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Synesthetic effects within computational design environments[1]

In his New York Times article on *The Triumph of the Baroque* exhibition, »When Ideas Took Shape And Soared,« the architecture critic Herbert Muchamp writes that the exhibition encapsulated the affinity between nascent digital architectural design and the drawings and models of Baroque architecture. He even goes so far as to describe the former as a new manifestation of the Baroque.[2] Antoine Picon points towards a relative unease when judging computer-generated forms, arguing that references to movement and flux are some of the reasons why so many analogies between digital and Baroque architecture have been drawn.[3] Moreover, spatial and theoretical parallels between the Baroque and computer folding have been made in architecture since the widely-available English translation of Gilles Deleuze's *Le pli. Leibniz et le baroque* (1988).[4]

In relating the sensorial perception of Baroque architecture to computational design, Muchamp identifies a certain similarity in the way Baroque and digital forms address the human senses: in a likeness that appears to be produced by curved surfaces. Common to both curvatures – the Baroque and the digital – is their ability to embody temporality and motion. As Jeffrey Kipnis suggests, architects of the 1990s were increasingly stimulated by Gilles Deleuze's and Félix Guattari's concepts of space. *The Fold. Leibniz and the Baroque* by Deleuze – in a quite literal translation – provided a model for architects who wished to explore spatial transformations while focusing on surfacing techniques. Kipnis points out the risks implicit in cross-referencing as such, where architecture becomes a mere tool for exemplifying a theory rather than producing original architectural outcomes. However, he also believes that the morphogenesis related to digital formmaking that emerged as a consequence of technological and cultural causes was specific to the discipline of architecture.[5] Interestingly, Deleuze too developed thoughts on the fold, by describing some features of Baroque architecture, stressing the »operative function« as central.[6]

The linkage between cultural and technological processes is particularly instructive in examining digital architecture of the 1990s, when new perspectives – opened up by digital tools – changed practices of design, fabrication and communication.[7] Analyzing the process of shaping a computer model by combining software and fabrication methods, one can observe an increasing interest among architects in material preconditions for the

1 The term »synesthesia« is understood in reference to aesthetics where the unity of the senses assumes a key role in perception, as it enables cognition. By analyzing computational design environment's ability to stimulate intermodal experiences, I shall focus on the tactile qualities of digital architecture.

The following ideas result from a research project *Architecture and new Media* funded by the *German Research Foundation* (DFG). I would like to thank the *Canadian Centre for Architecture* (CCA) for giving me access to the material of Greg Lynn's *Embryological House* project.

2 Muchamp 2000.

3 Picon 2008: 67; Picon 2010: 71.

4 Deleuze 1993 [1988].

5 Kipnis 2004: 60.

6 Deuleuze 1993: 3.

7 Besides reacting to an architecture of deconstruction, developments of the 1990s have to be seen in relation to computing perspectives that had influenced architecture since the 1950s, as well as to economic, social and cultural factors of the information society that emerged at the end of the 19th century, see Picon 2010.

processing of digital data. Bernard Cache argues that the physicality of information is a necessity, as only through visualizations can information be perceived. He contends that computer science depends upon »membranes« that turn information into words and pictures.[8]

8 Cache 1999: 241.

Computational design's ability – to store electric impulses numerically and reproduce them in different media – distinguishes the digital from other representational tools like drawings and models. This ability presupposes a design approach that presents the digital models not only on screen but also through physical artifacts. While on the one hand this signals a move from concrete design towards abstract processes, on the other working with the palpable qualities of forms – enabled by animation tools – aligns the design with the body and the senses.

Thus, when Muchamp compares digital design and Baroque, he highlights the interdependence between the movements in matter and movements within us, and he raises questions on the material and mental effects of digital architecture. In our context, the haptic qualities of digital visualization – that grant the eye haptic faculties – are of specific interest, and I will argue that central to the allure of digital architecture is the notion that designs could almost be touched, that is, experienced through tactile means. The questions I would like to ask are as follows: In what ways could a sensorial experience be part of a design process that tried to reach a wider range of attributes of space? Moreover, what exactly were the complementary experiences enabled by new technologies? I will reflect on these questions by looking in detail at the design process and the various presentations of Greg Lynn's *Embryological House*. Before examining the digitally generated forms of the project, I shall draw attention to Muchamp's notion of »the Baroque«, the operational accounts of the fold, and the way architects have interpreted them. What particular concepts of the body come into play when we interrelate computer-generated forms and Baroque architecture?

Concepts of the Body

Central to Muchamp's account of the Baroque is architecture's psychological and physical impact on the observer. In his review, he stresses that the exhibition *The Triumph of the Baroque* »Besides representing a style, […] explores a state of mind.«[9] Drawing an analogy between buildings and people, Muchamp claims that both can be overtaken by mass hysteria, as the walls, doors, and roofs of the Baroque city become twisted into vibrating shapes.[10] He draws attention to Ancient Rome's water supply system, which links technology and art, the rational and irrational. He captures the emotional atmosphere of the Roman fountains by quoting Eleanor Clark: »you walk close to your dreams […] In another minute, people in the crowd will be naked, or will have fish tails or horses' behinds, like the characters

9 Muchamp 2000: 31.

10 Muchamp 2000: 34.

in the fountains. … This is the vocabulary of our sleep, and the key image is always water.«[11] As he elucidates, Luigi Vantivelli's *Palace of Caserta* stimulates the senses so that gravity seems to be suspended. Muchamp points out that the illusory sensations are achieved through inclined planes, indirect lighting, and the twisted pattern of the coffering in the building's domes.[12] Similarly, Heinrich Wölfflin in *Renaissance and Baroque* writes about the Baroque's immediate impact on the observer, stressing the emotions of »excitement, ecstasy, intoxication« as characteristics of the experience.[13] The new experience of affecting the masses now displaces the tectonic conception of architecture. Wölfflin argues for an emotional relationship between architecture and observer. In his doctoral dissertation *Prolegomena to a Psychology of Architecture* (1886), he writes: »We designate the effect that we receive the *impression* [Eindruck]. And we understand this impression to be the *expression* [Ausdruck] of the object.«[14] For Wölfflin and others who were concerned with the notion of empathy, the bodily sense of self is central, as it mediates between spirit and form. It is the presupposition to experiencing architectural bodies.[15] Thus, when Muchamp refers to digital design as the new Baroque, he addresses theatrical and psychological aspects of Baroque architecture, and the ways they affect the perceptive faculties of the beholder.

11 Clark in Muchamp 2000: 34.

12 Muchamp 2000: 34.

13 Wölfflin 1964 [1888]: 38.

14 Wölfflin 1994 [1886]: 150.

15 Op. cit.: 151.

Referring to Deleuze, architects experimenting with computation were drawn to ideas on topology, morphology, and complexity. In an excerpt of *The Fold. Leibniz and the Baroque*, published in »Folding in Architecture,« Deleuze cites Wölfflin, who in *Renaissance and Baroque* describes the Baroque's material traits as a »horizontal widening of the lower floor, flattening of the pediment, [and] low and curved stairs that push into space« which subsequently enables an architecture of motion where »matter tends to spill over into space, to be reconciled with fluidity [while] at the same time fluids themselves are divided into masses.«[16] These types of spatial transformations express the idea that matter is fluid and malleable, curved and combinable. As Deleuze points toward the palpable quality and material culture of the fold, he lends physical substance to frames of mind, introducing a correspondence between material phenomena and metaphysical ideas, as well as between »the pleats of matter, and the folds in the soul.«[17]

16 Wölfflin in Deleuze 2004: 33.

17 Deleuze 2004: 33. In his essay *Skin and Bones: Folded Forms from Leibniz to Lynn* Anthony Vidler expresses reservations about the rather literal folding that dominated computational design practices of the 1990s. Alluding to Deleuze's sketch *The Baroque House (an allegory)* he writes: »No literal interpretation of ›folding‹ or of material folds, whether of fabric, facade, or space, can perform the Deleuzean/Leibnizian function; it would not be so much a question of illustrating complex folds, with all the geometric rigor of computer-generated images, as it would be of discovering the equivalent ›form‹ that might join the two floors of the material and immaterial.« See Vidler 2000: 233.

While affinities between Baroque and digital spaces can be identified, specific challenges are posed by digital form-making. As Anthony Vidler points out in his essay *From Anything to Biothing*, it was architecture that was distorted during the Baroque, such that new ideas of infinity were made in reference to previous concepts of built space and the perceiving subject. However, according to Vidler, generating forms by means of digital animation negates such an approach. Due to the ever-growing potential of software, architecture no longer makes an analogical reference to biology but rather »assumes its own biological character, and becomes, in a way, a biomorphic structure of its own.«[18] In addressing the dependency of ge-

18 Vidler 2001: 228.

netic evolution, biological organisms, and computational form generation, Vidler here refers to Greg Lynn's reflections on computation as outlined in Lynn's *Animate Form*.

However, rather than encouraging analogies between the computer and nature, Lynn believes digitally-generated forms are based on calculations that are further open to deformation and inflection.[19] In this sense, when addressing the architectural body, Lynn argues for the use of deformable geometries, which can at least partially overcome the rigidity of architectural bodies.[20] Lynn cites the morphologist, D'Arcy Thompson, who describes the transformations of natural form in response to environmental forces. In Thompson's geometrical system of description, Lynn observes that »Geometry is no longer a static measure of invariant and unitary characteristics but what Gilles Deleuze and Félix Guattari have referred to as a ›plane of consistency‹ upon which differential transformations and deformations occur.«[21] According to Lynn, the new properties of computational design, which have replaced the traditional drafting medium, are: »topology, time, and parameters.«[22] Accompanying these new properties is the idea of a self-organizing system that enables the merging of different parts and segments, shifting attention to a space that supports deformation.

19 Lynn 1999a: 19.

20 Lynn 1998: 42.

21 Op. cit.: 38.

22 Lynn 1999a: 20.

Lynn's perspective on the architectural body differs from the Baroque by focusing on the body's behavior and calls for processes of differentiation through which architectural bodies might emerge. Still, the fluidity he assigns to architecture's body recalls Wölfflin's notion of the Baroque. Furthermore, the conception of architecture as an adaptive and dynamic system emerges from the exploration of new material conditions.

It appears then that while Deleuze's interest in Wölfflin reveals an interest in the sensory body – as a material unfolding relates to mental experiences – Lynn stresses the dynamic ever-changing relations of the parts under the influence of internal and external forces. Significantly, the conceptual dimensioning of the architectural body in Lynn's methodology precedes the physical dimensions, yet the objects produced during the design process occur as a result of thinking with and *through* the production of objects. What results from Lynn's conceptual design is a process whereby the concept of different membranes is used to house corporal effects.

Embryological House Project

Having touched on some of the issues raised by computational methods and the perceptual dimensioning in the Baroque, I would like to examine the computer-generated artifacts of the *Embryological House* Project, a work that epitomizes Lynn's concept of unfolding architectural bodies.
The experiment set out to explore the possibilities of various modeling techniques. Starting with a rule-bound design process, the project was ai-

med at producing not one building, but a series of houses, thus challenging the concept of an »ideal villa« as formulated by Collin Rowe and Rudolf Wittkower. Further, it replaced the modernist idea of form based on modules with the notion of a potentially unlimited number of iterations derived from one basic form.[23] Lynn set parameters based on the question how forms could be described by curves of different inflections. He posed the following questions: What effect does the amount of inflections have on the surface? What is a sensible diameter for a house? In accordance with these questions, maximum values were set for the number of inflections and the diameter of surfaces.[24] Once these values were fixed, endless variations of forms could be generated by computer calculations. Lynn explicitly emphasizes the »family resemblance« in his approach to creating form where, though each object is different from the other, they all share a common DNA. This type of design based on generative processes leading to unprecedented modes of production in which non-identical parts can be mass-produced, came to be known as »non-standard« architecture.[25] What looks like the superimposing of a »rational« code led to the production of artifacts with sensory surfaces, such as renderings, animations, print layouts, as well as various models including their casts.[26] As Lawrence Bird and Guillaume LaBelle note, a precondition to the design work, which explores and analyzes many different design techniques, is a »›mix and match‹ approach: a project may be sketched out in one software product, shifted to another for design development, to a third for coordination with collaborative disciplines or for the production of working drawings, and to even more for instance for advertising purposes.«[27]

23 Shubert 2008: 361.

24 Lynn 2007.

25 The exhibition *Architectures Non Standard* (2003, Centre Pompidou) showed projects by architects exploring digital tools for architectural design and production, see Migayrou/Mennan 2003.

26 Bird/LaBelle 2010: 244.

27 Op. Cit. 244 f.

As changes to software affect the very conception of architectural shape previously defined through the descriptive system, they also act upon architecture's tactile qualities. Mario Carpo points out that all of the objects within the non-standard range bear similarities because they share some of the algorithms used to produce them.[28] In this sense, the different sensory aspects of physical models and visualizations that were produced during the *Embryological House* project, are based on the same algorithms.

28 Carpo 2005: 100.

The digitally-driven process begins with an ellipse, defined by a closed spline curve of twelve control points. Since all points are interdependently linked, the movement of one single point affects the whole shape. The three-dimensional ›primitive‹ from which the House iterations were generated consists of 12 (Non-Uniform Rational B-spline) ellipses revolving around an axis. Useful insights on both the conception and perception of the Houses can be gained through the sequence of geometric reshapings originating in the ellipse. Once the surfaces between the 12 ellipses are generated, a dense three-dimensional wireframe defines the shape more accurately. Accordingly, the visual effect of the forms provokes haptic experiences, and as the houses become more defined through the generation of surfaces, they also gain a sense of weight and gravity. The control points are always visible on the curves, which allows for further transformations.

Indeed, Manuel de Landa, in describing the impact of tools on different modalities of expression, views interactivity, modifiability and evolution as cardinal aspects of digitally-generated forms (Fig. 1 [LINK]).[29]

The tactility of surfaces can be further explored by examining the modeling processes that were carried out using *Maya*, a 3D visualization software originally developed for the film industry. Such tools for character animation enable the mapping of organic-looking patterns of behavior onto surfaces, enhancing a physical understanding of the architectural body. Being modeled in Maya, the Houses' surfaces are rendered in color, and through light reflections the forms attain a softness of a totally different effect than the line drawings. Attributes like color, texture, and lighting are no longer exclusive characteristic of the geometrical form, but can be operated beyond geometry. Using software tools, each of these properties can now be switched on and off according to visualization choices. The modeling techniques – through color and weight – encourage an understanding of architecture as a plastic continuum. Applied to animations, the geometry changes and biomorphic forms expand. Even in its final shape, the *Embryological House* transmits a potential for movement (Fig. 2 [LINK]).

29 DeLanda 2002: 139.

Fig. 1 Greg Lynn: *Embryological House* (1997-2001) [LINK]

While haptic values experienced through vision characterize the models described, another series of House design explores the physicality of objects. As a result of file-to-factory procedures becoming an integral part of the design process, physical models are now produced. Special attention is paid to the manufacturing of surfaces made of different materials. Therefore, the file undergoes several transformations in order to be run by fabrication tools. In the production of stereolithography models, the executing file steers a three-dimensional laser on photosensitive resin. The outcome is a series of translucent biomorphic objects. The models are composed of two parts, the inside is coated in a white material. Once assembled, the models give the impression of a transparent envelope around a dense core. The overall effect is one of blurred borders.

Fig. 2 Greg Lynn: *Embryological House* (1997-2001) [LINK]

In a series of ABS plastic models, the tool paths visible on the MDF moulds characterize the model's surfaces. Different production techniques bear on the haptic experience of the models, which range from rugged to smooth.[30] Since affinities between moulds used to produce the houses and the landscapes occur, the bi-directional relationship between the design and manufacturing of the *Embryological House* and its environment is self- evident.[31] Because of the iterative process, all the models bear geometrical similarities. While the models described so far were more or less palm-size, a full-scale section of the *Embryological House*, six meters high and four meters wide, was exhibited at the 7th Venice Biennale. It was built in tinted blue polystyrene, and its milled parts were assembled directly on site. The full scale allowed the visitors to relate in person to the curved surfaces, experiencing a kind of materiality of color. During the design process, many insights gained through digitally-produced physical models provided feed-

30 Lynn 2004: 78.

31 Shubert 2000: 257.

back between design and production.

Lynn says that the use of smooth surfaces was informed by the automotive and aeronautic industry. With respect to the car industry, he emphasizes how the idea of generic variation relates to mass customization and product branding. The idea of producing »one-of-a-kind« cars was directly applied to House design.[32] Lynn points out how variation and uniqueness gain significance in media culture, whereby things are marketed to be consumed.[33] The design approach must, therefore, go together with consumer culture where, in particular, information is used to predict consumers' behavior to stimulate more needs. A description as such clearly shows that technical advances cannot be separated from their economic aspects.

32 Lynn in Idem/Rashid 2003: 11.

33 Lynn 1999b: 232.

Muchamp, in addressing the effects of the Baroque on the body and mind, identifies the interrelations between consumer culture and expressive forms. He writes: »With Baroque architecture, space itself becomes a consumer product.«[34] Besides heralding the event of the consumer, he implicitly questions the architect's role in a society where economic, political, and global markets interact more and more with architecture.

34 Muchamp 2000: 34.

This further questions whether the digital design process, with its ability to take different expressions and parameters into account, can lead to a fruitful interaction between architecture, economics and communication. Yet, the discussions on »open« design processes, stimulated by the readings of Deleuze and Guattari, did not actually take their political agenda into account. Surprisingly, those design approaches that departed from postmodernism in order to open new productive paths, resulted in a model of more compulsive consumption. The real question is, can the processing of information – experienced through material artifacts – encourage open processes?

Computation and Intermodal Experience

As shown in my analysis, understanding the material conditions of computational practices with their multiple transformations and products may offer a way to access the impact of digital technology on architecture. By focusing on the material processing of information, computational methods are understood not only as an end in themselves but also by how they inform the shaping of design and building practices. Therefore, attention is devoted not just to the technological environment but to the whole setting in which digital architecture unfolds its potential. Of special interest are those intermodal experiences enabled by the many transformations digital files go through, as well as different tactilities related to software tools and visualization techniques. As objects are touched, used, and »consumed«, the sensorial experience becomes crucial to architecture's communication. The handling of amorphous shapes in Lynn's *Embryological House* en-

courages the beholder to touch and move its parts. The house's affinity to the human body – on an abstract level – is one of the reasons for this attraction. But at the same time, a kind of repulsion is induced by its unearthly colors and reflective surfaces. When experiencing the artifacts of the House project a shift from our dominating visual sense towards the other senses, such as touch, can be noticed. By being able to experience the different forces acting upon the design process, greater possibilities to interact and redirect within the design unfold. Thus, giving space to the realm of affect can encourage design strategies that take advantage of computational design's transformative potential.

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Figures

Fig. 1 *Embryological House*. Greg Lynn. Daniel Langlois Foundation for Art, Science, and Technology: http://www.docam.ca/en/component/content/article/106-embryological-house-greg-lynn.html [21.11.2013].

Fig. 2 *Embryological House*. Greg Lynn. Canadian Centre for Architecture: http://archives.docam.ca/en/wp-content/GL/GL3ArchSig.html [21.11.2013].

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