Capacity for change in Architecture:

Biological design paradigm

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Abstract: **Adaptive Architecture is a broad multi-disciplinary field that generally strives for sustainability. This paper delineates what the biological paradigm can attribute to adaptive architecture. Furthermore it describes the neo-materialistic progression from the digital age towards the post-digital age.**
Keywords: (adaptive architecture, neo-materialism, biological paradigm, material systems, performative capacities)

Introduction:

This brief essay is a combined result of the Research methods assignment and thematic investigations done for my current graduation project – the Hyperbody Msc3 studio called 'Continuous Variation'. One of the main things to be addressed in the design is the multitude of changing needs in an ever-changing environment, and as such this is a leading theme throughout the essay. Dealing with change in Architecture requires a particular way of thinking, a conscious approach of designing. Vacancy poses a large problem, especially within commercial buildings as they require to adapt frequently and often radically due to the changing market. Brand describes commercial buildings as metamorphic, having the need to change with its environment or perish – some sort of 'survival of the fittest'. While all buildings are adaptable and do so over time, but most of them are not designed to adapt and do so poorly. (Brand, 1995) Renovating, and thereby fulfilling contemporary requirements, existing, mainly older buildings, proves often too costly and difficult for it to prove viable. Architecture with a certain degree of adaptability or multiplicity in performance requires a conscious design process.

This essay should partly be treated as a heuristic writing, a chance to position and further comprehend the theoretical scope that these themes play in, and secondly as an essay that propagates a change in design paradigms. While this essay is meant as theoretical discourse, it contains of a few references that serve a further illustrative purpose.

Adaptive Architecture:

In this age where computer-aided design tools are prevalent and incredibly capable it is very accessible to adapt the design and its geometry to changing circumstances throughout the process. The design process is often a cyclical one, characteristic a process of change. Within tools and software this change can be largely anticipated and the design can be rigorously altered right up to the manufacturing stage (Hensel, Techniques and Technologies in Morphogenetic Design, 2006). This anticipation for change or flexibility can, and should in many cases, be transferred in to the design itself. That architecture is capable of adapting throughout its lifetime. Adaptive Architecture is a very broad field, concerning a large variety of disciplines. The reasoning behind it can range from a cultural to a societal or an organisational nature. Adaptability can furthermore take shape in a large selection of elements (Schnädelbach, 2010). The organisational driver is the probably most prevalent one, as it is more economic in nature. I'd recommend Holger Schnädelbach's Conceptual Framework about Adaptive Architecture for a further, albeit elementary, general context. He presents a very coherent and concise picture. There are a few references that require a brief mention in the context of Adaptive Architecture. Rietveld borrows from the traditional Japanese *lifestyle* architecture, which react to

spatial constraint with a multifunctional usage of space. The Schröder House is an iconic early modernist example of adaptive interiors, allowing the user to slide and fold partitions, altering the space to suit their needs. (Rietveld, 1985)

Grimshaw Architects is a more contemporary architecture firm that deals with adaptability and performativity of spaces in many of their designs. The IGUS factory in Cologne (1990-2000) was one of their 'early' designs in which they embedded adaptability. The factory consisted of a modular system in which the elements could be placed anywhere and function appropriately. Within ten years an organizational change occurred; the built-in flexibility allowing for a relatively easy and fast switch. (Branko Kolarevic, 2005) This flexibility does however have the tendency create a rather undetermined, neutral space. When designing a flexible, open space, one needs to create an identity for the space so that it won't play an inferior role compared to whichever usage of space it caters to. Kolarevic describes this identity as active flexibility of vagueness. As opposed to neutral space – vagueness possesses a multi-performative character; it allows for clearly defined goals as well as yet undetermined actions.

Biological Paradigm:

Adaptation is a natural occurrence in any form of life. Biological organisms evolve and adapt, assembling complex and strong structures from a mainly weak, simple entities. Self-organisation is the process that procures the internal organisation of these biological systems without any input of an external source. These systems display some form of emergence when the assemblage reaches a certain threshold of diversity, organisation and connectivity. (Hensel, Techniques and Technologies in Morphogenetic Design, 2006) These natural systems behave in seemingly complex and adaptive ways. Plants hold themselves up through gravity and they endure the forces of the wind. The way they are internally structured, the organisation at the cellular level, achieves their apparent structural goal. The (changing) environment moulds them; the plants adapting through a redundancy in their material system. *"In biological systems, redundancy is the primary evolutionary strategy, … Redundancy in a biological structure means not only that the system has more cells available in each tissue than any single task would require, but also that the hierarchical organisation of cells is arranged so that tissue has sufficient excess capacity for adaptation to changing environmental stresses."* (Hensel, Emergent Technologies and Design: Towards a Biological Paradigm for Architecture, 2010)

Translating this into more architectural terms, one could imagine redundant cells as extra imbedded capacities that are able to compensate for a sudden external change. This biological redundancy is the counterpart of what we deem as efficiency, but it is an important trait in organisms in order to adapt to its changing environment. An efficient design that is optimized for one particular task is very (cost) effective in accomplishing that one task, but it probably won't fare that well in any other given tasks. A system capable of surviving extreme external variations is considered robust; having an excess layer of fat is not optimized, but it does make ones system robust if there's ever a sudden food shortage. This robustness is formed at a genetic level in living systems. These traits are produced at a genetic level, described as the genotype. The physical morphology, referred as the phenotype, is derived from a combination of this genotypic information and environmental influences. A thorough understanding of these biological principles can be converted into the methodology in designing adaptive, flexible spaces that

possess a multi-performative capacity. The genotype would be the core understanding of the space; the active flexibility of vagueness. The phenotype would be its morphology; the way it embodies the physical space.

Delanda describes evolution as an automatic search process. It is blind and opportunistic; it doesn't plan, it only adapts to what is now. Through a large population of reproductive organisms evolution carries on with a sort of 'trial and error' process, a heterogeneous, differentiated population as a result. Although this seems to indicate a process of optimisation for functionality and performance for each individual specimen, but there is no purely optimised form for the entire population. (Delanda, 2009) This evolutionary process can be adapted in architectural design processes with the help of contemporary computational tools, letting a virtual population work through iterations of evolutionary growth.

This notion of an evolving organism is by no means a new phenomenon. Archigram's Plug-In City from the 1960's and early 70's was a technologically inspired investigation into a sustainable urban environment that could be programmed and structured for change. A collection of proposals resulted in a 'megastructure' framework, allowing for elements to be plugged in and out, depending on the needs of the city itself. It would be able to continuously build and re-build itself, continuously adapt. (Sadler, 2005) It remains a theoretical, albeit expansively illustrated, cornerstone of architectural theory and inspiration to many.

Michael Hensel states that the current biological paradigm for architectural design must move on from using weak biological metaphors and its biomorphic imitations. Biomimicry is simply not enough – understanding and abstracting biological

principles and applying it in intelligent ways is the next phase for the biological paradigm: *"The engineering principles of biological systems can be abstracted and applied to the design of artefacts and buildings, a process known as biomimetics. To do so requires a deeper engagement with evolutionary development and a more systematic analysis of material organisation and behaviour of individual species. "* (Hensel, Techniques and Technologies in Morphogenetic Design, 2006)

Neo-Materialism:

One arrives at Delanda's redefinition of Neo-Materialism once you follow the path of Hensel's biological paradigm, curious to understand the workings of biological systems and materials. As opposed to many philosophers, who in line with phenomenology, deem to world to exist through substantiating it by language and other mental concepts, the neo-materialistic approach poses that the world exists independently from our minds. (Delanda, 2009) Matter, the world around us, has its own internal morphogenetic capacities and is capable of coming into being without external influences. Neo-Materialism concerns itself with what is "ontologically prior". (Massumi, 2002) Even with the creative powers that materials possess, the designer still retains his top down 'godlike' decisive powers within the design process. Even though matter is active, its genotype doesn't present a clear blueprint of its final form, the designer needs to tease out the morphogenetic potential, as happens in nature. (Delanda, 2009) Frei Otto experimented with the inherent properties of soap film in order to naturally 'compute' surface tension minimization for a variety of shapes. This materialism encourages a partnership with the material world.

Many of the previous cited authors agree on the multi-performative capacity that materials

carry within. The complex organisation on a cellular level requires, other than a thorough understanding of these natural systems, a reworking of design methodology as well as a shift in the manufacturing industry. (Hensel, Techniques and Technologies in Morphogenetic Design, 2006) & (Branko Kolarevic, 2005) With Moore's Law holding its ground up until now, computing power has increased tremendously the last few decades. Computer-aided design has claimed an imperative spot in the architectural design process, rushing us into the digital age. Marjan Colletti illustrates that we are entering a post-digital age based on Neo-Materialism, with the aim of translating the products of the digital age into physical design and prototyping.(Colletti, An Example of [En]coding Neo-Materialism: ProtoRobotic FOAMing, 2013) Using the technological advances that the digital age has given us, we need to relocate our focus onto material potential in design and manufacturing. Malkawi and Kolarevic of Grishaw Architects shift their focus towards a model of performativity. They abstractly describe a process of architectural evolution through performativity and using the computational tools to simultaneously test its effects on social conditions. (Branko Kolarevic, 2005)

We maintain but transcend the tools and technologies from the digital age into a more physical and materialistic era that focuses on improved means of manufacturing and different methodology on how to approach materiality. Using the inherent material properties of foam, teasing it out as Delanda would put it, Colletti (in collaboration with the University of Innsbruck) creates an analogue, real-life simulation of natural growth and self-organization algorithms. These series of prototypes, called ProtoRobotic FOAMing, *"can be seen as a Neo Materialist example of encoding and decoding complex analogue formation processes by observing, computing and controlling material*

behaviour." (Colletti, An Example of [En]coding Neo-Materialism: ProtoRobotic FOAMing, 2013) Colletti sees a greater potential in experiments as these, they don't serve as simple imitations and simulations, but consider this as an exploration – an act of design. *"The creative act of [en]coding production, behaviour, properties, parameters, capacities, affordances and constraints of (natural, biological or chemical) materials by the aid of advanced digital, computational and robotic processes goes beyond simulation.*
It enters a world of production. Of cultural production through machinic – robotic – production."
(Colletti, An Example of [En]coding Neo-Materialism: ProtoRobotic FOAMing, 2013)

Concluding remarks:

The classification of Adaptive Architecture consists of a large multi-disciplinary field of design methodologies, with different intentions and drivers, utilizing a variety of elements to a specific effect.
The biological paradigm presents itself, due its natural affinity with these evolutionary aspects, as an inspirational methodology. Abstracting rules and principles from biological systems – especially in regards to neo-materialistic thinking about the innate performative capacities of materials – can remain rather vague and experimental. It is a fairly 'new' design methodology that shows much promise in this age of increasingly developed technologies (digital as well as non-digital). That is also one of its less established features; the architectural design that is being done in this particular field is primarily experimental in nature. Developing and articulating the tools as well as the means of manufacturing is where this post-digital age is leading us. Frei Otto stated once that '*it is only of importance that we recognize our future tasks.*' (Hensel, Techniques and Technologies in Morphogenetic Design, 2006)

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