiality in any type of architecture is a tangible state; however, for our purposes the discussion around the meaning and connotations of the idea of immateriality according to the architectural discourse is more relevant. In 1985 the French philosopher Jean-Francois Lyotard curated an exhibition titled: *Les Immatériaux* (translated as *The Immaterial*) at the *Georges Pompidou Centre* in Paris. Lyotard suggested a new kind of materiality which he terms "*immaterial*" that is linked to new states of interventions and environments connected directly to the technoscientific enquiry in an information age (Kluitenberg, n.d.). Such states alter the relationship between the human body and its environment where the notion of static and stable matter is replaced with multifaceted states of interaction (Alonso, 2005). Immateriality in this context relates to the perception and conception of architecture, meaning it relates to the consciousness of the active observer's interpretations of forms and spaces being observed. Jonathan Hill advocates that binding immateriality in architecture to perception centres our attention on the capacity to perceive one's perceiving and relations between the objects, spaces and users of architecture. Hill

argues, depending on Plato's assumption, that matter is modelled on ideal form and the immaterial is embedded within the realm of ideas; the immaterial can be associated with the formless (Hill, 2006, p72). According to Mary Douglas, the formless is not a representation of the absence of order, but it is order that is unacceptable or incomprehensible (Douglas, 1966, p104). Therefore Hill elaborates on Douglas' assumption and extends the definition of the terms "*material*" and "*immaterial*" that are in one another, they blur and slip, and therefore each is vital for the existence of the other (Hill, 2006, p72).

This thesis follows the position of Hill, and in addition it augments the meaning of materiality and immateriality in architecture to extend beyond the definitions above. Below are some considerations as to what connotations they may take relating to representation in architecture specifically. According to this research, materiality is not only embedded in the physical state of the outcome, i.e., in the execution of buildings, forms and spaces, but is also seen in the tools and means of communication in terms of representation and expression of ideas and narratives in architecture. Therefore, materiality is linked back to the act of jotting that Peter Cook refers to when talking about the tools of representation in architecture (Cook, 2008). As established in the previous three chapters when presenting the narrative of the thesis and the influence of the fields of biology, technology and perception, it appeared that representation is a *process of becoming* rather than an end or a mere tool of expression. Thus materiality in this sense is a mercurial, ludic and transient expression and representation of thoughts. As a notion it is not tied to a physical entity or matter, and therefore can be considered immaterial at times. Hence, materiality and immateriality shift boundaries

according to the dynamics of their relationship and the *processes of becoming*. This view does not tend to abolish but rather to partake in the distinction between materiality and immateriality which Mary Hesse explains in her book *Forces and Fields*:

“Materialism cannot rise until non-material forces or powers have been distinguished from matter” (Hesse, 2005, p39).

Hesse considered the non-material forces to be the functions of consciousness, for example, thinking, perceiving, moving, feeling, and willing that are assigned to a set of substances and expressed in space and time. From this, the distinction between the material and the immaterial begins to emerge (Hesse, 2005, p39). Materiality in architecture has been seen as being linked directly to the visual representation of objects, forms, spaces and environments, while immateriality is connected to expressions of our perceptual and cognitive apparatus or, according to Hesse, the functions of our consciousness. Edward Winters echoes much the same where he states:

“Visual representations, rather than linguistic representations, provide us with access to the visual properties of the supposed world. We see an object or scene and our visual awareness of that object or scene can contain everything that we can ordinarily see in the world when we put our perceptual apparatus under its usual obligations” (Winters, 2007, p140).

This thesis extends those connotations of materiality and immateriality to reach the Deleuzian fold and the gestaltian fields and forces surrounding forms and spaces, where for materiality and immateriality, representation is not meant to be the act of the fixation of meaning or a mimetic end to the world; rather, it is meant to be the process, the encounter, the tendency, and the continua of space and time (Massey, 2009, p20). Doreen Massey builds up her argument on Bergson’s and Deleuze and

Guattari's ideas of the dualism of space and time in relation to spatialisation and representation. Massey questions two main preconceptions: the first is concerning the assumption that representation fixes, deadens and therefore detracts from the flow of life. The second concerns a long-standing misconception that considers the product of this deadened process to be space (Massey, 2009, p26). She argues that representation is temporal, as fixated by Western philosophies such as the Bergsonian ideology; however, she adds that it is spatial too:

"What is at issue, in the production of representations, is not the spatialisation of time 'understood as the rendering of time as space', but the representation of time-space. What we conceptualise 'divide up into organs, put it how you will' is not just time but space-time" (Massey, 2009, p27).

Therefore, for Massey and other contemporary philosophers, representation is not static; it 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, p28). This thesis 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.

15.2.2. Reality and Virtuality (Medium)

Virtuality and reality act as the media in which representation can take place. The medium, acknowledged in this research, is in the sense of the hypothetical and sometimes the actual links that mediate between the process of representation and the process of experience in architecture. In architecture the actual or the real is

typically associated with the physical and the analogue, on the other hand, the virtual is typically associated with the Internet and computers; however, this is a limited interpretation of these concepts. According to Deleuze, the actual and the virtual cannot be separated; he argues that if perception were actual then the memories that are evoked by the act of perception would be virtual (Deleuze and Parnet, 2002, p148-150). In following Deleuze's thinking of the virtual and the real or actual, we are pushing the limited boundaries of their interpretations to reach further connotations and thresholds. Furthermore, Deleuze states, that a cloud of virtual images always surrounds actual objects. He explains their existence to each other in relation to the act and process of actualisation. Deleuze distinguishes between the actual and the act of actualisation in this the former is like a direct observation of an action, while the latter relates the outcome of the observed action back to its original state, meaning, "turning the object back into a subject" (Deleuze and Parnet, 2002, p150), where he says:

"The actual is the complement or the product, the object of actualization, which has nothing but the virtual as its subject. Actualization belongs to the virtual. The actualization of the virtual is singularity whereas the actual itself is individuality constituted" (Deleuze and Parnet, 2002, p149-150).

In his work, Jean Nouvel follows the Deleuzian sense of the non-dualist notions of virtuality and reality, and this is evident in his masterpiece *Cartier Foundation* building in Paris (1994) (Figure 106), where he deliberately attempts to achieve illusion, virtuality and reality in a building. The building is very simple, it is constructed from layers of glass that sit at a distance from each other, while the whole building blends with its surrounding context which is full of trees set back at different distances from the building. The reflections created on the glass façade of the building are of the

atmosphere and context that blends the reality and illusion into a hyper-reality or a meta-reality, where the virtual images described by Deleuze become the elementary images observed, perceived and conceived of the building. According to Nouvel, the virtual images here become the real in a meta-narrative scenario (Figure 107) (Baudrillard and Nouvel, 2002, p8). Nouvel's work highlights the evidence, in which the real can be virtual following the Deleuzian sense, and as a medium neither these notions belong exclusively to the actual or the digital but rather relate to both.



Figure 106: *Cartier Foundation*, Jean Nouvel, Paris 1994. (<http://www.flickr.com/photos/chanwoo/71281530/>).



Figure 107: *Cartier Foundation* in meta-narrative scenario, Jean Nouvel, Paris 1994. (<http://www.luxist.com/photos/works-of-jean-nouvel/1273056/>) and (<http://www.flickr.com/photos/ladernieremiette/2238720179/>).

Nouvel's architecture can be seen as "*open work*" in the sense of the idea described by Umberto Eco as deliberate ambiguity in meaning. Eco explains that "*open works*" must leave parts of their constituents unarranged for the observers, users or chance to arrange their own possible orders of ambiguity. This means that the designer will

deliberately avoid pre-described interpretations and thereafter, avoid the creation of conventional forms of expression that are direct and lacking ambiguity (Eco, 1989). Michael Hensel approaches Eco's call for "*open works*" through the incorporation of digital tectonics in the design process. Hensel elaborates that computational techniques add to the analogue interventions creating dynamics between the users, inhabitants and the built environment, which he explains via a description of his design-based research:

"The hypothesis that underlies the following design-based research is that the relational dynamic between object and subject, environment and inhabitants establishes a potential space in which social and cultural experience can be located" (Hensel, 2004b, p121).

Hensel, thereafter, speaks of the potential space, which lies in the creative thinking and computational design of the digital and the analogue combined. Paul Virilio discusses and criticises the potential space, and attributes new characteristics to this space such as the notion of disappearance as a new mode of appearance (Virilio and Ruby, 1998, p180-181). Virilio gives two conditions to the notion of disappearance that fit the real and virtual paradigms. The former is represented through the use of glass as seen in Nouvel's *Cartier Foundation* building and the latter is represented through digitised, technological and computational interventions in design processes that bear a resemblance to Hensel's research and practice. Both conditions define form no longer as static matter but rather as constantly changing and transiently emerging out of new configurations and encounters of tectonics and electronics merging together (Virilio and Ruby, 1998, p182). Virilio explains that by disappearance he does not mean elimination:

"The disappearance not only affects architecture but any kind of materiality: the earth 'deterritorialization', the body 'disembodiment' and architecture 'deconstruction – in the literal sense of the world, not the architectural style'. Any kind of matter is about to vanish in favour of information. You can see it also as a change of aesthetics" (Virilio and Ruby, 1998, p186-187).

Jean Baudrillard was the first to establish the notion of disappearance in arts and especially in the field of photography; however, his endeavours also apply perfectly well to architecture. Baudrillard explains the relationship between the virtual and the real through the idea of disappearance. He argues that psychologically it has been established that the real and reality intrigue us, but he later questions whether that is the case or whether reality's disappearance is what really captivates us, by stating:

"Behind every image, something has disappeared. And that is the source of its fascination. Behind virtual reality in all its forms 'telematics, IT, digitization, etc', the real has disappeared. And that is what fascinates everyone" (Baudrillard, 2009, p32).

From all the above, we can conclude that the medium in which architectural representation is experienced does not have clear boundaries or territories, its states shift and its conditions slide; it is limitless by being in constant oscillation between the real and the virtual. A clear definition of the boundaries between the real and the virtual is impossible to ascertain. Perceptually, both states oscillate between each other's territories and therefore, are never stable.

15.2.3. Intentionality and Interpretation (Experience)

Now that we have discussed representation through the non-dualist notions of materiality and immateriality, for representation to have a medium in which it can be characterised, whether real, virtual or both, it is vital to attempt to analyse these

notions through the observer's experience. It has previously been shown, in various sections of this thesis, that the essence of this research is not limited to the *being of* forms, spaces and events in architecture, but extends to the *process of becoming* through the meanings or interpretations and the intentions of those forms, spaces and events observed. However, understanding the haecceity of such forms, spaces and events by unpacking their ontological and ontogenetic characteristics is not to be discarded, but instead to be embedded within the interpretations of subjective and objective human interaction (Rudd, 1985, p9). Partly, this is based on the architects' intentions and partly on the imaginations and interpretations of the conscious experiences of architecture. However, most importantly, is to consider architecture as a critical act, following Colomina's distinction between architecture and building, where she states:

"Architecture, as distinct from building, is an interpretive, critical act" (Colomina, 2002, p207).

Slowly, architecture has come to be more in tune with its users by putting the psychological aspects of the observers' interpretations at the heart of the system (Norberg-Schulz, 1980, p5), through which the architect's role transformed from being the mastermind and the sole creator of architecture to being the creative establisher of rules and simple properties that interact with each other and with their users and observers to create far more elaborate, complex and stimulating designs. This former way of thinking about the relationship between architects and architecture assumed users to be predictable and to have no role in the aftermath of the creation of

architecture; however, the latter approach suggests a “creative user”³⁵ where the user initiates changes and development of his or her own spatial environment (Hill, 2003, p3 and 44).

It is crucial to discuss at this stage, the basis for interpretation in architecture depending on our individual experiences, our consciousness and behaviour which in turn are reflected on the whole experience of architecture and its own behaviour. William Rudd explicitly talks of the relationship between the *being* of object, form, space or event and its meaning or interpretations that pivot and oscillate around each other, where he states:

“[...] the essentiality of being is augmented by the temporality and variability of meaning recognizing that whether valid, desirable, appropriate or not plurality exists both in building, object or event and in man’s individual interpretation of them” (Rudd, 1985, p9).

Juhani Pallasmaa echoes much the same when he speaks of the phenomenology of architecture as it reveals itself through the interpretations of the consciousness experiencing it (Pallasmaa, 1996, p452). Mary Hesse, however, lists different aspects of the interpretations of the consciousness. She begins with the field of extrasensory perception or parapsychology and moves towards a more modern version, which is “ ψ ³⁶-phenomena”. Hesse describes the multifaceted aspects of the field through “ ψ -experiments” of mainly card guessing experiments in psychology or “ ψ -interpretations”, as “some kind of communication of the facts to the subject by abnormal means” such as telepathy, clairvoyance, and precognition (Hesse, 2005,

³⁵ In the thesis the phrase *active observer* arises from the interpretations of Hill’s “creative user” and the use of the phrase in second order cybernetics.

³⁶ ψ is the Greek letter translated into English to Psi and pronounced as /'saɪ/, *sigh*. The letter is used in psychology to mean the paranormal and is related to the supernatural or parapsychology.

p295-297). If the above sorts of communication are accepted, then the scope of interpretation will be widened and more complex. This thesis, does not consider the existence or nonexistence of such phenomena, however this work sheds light on other possible distractions and complications in the field of interpretation.

In 1979, Juan Pablo Bonta published an entire study on different modes of interpretation in architecture. His main concern was to be able to identify some patterns possibly emerging out of studying the chronological sequence of critics' interpretations of certain architectural works (Bonta, 1979, p131). Bonta's study depended more on the critics' opinions in their interpretations of architecture and partially ignored the intentions of the designer or the architect basing this method of study on the assumption that designers might not have intended to communicate anything through their designs (Bonta, 1979, p225). However, more to the point, he argues that people are more interested in conveying their own meanings and interpretations in the environment through their own expressive systems, and their own frame of reference that are perhaps shared with their community but not necessarily with the designer or the architect. Therefore, Bonta concludes that the focus should be on the interactions between the design and its interpretations regardless of the architect's intentions, where he states:

"In attempting a view of architectural history based on the paradigm of interpretation, one should concentrate on the interactions between design and interpretation. Such a history must deal not only with pioneering designs, but also with pioneering interpretations. It must elucidate not only the effect of forms over their interpreters, but also the effect of interpretations over the design of forms" (Bonta, 1979, p232).

Upon what has been presented from Hesse and Bonta, interpretation by itself is a volatile and multifaceted notion; Norberg-Schulz stretches its connotations to our intentions when experiencing architecture, which he refers to as “attitudes”. Norberg-Schulz argues, based on psychological experiments, that we experience things differently depending on our mood and physical properties, attitudes and orientations. He furthermore asserts naivety in assuming the existence of phenomena independently of attitudes as attitudes are often governed by situations. He adopts Egon Brunswik’s view on the use of the word “active” instead of “attitude” in expressing the act of perceiving, where he claims:

“Perception, therefore, is anything but passive reception of impressions. We may change the phenomena by changing our attitude” (Norberg-Schulz, 1985, p31).

According to Bonta, the designer or the architect has been isolated from the dialogue between notions of interpretations and intentions under the active act of perception. However, Adrian Snodgrass and Richard Coyne stretch Norberg-Schulz’s connotations of attitudes to the designer. Snodgrass and Coyne put the designer back at the heart of the equation as they consider the act of designing itself to be an act of interpretation (Snodgrass and Coyne, 2006, p4). This assumption means that the act of interpretation does not only begin when the design is finished and being experienced, criticised and interpreted by critics or by active observers, rather, it means that the act of interpretation emerges at the beginning of the design process. Snodgrass and Coyne base their argument on Gadamer’s dialectic hermeneutics³⁷, which is predicated on understanding the text and the context, i.e. the parts and the whole, in a dialogue. They suggest that the dynamics of the process of designing could be built on the

³⁷ Hermeneutics is the science of interpretation.

processes of interpretation, validation of interpretations through assessment of dialectic exchange, and constant reinterpretation through the identification of perceived errors in an open system (Snodgrass and Coyne, 2006, p39-40). By following Heidegger and Gadamer's ideologies of thought as being and existing in the world where we claim some of it as our own only when we participate in it, Snodgrass and Coyne argue that, throughout the design process, design itself is made of numerous varied interventions in the environment, where they state:

"Design presents itself as so many interventions into the environment. Thought is provoked anew, or set on a different course, when a drawing or model is produced, concrete cast, a new building appears, a sign is erected, or something is removed, excavated or defiled. By this reading we don't think to produce designs, but design interventions in the environment provoke thought and are constitutive of thought" (Snodgrass and Coyne, 2006, p258).

We can conclude from the above discussion that the architectural experience of intentionality and interpretation begins at the heart of the design process and does not stop thereafter, on the contrary it stays in constant exchange and flux with acts of reinterpretation of pre-existing thought. Snodgrass and Coyne's theory is also supported by the theories and writings of Christian Norberg-Schulz where he talks of the architectural experience as a whole. According to Norberg-Schulz, the experience of architecture is not limited to a play of forms and their aesthetics; it is dependent on the theoretical insights that are generated out of situations and contexts. He insists that objects or forms cannot be seen in isolation from their context but rather belong to situations and can be perceived as manifestations of each other based on presuppositions of thought that determined them (Norberg-Schulz, 1985, p85). This thesis takes the position of asserting the relevance of all dualist notions to processes of representation and experience in architecture, and the dependence of these notions

on one another, their contexts and situations. Therefore they cannot be separated and are considered to be non-dualistic and singular in their nature. Therefore, intentions and interpretations in architecture are born at the beginning of the design process and continue to exist as states ever after. Their territories and contexts are linked to the situations and different states of our consciousness, by which they belong exclusively to neither the architects, nor the critics, nor the active observers, but rather collectively exist as a representational, experimental or experiential state in the *process of becoming*.

"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, p59).

16. The System: Behavioural Architecture

Earlier in this chapter a clear definition of the word *system* was put in place which acted as a scaffolding for the non-dualist notions to be exhibited and intertwined with the territorial instability emerging from the interwoven fields that influence architecture. The two sub-systems have encountered notions of instability and incompleteness on all levels from the representation to the medium and later on the experience of both architecture and the self. It is now accepted that there is a feedback process of learning that occurs between architecture and the self. As established throughout history, architecture can learn to adapt to our needs, as in interactive architectures, and at the same time can teach us new ways of exploring and enhancing the environment around us, as in particular sustainable energy strategies such as cross ventilation (Fox and Kemp, 2009, p142).

The collision of the two sub-systems presented in this thesis, influenced by interdisciplinary research and passing through integrated states of representation, medium, and experience will result in a system of architecture that is constantly changing and therefore can be seen as behavioural. The behavioural system of architecture embeds transient dynamic changes of states over time. Multiples of such states collectively will create patterning of material and/or immaterial information of representation in constant dialogue with the intentions and interpretations of the experience in a certain medium in space-time. These states captured individually in a patterning sequence, when aggregated collectively, will create behaviour within a system, while individually they represent *frozen behaviours* of space-time in the architectural system.

This attempt to identify behaviour in architecture might represent a departure from *convention*; however, it does not require that the existing body of architectural theory must be ignored. The elements that constitute behaviour in architecture can be identified, and then drawn upon.

Homogeneous materials exhibited behaviour in architecture as in the form of compression; however, this kind of behaviour is predictable. This was the case until the appearance of theories of self-organization and complexity and their impact on architecture, which began in the last decade or so of the 20th century. According to Manuel DeLanda, thinking about forms and structures in architecture shifted as the

involvement of complexity theory increased in material technology and design, where he states:

"We may now be in a position to think about the origin of form and structure, not as something imposed from the outside on an inter matter, not as a hierarchical command from above as in an assembly line, but as something that may come from within the materials, a form that we tease out of those materials as we allow them to have their say in the structures we create" (DeLanda, 2004, p21).

Therefore, the behavioural architecture product is a fusion of all three form and space generations (discussed in chapter two); it embeds transient dynamic perceptual complexity that emerges layered over time and space. The overlapping layers of behavioural complexity that it exhibits are:

- Behaviour within the formation and development of the form, space, and their environment – representational behaviour.

This level of complexity focuses on the developmental processes and growth of forms and spaces via amalgamation of notions of real and virtual. It depends on principles and properties of complex systems such as emergence, self-organization and adaptation. This phase is practically a reflection of the relationship between the non-dualist notions of materiality and immateriality through ideas of reality and virtuality that were discussed earlier (sections 15.2.1 and 15.2.2 in this chapter). It is focused on the main characteristics of behaviour embedded in architectural representation through the hybrid medium of both real and virtual.

- Behaviour within the interaction required for the form, space-time, the responsive environment, and the active observer – collective behaviour.

This level of complexity depends mainly on circularity and feedback processes, negative and positive feedback between the body, the observer and his or her own consciousness, and the forms and spaces perceived and conceived in a *process of becoming*. At this level, and according to the cybernetic phenomenological model of the methodology, the observer actively enters the system and the feedback processes act as the mediating processes that will guide the thresholds between form, space-time, the responsive environment and the active observer to shift and change in a hybridised world of real and virtual. In this phase, the rise in the complexity of the behavioural characteristics of architecture is firstly evident in the transition from the material and immaterial representation. Secondly, it is evident in the introduction of the observer into the system through a medium of communication. An amalgamation of the oscillating patterns of communication between representation and the active observer – based on feedback processes occurring between each component of the system as described and space-time – reveals such behavioural characteristics.

- Behaviour within the overall architectural experience – experiential behaviour.

This level of complexity represents a perceptually challenging and highly speculative layer where architecture will interact and respond by following its own judgments on active behaviour. This layer of behaviour cannot be seen in isolation from the intentionality and interpretations of the experience of architecture as a whole, which are evident at the very early stages of the design process and never subside (as discussed in section 15.2.3 in this chapter). This phase of the behavioural characteristics of architecture completes the intertwined and overlapped interventions and diverse interactions and components of the entire system discussed in this

chapter. Nevertheless, it is crucial to point out that the system itself is open and this means that it will certainly be possible for other speculative research to add to the list above. However, the behavioural characteristics listed above form the basis for the architectural system.

This view of architecture as a fluid animated perceptual experience is not unprecedented; however, contemplating architecture as a system and maintaining the flow of the system as a whole, as well as considering the collectivity of its individual parts leads to a speculative future for architectural theory. It may appear that the main theoretical arguments discussed in this thesis are striving to dismantle the differences between the non-dualist notions, as the behavioural characteristics of the architectural system portrayed in the materiality and immateriality, reality and virtuality, and intentionality and interpretation. It is not the intention of this thesis to dismantle the differences and close the gap erected throughout the history of architecture between the non-dualist notions. These differences drive a constant conspicuous oscillation between architecture and the rest of the dynamic system and its influential fields, such as biology, perception and technology. Therefore, highlighting the differences as well as accentuating the gap, although this might seem a controversial idea, will contribute to the emergence of new imperatives for generating a theory of behavioural architecture and furthermore, realise architecture as a dynamic system.

A pre-programmed model has been created, which will be explained shortly, to realise the territorial instability of the interwoven fields of biology, perception and technology in architecture through the exploitation of local rules of emergence, self-organization,

bottom-up as well as top-down behaviour and active perceptual and cognitive representations of situations and events, all based on an anthill structure.

Ant behaviour and nest architecture are the richest natural examples of generative systems composed of simple individuals. These individuals follow patterns of indirect interactions developed through experience, where stigmergic behaviour is exhibited within the collectivity of their colony (Grassé, 1959) rather than a pre-designed pattern. These performances in time represent indirect communication between the ants in their environment which leads to an organized emergent behaviour that shows ordered patterns of interactions reflected in the achievements of the colony as a whole: maintaining food flow, storage, cleaning, taking care of larvae, the queen, and protecting the entire colony.

The pre-programmed model created for this thesis was inspired by the work of Dr. Walter R. Tschinkel, a biological scientist based at Florida State University. Tschinkel and his team excavated an entire ant nest in order to provide information on the functionality of such colonies and the performances of the individuals that can produce such complex systems (Tschinkel, 2005). A thin plaster was poured into the void of a chosen nest in Florida through the main chambers which was left to set and later excavated to reveal the three-dimensional structure of the nest (Tschinkel, 2005, p3). Tschinkel and his team were more interested in the outer hierarchical three-dimensional structure of shafts, chambers, pockets and rooms, etc. of the nest (Figure 108); however, in this thesis the interest is more focused on the inner experience of the nest structure, which was hypothetically orchestrated based on the outcomes of

Tschinkel's research and the principles and processes gathered from the previous four chapters.



Figure 108: Excavated Ant's nest architecture, Dr. Walter R. Tschinkel, Florida, (<http://www.youtube.com/watch?v=tyBf3GcGX64&feature=search>).

Three main points from Tschinkel's research directed the intentions and the representational interpretations of the design of this thesis' final model. These points were:

- Network/Communication/Interaction: a decentralised network of communication appears as a result of mapping the entire pattern of interaction of the nest structure which reveals multiple layers of complex patterns.
- Distribution of function: as part of these complex patterns, the distribution of roles and tasks stemmed from the ants' behaviour around and about the structure of the nest which appears as multiple layers cascading in complexity from the exit shafts and winding further down to chambers with different functions such as storage rooms, cultivation spaces, nurseries for eggs/larvae, housing and the main queen chamber which normally lies deep in the heart of the nest.
- Patterns of orientation and movement: the ants' movement forms another part of this complex communication system. Scientists (Hölldobler and Wilson, 1994) have discovered that ants walk at a certain angle, speed and motion depending on their role

and size within the colony. In general this movement maps out a zigzag path which is clearly reflected in the construction of the nest.

The pre-programmed model³⁸ starts off with a hypothetical nest context (Figure 109) which was created to draw on the above three levels of complexity in the form of sections (Figure 110). These sections reveal a conceptual vectorial pattern that radiates from the main nodes, which form the most connected parts of the nest structure (Figure 111). These nodes originated out of the main connections and crossovers during the colony's daily activities. The next stage of this model emerged out of the theoretical pattern of the previous figure to conceptualise the shift in the perceptual experience of the observer and to place him or her in the created visionary architectural spaces of the internal nest structure.

³⁸ Proposed model description published in *New Realities: Being Syncretic* (2009), Vienna: Springer, p202-206, and presented at the 9th International Consciousness Reframed Conference, Vienna 2008 (Murrani, 2009).

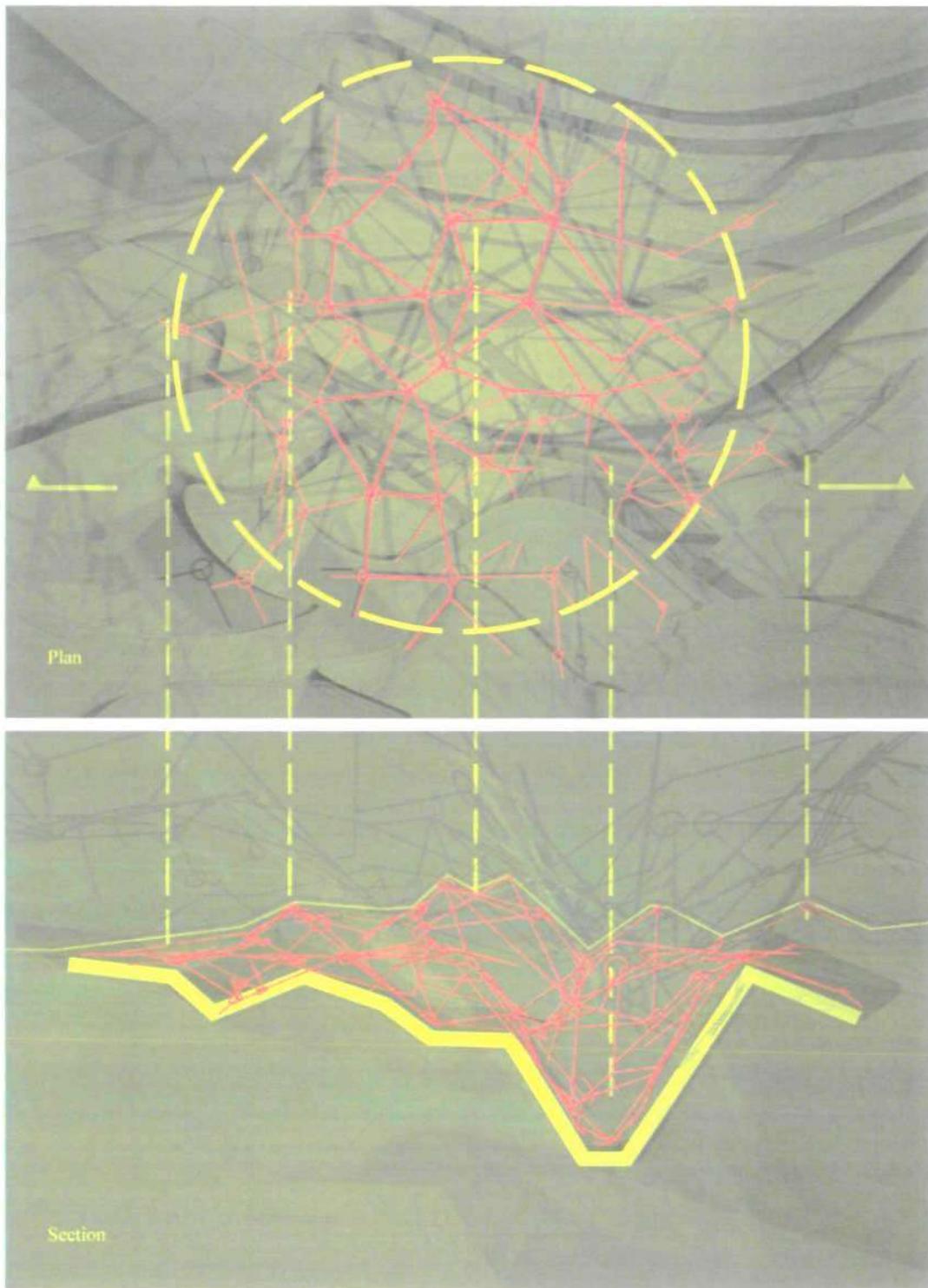


Figure 109: Illustration of a hypothetical nest context.

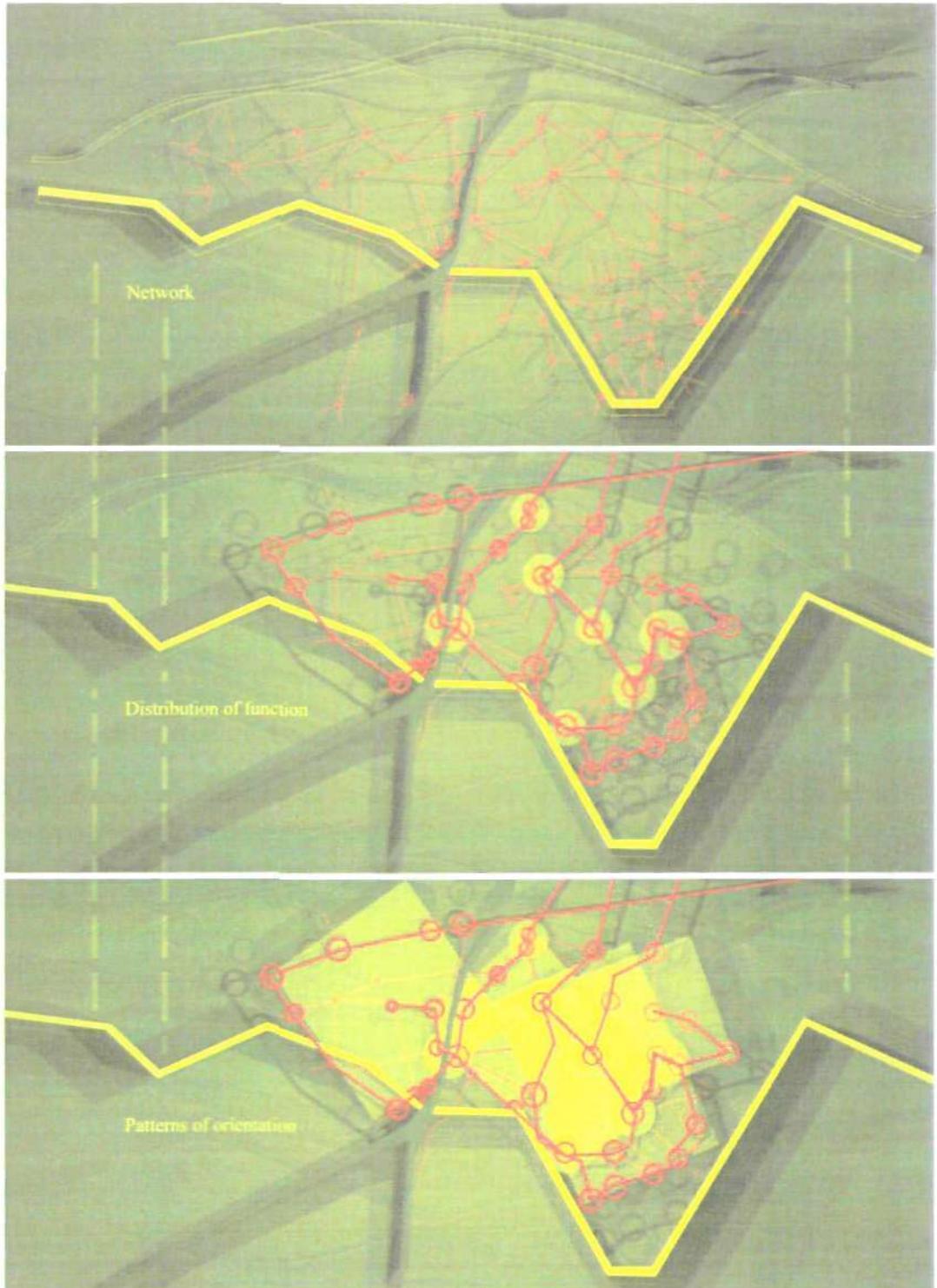


Figure 110: Illustration of three levels of complexity in the form of sections.

The shift happens on two levels. The first level introduces the observer to three-dimensional fragments of the conceptual space, where the observer will experience

parts of the yet to be connected system (Figure 112). These fragments, which are called pockets, have different spatial orientations due to the overlapping and the interaction of the complex patterns of movement/role/function of the gestaltian structure of the nest architecture. The second exposes them to sections of the model, layer by layer (Figure 113), in order to experience the whole in a certain moment in time, i.e. exposing the observer to *frozen behaviours* as representations of situations, events and folds during the experience as a whole. Therefore, the interpretation of this model at any given moment depends dramatically on the consciousness of the observer and his or her own subjectivity, hence the architectural experience is constructed when the observer enters the system by stipulating his or her own purpose.

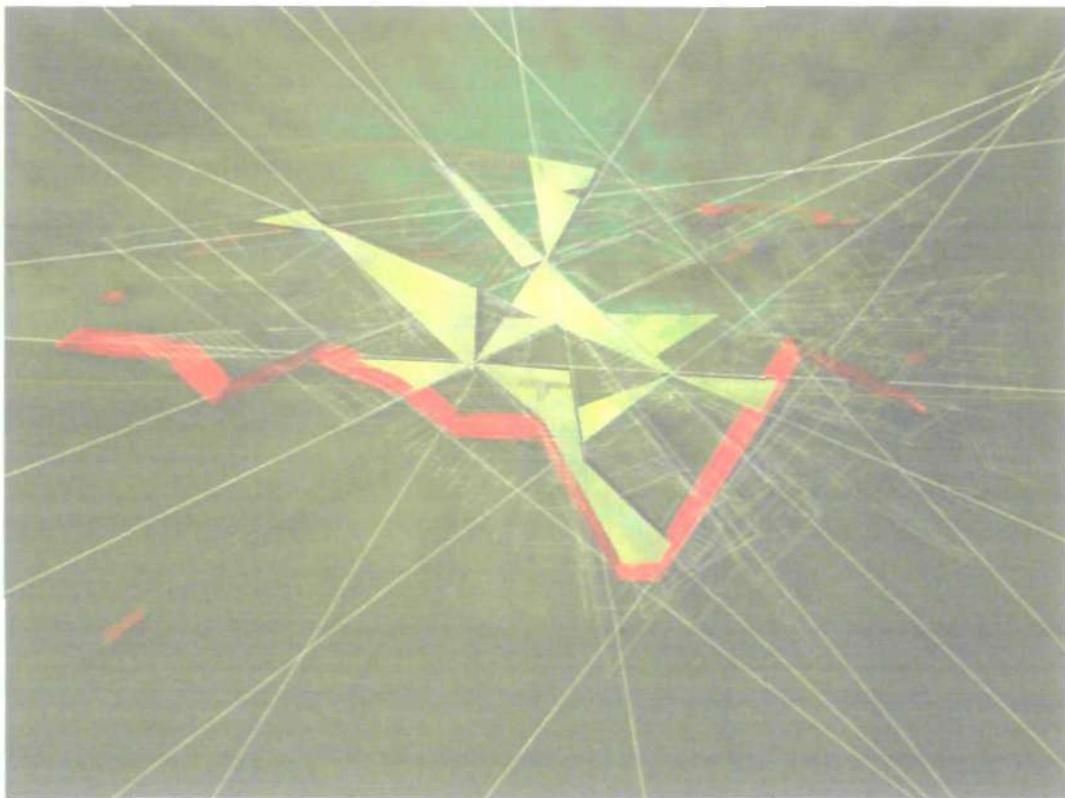


Figure 111: Illustration of a conceptual vectorial pattern of the connected parts of the nest structure.

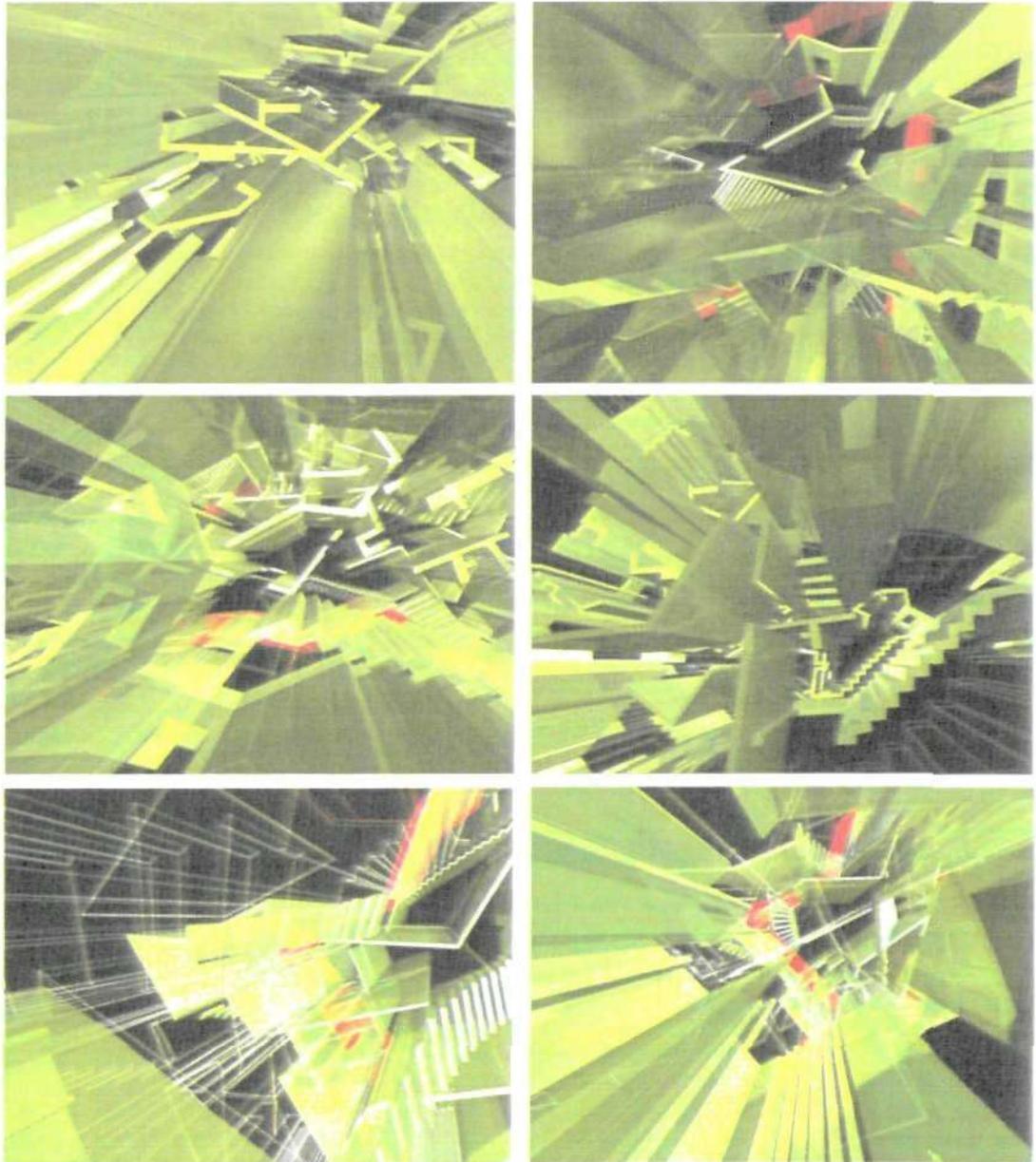


Figure 112: Illustration of a series of fragments of the model.

Ascott urges the need for a new understanding of human presence and consciousness to enable the observer to inhabit both the real and virtual worlds at the same time and to enter the system while being able to observe it from the outside. He refers to this whole new faculty as *“cyberception”* (Ascott, 2003b, p319). Moreover, Ascott differentiates *“cyberception”* from perception and conception where he states:

“The answer lies in our new understanding of pattern, of seeing the whole, of flowing with the rhythms of process and system” (Ascott, 2003b, p321).

He then goes on to assert that *“cyberception”* means sensing the whole unlike the result of a linear style of thinking that leads to dividing the world up into classes of things:

“Objects with impermeable boundaries, surfaces with impenetrable interiors, superficial simplicities of vision that ignored the infinite complexities” (Ascott, 2003b, p321).

This claim of the need for *cyberception* as a mode of consciousness is supported by the notion of second-order cybernetics as the cybernetics of observing systems as opposed to the cybernetics of observed systems (von Foerster, 1979).

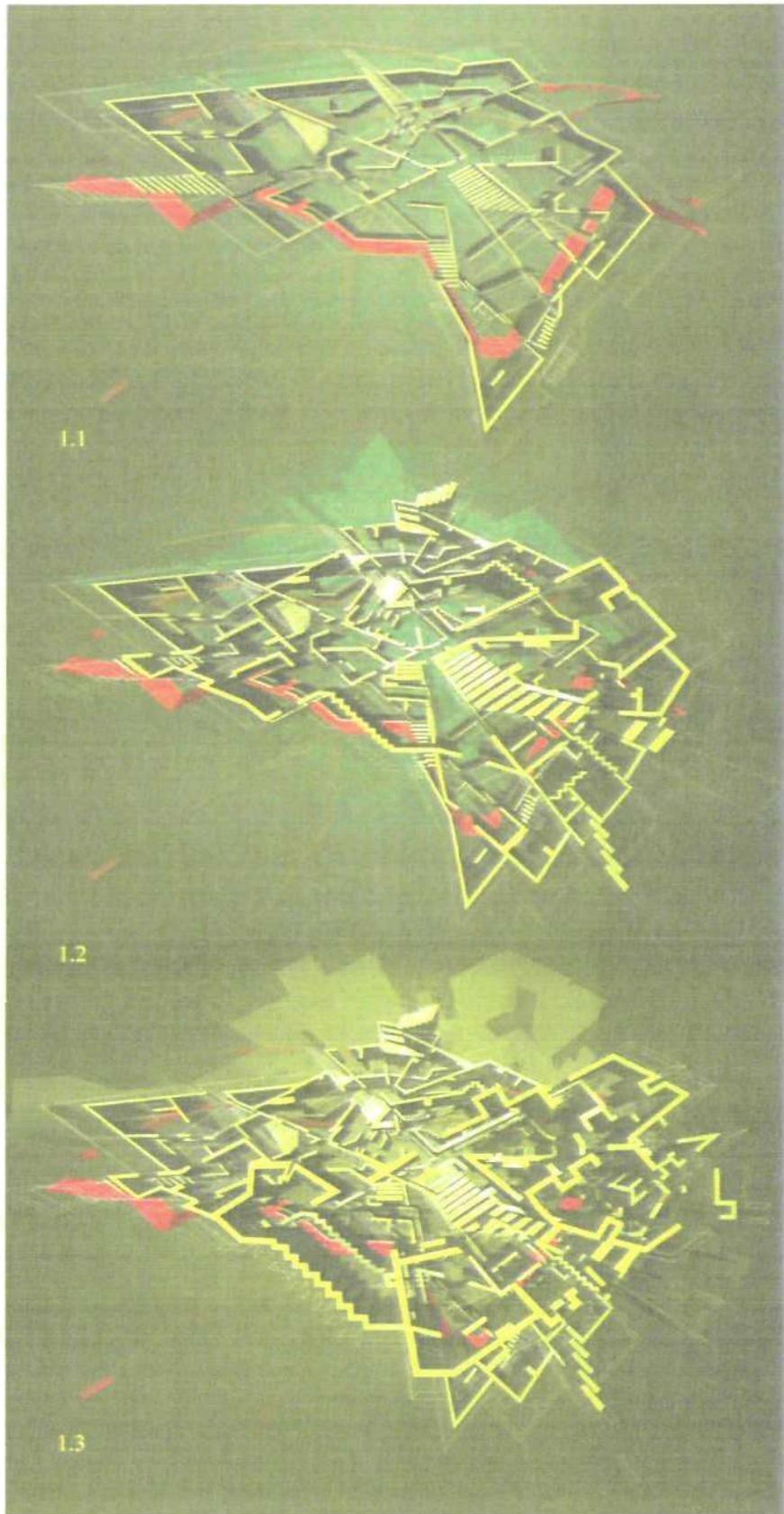


Figure 113: Illustrations of a series of frozen behaviours as representations of situations, events and folds of the model.

The intention of this model was to shift the perception of the observer from imagining an ant colony into placing oneself in such spaces. This will evoke dialogues between two different perceptual and experimental experiences. The use of architectural tectonics, such as ladders, that pre-exist as types in our consciousness with their function of linking spaces in different spatial orientations was intentional. It assists in activating links that lead the observer to a deeper level of cognition of information/space. This model is equivalent to the idea of a hypertext but in the context of the situational and perceptual space. Instead of the *click and jump* words in the virtual world, spaces in this model are modulated by the behaviour of the system and the consciousness of the observer into situations, events, and experiences rather than actual physical or literal interpretations of forms and spaces.

In this model, visual fields and forces that surround the original nest structure have impacted on the intentions and the interpretations, which were reflected in the representation of the hypothetical experience, situations, and events. The construction of such experiences will eventually have a great impact on the emergence and regeneration of new active conceptual and experimental forms and spaces in the environment. These visual forces are vectors of perceptual fields surrounding a form-space generated by its structure (Arnheim, 1978, p28). Collectively, vectors of multiple forms in a context will create organized structural patterns of behaviour in space and time that represent architecture as a system. Furthermore, the integration of principles and properties of complex systems and dynamic perception creates a platform for the synthesis and analysis of architectural behaviour through representation and experience.

This dynamic complexity is always subject to change as it is connected to the users/observers/designers, some of whom are connected through virtual and physical communities; this change is the product of technology and deeper biological understanding. As architecture forms a great part of these virtual and physical environments, eventually it will leap into this volatile context of contrasting capabilities, perception, memory and history reflected upon architecture from its active users/observers/designers. This work represents a speculative future and an early stage of development, anticipating a theoretical architecture that is humanised by its placement in the perception of the observer, its recognition of the body, and its consciousness as part of a transient ecology.

A movie clip has been created to exhibit the stages of creation of the model titled: *Unstable Territories*³⁹. It starts with the hypothetical context and then shows in sequence the emergence of the conceptual structural pattern via the analysis of the network of communication, the main nodes of connection, the trails of the functional connections between the agents, and the layers of overlapped functionality and communication. Thereafter, the clip develops into motions of hyper-experiences when the observer enters the structure and their body becomes an extension of the situations, events and experiences created. The body becomes light and boundaryless, it travels through, in-between, and inside form and space-time. Later, the motion of the clip will take the observer into another stage of experience, outside the structure,

³⁹ Movie clip can be found at: <http://sanamurrani.me.uk/unstableterritories/UnstableTerritories.m4v>

to explain the two-dimensionality and the three-dimensionality of the representations of important pockets of connections and the main three layers constituting the whole.

This final stage of this experimental model created and discussed for this thesis lies in the attempt to create a perceptual dialogue between representation and experience of architectural events and situations through form and space. The final stage acts as an extension to the notion of the Grotto⁴⁰ (Figure 114).

"It is always elaborately artificial; absurdly fake. Against this backdrop of theatricality, forbidden pleasures can occur: hidden and discovered, stolen and intimate. The grotto found its heyday in eighteenth-century English gardens, providing a dark and erotic narrative to the landscape gardener's palette" (Aranda and Lasch, 2006, p80).

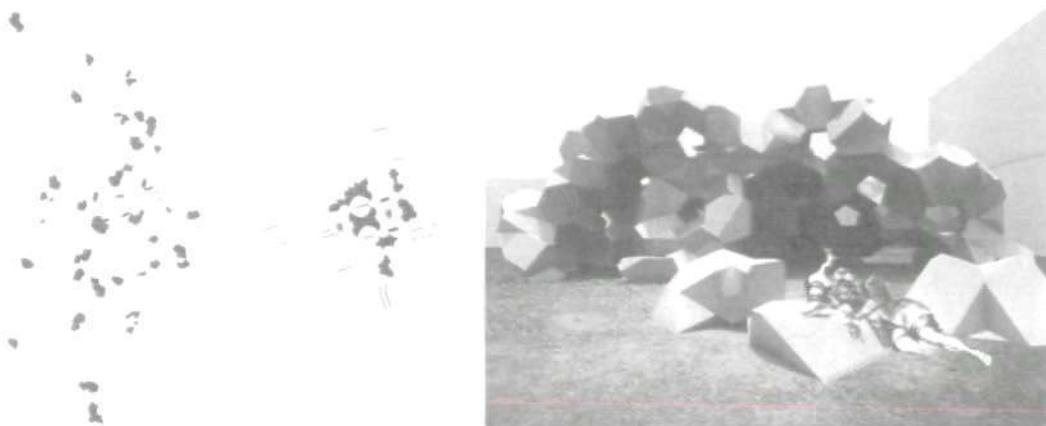


Figure 114: Illustration of project *Grotto*, a temporary summer pavilion developed at Arup AGU incorporating the notion of the Grotto (Aranda and Lasch, 2006, p86 and 89).

The effect of the Grotto was at the heart of the creation of the model described above, where the main focus was on the representations and experiences of situations, events and the links between them rather on the creation of actual spaces and forms. Thus the model succeeds in exposing the relations between cybernetics and

⁴⁰ The grotto is an artificial structure or excavation in a garden made to resemble a cave.

phenomenology in a hypothetical and virtual architectural context. In her book titled: *How We Became Posthuman*, N. Katherine Hayles suggests that:

"[...] living in a condition of virtuality implies we participate in the cultural perception that information and materiality are conceptually distinct and that information is in some sense more essential, more important, and more fundamental than materiality" (Hayles, 1999, p18).

Therefore, an anticipation of an experimentally and experientially based architectural theory is created which humanises architecture and places it in the perception of the observer; it furthermore recognises that the observer plays a vital role in our dynamic culture and responsive environments. This is achieved by establishing a conspicuous exchange of relations between architecture and its context, between the context and the active observer, and furthermore, between the observer and architecture in a transient *process of being and becoming*.

17. Speculative Future

It may seem impossible to build up a theory for a speculative future when it has already been established that all the components of this theory are mercurial, they slide and shift boundaries and cannot be pinned down or identified as static. In order to tackle this difficult task, the thesis firstly tends to shift three main ideologies established in architecture since the *Modern Movement* relating to representation, experience and the spaces-in-between under the technological advancements of the current age and beyond. In relation to representation, a shift from abstraction to figuration is later on transformed into notions of situations and folds. Instead of the standardisation of forms, spaces, and their relations to the imagery, representation is

now based on the perceptual and experiential communication with the body, an observer. As for technology, the shift is mainly from the lifeless and clinical mechanisation to the technological sensibility visualised as a prosthetic device, an extension of the body itself (Schrijver, 2009, p200). These three shifts were interrogated through the analysis of a vast array of examples from practices and theories of art and architecture that contributed a great deal to the development of the conclusive behavioural system in architecture. These examples acted as mediating devices, and explorations of narratives that exposed different experimental and perceptual experiences in architecture embedded in their representation.

Secondly, this thesis has exhibited, explored and teased out throughout the research undertaken, multiple dualisms where each part of the bifurcation is dependent for its existence on its complementary part. The continuous oscillation between the bifurcation and dichotomies of the dualisms explored, resulting in their resistance to belong to either the form or its surrounding space took form in architecture through the notion of the *spaces-in-between*. Based on Haraway's definition of the form which is seen as a *formative process of becoming* (Haraway, 2004) and Blumer's *Symbolic Interactionism* methodology (Blumer, 1986), the *spaces-in-between*, in architectural terms, can be seen as a collective relational formative and perceptual process of becoming spatially, temporally and experientially. The *process of becoming* in its nature implies continuity, change and transient actions, and therefore, it continually passes through unstable states between being and becoming. These unstable states are direct results of the tensions of the dialogues between architectural embodiment in the spatial and temporal context and the cognitive and perceptual experiences of its

observers. Thus, the allocation of such states remains always incomplete under the formation of architectural representational, perceptual and experiential patterns. Instability and incompleteness are the two main properties exhibited by these states due to the fact that they are always constructed out of equilibrium, which is the tendency of all formative processes in natural systems (Ball, 2004b).

Thirdly, the thesis declares architecture to be not just a field of formalistic and material behaviouristic enquiries but also a social active medium of constant collaborations and explorations into interventions for the collective dynamic cultures of today. Certain aspects of such media have been explored via illustrative and experimental models through representational and experiential interpretations of spatially constructed narratives, situations, and folds that follow rules of emergence and collectivity in complex systems. Through the resultant outcomes of these three stages, the thesis establishes a system of behavioural architecture, a theory based on and acting upon architecture's representation, the active observer's consciousness and experiences, as well as the mediating tools, spaces and processes for the experiences to be actualised or in Baudrillard's vision, to disappear (Baudrillard, 2009). In doing this, the thesis has answered the research questions posed regarding the identification of the influences of the interwoven fields of biology, technology and perception on architecture, and confirmed the instability of the architectural system through its transient representations and experiences. In addition, it has defined the behavioural characteristics of the system to be embedded within its non-dualist notions of materiality/immateriality, reality/virtuality, and finally, intentionality/interpretations.

In a hyper culture of change influenced by physical and cyber communities, worlds and networks, further speculations for the future of the field of architecture will necessarily be directly linked to that cultural and technological change. This change starts with the multiple identities of one's representation as seen in MySpace, Facebook, Twitter, ordinary e-mail accounts and highly interactive mobile phone and other digital devices as well as avatars on Second Life, CyberTown and Active Worlds. The body is no longer seen as a physical entity composed of matter and energy but rather a volatile extension of our consciousness and experiential worlds of hybrids of physical, digital and augmented realities and virtualities. Therefore, there are different kinds of persons in the world, some of whom are connected, some virtually and others physically through their communities, provoking the question: what happens when architecture itself takes on many attributes of the observer, namely; growing, changing, reacting and interacting (behaving) to the observer/user as much as to the environment?

Possible attempts at answering the question proposed for further research could be based on the writings of Elaine Graham in *Representations of the Post/Human* (Graham, 2002), Donna Haraway in *When Species Meet* (Haraway, 2008), as well as N. Katherine Hayles in *How We Became Posthuman* (Hayles, 1999). N. Katherine Hayles a professor at Duke University in North Carolina who specialises in investigating the hyperreality of posthuman existence between the two tendencies of material and information relationship to the body and the machine under the cybernetic perspective. In her book *How We Became Posthuman*, Hayles describes the

relationship between humans and machines to be integral but with limits, where she states:

"Humans may enter into symbiotic relationships with intelligent machines (already the case in many places on the globe); they may be displaced by intelligent machines (already in effect, for example, at Japanese and American plants using robotic arms for assembly labour); but there is a limit to how seamlessly they can be articulated with machines, because they remain distinctively different from intelligent machines in their embodiments" (Hayles, 1999, p372).

Therefore, investigations into the embodiment of both humans and intelligent machines are important for the construction of speculative environments in architecture. Furthermore, it has been asked before (Kurzweil, 2005), what happens if machines become more intelligent than humans? Thus this thesis elaborates further to ask: what happens if architecture becomes more intelligent than humans? And can we call present innovations and interventions in architectural theory and practice *Postarchitecture* as in the environment of *Posthuman* and intelligent machines?

Attempting to answer the questions initiated in this section regarding the future speculation of architecture will require a theory that considers architecture to be a behavioural system and for that theory to be supported by a vast array of accounts of history and theory of architecture based on projects charged with experimentations, speculations, representations and experiences. Besides the contents and intentions of this thesis, writings and published work about this particular subject of speculation in architecture can be found in *Architectures of the Near Future* by Nic Clear (Clear, 2009), *Performative Architecture: Beyond Instrumentality* edited by Branko Kolarevic and Ali Malkawi (Kolarevic and Malkawi, 2005), as well as *Beyond Architecture: Imaginative Buildings and Fictional Cities* edited by Lukas Feireiss and Robert Klanten

(Feireiss and Klanten, 2009) among others. These projects envision a hyper-reality scenario with anti-narratives, spatially, temporally and most importantly experientially expressed.

This thesis endeavoured to become the grounding theoretical basis for the questions initiated in this final section by interconnecting the theoretical and the practical in current and future architectural discourse. It furthermore attempted to push the boundaries of our understanding of the involvement of behaviour in architecture to reach beyond material and structural properties. It shifts our understanding towards the identification of the existence of behaviour on a collective perceptual and experiential level through an analysis of representations of architecture. The basis for this theory is dependent on hypothetical thresholds and unstable territories between multifaceted dichotomies related to the elastic meaning of the body, one's self and consciousness, the medium of expression between representation and experience, as well as the sliding boundaries of meanings, intentions and interpretations of forms, spaces and time in architecture.

The trajectories of this theory represent the seeds for the emergence of further development in theories and practices in the *Posthuman* age suggested by Katherine Hayles and the *Moistmedia* world envisioned by Roy Ascott. Accordingly, the collective behavioural system of architecture that emerges out of interactions between the two sub-systems – influences of the interwoven fields on architecture, and the non-dualist

notions – exhibits notions of Maturana and Varela's *structural coupling*⁴¹ and at the same time acts as an *autopoietic system* (Maturana and Varela, 1987). Maturana and Varela maintain the definition of structural coupling in systems to be, “[...] a history of recurrent interactions leading to the structural congruence between two (or more) systems” (Maturana and Varela, 1987, p75). Through oscillations between the *processes of being and becoming*, the behavioural system of architecture maintains its existence, instability and incompleteness.

⁴¹ *Structural Coupling* is a property of *Autopoietic Systems* where the system exhibits both autonomous, closure and self-preferentiality as well as maintaining a constant relationship of interactions with its context or environment (Varela, 1979).

CHAPTERSIX: BETWEEN CYBERNETICS & PHENOMENOLOGY: THIRD WAY PHILOSOPHY FOR ARCHITECTURAL DISCOURSE

This chapter in its essence is there to challenge and unfold, each at a time, two different fields of methodology – cybernetics and phenomenology – that have direct effects on the product of *being* and the process of *becoming* in architectural discourse. Furthermore, this chapter suggests a third way philosophy for architecture that relates notions of postphenomenology and technoscience and considers both to be equally vital to development and speculation within current architectural discourse. Firstly, the history of each of the two fields – cybernetics and phenomenology – will be unveiled with a focus on exploring their impact upon architecture in particular and diverse fields such as: other art disciplines, computer science, and psychology. Secondly, a critique of the historic rivalry between pioneers in each of the two fields will be unpacked through their errors and limits. Thirdly, attempts will be discussed at converging the two fields in order to address the relationship of notions of humanism, machinism and technology. Finally, a declaration of the characteristics of such a convergence that will lead to a third way philosophy for architectural discourse will be asserted.

The first documented use of the term “*kybernetike*” dates back to 400 BC and is found in Plato’s philosophical essay *The Republic* in an attempt to describe the art of navigation. This early description of the term formed the basis for André-Marie Ampère’s foundation for the classification of sciences: “*The future science of government should be called ‘la cybernétique’*” (Ampère, 1834). In 1948 Norbert Wiener subsequently adopted this later use of the term where he gave the study of *control and communication in the animal and the machine* the name *cybernetics* (Wiener, 1961). Since then cybernetics has evolved from the first-order cybernetics

concerned with the behaviour of machines and self-regulating systems to the second-order cybernetics that extended to the involvement of the observer, his/her behaviour and consciousness as influential contributing participants in the system (von Foerster, 1979). Cybernetics became widely known in the second half of the 20th century after the series of *Macy Conferences* held mainly in New York city between the years 1946 and 1953, where heated debate and discussions took place, exposing relations and issues of interdisciplinarity between cybernetics as a major field of influence and the rise of other fields such as systems theory, emergence, and interactive technologies (Herr, 2010). This wave of interest in cybernetic thought impacted many fields in the arts and architecture. One of the early advocates and educators of the second order cybernetics in the field of interactive arts is Roy Ascott. His artwork *Change-Paintings* exhibited in Molton Gallery in London in 1961 was one of the early pieces of art that demonstrated the need for participatory interaction from the audience for what is ultimately an open-ended piece of work (Ascott, 1961). Simultaneously in architecture, the cybernetician Gordon Pask worked on several architectural projects alongside architects such as Cedric Price and John Frazer, implementing cybernetic thinking into architecture to achieve environments that respond to their inhabitants through change and interactivity.

Similarly to the history of cybernetics, the history of phenomenology was rooted in the philosophy of the early 16th and 17th century *Renaissance* before its modern use by Husserl, Heidegger and Merleau-Ponty. The *Renaissance* scholars' ethos of the search for humanist methods for realism and particularly in the arts, have extended to Hegel's idealist account of reality which was the basis for the early involvement of

phenomenology in philosophy. At the same time they expected of the field of art a constant process of technical involvement – “*not in order to de-anthropomorphize art... but in order to render its human truth complete*” (Heller, 1978, p411).

Throughout history, phenomenology has developed and taken different directions. The transcendental basis in particular was founded by Edmund Husserl at the start of the 20th century and subsequently applied to varied topics such as time, space, causality, aesthetics, psychology and sociology. This soon diverted into the level of philosophy, a philosophy of existence under the ontological and existential phenomenology of Martin Heidegger that discusses *consciousness, being, and subjectivity*; notions explored further by Sartre. This later became the main fascination of Merleau-Ponty who attempted to explain ontological philosophy in relation to human sciences by adopting the notion of embodiment to lay the foundation for phenomenology and perception (Macann, 2007).

The phenomenological chronicle did not end with the philosophical account but extended to reach the field of science and in particular the study of actual statistical and mechanical analysis of phenomena known as *phenomenological thermodynamics* (Cerbone, 2006, p1). Thus phenomenology has contemplated technology and its relationship to cybernetics since its early existence, however, this relationship has become the subject of much passionate debate and discussion for decades beginning with the writings of Heidegger regarding the distinction between the technological and the essence of technology and fuelled by the writings of Norbert Weiner (Heidegger, 1977b).

Until the industrial revolution of the 18th and 19th centuries the subject of *technology* was connected to mere construction techniques and by the mid 20th century and with the invention of the first developed computer, technology shifted to the design tools and later on to processes of design. This is true not only in the field of art but also architecture. At the same time computer scientists such as Terry Winograd were focusing on the influence of cybernetic methodology, and have also investigated the understanding of what it is to be human, a question deeply rooted in phenomenological thought (Winograd and Flores, 1986).

"All new technologies develop within the background of a tacit understanding of human nature and human work. The use of technology in turn leads to fundamental changes in what we do, and ultimately is what it is to be human. We encounter the deep questions of design when we recognize that in designing tools we are designing ways of being. By confronting these questions directly, we can develop a new background for understanding computer technology – one that can lead to important advances in the design and use of computer systems" (Winograd and Flores, 1986, pxi).

Computer scientists developed arguments connecting cybernetics to phenomenology through the writings of Kant, Husserl, Heidegger, Gadamar, and other phenomenologists whose work was primarily concerned with interpreting the workings of the mind by drawing a distinction between *"the thing-in-itself and the phenomenon it presents to us"* (Sharoff, 1995).

"I cannot explore my soul as a thing-in-itself by means of theoretical reasoning (still less by means of empirical observation); hence, I cannot explore free will as a feature of a being [...]. Nevertheless, I can think about freedom, that is, the representation of it is at least without contradictions" (Immanuel Kant, "Preface to the Second Edition," Critique of Pure Reason, trans. Kemp Smith, 1787; New York: St. Martin's, 1965, 28 (B XXVIII)).

In essence the connections between the *thing-in-itself* and its representation, the connections between our consciousness and the possibility of creating *artificial consciousness*, is exactly what computer scientists and particularly Artificial

Intelligence (AI) experts are interested in exploring. Winograd asserts the involvement of phenomenology and its theory of interpretations known as *hermeneutics* in the development of understanding cognition in computer science as a field (Winograd and Flores, 1986, p38). Such interests originated from the writings of Humberto Maturana and Francisco Varela through their investigation into neurophysiology, cybernetics and the organisation of living systems and their search for an understanding of the biological processes that can give rise to the phenomenon of *cognition* (Varela, 1979) and (Maturana and Varela, 1980). Similarly, Heinz von Foerster wrote extensively about the relationship between cybernetics, cognition and perception through the involvement of technology and machine intelligence in his essays in *Understanding Understanding* (von Foerster, 2002).

Other disciplines that crossed between cybernetics and phenomenology with their different trajectories are neuroscience, psychology, and active perception. Pioneers such as Hermann von Helmholtz and Richard Gregory stretched and blurred defined thresholds between explaining the phenomenon known as *errors of perception or illusion* through brain models and theories of vision (von Helmholtz, 1962) and (Gregory, 1997).

This brief scan over history is not only intended to provide a snippet of background of the two fields in question but rather is an attempt to assert the rootedness of their existence firstly alongside each other and secondly in opposition to one another, explained in the next section with their relation to architecture; their main conflict

comes in the form of dispute over the meaning and the extent of the involvement of *technology* in our daily lives, existence and consciousness.

18. Between Cybernetics and Phenomenology

Previous attempts at understanding the convergence between cybernetics and phenomenology as fields of influence or their trajectories onto architecture were explored by Sanford Kwinter (Professor of Architectural Theory and Criticism, Department of Architecture, Harvard Graduate School of Design) in his book *Architectures of Time* (Kwinter, 2002). Such explorations might not be as explicit as this research is attempting to achieve but nevertheless Kwinter's writings and theory are deeply concerned with the cybernetic approach of complex dynamic systems. Featured in many recent philosophical movements, and its relevance to the notions of immanence and individuation, derived from the philosophy of Gilbert Simondon that later influenced the philosophies of both Gilles Deleuze and Bernard Stiegler, Kwinter developed a theory of time that is based on a materialist approach to movement and time rather than space and time. Kwinter asserts that the dynamism of such philosophical and cosmological systems serves as the principle of infinite potential possibilities which when combined redefine, what Kwinter termed, the ontology of the "event" (Kwinter, 2002, p214). Kwinter's theory of "time" bridges two main networks of connections: the first on a cybernetic phenomenological level between theories of complex systems and Heidegger's ideology of time; and the second on a level of dynamic difference positioned between the philosophies of Heidegger in *Being and Time*, and those of Alain Badiou in *Being and Event*.

"The event is not actually internal to the analytic of the multiple. Even though it can always be 'localized' within presentation, it is not, as such, presented, not it is presentable. It is – not being – supernumerary" (Badiou, 2007a, p178).

Badiou's conception of the *multiple* parallels Heidegger's thinking regarding the terms *earth* and *world* in his exploration of difference. Badiou speaks of the *event*, which belongs to conceptual construction:

"[...] in the double sense that it can only be 'thought' by anticipating its abstract form, and it can only be 'revealed' in the retroaction of an interventional practice which is itself entirely thought through" (Badiou, 2007a, p178).

While Richard Coyne explains Heidegger's acknowledgment to the difference between *earth* and *world* as:

"[...] the earth is that which is not knowable. What it 'brings forth' (reveals) it also conceals. Earth offers the greatest resistance to the 'openness' (truth) made possible by the work of art. World is well understood in terms of the culture of a people, in the sense of Hegel's idea of an epoch. So, the earth conceals, whereas the world reveals" (Coyne, 1995, p196).

Coyne reflects on the phenomenology of virtual reality in relation to Heidegger's definition of the difference between *earth* and *world* in an attempt to not only find parallels between the two trains of thought but also to expose Heidegger's limitations towards thinking about *technology* and the *essence of technology* in our current time. While questioning the essence of the operation of difference in the case of computer technology such as virtual reality Coyne asserts that:

"The technology reveals, discloses, and opens up a world, but not primarily in the sense expected by virtual-reality writers. The world is disclosed through difference. [...]."

Recognizing difference within the play of metaphors opens up the possibility of new metaphors. The issue of difference brings us back again to Heidegger's notion of disclosure. Our discussion of virtual reality brings us to a consideration of metaphor and of difference, which clearly play a role in how we understand information technology" (Coyne, 1995, p197 and 200).

The identification of the close interlinked processes, of feedback and circularity between metaphors and difference in reality and those of virtual reality identified by Coyne, has contributed a great deal to the convergence between cybernetics, information technology and phenomenology in architecture. Similarly, Christopher Hight in his book *Architectural Principles in the Age of Cybernetics* does exactly that with a clear declaration to the links and shifts found between the *Renaissance* and mid 20th century architecture as well as current tendencies towards *post-humanism* and digital interactivity in design (Hight, 2008). Hight put forward a discussion for the theories of form in architecture not in the sense of formalism but in the relationship between architectural thought and production of processes that rely on both the dialectic history of preserving the body of architectural knowledge formed in the late 19th century as well as celebrating its ontology though the effects of technology (Hight, 2008, p194-195). Thus, Hight is neither surrendering to the thoughts of the phenomenologists and their antagonistic views towards the degree of involvement of technology in the body of architecture nor to the post-structuralists' desire to conserve it (Hight, 2008, p195). However, he is asserting Heidegger's notion of difference in relation to Coyne's notion of metaphor and Kwinter's notion of *event* by exposing the historical ambiguity of the body in relation to architecture:

"There is no need to dream of the day that humanist architecture and its subject might be erased. The figure of the 'anthropos' was never so clearly drawn. Its contours were not etched in a sandy firmament soon to be washed away by the tides of 'history,' but are indeed more like the turbulent flow of the waves themselves, emerging as momentary singularities, vortices measurable only amidst the laminar and nonlinear flows of history. It is within this turbulent space of formation that architecture and its subjects whirl. And it is within this immanence that we can measure resistances and currents to surf alternative tangents" (Hight, 2008, p195).

According to the architectural historian Alberto Pérez-Gómez, contemporary phenomenology has revealed that technological theory alone cannot resolve the

fundamental problems of architecture disillusioned with rational utopias and obsessed with reason over imagination (Pérez-Gómez, 1983, p325). Thereafter he confirms the foolishness of denying the “*ever present enigma of the human condition*” that he relates directly to intuition and mystery, which he calls upon architects to directly address (Pérez-Gómez, 1983, p326).

“Part of our human condition is the inevitable yearning to capture reality through metaphors. Such is true knowledge, ambiguous yet ultimately more relevant than scientific truth. And architecture, no matter how much it resists the idea, cannot renounce its origin in intuition. While construction as a technological process is prosaic – deriving directly from a mathematical equation, a functional diagram, or a rule of formal combinations – architecture is poetic, necessarily an abstract order but in itself a metaphor emerging from a vision of the world and Being” (Pérez-Gómez, 1983, p326).

Significantly what is in question here is the impact and the level of involvement of *technology* and technological theory in our life in general and architecture in particular. It seems that philosophers and theorists who criticised the involvement of technology in our society embraced the Heideggerian philosophy embedded in the phenomenological ideologies, and those who supported the transient evolution of technology that comes from cybernetics have accepted infinite involvement of the machine and later on prosthetic beings as agents of equal participation to humans in any system. However, regardless of the degree of involvement that technology is pursuing, this chapter is attempting to emphasise the importance of the integration of both ideologies – the phenomenological and the cybernetic – and the embedded significance of understanding the principles and processes of *becoming* rather than the mere focus on the outcome as *being*.

Heidegger pioneered the question of the ontological ground of *being* in *Being and Time*. He argues that we do not know what we mean by the term *Being* as it has been

overwhelmed by the preconceptions of Western metaphysical philosophy since Plato's time (Heidegger, 1962, p2). Therefore, in *Being and Time* Heidegger embarks on a process of defining the meaning of *Being* concretely and does so with reference to *time* as he considers it to be "the possible horizon for any understanding whatsoever of being" (Heidegger, 1962, p1). A pre-understanding suggests that the meaning of *Being* is the "most universal concept" of existence for any entity. However, Heidegger asserts that the "universality of *Being*" is not attached to a certain class or genus but rather a temporary condition of possibility for any entity (Heidegger, 1962, p22).

"[...] 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, p23).

"Something like 'Being' has been disclosed in the understanding-of-Being which belongs to existent Dasein as a way in which it understands. Being has been disclosed in a preliminary way, though non-conceptually; and this makes it possible for Dasein as existent Being-in-the-world to comport itself 'towards entities' – towards those which it encounters within-the-world as well as towards itself as existent" (Heidegger, 1962, p488).

Deleuze tangles the two notions, *being* and *time*, into the concept of *becoming*.

Together with Felix Guattari, Deleuze attempts, in *Becoming-Intense, Becoming-Animal, Becoming-Imperceptible*, to reinterpret the essence of *Becoming* through the memories of a *Moviegoer*, a *Naturalist*, a *Bergsonian*, a *Sorcerer*, a *Theologian*, a *Spinozist*, a *Molecule* and others (Deleuze and Guattari, 2004, p256-341).

"[...] 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 and Guattari, 2004, p262-263).

To some extent, it appears that Deleuze's concept of *Becoming* is very close to Heidegger's meaning of *Being* as *Being-on-the-way* (Badiou, 2007b). Contemporary continental philosopher Alain Badiou has dedicated a great deal to mapping out the parallels between Heidegger's meaning of *Being and Time* and Deleuze's *Becoming and Event* (Badiou, 2007a). Furthermore, Badiou identifies the close relationships between Heidegger's and Deleuze's philosophy in that *Being* and *Becoming* are essentially interpretive thought (Badiou, 2000). However Deleuze and Guattari in *What is Philosophy?* state a clear distinction between *time* and *event*.

"It is no longer time that exists between two instants, it is the event that is a meanwhile [un entre-temps]: the meanwhile is not part of the eternal, but neither it is part of time – it belongs to becoming. The meanwhile, the event, is always a dead time; it is there where nothing takes place, an infinite awaiting that is already infinitely past, awaiting ad reserve. This dead time does not come after what happens; it coexists with the instant or time of the accident, but as the immensity of the empty time in which we see it as still to come and as having already happened, in the strange indifference of an intellectual intuition. All the meanwhiles are superimposed on one another, whereas times succeed each other" (Deleuze and Guattari, 1994, p158).

Deleuze criticises Heidegger's limits of the interpretation of consciousness and intentionality, arguing that intentional relations derived from the non-relational, or what Deleuze calls the "*disjunctive synthesis*", are apparent between *nomination* and the *being*, or between consciousness and the object (Deleuze, 1988). Thus this non-relational synthesis suggests that thought relates to the *Being* that constitutes it.

"We can thus clearly state that what Deleuze considered as Heidegger's limit is that his apparent criticism of intentionality in favor of a hermeneutic of Being stops halfway, for it does not attain the radicalness of the disjunctive synthesis. It retains the motif of the relations, even if in sophisticated form" (Badiou, 2000).

Heidegger's limit did not stop at the ontological interpretations of intentionality and consciousness, but rather extended to his attempts at explaining the essence of technology through accusing humanism (Dupuy, 2008).

19. Heidegger vs. Wiener: Errors and Limits

The main dispute between pioneers of cybernetics and phenomenology came in their interpretation of the impact of technology on our lives and perhaps their fear of it reaching a point of overwhelming the human being and eventually cultures. Norbert Wiener wrote in critique of what he called the "*modern industrial revolution*" referring to the "*incidental contribution*" of the power of information technology (Wiener, 1961, p29):

"Perhaps I may clarify the historical background of the present situation if I say that the first industrial revolution, the revolution of the 'dark satanic mills,' was the devaluation of the human arm by the competition of machinery. [...] The modern industrial revolution is similarly bound to devalue the human brain, at least in its simpler and more routine decisions" (Wiener, 1961, p27).

It is important to clarify the context in which Wiener derived his thoughts on the decentralised power of information technology. During World War II when Britain was under Nazi air attack, Wiener developed a computational device with automatic aiming and firing for war aircraft. Therefore, he was referring to the power of information technology used in war. Since then Wiener advocated blurred boundaries between humans and machines that open an infinity of possibilities (Rosenblueth et al., 1943) and (McCulloch, 1974). This vision of an open-ended infinity of possibilities for the relationship between *humans* and *machines* was the concern of cyberneticians and for Wiener it represented an incarnation between *God* and *man* (Wiener, 1988).

Critics of classic cybernetic thought observed that cyberneticians have put power and control at the central definition of their philosophy relating *technology* and *man* to *religion* and *God* (Haraway, 1991). Peter Galison speaks of the shift from classical cybernetic thought to the *postmodernist cyborgian manifesto* addressed by Donna Haraway as she focuses on the variability and the unfixed nature of the cyborg not as the unlimited power but rather for the partiality of what is human (Galison, 1994).

"As she put it, we are ourselves already in so many respects cyborgs through our reproductive technologies, our psychopharmacologies, our prostheses (mechanical and computational) – that we can no longer put any stock in essentialist definitions of the classic dichotomies of mind and body, animal and human, organism and machine, public and private, nature and culture, men and women, primitive and civilized" (Galison, 1994, p261).

In essence, the writings of Wiener on the potential of information technology to devalue the human brain and at the same time referring to the integration between *human* and *machine* as an incarnation between *God* and *man*, were the main points of critique that Heidegger sought. Thereafter, Heidegger decided to take on the complex subject of untangling and explaining the difference between *technology* and the *essence*⁴² of *technology* (Heidegger, 1977b).

Heidegger does not explicitly state what kind of technology he is referring to when attempting to formulate the meaning of technology, however later, he notes that according to the Greek definition, there are two meanings: the first is *Techné* relating to activities and skills of the craftsman and the second is *Techné* which belongs to "bringing-forth" or to *poiesis* (Heidegger, 1977b, p13). Historically technology has been

⁴² Heidegger explains that essence means "enduring as presence" (Lovitt, 1977, p3).

defined as *"a means and a human activity"* and can therefore be called *"the instrumental and anthropological definition of technology"* (Heidegger, 1977a, p5). However, Heidegger relates those *means to an end* and *instrumentality to causality* and establishes that technology is not a means but rather a *"way of revealing"* (Heidegger, 1977a, p12).

Heidegger connected *"revealing"* to *"truth"* and the essence of things to the origins of their causality and argued that the destining of revealing is a mode of *"Enframing"* which he refers to as *"supreme danger"* (Heidegger, 1977a, p26). Furthermore, he states that technology itself is not dangerous, however its essence is, as it is *"destining of revealing"* and *"Enframing"*:

"The threat to man does not come in the first instance from the potentially lethal machines and apparatus of technology. The actual threat has already affected man in his essence. The rule of Enframing threatens man with the possibility that it could be denied to him to enter into a more original revealing and hence to experience the call of a more primal truth" (Heidegger, 1977a, p28).

Heidegger's questioning of the essence of technology is ontological rather than sociological. Despite his assumption of the lethal impact of the machine or the apparatus of technology, his main fear is that the essence of technology is *"enframing being"*. Andrew Feenberg explains Heidegger's technological concern by stating:

"Humans become mechanical parts in systems that surpass them and assign them their function. They begin to interpret themselves as a special type of machine. [...]. The role of humans in the revealing of being is occluded. We no longer wonder at the meaningfulness of things. The system appears autonomous and unstoppable" (Feenberg, n.d.).

Not only Heidegger but also Gilbert Simondon, a French philosopher known for his *theory of individuation*, has critiqued Norbert Wiener's theory of cybernetics and later developed a "*general phenomenology of machines*". Simondon criticised Wiener's cybernetics as a theory of technology for accepting classifications of technological objects operated by established means and criteria with certain genera and species, which he refers to as the main thing that any theory of technology must reject (Simondon, 2009a, p7) and (Simondon, 2009b).

In his essay on *Machinic Heterogenesis*, Félix Guattari criticises both Heidegger's and Wiener's positions on technology. He notes that the relationship between *human* and *machine* has been a source of reflection since the beginning of philosophy. Guattari refers to Aristotle's consideration of *techné* as a creative mediator between *human* and *machine* to create what nature finds it impossible to achieve. He argues that Wiener believed in the mechanistic conceptions of the machine by assimilating it to living beings; while Heidegger assigned the mission of "*unveiling the truth*" to *techné* setting it ontologically, and by doing so has compromised on its definition as a "*process of opening*" (Guattari, 1993, p13). Therefore, Guattari establishes that by oscillating between the two schools of thought:

"[...] we will attempt to discern the thresholds of ontological intensity that will allow us to grasp "*machinism*" [*le machinisme*] all of a piece in its various forms, be they technical, social, semiotic, or axiological. With respect to each type of machine, the question will be raised not of its vital autonomy according to an animal model, but of its specific enunciative consistency" (Guattari, 1993, p13-14).

20. Notions of Humanism, Machinism & Technology: Third Way Architecture

This thesis follows Guattari's thinking regarding the conception of an oscillation

between two methodologies: *cybernetics and phenomenology*. Moreover, the thesis distinguishes between Wiener's cybernetics and Heinz von Foerster's second-order cybernetics where the observer becomes part of the creative process through participation. From the previous sections above, it seems that the dispute between phenomenology and cybernetics is more fundamental than the question of technology. It is in fact a dispute over notions of *humanism, machinism and information* that this thesis takes the position of addressing, no longer as a dispute but rather as a third way conception for the architectural discourse.

To unpack this entangled prosthetic system is to involve current contributions to the fields of both *technoscience and postphenomenology*. However, before attempting to reach the conclusion of this chapter, it is vital to clarify some crucial points that have contributed to the later development of *technoscience and postphenomenology*. To continue with the build-up that this chapter attempted, the question of technology and its impact on our lives has not merely been a recent concern. Early surrealist writers questioned a world where machines will start thinking (Pias, 2005), this was followed by a response from the cybernetician and neurophysiologist Warren McCulloch and Walter Pitts in their famous paper on the *Logical Calculus of Ideas* (1943) where they provoked the question: "what if our thinking is already done by machine?" (McCulloch and Pitts, 1943). Claus Pias in his essay on *Analog, Digital, and the Cybernetic Illusion* describes McCulloch's techno-philosophy to be:

"[...] subverting or deconstructing several hierarchical differences like human and non-human, subject and object, psyche' and techne', man and apparatus" (Pias, 2005).

McCulloch's *techno-philosophy* challenged other philosophers' thinking of technology; from Freud to Nietzsche and McLuhan where technologies meant an extension of man, McCulloch blurred the notion of man, which was in question in Kant's "*What is Man?*" and Foucault's statement concerning "*the death of Man*" (Pias, 2005). The reality is that cognitive scientists and neurophysiologists have always been concerned with "*the mechanization of the mind, not the humanization of the machine*" (Dupuy, 2008). This question of humanisation or inhumanisation of man and machine was the concern of many philosophers and writers such as the phenomenologist Hannah Arendt. Arendt expresses her critique of science and technology describing it as "*rebellion against human existence*":

"Natural sciences have become exclusively sciences of process and, in their last stage, sciences of potentially irreversible, irremediable, 'processes of no return'" (Arendt, 1958, p231).

Jean-Pierre Dupuy, French philosopher, friend of both Francisco Varela and Heinz von Foerster, and advocate of defending the *essence of humanism* against the excesses of science and technology, relates technoscience to cybernetics and both to metaphysics through the act of "*calculating*":

"Technoscience, insofar as it constructs mathematical models to better establish its mastery over the causal organization of the world, knows only calculating thought. Cybernetics is precisely that which calculates – computes – in order to govern, in the nautical sense [...]: it is indeed the height of metaphysics" (Dupuy, 2008).

Don Ihde, a post-phenomenologist and a philosopher of science and technology, argues that technology does not determine the human condition but rather:

"[...] humans using technologies enter into interactive situations whenever they use even the simplest technology – and thus humans use and are used by that technology, and all such relations are interactive – the possible uses are always ambiguous and multistable" (Ihde, 2002, p131).

Dupuy's informed view over phenomenology and cybernetics has led him to the conclusion that both fields were vital for the existence of one another as the questions that their followers raised and are still raising are fuelling a historic debate over *humanism, machinism and technology*. Ihde developed the theory of *post-phenomenology* as an approach to *technoscience*⁴³ revealing such theory through the history of material technology (such as *Stone Age* tools), through to industrial technology (such as electricity, rail systems, factories, etc) and finally information technology (such as computers, the Internet, mobile communications and other media) which he refers to as *technoscientific* (Ihde, 2009, p38-39).

Ihde addresses the ultimate convergence between the two methodologies in question in this chapter – *cybernetics and phenomenology* – where he points out that since technologies are historically older than humans and while contemporary technologies are *technoscientific*, therefore, the way to critique and philosophically investigate this relationship has to be *phenomenological* – or what he finally terms *postphenomenological* as it unveils the variety of the human experience of technology (Ihde, 2009, p43).

Implications of such convergence are already evident in the participatory art practice, interactive architecture, cyberspace, virtual realities, *neoplastic* designs, and *prosthetic/posthuman* entities; all have contributed a great deal to creating parallel

⁴³ Technoscience: The study of both science and technology.

selves and other architectures where technology was and will always be at the heart of their creation. Instances of architecture, currently and historically, have had a close association with *humanism*. They were formally considered as mere sheltered environments and towards the start of the industrial revolution the field took *machine-like* trajectories (Banham, 1982). This approach was later criticised in favour of architecture that is more linked to the human *sense of space* (Bachelard, 1994). Two decades ago or so, with the start of the age of information technology, architecture started allowing for collaborations with other fields such as computer science and participatory art practice influenced by the cybernetic methodology (Pask, 1969). Since then, such collaborations have become widely practiced in architecture (Spiller, 2006), (Cruz and Pike, 2008) and (Hensel et al., 2006a), which has fuelled a phenomenological critique of the emerging architecture accused of *anaesthetisation* of the architectural practice (Leach, 1999) for fulfilling technological experimentation detached from the human senses (Pallasmaa, 2005b). However, if we look beyond the computer-generated images (CGI) that are wallpapering end-of-year shows and exhibitions, such technological experimentations are far from being detached from humanism but rather they create constant dialogues between *humanism* (through participation and interactivity), *machinism* (through experimentations and interdisciplinarity) and *technology*, to heighten the human experience.

This chapter has confirmed the importance of two critical points: the first states that the dispute over technology has contributed to sustaining philosophical debates and arguments, and the second asserts the vitality of the oscillations and the convergences between the two methodological approaches adopted for this thesis to enable a third way philosophy of architectural discourse to emerge.

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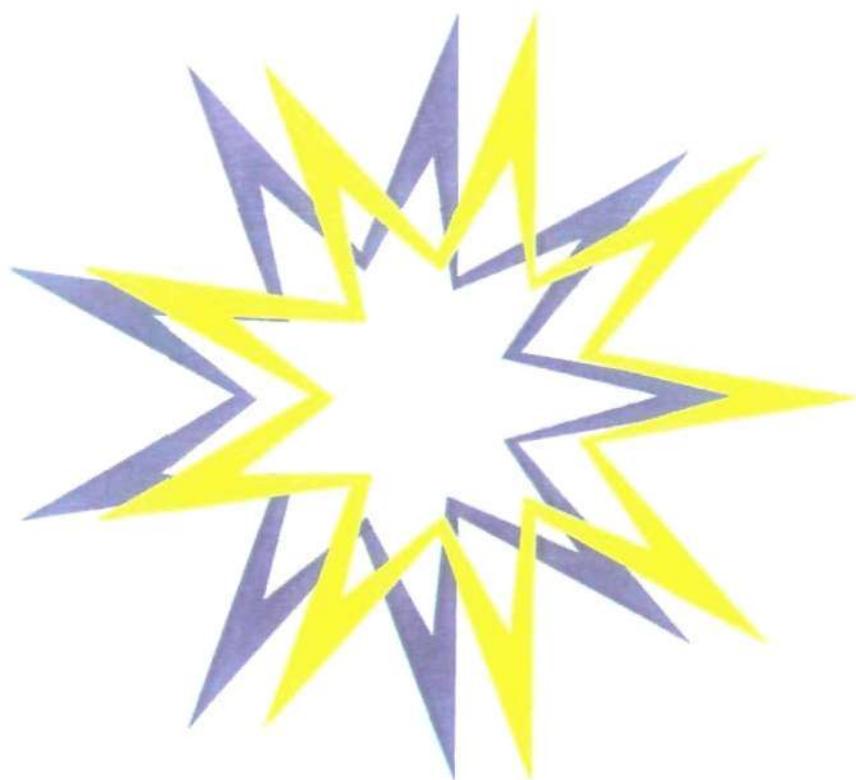
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SANA MURRANI



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Author:

Sana Murrani
University of Plymouth
Department of
Architecture,
UK
sanamurrani.me.uk

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Contact:

sana.murrani@gmail.com

Paper ARCHITECTURE OF GENERATIVE SITUATIONS

Abstract:

Interdisciplinary debates focusing on the cybernetic and biotechnological advancements of semi-natural systems in architecture have contributed a great deal to the creation of new design imperatives and theoretical discourse in the field of experimental architecture (Cruz and Pike, 2008). This paper explores interim stages of such advancements theoretically and practically derived from biology and cybernetics, based on the writings of Francisco Varela and Sanford Kwinter, as well as the work of Marcos Cruz and Steve Pike.

The paper will exhibit and illustrate through a simulation elements of cellular automata and autopoietic system behaviour (Maturana and Valera, 1980). This research establishes that such principles and processes in biology have a direct impact on the creation of generative situations in architecture. Furthermore, it illustrates the difference between the being of architecture as an outcome of the process of design and the becoming of architecture as a generative and collective process of situations. *Situations* as opposed to mere forms and spaces in architecture are the elements of this paper.

Situations imply a spatio-temporal generation 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 – singularity in-between complex systems and architecture (Kwinter, 2002). This is a theoretical paper – with an element of practice – that seeks to distinguish between generativity for the process of being in architecture and generativity for the *process of becoming*, where the latter is the central focus of this research.



Snapshots of the Cubeolony simulation (Murrani 2010).

Keywords:

Situations, Cybernetics, Autopoiesis, Generativity, Complex Systems, Process of becoming, Experimental Architecture

Architecture of Generative Situations

Mrs. S. Murrani, BSc Arch, MSc Arch, PhD (awarded pending corrections),
Department of Architecture, University of Plymouth, Plymouth, United Kingdom
sanamurrani.me.uk
e-mail: sana.murrani@gmail.com

Abstract

Interdisciplinary debates focusing on the cybernetic and biotechnological advancements of semi-natural systems in architecture have contributed a great deal to the creation of new design imperatives and theoretical discourse in the field of experimental architecture. This paper explores interim stages of such advancements theoretically and practically derived from biology and cybernetics, based on the writings of Francisco Varela and Sanford Kwinter, as well as the work of Marcos Cruz and Steve Pike.

The paper will exhibit and illustrate through a simulation elements of autopoietic system behaviour. This research establishes that such principles and processes in biology have a direct impact on the creation of generative situations in architecture. Furthermore, it illustrates the difference between the being of architecture as an outcome of the process of design and the becoming of architecture as a generative and collective process of situations. Situations as opposed to mere forms and spaces in architecture are the elements of this paper.

Situations imply a spatio-temporal generation 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. This is a theoretical paper – with an element of practice – that seeks to distinguish between generativity for the process of being in architecture and generativity for the process of becoming, where the latter is the central focus of this research.

Interim Stages: Experimental Architecture

The influence of interdisciplinarity in architecture accounts for the change in its generation through the media of representation from the past, present and future of design tools, presentation techniques and drawings to the experience of architecture as a whole and is also the motivation of this paper. Both representation and experience have a direct impact on the development of the tools of design and generation as well as interactivity in architecture. This is due to the tools of representation and methods of generation that have changed and developed dramatically under the influence of the technological/digital and biological advancements of the current age [1]. This has had a great impact on the way we perceive and conceive architecture and to some extent has called for a divided age of representation. 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 [2]. The inputs of this paper – experimentation in architecture under the influence of the biotechnological age and the principles and processes of generativity – are at the core of interdisciplinary 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 [3], [4].

Nature builds architectures composed of trillions of moving components, the number of interactions between these components increases exponentially with the number of the components themselves and so these architectures are inevitably complex. 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. 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 paper focuses on obtaining relevant knowledge from natural systems, analysing it, reconstructing it, and using it to build a new hypothesis, a hypothesis for design and generation evoked by experimental representation in architecture.

Attempts at reaching some levels of investigation in this field of semi-natural systems 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 extending to Philip Beesley's immersive and interactive environment created for Venice Biennale 2010 Hylozoic Ground. Cruz and Pike's projects deliver a degree of integration between biological entities and design practices on a conceptual and experimental level. This can be seen 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 [4]. 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" [4].

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.

Cybernetics and Architecture: Between Principles and Processes

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 [5]. 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.

Architects, engineers and designers have always been fascinated by nature's various patterns and their formation on multiple scales and levels of sophistication. Nevertheless, there is a single aim, it lies in learning techniques and rules that can be taken into another field, such as architecture, which have been tested in nature. Thus nature is 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" [6].

In addition to this, cybernetics focuses on the possible behaviours of its variables rather than their material presence [7]. Most important for this paper is 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" [6]. Cybernetics was popularized 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 [8].

In an attempt to define behaviour in architecture based on Wiener's findings, change can occur to any architectural form and space in their environment and context. In architectural terms, output would mean changes in the material and immaterial representation of architectural form and space, 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 system, generation, representation and experience are vital processes that feed back into each other, and hence, cannot be separated [9].

To imply behaviour in architecture through cybernetic principles does not mean referring to architecture which attempts to illustrate cybernetic processes, nor to an architecture which embodies cybernetic machines such as robots. On the contrary, it is the relationship between the underlying forces which construct a cybernetic system in architecture that is the crucial concern here. These underlying forces are what Wiener refers to as the changes between the output and the input which 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 contributes a great deal to inventions of current contemporary design and presentation tools in architecture such as Computer Aided Design (CAD) programmes. 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" [10].

Pask referred in his famous article *The Architectural Relevance of Cybernetics* in 1969, 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 which would make use of Computer Aided Design (CAD) programs to help develop useful instruments in design, and principles and processes in different disciplines such as psychology, ecology and economics. A cybernetic theory will have a greater unified influence on architectural theory for analyzing 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 [10]. 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 complex systems from which *cybernetics as a field emerged*.

The key writings by Gordon Pask of the New Cybernetics are about putting the observer in the heart of the system of observation [11] 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 [12]. 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 [13].

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 [14]. "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' [14]

This indirectly leads to the assumption that the cognition of spatial architecture is dependant on the articulate organizations recognized in patterns that can be derived from abstractions of biological 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 architectural forms and spaces are 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 form and space in particular.

Generativity between Being and Becoming: Situations

One of the leading architectural critics, the first to write extensively about the effect of the complexity of natural systems on architecture, 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 in architectural influences at the 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 [15]. Many architects such as Peter Eisenman, Rem Koolhaas, Greg Lynn and others have written and practiced 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 [16]. 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" [17].

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. Hence the outcome of the process of becoming 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. For Doreen Massey and other contemporary philosophers, not only generation and experience, but also representation is a dynamic process. 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 [18]. This paper 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

Among the wide range of designers and architects who have attempted to generatively produce formative relational designs through the use of algorithms are Michael Hensel of the Architectural Association in London, Celestino Soddu, founder of the Generative Design Lab in Milan Polytechnic University, and others such as Benjamin Aranda and Chris Lasch who in their architectural pamphlet *Tooling* explored principles of morphogenesis in design by utilizing an algorithmic language for each process they 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 [19]. 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" [20].

Mathematically and with the aid of digital computers Turing establishes a theory of morphogenesis where he 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, Turing develops a non-linear theory of instability due to differences in reaction rates as functions of concentrations in patterns, later known as Turing Instability [21]. 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.

Sanford Kwinter echoes much the same when he recalls Alan Turing's breakthrough of algorithms, where "numbers could be automated within functions" in order to explain the complexity of nature [20]. Kwinter goes on to describe 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" [20]. Kwinter in representing the world as a complex dynamical system and fluid manifolds identifies two kinds of influence that occur in time during the process of becoming. Kwinter distinguishes 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" [3].

Kwinter builds his idea of singularity on the existing knowledge of the field of computer science and in particular the promise of ultra-artificial intelligence which will be marked by the development of machines or robots that achieve superhuman intelligence. Those machines will later be capable of building still more sophisticated intelligences creating what is known as "intelligence explosion" [22]. This hypothetical event in time is called "The Singularity", the term was originally coined in the 1950s

by the American mathematician John von Neumann 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 [23]. 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.

A model was created (Cubeolony) to illustrate the impact of simple rules that influence simple components to create complex patterns and structures based on notions of singularity. The description of the Cubeolony model is as follows:

Phase one: Growth, division and formation

- This phase is limited to generating cubes on the screen according to a given number, which can be altered by the user of the model.
- Each face of the cube will have six amino acids (a combination of six of the main four amino acids found in any DNA: Adenine (A), Cytosine (C), Guanine (G) and Thymine (T) where G is always attracted to C and similarly T to A, and vice versa).
- In this initial phase, the cubes are not attracted to each other. It is merely a generation process.

Phase two: Gravity power (feedback)

- The simulation begins to identify matching pairs of faces (eg AACATG matches TTGTAC). As each pair is identified, the faces become connected by a virtual spring that draws the cubes towards each other with a strong attractive force proportional to the distance between them where the force at a greater distance is higher than at a lesser distance.
- As a consequence of this process, small clusters of cubes begin to appear. At this stage the interactions between the elements of the system are simple and stereotyped (Figure 1).

Phase three: Energy flow (local rules – self-organization)

- In phase three, the simulation continues to progress according to the above rules, however, the resulting dynamics are very different due to the increasing level of organization of the system.
- Clusters of cubes begin to merge together to form bigger clusters. Larger clusters contain more faces (which are targets for potential connections to other cubes) and so have a greater ability to attract smaller clusters and single cubes.
- The system reorganises itself when the larger clusters are hit by a small cluster as the strength of the impact of the collision is higher than the strength of the springs holding the cluster together which are relatively relaxed due to the small distance between the cubes.



Figure 1: Connections and potential emerging generative form and space

The simulation (Figure 2) can be found at <http://sanamurrani.me.uk/cubeolony/Cubeolony.htm>. It provides the ability to control the number of cubes to be generated, the speeds at which cubes and springs are created, as well as the strength and damping of the springs. The display can be rotated using the W, A, S, and D keys and zoomed using the up and down arrow keys. The expand button temporarily causes all springs to be extended, which causes the forms to become unstable; they will be regenerated in different configurations when the button is released.

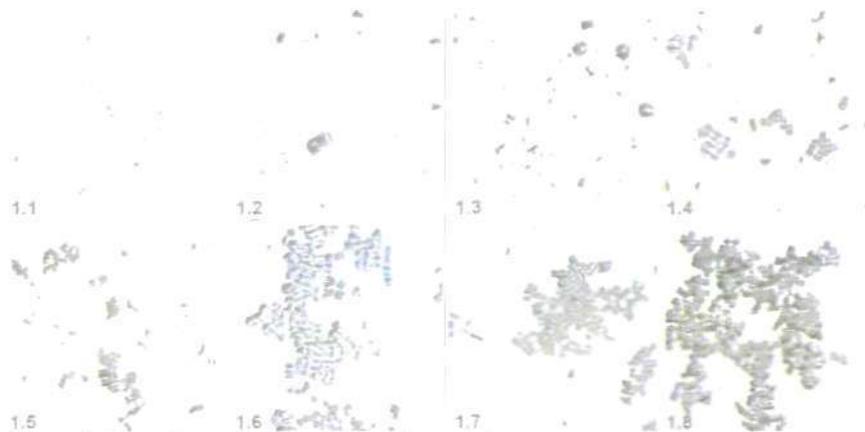


Figure 2: Snapshots of the simulation through time showing its behaviour.

The simulation exhibits generative behaviour for some time; however, it will eventually reach a stable state. This depends on various parameters of the simulation, most importantly the number of cubes given at the start of the simulation. The design of this simulation exhibits a complex relationship between the rules of the simulation and the physics of the environment, leading to highly dynamic and unpredictable behaviour. A cube within a cluster exhibits collective behaviour in relation to the other cubes in the same cluster; at the same time, any cube can exhibit powerful individual behaviour when it becomes attracted to a cube outside its own cluster. Simple rules guide the whole system, which results in the generation of different spatio-temporal forms. This simulation can work as a model for further

projects to assist in the creation of emergent interactive architectural spaces and forms

The simulation takes inspiration from the field of Cellular Automata and particularly Conway's Game of Life, where each unit follows a straightforward rule that produces emergent behaviour in the system as a whole. The initiated simulation is in fact an autopoietic system as it exhibits self-production behaviour through interactions between its constituting agents or components. The term autopoiesis is adopted from Maturana and Varela's descriptions of the processes of living machines: "An autopoietic machine is a machine organised (defined as a unity) 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" [14]

The essence of this paper lies in both its explanation of the trajectories of the folds and thresholds of cybernetics in 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. Thus, the influence of the field of biology and the technological generation has affected architecture directly and indirectly, through both bottom-up and top-down trajectories. This effect was embodied in its processes of representation and experience for the generation of unstable states and situations (Figure 3) "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" [13]. 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 [24]. Through oscillations between the processes of being and becoming, the generative situations of architecture maintain their existence, instability and incompleteness.

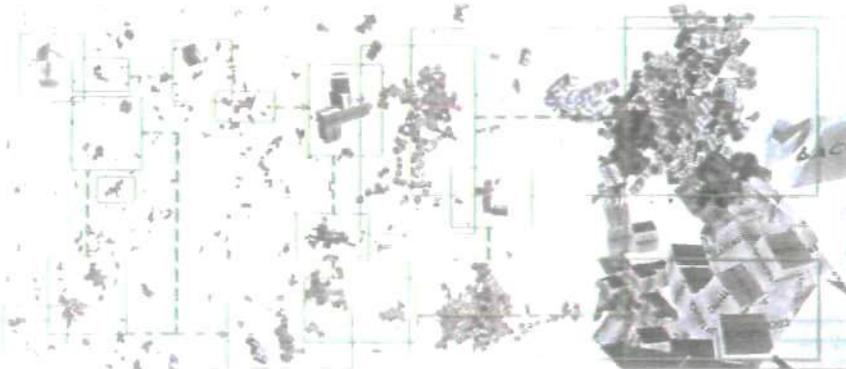


Figure 3 Map of spatio-temporal situations

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New Realities: Being Syncretic

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Editors

Roy Ascott

Professor of Design, Faculty of Architecture, Design and Planning, University of Technology, Sydney, Australia

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Professor of Design, Faculty of Applied Arts, Vienna University of Applied Sciences

Wolfgang Fietz

Lehrstuhl für Gestaltung, Universität der Saar, Saarbrücken, Germany

Margarete Jahrmann

Professor of Game Design, University of Applied Sciences, Switzerland

Ruth Schnell

Lehrstuhl für Gestaltung, Vice-Chancellor, Faculty of Applied Arts, Vienna University of Applied Sciences

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Instability and incompleteness in architecture

Abstract

Architecture, digital and analogue, has dramatically transformed under the influence of technological advancements in design and construction. In particular, these developments have motivated new thinking and re-conceptualizing of contemporary architectural theory. This paper suggests that a conspicuous instability exists between multiple fields that are interwoven with architecture. Furthermore, it hypothesizes the existence of an unstable state of integration between complex life processes and dynamic perception, under the technological advancements of the digital age and the post-biological ecology. Recognition of this integration stimulates a re-questioning of the origins of form in architecture, why it was first pushed by Eelco Saarinen (1985), and also deterritorialization of the contemporary dynamic processes of form and behaviour of architectural forms, a discussion initiated first by Rudolf Arnheim (1978).

The general narrative of this paper is based on the interrelation between the fields of biology, perception and technology, and their influences on architecture. However, the main focus is the idea of transient biological and spatial states which penetrates these fields, architecture in particular. Many architects, architectural philosophers and theorists, such as Catherine Ingraham (2006), and Safford Lewis (2007), have troubled questions about the concept of absolute time in architecture.

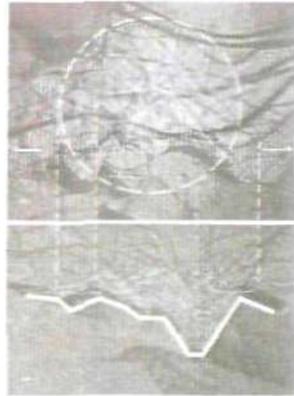
Additionally, a critical one has been discussed originally as an extension of a perceptual experience by Rudolf Arnheim (1978) and Christian Norberg-Schulz (2000), carried this notion further when he linked similar cognitive and perceptual experience from a phenomenological perspective.

A cybernetic phenomenological model is adopted, which emphasizes two main systems overlapping each other. The first system defines the territorial instability between the suggested fields, and the second system initiates dialogues between the form, its environment/context, the architect/observer/user and the spaces in-between. Three integrated stages of cognition are involved in the overlapping of the two systems. The first stage deals with the conceptualization of the materiality/immateriality of form; the second stage embodies the interactions between the architect/observer/user and the form in a specific context. Finally, in the third stage, the architect theorist steps outside the system to observe the form as it becomes increasingly interactive, changeable and dynamic.

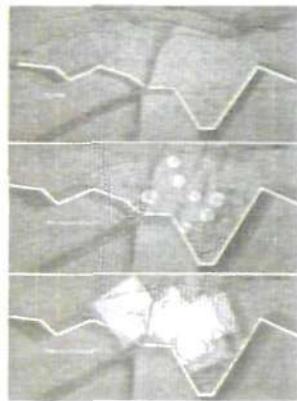
The integration of the two main systems, the digital *instability* of the fields and the collective dynamic *spaces in-between*, generates continuous states of transformation and furthermore, confirms architecture as part of a transient ecology that is *incomplete*.

Territorial instability

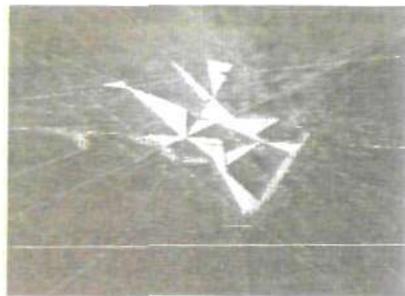
This paper considers architecture as a *living apparatus*, a hybrid of digital, analogue and theoretical/conceptual forms. Therefore, it is crucial to define the architectural problem as an ecosystem of fields and forces of energy that help sustain the continuity of such conceptual forms. In order for this continuity to remain active, changing and transforming, it is essential for all forces contributing to this sustainability to coexist within *architecture as a system*. The observer is an active part of this system where dynamic perceptions of inter-subjective material and immaterial expressions of presence and cognition have direct influence on creating and analyzing architecture. Hence, a cybernetic-phenomenological model was chosen to unfold the complexity of the system and to expose its structure, yet to discover that the interwoven interactions within the system as a whole are more than the sum of its parts. The realization of the impact of the unstable states of interaction between biology, active perception and technological advancement (as the source of energy) that stimulates the system. Moreover, maintaining the flow of this energy is essential for the system's transformation. Eventually, these states will influence change mechanisms by confirmation as part of a transient system.



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The ways of thinking have shifted paradigms and perspectives under the influence of digital and biological technology in reference to issues of post-humanism, genetic engineering, cybernetics, digital and interactive complexities. The transient impact of these issues on architecture has resulted in decentralized thinking in theoretical and conceptual architecture. Furthermore, it revealed the importance of the idea of immateriality in relation to architecture's subjectivity and the milieu in which form materialise in space and time. This way of thinking confirms that architecture emerges out of a conceptual apparatus of infinite complexity. The concern of this paper lies in the links and the hypothetical borders between the components of this apparatus: the spaces in between the form and its context as experienced by individuals depending on their various observations in time.

Dialogues between conceptual forms

For generations, conceptual architecture has been the subject of a multiplicity of theories and movements. The dynamic complex interactions between these theories support the notion of architecture as a milieu. Almost all claim that creating architecture is a living process in one way or another, but few have embodied aspects of the principles of living processes necessary to theorize about the abstraction of architecture to its elementary structure which manifests itself as a living entity rather than one composed of static matter. The territorial elements of this context depend on existing work such as Archigram's *Living City* (Cook & Clark, 1999), Cedric Price's *Generator* project (Price et al., 2003), Peter Eisenman's autonomous houses (Eisenman, 1999), Neil Spiller's *Velazquez Machine* (Spiller, 2005), Greg Lynn's *Embryonic house* (Lynn, 2000), passing by the recent involvement of interactivity in NON's *machining architecture* (Spuybroek, 2004) and Michael Hensele's *differentiated structures and multiphonic designs* (Hensele et al., 2006) and others, where extensive use of cutting edge technology was used for generating ideas and/or execution. This work is marked by the reappearance of the influence of the human body on architecture from the mid twentieth century until the present, providing insights to new methodological imperatives, shifts in paradigms, and unconventional implementations in the creation of conceptual forms.

The *conceptual forms* most relevant to this paper are constantly affected by the tensions of the changing dialogues between their embodiment in a spatial and temporal context and the cognitive and per-

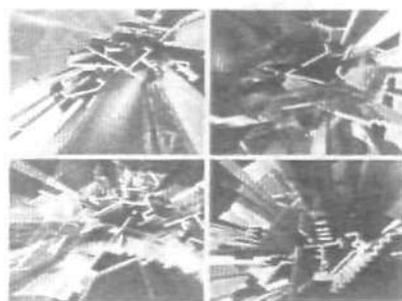
1. top-down view of context
2. top-down view of conceptual form
3. top-down view of conceptual form in context

ceptual influence of the observer on the system as a coherent whole. These dialogues consist of systems within subsystems of behavioural notions perceived and conveyed by the observer. The *space-in-between* arises from, and is, form between the form and its environment on one level, between the environment and the active perception of the observer on another level, and between the dynamic perception and the cognitive experience as a whole on a further level. Within this nested structure of complexity, the allocation of the space in-between remains always incomplete under the influence of the unstable states that confirm the importance of architecture as a system in a transient ecology. The notion of the space in-between has been referred to as an *interspace* by theorists and architects such as Arnheim (1978), Portoghesi (2000) and others. In Arnheim's work the space between buildings is an inseparable part of the whole visual continuity that supports the idea of dynamic perceptual experience of form in space and time (Arnheim, 1978, p. 17). Here the space is created as a relation of rhythm and tension between the forms. Norberg-Schulz (2000) explains this relation in terms of horizontal extension (rhythm) and vertical elevation (tension) that configure the environment, while Arnheim (1978) refers to the same relation as a field of perceptual forces of attraction and repulsion surrounding a form. This relation is expressed in space and form as a figure of gestalt (Norberg-Schulz, 2000, p. 133-134). In order for a thing to be conceived as a gestalt, the form, its context and the spaces in-between should be expressed as an organized structure that generates animated patterns. There are two ways of perceiving and conceiving the space in-between which places architecture in constant oscillation between being seen as a whole in space and alternately as an ensemble of actions experienced in time. This oscillation creates dynamics in the system and configures the perceptual forces that generate behaviour in architectural form.

Regenerating architecture as a system

The importance of the discrepancy between form in space and its structure lies in the dynamic of the notion of the gestalt in figure as a representation of a whole and as an abstract pattern at any moment. The experience of a sequence of overlapping urban perspectives that unfolds according to motion, angle and speed as well as a fusion of subjective and objective expressions, develops our perception (Holl et al. 1994). Collectively, these experiences in time will form multiple *unstable states* of consciousness which will contribute to the formation of architecture as a system of fields.

A model has been created to realize the territorial instability of the suggested fields of biology, perception and technology in architecture through



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the exploitation of local rules of emergence, self-organization, bottom-up as well as top-down behaviour and active perceptual and cognitive representations. Ants' behaviour and their nest architecture are the richest natural examples of generative systems composed of simple individuals. These individuals follow patterns of indirect interactions developed through experience, where stigmergic behaviour is exhibited within the collectivity of their colony (Grasse, 1959), rather than a pre-designed pattern. These performances in time represent indirect communication between the ants in their environment which leads to an organized emergent behaviour that shows ordered patterns of interactions. Therefore, and on an individual level, the behaviour of

4: System of architectural forms
5: System of architectural forms

the whole emerge while at the level of the nest structure and the behaviour is cooperative and self-organized without any pre-ordained designed plan. Simple rules will guide the whole system which results in self-organizing different forms. The pre-programmed model discusses three levels of complexity derived from the structure of the nest architecture mainly constructed of vertical shafts and horizontal chambers (Hestinko, 2005).

1. Network/Communication Interaction: Decentralized network of communication appears as a result of mapping the whole pattern of interaction of the nest structure which reveals multiple layers of complex patterns.

2. Distribution of function: as part of these complex patterns, the distribution of roles and tasks stemmed out of the ants' behaviour around about the structure of the nest which appears as multiple nodes of different functions cascading in complexity from the exit shafts and winding further down to chambers with different functions such as storage rooms, cultivation spaces, nurseries for their eggs, larvae, housing and the main queen chamber which normally lies deep in the heart of the nest.

3. Patterns of orientation/Movement: The ants' movement forms another part of this complex communication system. Scientists (Holladobler & Wilson, 1990) discovered that ants walk at a certain angle-speed and motion depending on their role and size within the colony. In general this movement maps out a zigzag path which is clearly reflected in the construction of the nest.

To begin with, a hypothetical nest context (Fig. 1) was created to draw on the above three levels of complexity in the form of sections (Fig. 2). These sections reveal a conceptual vectorial pattern that relates from the main nodes which form the most connected parts of the nest structure (Fig. 3). The next stage of this model emerged out of the theoretical pattern of the previous figure to conceptualize a shift in the perceptual experience of the observer to replace him/her in the created visionary architectural spaces. The shift happens on two levels. The first level introduces the observer to three-dimensional fragments of the conceptual space, where the observer will experience parts of the yet unconnected system (Fig. 4). These fragments have different spatial orientations due to the overlapping and the traction of the complex patterns of movement, i.e. function of the gestaltian structure of the nest architecture. The second exposes these sections in the model layer by layer in order to experience the whole in a certain moment in time (Fig. 5); therefore, the interpretation of this model at any given moment depends dramatically on the consciousness of the observer and his/her subjectivity. The architectural experience is constructed when

the observer enters the system by stipulating his/her own purpose. Here, Ascott (2003) urges the need for a new understanding of human presence and consciousness to enable the observer to inhabit both the real and virtual worlds at the same time and to enter the system while being able to observe it from the outside. He refers to this *whole new faculty as cyberception* (Ascott, 2003, p. 319). Moreover, Ascott differentiates cyberception from perception and conception where he says: "The answer lies in our new understanding of pattern: of seeing the whole, of flowing with the rhythms of process and system" (Ascott, 2003, p. 321). He then continues to state that cyberception means getting a sense of the whole unlike the effect of the linear way of thinking that leads to dividing the world up into classes of things: "objects with impermeable boundaries, surfaces with impenetrable interiors, superficial simplicities of vision that ignored the infinite complexities" (Ascott, 2003, p. 321). This claim of the need for cyberception as a mode of consciousness is supported by the notion of second order cybernetics as the cybernetics of observing systems instead of the cybernetics of observed systems (Foerster, 1979).

The intention of this work is to shift the perception of the observer from imagining an ant colony into placing themselves in such spaces. This will evoke dialogues between two different perceptual gestaltian experiences. The use of architectural tectonics such as the ladder that pre-exist as a type in our consciousness with its function of linking spaces in different spatial orientations was intentional. It assists in activating links that lead the observer to a deeper level of cognition of information/space. This model is equivalent to the idea of a hypertext but in the context of the physical perceptual space. Instead of the *click and jump* words in the virtual world, spaces in this model are modulated by the behaviour of the system and the consciousness of the observer.

In this model, visual fields and forces that surround the form will have an impact on the emergence and regeneration of new active conceptual forms and spaces in the environment. These visual forces are vectors of perceptual fields surrounding a form generated by its structure (Arnheim, 1978, p. 28). Collectively, vectors of multiple forms in a context will create organized structural patterns of behaviour in space and time that represent architecture as a system. This will generate a dynamic perceptual system between the spaces in between the form and its environment which will further provide assembly instructions consisting of various properties of perception such as figure-ground, solid-void effects, exaggeration of parts over the whole, the influence of missing subjects, objects, and the layering of patterns.

If perceptual studies the focus has been on the simple case of the figure-ground relationship in which the figure has an articulated form and the ground appears shapeless and endless and is sometimes considered empty. In this context however, the idea is that space surrounding form is not empty: it is charged with vectors of generated fields of forces that spread in space. Under such conditions, these spaces are conceived as ground in the total context but they are not endless or empty. They rather act as negative spaces with a shape of their own that contributes to the whole pattern. Forcing the structure of the whole pattern to invert itself, where positive spaces will exchange places with their negative surroundings and figure will become ground for a moment, will assist in analyzing and controlling the influence of such negative spaces to reach a state of perceptual ammuter. "Space is therefore not some pure extension, lacking all qualities or forces, but is rather a kind of primordial atmosphere, endowed with pressure and tension and bounded by the infinite void" (Arnheim, 1978, p. 71). The boundary between the positive and the negative space is a dynamic multifaceted state in time striving to create a balance within one part or another in the system at any moment. Therefore, this interplay contributes to the uniqueness within the system as a whole. These gestaltian properties along with the conspicuous instability between the suggested fields create different dynamic states in the system, and therefore establish *incompleteness in architecture*.

Conclusion

Considering architecture as a fluid animated perceptual experience is not unprecedented however, contemplating architecture as a system and maintaining the flow of the system as a whole, as well as considering the collectivity of its individual parts, leads to a speculative future of architecture theory. A field theory of architecture spaces must acknowledge that the gestaltian figures create fields of forces around themselves where the configuration of such fields depends on the forms generating structure. It may appear that the conceptual forms most relevant to this paper are striving to dismantle the differences between digital and analogue and close the gap that has been erected throughout the entire history of theories of architecture. Rather, the contrary is the main focus, these differences drive a constant conspicuous oscillation between architecture and the rest of the dynamic system and its influential fields, such as biology, perception and technology. Therefore, highlighting the differences, as well as accentuating the gap, although this might seem a controversial thought, will contribute to the emergence of new imperatives for generating and hybridizing digital and analogue forms and furthermore, realize architecture as a system.

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Technoetic Arts: A Journal of Speculative Research

Volume 5 Number 3

Purpose of the Journal

The journal aims to provide a forum for the presentation of new ideas, projects and practices arising from the confluence of art, science, technology and consciousness research. It has a special interest in matters of mind and the extension of the senses through technologies of cognition and perception. It will document accounts of transdisciplinary research, collaboration and innovation in the design, theory and production of new systems and structures for life in the twenty-first century, while inviting a reevaluation of older world-views, esoteric knowledge and arcane cultural practices. Artificial life, the promise of nanotechnology, the ecology of mixed reality environments, the reach of telematic media, and the effect generally of a post-biological culture on human values and identity are issues central to the journal's focus. It welcomes speculative and anticipatory approaches to research, and the unorthodox expression of ideas wherever the topic justifies such innovation. It aims to communicate to an international non-specialist readership.

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Editor

Roy Ascott
The Planetary Collegium
+44 (0)117 955 0918
e-mail: roy@planetarycollegium.net

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The behaviour of architectural forms

Sana Murrani *The University of Plymouth*

Abstract

Technological advancement and a new understanding of complex life processes have contributed to the development of radical decentralized thinking in architecture. Architecture is no longer regarded as a straightforward matter of design, construction and use, instead it is now seen as an inter disciplinary field which evokes issues of life, survival and complexity.

This article questions the behaviour of architectural forms. It proposes the creation of an active model of the fusion of biologically inspired systems and dynamic perception, which allows this behaviour to be generated and analyzed. It introduces this notion, considering multi-layers of complexity derived from various phenomena and observation.

The narrative of this work is derived from the notion of conceptualizing architectural form based on a cybernetic model, arguing that architecture needs to consider a collective dynamic 'space in between', the form, its environment, the user, the observer and the theorist. It approaches issues of living processes, survival and emergence, and conveys the concept of behavioural architectural form through a pre-programmed model that encapsulates the ideas of complex systems and perception.

Keywords

active perception
behavioural form
collectivity
complex systems
conceptual
architecture
patterning

Conceptual/immaterial form

The main focus of this article is on architectural form, its environment and the space in between, where a flux of processes and fields of energy (visual) collide in a complex behavioural system. More specifically the focus is on conceptual/immaterial architectural forms – the 'product in process' of a complex system of emergence and self-organization – which grows, behaves and learns as a result of interactions with its environment on the one hand, and with its observer/user/designer on the other. This can be achieved by locating architectural form in the eye of the observer/user and creating a dynamic perceptual and complex interaction between architecture and the observer/user, where architecture can be perceived and conceived in a behavioural context.

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 in time. The conceptual form presented here is abstracted away from its material instantiation and encoded as a system of behavioural patterns interacting fluidly together. Eric Lum proposes the same idea in his article, 'Conceptual matter: On thinking and making conceptual architecture' – 'when so much rides on the perception that what one is seeing and walking in is not so much a

building as an idea, the building as constructed object needs to disappear, replaced by something not quite a building' (2003: 3)

Projects such as Peter Eisenman's serial houses and Neil Spiller's Velazquez Machine and the Dee Stools are very different in concept and execution. Eisenman's work embeds messages that promote notions over the tectonics of the buildings themselves, while Spiller's projects evolve conceptually over time. He calls them 'time capsules moving between the history of art and architecture, the virtual and the actual and the challenge of the future with all its magical potential' (Spiller 2005). It is crucial to state that conceptualizing architectural form is not only concerned with de-materializing it *per se*, as some of the examples mentioned above were realized as physical buildings. It deals with forms that extend further than their material world and encapsulate a coded process of becoming, developing and learning from their environment, users, observers and the spaces in between.

The space in between emerges from different layers of complexity within a cybernetic model. As Ross Ashby argues, 'cybernetics treats not things but ways of behaving' far away from the material world. 'Cybernetics does not ask "What is this thing?" Instead it enquires about its function. Thus it is 'essentially functional and behaviouristic'. The materiality of the subject is irrelevant (Ashby 1960).

The model deals with systems within subsystems of behavioural concepts perceived and conceived by the observer. In an attempt to allocate the space in between the form and its environment, another potential space arises: the space in between the form and its environment, and the user. On a magnified scale another level of complexity emerges with another space in between the form and its environment, the user and the observer. Furthermore, space in between appears on another magnified level, in between the form and its environment, the user, the observer and the theorist who synthesizes the layered system. The system works collectively across all the complex overlapping levels of 'spaces in between' that occupy a space in time.

Collectivity of a complex process

'Everything that is static is condemned to death; nothing that lives can exist without transformation' (N. O. Suybroek and NOX 1996)

Complex systems undergo constant transformational processes in an attempt to reach a stable equilibrium. Therefore, systems are always anxious to push themselves to the threshold between order and chaos. Hypothetically, equilibrium represents a single state of the dynamic complex process that arises at a certain time and is influenced by changing factors in the environment. An inability to predict the outcome is associated with the cyclic nature of the phenomenon.

The threshold lies somewhere in between two extremes: perfect order and total chaos. The space in between these two extremes is where the complexity of the system emerges and formalistic multiplicity generates dynamism in the system. Pierre von Meiss argued that the relationship between order and chaos is subjective, as order can be identified in relation to disorder or chaos (Von Meiss 1996: 31).

Self-organization is one of the properties of dynamic complex systems, which push themselves to the threshold between order and chaos in an

attempt to organize their complexity so as to optimize energy flow. In an insightful observation, Nikos Salingaros refers to this organization as a kind of 'learning process' where 'the system uses internal forces to influence its own structure or growth' (Salingaros 2004).

The difficulty in interpreting living processes is related to the non-linearity and the dynamism of these phenomena. Architecture has formed a great part of the complex dynamic phenomenon that is human culture. It is a constantly changeable process that involves high levels of overlapping, interaction, emergence of certain events and phases of transition that lead to many aspects of the form, or in other words, a temporary form (Murrari 2015). A temporary form is a product of emergence that is unleashed after phases of transformation in the process of becoming. It represents one stage of the form, one aspect for each time in each space. This phenomenon is dynamic and constantly in flux.

A living process grows, unfolds and adapts gradually to allow the temporary form to emerge from the coherent whole with the help of feedback loops. It is essential for the complexity of the process to embed feedback to reinforce adaptation and survival; it is the secret of biological evolution. Some more adaptation during the course of evolution, happens gradually (Went 1960).

The process runs through phases which are considered the transformational periods that form and guide the coherent whole in a complex system to create a series of distinct images for the form. These periods are image leads of a certain system, which are followed by a new emergence and consolidation in the course of the system. Hence, they become the main generator for the dynamic continuation and change in any system. These images are temporary forms of transformations.

These transformations could represent a shape, a function, a movement or a symbol. The combination of a number of images in one phase leads to the formation of a certain shape. This shape will change if another image is added or changed. A change in their arrangement creates a dynamic tension state. Thus, architectural form is a thought and artefact with changing relations and transformation of connections. Sanford Kwinter maintains the idea of transformation:

An object in nature – be it organic, mineral, or entirely abstract or immaterial – as an idea, a desire, or a function – escapes the perpetual onslaught of differentiation according to which objects are continually becoming different from themselves, undergoing transformation.

(Kwinter 2002: 7–8)

Collectively, these processes generate new order in new forms in space and time. However, while the processes of formation build up the hierarchy of a living structure, the entropy process breaks it down through feedback loops that are essential to each complex system. The interest of this work is the emergent behaviour that such processes generate in each form.

Architects have frequently taken inspiration from nature, motivating new structures, forms, materials and more recently, processes of creation. Any piece of architecture is part of the environment, the context, which is in turn part of nature. This observation gives rise to an important and pressing

Active behaviour: the source of energy is generated in the form and appears in the output.

Non-active or passive behaviour: the source of energy in the output comes from the input.

question: whether architectural forms can behave, and whether it is possible to define the behavioural characteristics of architectural forms.

The creativity of a living process evolves around the notion of the temporary form – a state in a transient process that preserves the structure of what exists, and grows and adapts itself as it creates change, evolution or development.

In their 1943 article 'Behaviour, purpose, and teleology', Rosenblueth, Wiener and Bigelow, define 'behaviour' as 'any change of an entity with respect to its surroundings' (1943).

Both living beings and architecture are products of the same forces – namely, technological and biological insights, and computational flexibility. All these elements influence development or evolution in the observer/user/designer and as a consequence this tends to influence change in architecture.

Furthermore, living beings have an embedded urge for survival that implies patterns of behaviour in time and space. This urge is expressed in a fusion of active and passive behaviours.²

The process of survival can only take place within some medium, and so we are compelled to focus on the context, the environment and their constraints as a reflection of the behaviour of architecture and its users. This context will be in a continuous state of flux in which all parameters inevitably change over time. Ecological, cultural, economical and political variables have a direct impact on the environment and the shape of the context in which architecture survives. These variables can themselves be considered as systems with their own attractors and forces of compression and tension that define a space within the larger set of possible contexts and create the environment in which the form grows.

Survival and evolution are two conflicting challenges that draw architecture in opposing directions. They both depend on the structure as represented by its architecture as a temporary form. A form survives in two cases: one, when it fulfils a need or function for which it was constructed and built, and two, when it changes its initial function into one that is now more suitable. However, in the real world, many constraints and requirements continue to change, therefore, survivability, though necessary, is not efficient. At the same time, a form evolves as long as it can adapt to its transient context. However, the form cannot afford to lose its ability to survive in an attempt to evolve. The capacity to satisfy these two conflicting challenges is a vital and essential quality of any living form.

This article is particularly concerned with the idea of behaviour in form and moreover, the collectivity of form's behaviour. Behaviour usually refers to the action or reaction of an object or organism in relation to its context. Collective behaviour is a term used in sociology to refer to an embedded emergence and spontaneous impact on social events and processes of a crowd which do not reflect existing social structure (laws, conventions and institutions). For example, the state of panic that emerges in a burning building.

Hence, to understand the complex collectivity of the behaviour in form, it is essential to decompose the system into patterns and furthermore into images of frozen behaviours.

Frozen behaviours are images captured individually in sequence, which when aggregated collectively create a form within a system. Moreover, a

rozen behaviour represents a single state of a collective behaviour of multiple individuals/agents in space and time. This term is also used by biologists to refer to artefacts as they leave an enduring record of the behaviour that resulted in their creation. A sequence of frozen behaviours will explain the complexity of the collective behaviour in a system.

The narration of a complete origami design³ provides an approximate example of the idea of patterning⁴ frozen behaviours. Describing the final form of the paper in detail is very difficult due to the complex relationships between its features. However, the sequence of instructions that yields this form is relatively easy to formulate. Thus, simple instructions about folding the paper have complex spatial consequences.

- 3 Origami design is the outcome of manipulating a sheet of paper through a sequence of foldings.
- 4 Patterning: Multiple images that work collectively.

Creating emergence

Johnson⁵ argues that the study of emergence has entered a new phase in the last decade or so, one that is more revolutionary than the other two phases:

In the first phase, inquiring minds struggled to understand the forces of self-organization without realizing what they were up against. In the second, certain sectors of the scientific community began to see self-organization as a problem that transcended local disciplines and set out to solve the problem, partially by comparing behaviour in one area to behaviour in another [...] but in the third phase, we stopped analyzing emergence and started creating it.

(Johnson 2002: 20–21)

Creating emergence requires decentralized thinking with the potentiality of bottom-up behaviour – organization from below in the hierarchy of any system. An ant colony or a slime mould for instance embeds this behaviour, where the agents work together to generate a flow of information guided by simple locally applied rules. They self-organize their structure according to changes in their context, thus they are adaptive, they learn from their environment to solve a problem and to survive. These systems are complex and adaptive and they exhibit emergent behaviour.

Johnson highlights two main factors for emergent behaviour, the bottom-up generation of rules and adaptation which implies self-organization, when he states: 'The movement from low-level rules to higher-level sophistication is what we call "emergence" (Johnson 2002: 18). 'Emergent complexity without adaptation is like the intricate crystals formed by a snowflake: it's a beautiful pattern, but it has no function' (Johnson 2002: 20).

Communication is another vital process for generating collective behaviour in decentralized and self-organized systems. Generative systems are composed of simple individuals which follow patterns of indirect interaction developed through experience as opposed to a pre-designed pattern. Consequently, the frozen behaviour or the temporary form is vastly more complex than the individuals themselves which sometimes behave randomly on an individual level. This field is known in computer science and robotics as swarm intelligence. In swarm intelligence the indirect interactions of a distributed group of simple agents which communicate locally with each other and the environment is referred to as 'stigmergic behaviour'.

Stigmergy is a tool of communication in emergent systems, where the individual parts of such a system communicate with one another by modifying their local environment. The term was introduced by French biologist Pierre Paul Grassé in 1959 to refer to termite behaviour. He defined it as 'Stimulation of workers by the performance they have achieved' (Grassé 1959).

The richest natural example of stigmergic behaviour can be seen in ant colonies. The discrepancy between the complexity of the anthill and the complexity of the individuals that construct it is striking. The ant hill exhibits emergence (emergent drive) as well as growth and development through the individuals' communication with the environment. As a consequence of the interaction between those individual ants/agents/parts and their environment, the system starts to encode learning through feedback loops. It is a bottom-up system with collective behavioural patterns (Murrani 2006). Feedback loops can be negative or positive depending on the information flowing in and out of a system. Negative feedback tends to reduce output and positive feedback increases it.

These are the basic rules for emergence which cannot be separated from other rules of communication mentioned above, as part of the survival of the coherent whole. All these rules are based on patterns of interaction and changes in the environment as well as the needs of the system. The individuals have an embedded coordination that induces a spatial and temporal frozen behaviour which is revealed, depending on the state of its immediate environment, as stigmergic behaviour.

As a preconceived notion, nature builds 'buildings' made of trillions of moving components; the number of interactions between these components increases exponentially with the number of the components themselves and so these 'buildings' are inevitably complex. 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. Architecture design 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 work focuses on obtaining relevant knowledge from natural systems (analyzing it, reconstructing it and using it to build a new hypothesis) which can then be applied to architectural form.

The forms of emergent behaviour most relevant to this work are those that develop greater intelligence through experience and so learn to respond appropriately to their environment. The ability to learn from the environment, to respond to its demands, and to develop sophisticated social interactions through decentralized thinking is a feature of the speculative future of behavioural architectural forms.

When nature and observation collide

Many artificial, natural objects and networks are complex systems. The term 'complex system' refers to any system with strongly coupled behavioural and structural freedom.

Behavioural characteristics emerge during a growth process starting from a seed. This seed, whether it is matter or immatter (information and

of growth represents the starting point from which behaviour emerges. The emergence of a growth process was argued until 1917 when D'Arcy Thompson explained the origins of biological form as a necessary result of biological growth. He showed by examples that biological form could only be understood as a part of the 'growth process'. Thompson based his analysis of biological processes on mathematical and physical aspects, drawing particular attention from the Fibonacci sequence, and the hybrid theory of Pythagoras and Newton.

Thompson highlights the effect of multi-layers of forces on the shape of the organism where he explains that physical forces shape organisms. Effectively, surface and volume ratios must influence the organism as it grows in size and as it inhabits different realms of forces. As a consequence of this, all creatures are influenced primarily by surface forces, while large creatures received stronger influences from volumetric or gravitational forces.

Although Thompson has been criticized for his views on natural selection, some of which have been contradicted by modern evolutionary and developmental biology, many of his ideas remain highly relevant. One of the most compelling of these ideas is the theory that the growth and form of an organism have two tendencies, the first consists of the genes which are responsible for producing proteins which in turn produce structure or form, and the second tendency consists of factors which limit the role of the genes. Those limits are due to the nature of the structures providing assembly instructions (Thompson 2005).

In this work, visual forces and fields have the potential to create and shape affective spaces for new forms to emerge. The dynamic perceptual system between the observer and the space in-between will provide assembly instructions, consisting of various properties of perception, such as figure/ground, solid/void effects, exaggeration of parts over the whole, the influence of missing subjects/objects and the layering of patterns. These gestal and properties create different dynamic states in the system, and establish incompleteness in the process of behavioural emergence.

The best examples in art can be seen in the work of M. C. Escher (1898–1972), a Dutch graphic artist. His work was mathematically inspired and also he had a great fascination with explorations of infinity, geometry, architecture. 'Print Gallery' has a multi-layered and disorienting effect, where the print eventually mixes with the arches in the gallery where the print hangs. 'Balcony' and 'House of Stairs' are both about focusing on one point, a focal point in architecture and exaggerating the effect. 'Bulldog' is one of many of Escher's drawings that represent an interaction between the effects of solid/void, figure/ground and continuation of patterns. 'Puddle' represents a new transition into the influence of the missing subjects, where the eyes and the mind will build up a story of the image. Aspects of growth and development can be seen in 'Metamorphose' which demonstrates transitions, layering and patterns that transform and evolve. Although Escher's work is based on a gestalt perception, it shows a pre-designed complexity rather than the emergent complexity that is the focus of this article. On the contrary, an isolated experience of any image has far less effect on the observer than a collective sequential experience in which it's spatial building or form. Therefore, perceptual experiences of

Gestalt theory started in Austria and Germany towards the end of the nineteenth century. It focused on the mind's perceptive processes. It refers to the concept of a unified whole.

architectural spaces and forms embed several layers of complexity which will be unravelled in the final section of this article.

When examining the perceptual experience, spaces surrounding buildings cannot be considered as empty (Arnheim 1978: 28–30). Instead, these spaces are packed with energy determined by visual forces generated by architectural structures. The first architect to acknowledge this idea was Paolo Portoghesi, who in 1974 adopted the notions of perceptual and social fields from physics. He emphasized the origin of the surroundings of architectural form as a consequence of fields of visual forces which can be illustrated as patterns.

The proposed environment, presented in this article, encompasses fields of forces that influence the emergence and growth of new forms. The potential energy inside each form could have a great impact on the fields of forces in the environment. Hypothetically, architectural form could emerge out of multi-dynamic states of visual fields in the environment, its internal energy feeding back into the environment to create the potential for the generation of seeds and their growth into new forms. The dynamics of this process are always transforming in time in a certain space; these transformations are referred to as behavioural patterns.

Generating the behavioural form

The forms discussed here are the ones that are based in their formation and development on natural phenomena and perception.

Four types of architectural forms are identified as physical, theoretical, digital and interactive. The four types can be classified into two categories: material and immaterial forms. The physical forms that dominate our environment are material forms. The work of many architects falls into this category; hence the most interesting pieces of architecture have a consciously growing perceptual complexity. An example is Barcelona Pavilions, 1929 by Mies van der Rohe. This building and its furniture carried notions of beauty and perfection in the creation of architectural spaces. It succeeded in this to the extent that it was regarded as too singular to be used for its original intended purpose. Therefore, it was left non-functional as it became an icon of rich perceptual experiences. Furthermore, complex designs such as the futuristic buildings of Peter Cook (of the Archigram Group) had great influence on the development of architecture.

Digital forms are material forms consisting of data and information flow. Architects that have taken an interest in the creation of digital forms have almost always striven to achieve some degree of transformation or adaptation in space, if not necessarily through the use of biological systems. Marcos Novak is one of the most active figures in this field. In his work, algorithmic techniques are used for the design of actual, virtual and hybrid environments such as cyberspaces. Novak introduced the expressions 'Liquid Architecture' and 'transArchitecture' (1991) meaning architecture which is no longer a static given but a flexible, transmittable epistemological space.

Furthermore, an interactive form is a flux of physical matter and data/information flow, for example, Nox's 'Whispering Gardens' and Michael Fox's 'Robotechture' movement that stemmed from an early interest in Kinetic architecture in the mid 1960s.

In contrast, theoretical forms are immaterial forms consisting of concepts and notions. The radical thinking behind Cedric Price's projects, the 'Fun Palace' 1960 for East London and 'The Generator' 1980 in Florida led to the creation of a platform for a visionary, cybernetic and intelligent architecture. These projects and many others by Neil Spiller, Rem Koolhaas and Peter Eisenman reflect the liveliness of the conceptual form.

Two main values in architectural form are emphasized: functionality on a complex formation and development level as opposed to utility, and aesthetics on a perceptual and pattern formation level as opposed to beauty. These values challenge the integration of architectural form in its environment on different scales: context, space and the active user's impact. The flux of these challenges influences the emergence of behaviour in architectural form.

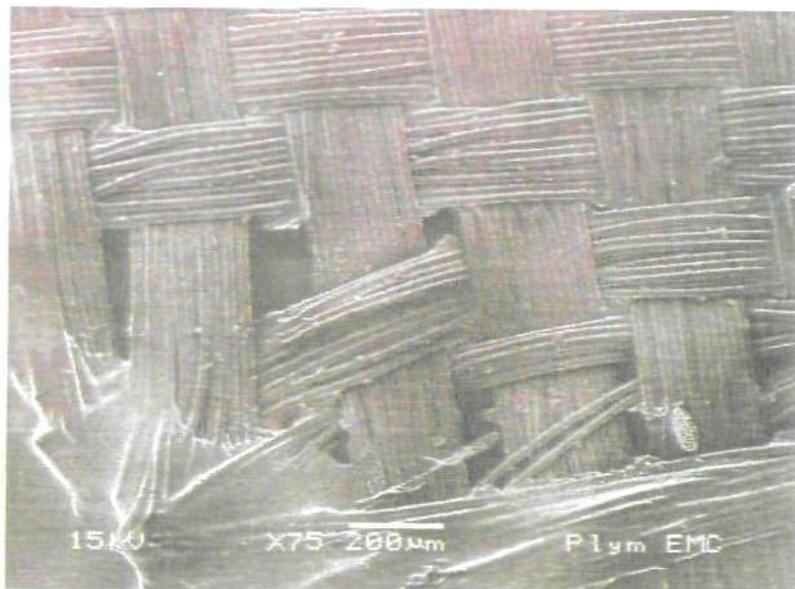
The behavioural form is a fusion of all four form types; it embeds transient dynamic perceptual complexity that emerges layered over time and space. The overlapping layers of complexity in the behaviour of architectural form are:

1. *Behaviour within the formation and development of the form.* This level of complexity focuses on developmental processes and growth of form. It includes principles and properties of complex systems such as emergence, self-organization and adaptation.
2. *Behaviour within the learning required for the form to integrate in its environment and space, moreover, to interact with its users.* This level of complexity focuses mainly on feedback processes, negative and positive feedback to develop the learning required for the form to survive in its context.
3. *Behaviour within its self-perception.* This level of complexity represents a perceptually challenging and highly speculative layer of complexity where the form will interact and respond by following its own judgments on active actions.

A model is described to demonstrate the dynamic complexity of the behavioural form. This model was developed as part of the SlidingScales workshop. Additionally, it was presented as part of a lecture in February 2007 (Architecture Week) to i-DAT Institute of Digital Art and Technology final year students as part of an architect's experience between theory and practice. Since then it has been developed further to embed discussion about the behavioural characteristics of architectural form.

The workshop focused on the idea of scale in the relationship with our view of the peculiar landscape of digital technology as ecology. An item was selected to be scanned under the electron microscope (SEM); the resultant image was then interpreted as a system. This system was then decomposed into a set of processes, which formed the basis for the design of a model. This model was then manufactured using a rapid prototyping machine (RP).

A piece of umbrella fabric was chosen for scanning as, to some extent, the umbrella represents a dividing layer between the user and the environment. However, this project emphasized the process of development as opposed to the specific properties of the individual object selected for analysis.



SEM Image



Figure 1: SEM image and its potential complexity

Figure 1 represents the chosen image and its potential complexity. This particular image has a multidimensional effect (designed order/emergent chaos/emergent order) with complex potential.

Before further details of the development of this model are provided, it should be made clear that this model represents 'a stage in the development of the behavioural form' or in other words a 'frozen behaviour' that captures one instant in time from a dynamic and transient process.

To begin the design process some fundamental starting points or 'seeds' must be provided in order for the process to grow. The concept for the early sketch of the model was derived from the following considerations:

- The SEM image of the weaving of the textile
- The workshop theme of scaling in between processes and systems.
- The concept of the umbrella as the dividing layer between the user and the environment.
- The three levels of complexity of the behavioural characteristics mentioned earlier.

This initial concept was refined through a sequence of stages of growth and development, the improved model illustrates aspects of articulation and perceptual effects, such as figure/ground, solid/void, influence of parts on the whole and the relationship between form/environment and the 'space in between'. Figure 2 represents the first level of complexity (growth and development).

Figure 3 proposes the idea that perception of the whole form depends on the material/immaterial representation of its parts and the space in between.

Figure 4 identifies the fields and forces of energy in the form that induce further seeds to emerge in the environment.

6 Sliding Scales. This workshop took place in December 2000 at the University of Plymouth, organized by i-DAT Institute of Digital Art and Technology at the University of Plymouth and The Bartlett School of Architecture at University College London.

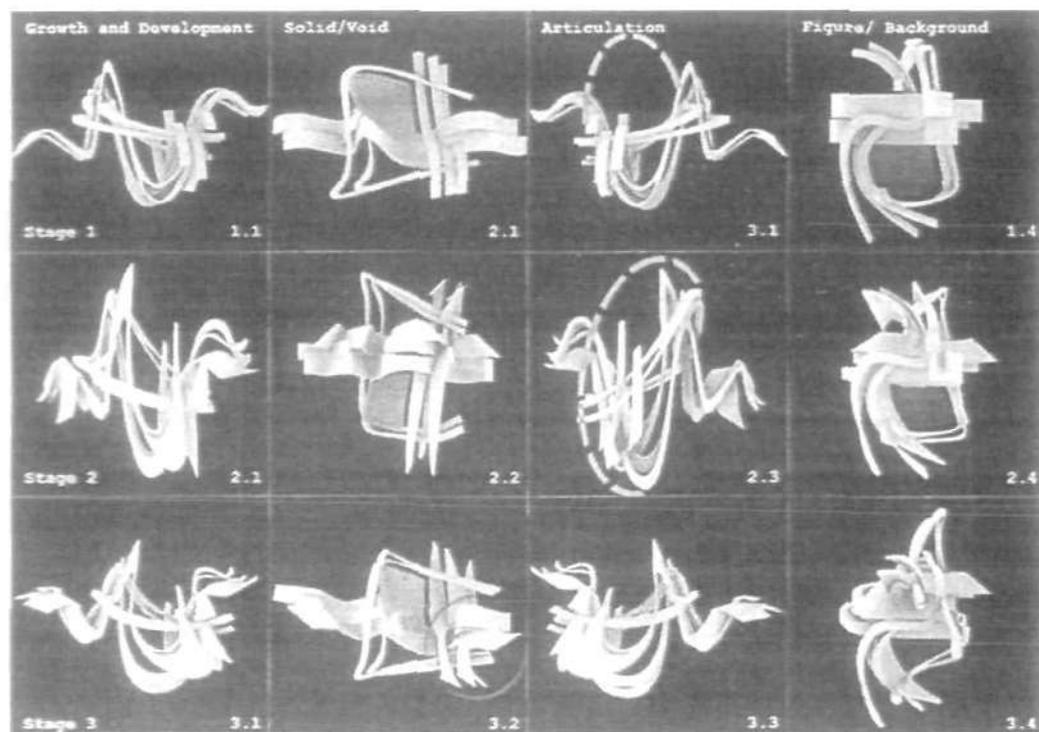


Figure 2 The first level of complexity in stages of growth and development.

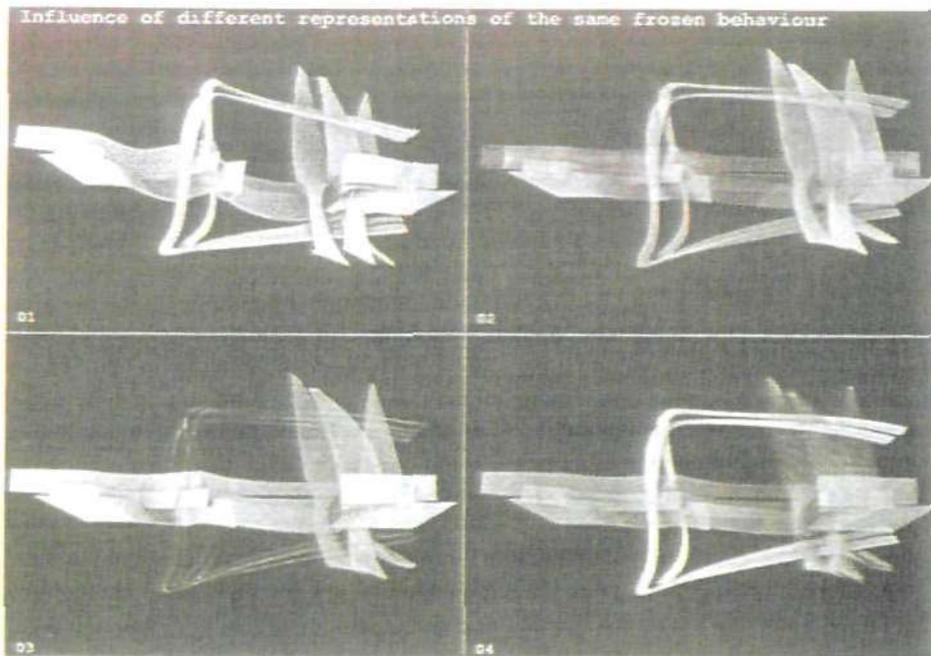


Figure 3: Material/immaterial representations

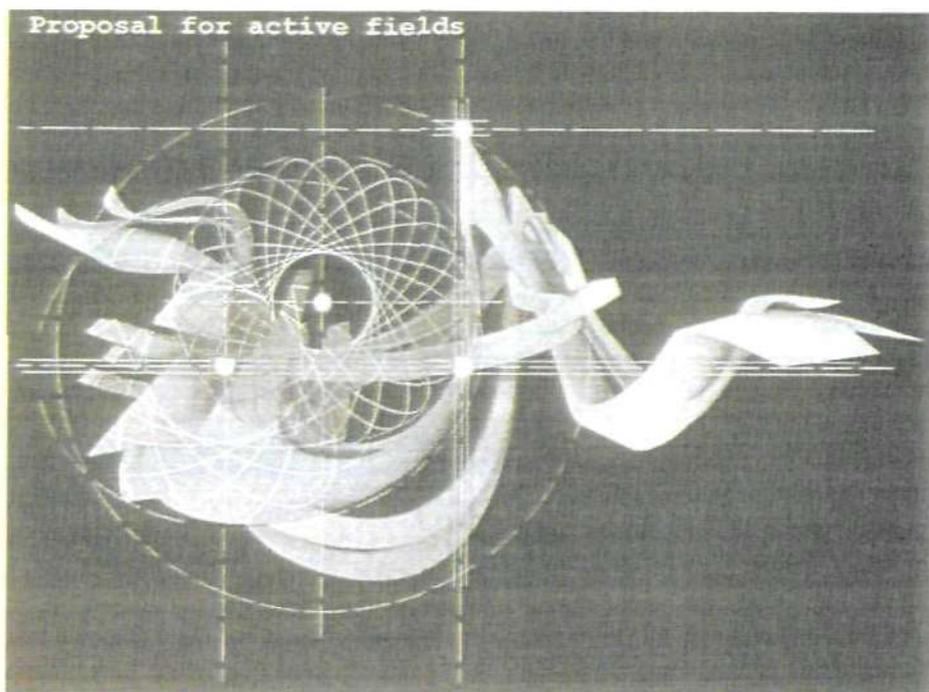


Figure 4: The fields and forces of energy in the form

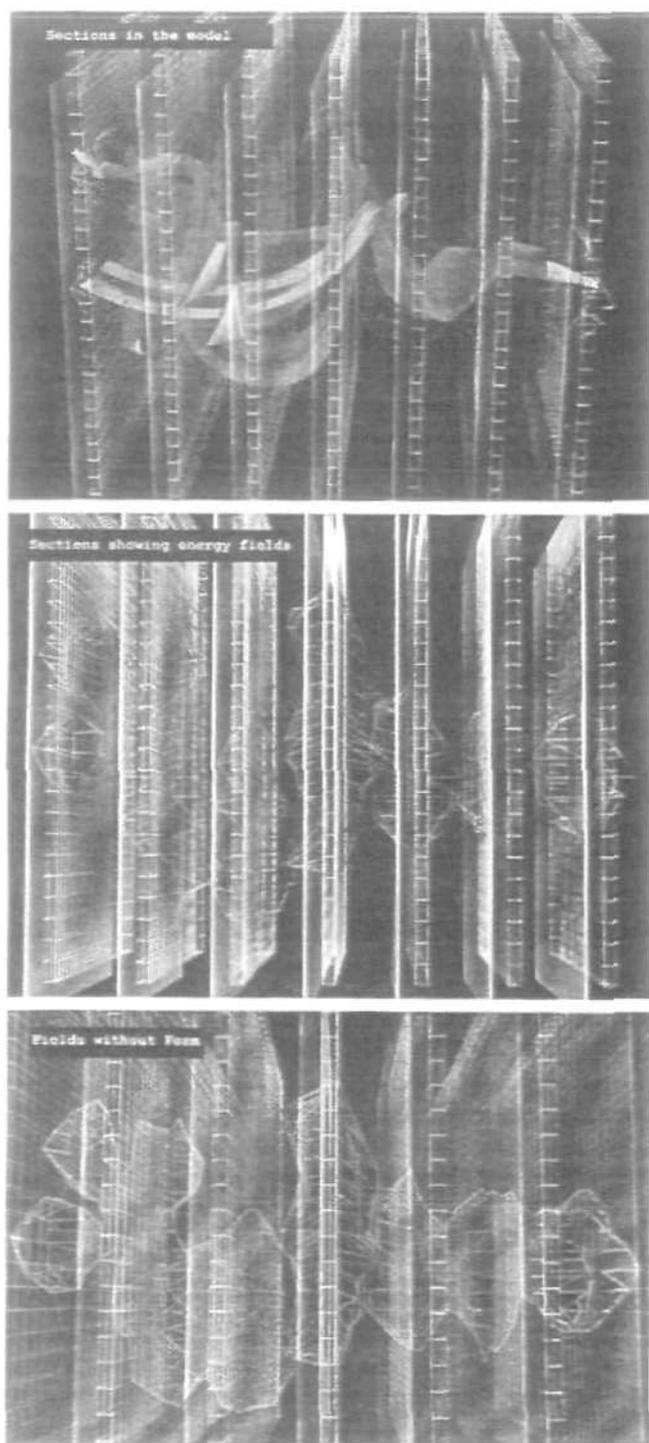


Figure 5 Sections in the form

Sections out of architectural forms

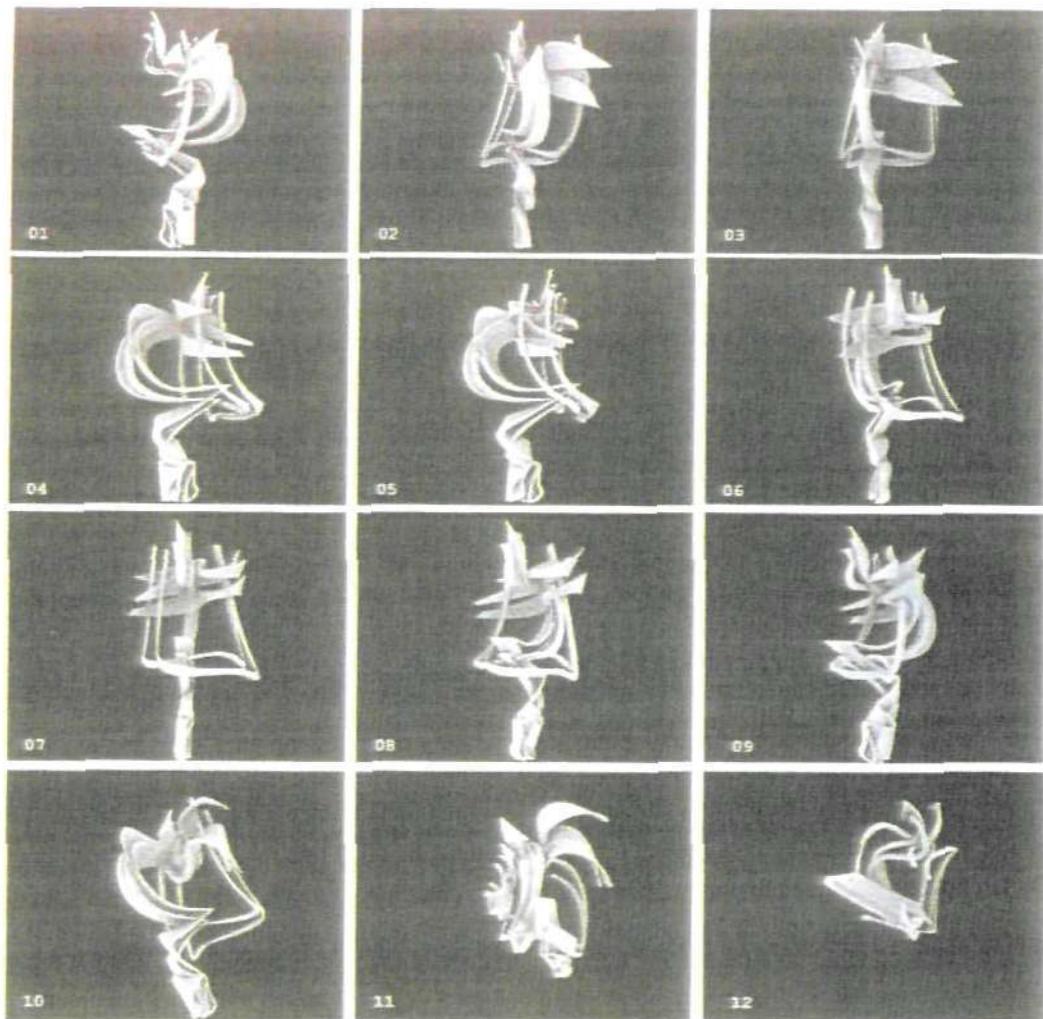


Figure 6. Sequence of frozen behaviours.

Figure 5 illustrates sections in time while the form is changing/transforming in an attempt to map the fields of forces that exist around the points of tension located close to the melted boundaries between the form and the environment. This visualization revealed that the idea of continuous change and transformation could be represented as behavioural patterns (the second level of complexity in the behaviour of form). Each static image of these sections represents 'a stage in the development of the behavioural form' or frozen behaviours. Eventually, the sequence of frozen behaviours will represent the entire form in a certain time as shown in Figure 6.

Further development of the model was undertaken to illustrate the third complex level of behaviour, the form's self-perception that emerges after



Figure 7. Form's self-perception

through the form. Figure 7 illustrates the reaction of form to the perceptual experience of the observer – reflecting the observer's experience.

Conclusion

This article generates a dynamic complexity by placing architectural form and perception in the consciousness of the user/observer/designer. This dynamic perception means that any architectural form or space can only be understood through the patterns within diverse accounts of experience and a single analysis will be deceptive.

Furthermore, the integration of principles and properties of complex systems and dynamic perception creates a platform for the synthesis of a lexicon of architectural form through its behaviour. This dynamic complexity is always subject to change as it is connected to users/observers/designers some of whom are connected through virtual and physical

communities: this change is the product of technology and deeper biological understanding.

As architecture forms a great part of these virtual and physical environments, eventually it will leap into this volatile context of contrasting capabilities, perception, memory and history reflected upon architecture from its active users/observers/designers.

This work represents a speculative future and an early stage of development, anticipating a theoretical architecture which is humanized by its placement in the perception of the observer and its recognition of him/her as part of a transient ecology.

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Contributor details

Sana Murrani is an architectural designer. She studied architecture in Baghdad University College of Engineering, Department of Architecture graduating in 2000 and obtained her masters degree from the same school in March 2003. Her thesis dealt with the emergence of architectural form and formulation by drawing an analogy between architecture and genetics. Murrani started working as a professional architect in 2000 in Iraq. In July 2003 she joined The Planetary Collegium through the School of Computing, Communication and Electronics at the University of Plymouth and currently is a doctoral candidate. She is presently exploring aspects of the emergence of biological/artificial systems and perception, and the behaviour of architectural form. Contact: Planetary Collegium, SoCCE, The University of Plymouth, Drake Circus Plymouth, UK.
Tel: +44(0)7743326309
Email: sana.murrani@gmail.com
Website: <http://sanamurrani.me.uk/>



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Abstract:

Re-thinking architectural form leads to a new approach towards the use of principles of growth and development derived from biological systems. Such forms will exploit self-organizational principles; as a consequence, adaptation will emerge through interactions between the components of the form and their ever-changing context.

Complex interactions between the components will lead to a state of near-continuous flux that shapes the form. As a consequence of the self-organizing principles embodied in these interactions, the system reaches an unstable equilibrium to reveal a form in time or space. This is the phenomenon of emergence.

Emergence cannot be designed. It happens as a spontaneous burst of form accumulated through the complex interactions between materials, appearance, ontogeny and the purpose of the form in relation to its context. While we cannot design a specific emergence, we can create conditions for it to happen, we can seed it and watch it grow, then let it adapt through time and space in its context.

Adaptation is essential for any species to survive the continuous flux of natural phenomena. Architectural forms that can adapt to their context will be more efficient and develop a richer relationship with their users.

Current architectural structures represent a planned organization of self-interest (architect's will) where forced structures result in a static form. The outcome (architectural form) is predicted and even if it has the ability to adapt (e.g. removable partitions, self cleaning glass) such adaptation is limited and stereotyped. By focusing on some of the principles of natural and artificial systems that have self-organization in achieving adaptation and drawing parallels between these systems to extract general principles which can be applied to architectural form; we can witness the emergence of self-organized architectural form. A concept the paper presents in 3D animated model.

Key Words:

Architectural form, living process, emergence, growth, self-organization, adaptation, biological systems

Author Bio:

Sana Murrani is an Architectural designer. She studied Architecture at the University of Baghdad, College of Engineering, Department of Architecture, and graduated in 2000. She got her Masters degree from the same school in March 2003. Her Masters thesis dealt with the emergence of architectural form and formulation by drawing an analogy between architecture and genetics. Murrani started working as a professional architect in 2000 in Iraq. In July 2003 she joined The Planetary Collegium through the School of Computing, Communication and Electronics at Plymouth University, and is now working on research in Advanced Architecture. She is presently engaged in all aspects of the emergence of biological and artificial systems and their behaviour. She intends to apply these properties to new buildings that she calls Living Architectural Forms.

Institutional Affiliation:

Planetary Collegium i-DAT Plymouth University, UK

Address:

Research Student Planetary Collegium, School of Computing, Communication and Electronics, Plymouth University, Drake Circus, Plymouth, PL1 5AJ Devon UK
sana.murrani@plymouth.ac.uk <http://sanamurrani.me.uk/>

Re-thinking Architectural Form:
The Emergence of Self-organized Architectural Form

Sana Murrani
Architectural Designer

Planetary Collegium
Plymouth, UK

Sana.murrani@plymouth.ac.uk
<http://sanamurrani.me.uk>

July, 2005

Introduction:

This work focuses on the creation of architectural forms using a new approach based on scientific principles. The three main parts of the paper embrace the ideas behind the ontogeny of architectural forms.

Part one introduces the concept of the architectural phenomenon as part of the emergence of a living process, where *architecture is not only a process in change; it is a phenomenon*. The natural living process is a flux of complex but smooth transformations and phases of transitions which reveal the form, e.g. the formation of an embryo, the evolution of a splashing drop, the structures produced by a colony of social insects. In all these cases, we find the sequence of development to be what Christopher Alexander refers to as a,

"sequence which is essentially smooth in character" (Alexander, 2004).

Part two explains the properties, self-organization and adaptation, which the paper consider as the most effective properties in a living process. The overlapping of external and internal effects is the generator of these properties. For Steven Johnson, however,

"a system may self-organize but not be adaptive; it is independent of its surroundings; that is a closed system. An adaptive system on the other hand whether it self-organizes or not, develops according to inputs from its surroundings" (Johnson, 2001).

In order for the form to emerge and grow from its living process, self-organization and adaptation are essential properties. This open-ended living process allows unpredicted outcomes to exist.

Part three explores some of the principles exhibited in natural and artificial systems that can be exploited in order to achieve adaptation in architectural form.

"In natural systems there is nothing else but "coming into being", everything is coming into being continuously" (Alexander, 2004).

The paper focuses particularly on the developmental processes of the embryo, cell growth running through phases of self-replication and differentiation until the form emerges. Artificial self-organization as found in cellular automata like Conway's game of life is described. Finally, a model is presented that describes theoretically a way of growing architectural forms, focusing on the idea of creating complex structures from simple inputs.

The Architectural Phenomenon: Emergence of a Living Process

"Everything that is static is condemned to death; nothing that lives can exist without transformation" (Nio, Suybroek, 1996).

Living processes are difficult to interpret because they are non-linear dynamic phenomena. Architecture has formed a great part of such phenomena. It is not only a constantly changeable process but it also involves high levels of overlapping, interaction, emergence of certain events and phases of transition that lead to many aspects of the form which I prefer to call the *temporary form*. Each temporary form is a product of emergence that is unleashed after phases of transformation in the process of becoming. It is one image of the form, one aspect for each time in each space.

This phenomenon is dynamic and constantly in flux. Alexander echoes much the same observation when he argues,

"process is the transformations from moment to moment which govern order in a system" (Alexander, 2004).

The process runs through phases which are considered the transformational periods that form and guide the coherent whole in a complex system to create a series of distinct images for the form. These periods are image leaps of a certain system, which are followed by a new emergence and confusion in the course of the system. Hence, they become the main generator for the dynamic continuation and change in any system. These images are temporary forms of transformations; in Alexander's words,

"living centers have properties and they are the way in which centers appear in the world, come to life and cooperate to form other living centers" (Alexander, 2004).

They may be a shape, a function, a movement or a force. The combination of a number of images in one phase leads to the formation of a certain shape, that changes if another image is added or changed. A change in their arrangement creates a dynamic tension state. That is why architectural form is a thought and artefact with changing relations and transformation of connections. Alexander similarly argues that the emergence of new structure in nature is brought about by a

"sequence of transformations which act on the whole, and in which each step emerges as a discernible and continuous result from the immediately preceding whole" (Alexander, 2004).

Alexander refers to these transformations as a living process until they reveal the form: the outcome. He calls them living centers because they interact with the context where they belong in a conceptual way, his centers do not transform physically but conceptually.

This phenomenon is therefore born after a number of processes accompanied by transformational periods and phases to reach a near-equilibrium. Yet, this phenomenon begins to change in order to attain another near-equilibrium and all this is accompanied by a formalistic multiplicity and reaches its aim in a non-linear manner. This *process* as Kas Oosterhuis describes it, is in action, it never stops because it is part of a great action which is life.

"If we think of it as data that carries information then this data is always in action, exchanging places with other data somewhere else and spreading action all over" (Oosterhuis, 2002).

Lebbeus Woods, however, describes the process in a more radical way when he refers to it as multi-transformations in architectural form where,

"composition is gone, because the process continuously recomposes itself within an almost infinite range of possibilities. Furniture is gone, because it is unknown in advance. Structure is gone, because it is entirely fluid - dynamic, nonlinear, even mathematically chaotic" (Woods, 2001).

All that remains is an intimate and unpredictable interaction between the users and the architectural form on one hand and between the components of the form itself on another.

A living process always embeds the temporary form - the state of what exists - and is always anxious to push itself forward to preserve the structure of what exists, and it grows and adapts itself as it creates change or evolution or development. This is the creative process: the living process.

Self-organization and Adaptation

The most distinguishing factor of the universe and its phenomena is the one that is always anxious to push itself to the threshold between order and chaos. This threshold is unstable and it gives, at the same time, a formalistic multiplicity that generates dynamism in the system. The inability to predict the outcome is associated with the cyclic nature of the phenomenon. Self-organization is one of the properties of dynamic complex systems which push themselves to the threshold between order and chaos in an attempt to organize their complexity so as to optimize energy flow. Nikos Salingaros puts it in a very interesting way when he refers to this organization as a kind of "learning process" where,

"the system uses internal forces to influence its own structure or growth" (Salingaros, 2000).

We can witness self-organization in many natural systems, for example snowflakes, or the shape of a pile of sand. Any natural pattern that shows organization at every scale is a consequence of some mechanism of self-organization.

Processes in this type of phenomenon overlap in a way that can be seen only after the form emerges. The entire process is but a complex organization of components with internal and external effects that guide the process in non-linear directions. These processes involve complexity and hierarchy with continuously overlapping transformations in their structural formulation. This finally leads to the formulation of the form: the temporary form. These internal and external effects that guide the process are actually the self-organization and the adaptation that is embedded within the complex process. This argument draws on the work of Salingaros as he distinguishes between self-organization and adaptivity and contends,

"Whereas self organization is driven primarily by internal constraints, adaptivity is driven by external constraints, so the system has to be open" (Salingaros, 2004).

The most significant feature of a living process is that it grows, unfolds and adapts gradually to allow the temporary form to emerge from the coherent whole with the help of feedback. Without step by step feedback, there is no way for a process to be complex and living. By creating a small system of 30 variables, Alexander suggests two possible approaches to achieve adaptation. He takes 30 coins which he considers successfully adaptive when they are all heads and non-adaptive when at least one is tails. His goal is to get them all heads. In the first possible adaptive mechanism "*The All-or-Nothing Approach*", he tosses the coins all together at the same time and then he looks to see whether they have all come down heads. If not, he spins them all again, looks at them all again, again checks to see if they are all heads. In this approach, the essential rule is that they must all come down heads together. Even if 29 come down heads, but one comes down tails, it is not good enough. In this approach, it will obviously take a long time to achieve a properly adaptive configuration. In fact it will take on the order of 2^{29} trials (about 10^{10}). After calculating the whole process he found out that it actually takes 10^{10} seconds or some 150 years with one trial per second. The second approach is "*The Step-by-Step Approach*". In this case he spins one coin at a time. When it comes down heads he leaves it on the table and spins another one. Here the adaptation is happening step by step, one step at a time. In this approach, it will take on the order of about 2 seconds per coin, or about 60 seconds altogether—roughly one minute to complete the adaptation. The step-by-step approach works while the all-or-nothing approach does not, (Alexander, 2004). This is the secret of biological evolution. Ross Ashby equally argues

"During the course of evolution, the adaptation of the thousands and millions of variables that must occur to make one successful organism happens gradually" (Ashby, 1960).

Richard Dawkins echoes much the same observation when he sees cumulative adaptation is the only possible way for evolution.

"It would be impossible for nature to "design" a system as complex as an organism all at once" (Dawkins, 1989).

Generative Natural and Artificial Complexity

In 1917 D'Arcy Thompson described the origins of biological form as a necessary result of biological growth, he struggled intellectually, showing again and again by examples, that biological form could only be understood as a part of the "*growth process*" (Thompson, 1942). Now, and at the turn of the 21st century, insights into the "process" are finally being revealed in most scientific disciplines where *transformations from moment to moment* through time and space are governing order in a system. However, and despite all the progress made in many scientific and humanities areas, the idea of living process has not yet become part of the way we think about architecture. Ilya Prigogine's criticism of mainstream 20th century physics could still be applied equally on mainstream contemporary architecture.

"Our current view of architecture rests on too little awareness of becoming as the most essential feature of the building process" (Prigogine, 1980).

Current architectural structures represent a planned descriptive organization of self-interest (architect's will) where forced structures result in a static form. The outcome (architectural form) is predicted and even if it has the ability to adapt (e.g. removable partitions, self cleaning glass) such adaptation will be limited and stereotyped because it is not an outcome of a generative process.

The difference between a generative and a descriptive program is fundamental and crucial to any living process. A descriptive program, such as a blueprint or a plan describes an object in some detail which tell us what the outcome is supposed to be, whereas a generative program describes how to make an object, what actions to take, step-by-step to unfold the form. And this is exactly how architecture limited itself; instead of using a generative process that allows the form to grow and adapt; it designed and planned pre-images for the outcome.

The best generative natural living process this paper focuses on is the developmental processes of the embryo that contain a generative rather than a descriptive program. The fertilized egg contains all the genetic information required for embryonic development. Lewis Wolpert asks some crucial and rather important questions:

"How is this information interpreted to give rise to an embryo? One possibility is that the structure of the organism is somehow encoded as a descriptive program in the genome. Does the DNA contain a full description of the organism to which it will give rise? The answer is NO. The genome contains instead a program of instructions for making the organism-a generative program-in which the cytoplasmic constituents of eggs and cells are essential players along with the genes like the DNA coding for the sequence of amino acids in a protein" (Wolpert, 2002).

For Wolpert, this process is like origami: the art of paper folding, whereby folding a sheet of paper in various directions you get a paper hat or a bird from a single sheet.

"To describe the final form of the paper in details with its complex relationships between its parts is very difficult. Much more useful and easier to formulate are the instructions of how to make it. The reason of that is that simple instructions about folding have complex spatial consequences. In development, gene action similarly sets in motion a sequence of events that can bring about profound changes in the embryo" (Wolpert, 2002).

That means the genetic information in the fertilized egg is equivalent to the folding instructions in origami: both contain a generative program for making a particular structure. It is just like what happens in football games, when all the players know the rules and the boundaries but each time you see different performance.

Essentially, the same thing can be said about the way - and the only way - to generate architectural forms that can adapt to their context during and after emergence; is that, they are generated from a living process. From conception, designing the first sketches, detailing here and there, to playing with the material;

are all unfolded processes that happen gradually in space and time. After generating these temporary forms gradually; these forms will then *coordinate* to adapt to one another and to their surrounding to form a coherent whole: a living architecture.

Another essential aspect of the living process is that all its components and its outcome/forms are *geometrical*. The gradual unfolding of the developmental processes throughout the division and the differentiation, the DNA, each cell's shape, the protein's shape, on all different scales have geometry in their forms. Alexander has similar beliefs as he argues,

"The unfolding is geometrical in its essence, although there are many side features to living process, it is fundamentally the unfolding of coherent geometric form, even when it appears loose and organic" (Alexander, 2004).

After pointing at different aspects in living processes that are worth mentioning, now the focus will be on the famous five developmental processes involved in creating an embryo.

It all starts with a *fertilized egg* followed by a rapid *cell division* that is not yet accompanied by growth; it is all positional, mass division. Each of these cells contains a copy of the genome (which contains the entire generative program). At the start of this process, the geometry will reveal and will never stop not even after the embryo comes to the outside world. *Pattern formation* is the second process that comes after multiple phases of division; this process will allow a spatial and temporal pattern of cell activities to be organized so that a well-ordered structure will develop. It involves laying down the overall body-plan defining the main axes of the embryo and allocating the cells to different germ layers. I call what reveals from each stage of the process; a temporary form, because it is subject to transformations and changes where all the germ layers will acquire different identities throughout the whole process, so that the organized spatial pattern of the cell differentiation emerge, such as the arrangement of skin, muscle, and cartilage in developing limbs and the arrangement of neurons in the nervous system. The third important process is change in form, *morphogenesis*. It is a process of 3D changes, transformations and migrations that involve multiple-complex phases. For example, most of the cells of the human face are divided from cells that migrated from the neural crest, which originates on the back of the embryo. The fourth process is *differentiation* in which cells become structurally and functionally different from each other, such as blood, muscles, and skin cells. Differentiation is a gradual process where overlapping and interaction can be witnessed during the process of pattern formation. These interactions as Wolpert describes them,

"are very closely interrelated, as we can see by considering the difference between human arms and legs. Both contain exactly the same type of cell-muscles, cartilage, bone, skin and so on-yet the pattern in which they are arranged is clearly different. It is essentially pattern formation that makes us different from elephants and chimpanzees" (Wolpert, 2002).

The fifth process is *growth* – the increase in size which can be brought in a variety of ways like cell multiplication, increase in cell size, and deposition of extra cellular materials such as bone and shell.

We may see some of these processes and aspects such as *replication, coordination, pattern formation*, but not differentiation in creating artificial complex systems using nanotechnology. Differentiation is not possible using the current technologies in artificial systems even if using living materials such as tissue and cell culture. Thus, in order to control the growth of living culture, experts use moulds and leave the tissue to grow. This can be seen in the art work of Oron Catts the director of SymbioticA and Ionat Zurr at the *Tissue Culture & Art Project* in their attempt to grow a semi-living jacket to create "*victimless leather*" (Catts). This project highlights the possibility of wearing leather jackets without killing an animal. Catts and Zurr grow a living tissue into a leather-like material and have it mature in the form of a miniature, stitchless, coat-like shape. There is also the field of cellular automata like Conway's game of life where each unit is following a rule that produces emergent behaviour in the system as a whole. All the cells in Conway's game of life follow simple rules which capture coordination between the cells to form a certain pattern.

"A cell can be live or dead. A live cell is shown by putting a marker on its square. A dead cell is shown by leaving the square empty. Each cell in the grid has a neighborhood consisting of the eight cells in every direction including diagonals" (Paul Callahan, 2000).

By counting the number of live neighbors for each cell, we can tell what will happen next.

"A dead cell with exactly three live neighbors becomes a live cell (birth), A live cell with two or three live neighbors stays alive (survival), in all other cases, a cell dies or remains dead (overcrowding or loneliness)" (Callahan, 2000).

The life game is an excellent example of emergent complexity and/or self-organizing systems.

How do these principles apply to architecture? The most outstanding pieces of architecture evolved to be the living centers of their context. This can be seen in the Sumerian ziggurat, the hanging gardens of Babylon, the Egyptian pyramids, the Basilica and Coliseum in Rome and even in some architectural pieces created as recently as a hundred years ago. These artifacts grew in a gradual living process and are immortal through their presence. They grew in their contexts each at a certain time for a certain cause using technologies that were the cutting edge at that time, and their startling originality evoked a sense of mystery and wonder that persists to this day. They were the emergence of revolution and evolution of new forms and any copy - lacking the properties of a living process - would not have the same effect. Here I would like to stress the fact that creating new active centers in architecture requires a massive transformation in the way we think of this process: the living process of emergence. The transformations and evolutionary changes that we've seen in biology and technology are what current architecture is lacking.

Model

Now I would like to present my model which explains most of the aspects and the principles of natural and artificial systems that I mentioned before; applied to the emergence of architectural form. The model is theoretically structured on the

principles of development and the cutting edge technology of nanotechnology and cellular automata.

In the early stages of the model process there is one "Cube" which is a space-filling polyhedron (Weisstein, 1999). With the help of nanotechnology this component *replicates* itself but cannot differentiate and this is the threshold between scientists and engineers on one hand and nature on the other. After the component replicates itself for many times, we code all faces on each component with a codon from a complete sequence of DNA (see movie & image 1). Then I'll put the components randomly in a glass box and shake it to mess the sequence. As a result we'll find that each face in the components will try to look for the matching face that completes its sequence, just like what happens when two strands of DNA join together, where a G has to match a C and A has to match a T and vice versa. For example, CGT has to fall on GCA. They will all settle after a while to form a certain shape: a temporary form. Then we'll try to manipulate them again by changing one or two or even more of the sequences on the faces of one of the components; they'll try again to push one another to form a different pattern to match the new sequence, and this is *pattern formation* (see movie & image 2).

The whole idea is simple, there are simple rules guiding the way. These 3D components need to know nothing else but this simple rule which is: every face on the component has to find its match according to the given example above: high coordination. The ability to grow generative structures comes from their self-organization that is guided by the internal effects: the rules, whereas the change in the sequence: the external effect results in the ability for adaptation. This is what happens in real life, where complicated forms grow from simple rules between the components.

There is *high geometry* on the individual level and on the coherent whole. There is *simplicity* in this *generative complex system*, thus the model exhibits an *emergent behavior* on all levels and scales. Steve Grand reflects on the same idea,

"when populations of interacting structures become arranged in certain configurations, and new and surprising comes into existence, we call this an emergent phenomenon" (Grand, 2000).

I would like to stress on the fact that the same idea works on bigger systems with millions and hundreds of millions of components and this is where it becomes a nano-form where smoothness is at its highest level.

Changing the sequence is equivalent to an external effect and if the system has the *ability to adapt* to this change then it runs through *gradual phases of transformations* and *feedback*, which is exactly what happened with the components when I tried to change the sequence.

I presented the coherent whole where complex systems arise out of simple interactions between the components: the temporary form, the living fractals that grow to a coherent living architecture.



1.1. Division started



1.2. Spreading out



1.3. Coding started



1.4. Coded (Full sequence)



1.5. Arranging patterns



Image - 1 - Division and coding throughout time and space
For further details see movie 1.

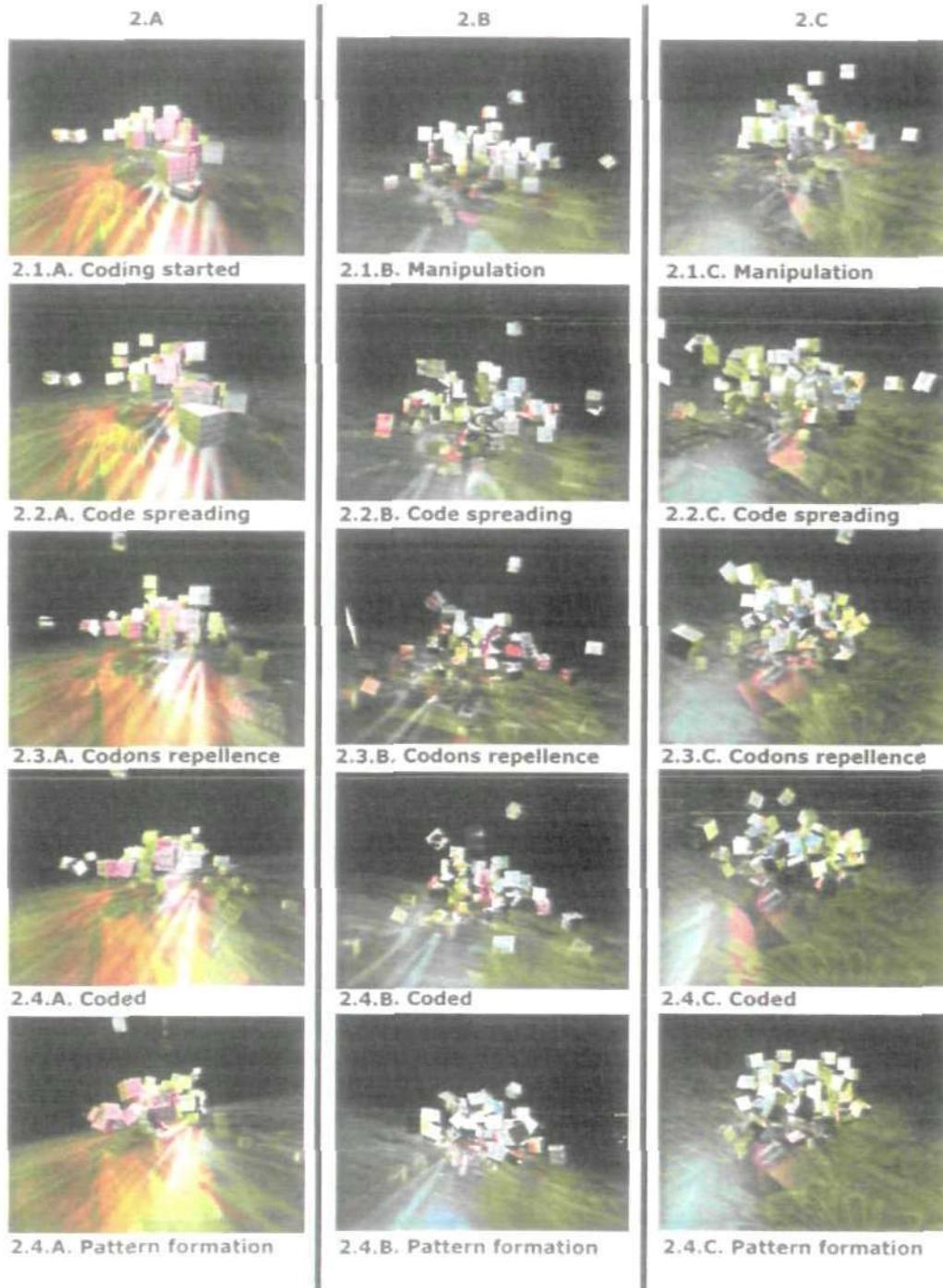


Image – 2 – Three examples that show pattern formation and manipulation of code
 For further details see movie 2.

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**Vice Chancellor's
Research and Innovation
Conference**

4th April 2007

Poster Presentations
(Titles and Locations)



Research and Innovation

9 - 22: Sherwell Centre, Mezzanine Level

| | |
|------------------------------|--|
| 12 Abigail McQuatters-Gollop | School of Earth, Ocean & Environmental Science |
| Title: | A long-term chlorophyll dataset reveals regime shift in North Sea phytoplankton biomass unconnected to nutrient trends |
| Abstract: | <p>During the 1980s a rapid increase in the Phytoplankton Colour Index (PCI) a semi-quantitative visual estimate of algal biomass, was observed in the North Sea as part of a region-wide regime shift. Two new datasets created from the relationship between the PCI and SeaWiFS Chlorophyll a (Chl a) quantify differences in the previous and current regimes for both the anthropogenically affected coastal North Sea and the comparatively unaffected open North Sea. The new regime maintains a 13% higher Chl a concentration in the open North Sea and a 21% higher concentration in coastal North Sea waters. However, the current regime has lower total nitrogen and total phosphorus concentrations than the previous regime. Besides becoming warmer, North Sea waters are also becoming clearer (i.e. less turbid), thereby allowing the normally light-limited coastal phytoplankton to more effectively utilize lower concentrations of nutrients. Linear regression analyses indicate that winter Secchi depth and sea surface temperature (SST) are the most important predictors of coastal Chl a while Atlantic inflow is the best predictor of open Chl a. Nutrient concentrations are not a significant predictor in either model. Thus, despite decreasing nutrient concentrations, Chl a continues to increase, suggesting that climatic variability and water transparency may be more important than nutrient concentrations to phytoplankton production at the scale of this study.</p> |
| 13 Sana Murrani | School of Computing, Communications & Electronics |
| Title: | Architectural Form between Theory and Practice: Architectural Form perceived as a Set of Behaviours |
| Abstract: | <p>The work identifies and attempts to bridge a gap within the area of architectural design processes that deal with generative systems. It focuses particularly on the relationship between architectural form, its environment and the space in between the form and the environment. This relationship is based on a multidisciplinary theoretical background consisting of the analysis and construction of principles of complex systems, the perception of form and the Gestalt theory. A crucial point should be mentioned here: any proposed outcome which emerges as a result of complex systems and multi-layering of fields of perception is dynamic, and consists of multi-dynamic states continuously transforming in time. These transformations could be representations of sets of behaviours of the relationship between the form, its environment and the space in between. Therefore, it is more important to focus on the systems and the processes that lead to the form rather than the form itself. In this poster I shall demonstrate an application of the theoretical background of my research through the design of a three-dimensional model. This model could represent a multi-dimensional state for the form between theory and practice.</p> |

Consciousness Reframed:
art and consciousness in the post-biological era
7th International Research Conference

Abstracts
Roy Ascott editor

Consciousness Reframed: 7th International Research Conference
7-10 June 2010, Plymouth, UK. Roy Ascott, Ed.

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Sana Murrani

Stigmergic Architecture

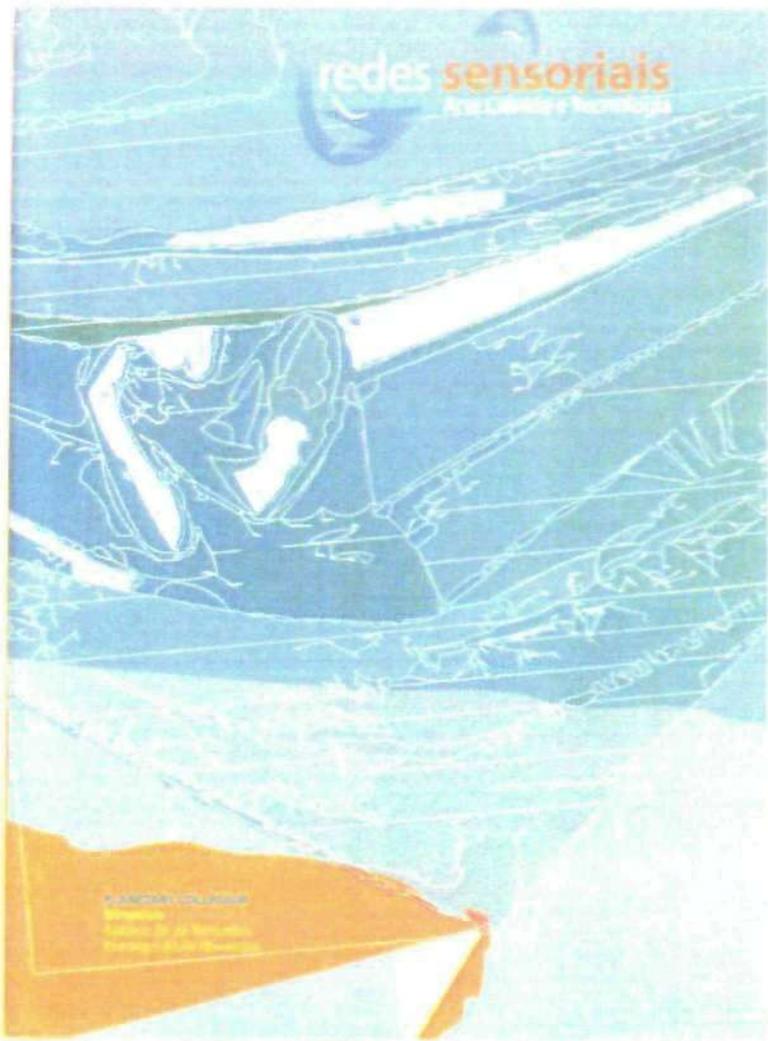
Exploring the Architecture generated by systems which exhibit stigmergic behaviour

Stigmergic Architecture is the architecture of the post-biological era, in which generative systems and decentralised thinking stimulate the growth of autonomous living architectural forms that are able to communicate with their context by interaction with the environment. This speculative nature for an architectural theory suggests architectural forms with unpredictable outcomes following a set of emergent rules of communication with a bottom-up hierarchy.

This work studies the processes behind the growth and development of architectural forms that are able to survive in their context. It focuses on processes for generating life forms as temporal sequences of frozen behaviours in an emergent system. Such forms will undergo endless transformation in response to their relentlessly changing environment, and so it is argued here that the outcome of the process will always be a temporary form, as it leaves an enduring record of the behaviour which resulted in its creation in a certain time and space. Thus, this work is concerned with the processes within a system rather than the resulting form.

The development of modernist, post-modernist and de-constructivist images in architectural theory has led to an approach which identifies and seeks to promote a superficial analogy between buildings and living structures, but such a model cannot capture the fundamental essence of living structures that are dynamic and self-organised. This has left the gap between the images of architecture and advances in technology and biology undressed. This work is concerned with bridging this gap.

The paper proposes the development of theoretical forms of architectural behaviour that are able to communicate with each other through interactions with their environment. The form is abstracted away from its material instantiation and encoded as a system of rules and principles working fluidly together. This work investigates the stigmergic behaviour of ant colonies in natural systems and the forces and attractors that influence the creation of architectural forms, which can be demonstrated via a behaviour-structural configuration pattern of organisation or system of relations that can occupy a space.



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RON WARRBY

abstract: **RESPOSTA PADRÃO: UMA ABORDAGEM EM REDE PARA O DESIGN?**
portuguese: **resposta à rede: approach design?**

Abstract: This article discusses the concept of 'response design' as a networked approach to design. It explores the idea of a 'response design' as a way of thinking about design that is more fluid and adaptable than traditional design processes. The author argues that this approach is particularly relevant in the context of the current global economic crisis, where designers are often faced with complex and rapidly changing challenges. The article concludes by suggesting that 'response design' offers a more holistic and collaborative way of working that can better address the needs of a complex and interconnected world.

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SARA MURRAY

abstract: **ARQUITETURA TRANSFENÔNICA**
portuguese: **arquitetura transfenônica**

Abstract: This article explores the concept of 'transphenonic architecture' as a way of thinking about architecture that transcends traditional boundaries and disciplines. The author argues that this approach is particularly relevant in the context of the current global economic crisis, where architects are often faced with complex and rapidly changing challenges. The article concludes by suggesting that 'transphenonic architecture' offers a more holistic and collaborative way of working that can better address the needs of a complex and interconnected world.

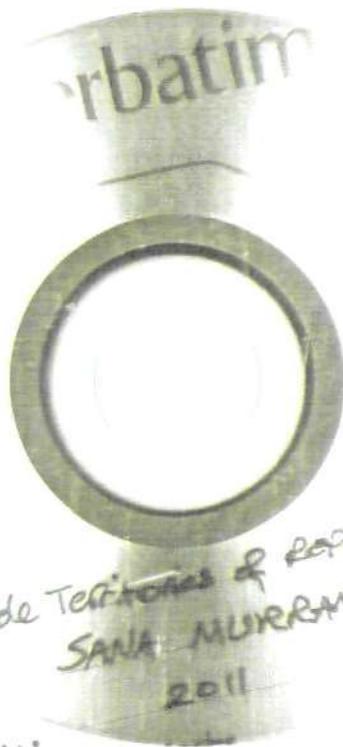
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MIKE PHILLIPS

abstract: **CONSTRUÇÕES FLEXÍVEIS**
portuguese: **soft buildings**

Abstract: This article discusses the concept of 'soft buildings' as a way of thinking about architecture that is more fluid and adaptable than traditional building types. The author argues that this approach is particularly relevant in the context of the current global economic crisis, where architects are often faced with complex and rapidly changing challenges. The article concludes by suggesting that 'soft buildings' offer a more holistic and collaborative way of working that can better address the needs of a complex and interconnected world.

Unstable Territories of Representation.



SANA MURRANI
2011