BEYOND EMBODIMENT

An Existential Project of Digital Tectonics in the Posthumanist Discourses

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Abstract. The paper is a theoretical review on the nature of tectonic expressions in the context of digital design and construction. By investigating the origin of digital tectonics as a methodological exploration to dissolve the oppositional relationship between the digital and the tectonic, the paper identifies the lack of focus on the essential task of tectonic expression-constructing embodied experience on the building form. Therefore, the paper firstly reviews how tectonic expression is understood in its traditional sense, particularly within its indispensable relationship to human body in order to construct the empathic perception of structural dynamics. Then, the paper reveals the disassociation between human body and tectonic form in the posthumanist mode of design-to-construction of the digital age. Further, by articulating the dynamic nature of embodiment in the posthumanist scenario where the body is constantly reconstructed by the technocultural conext of the living environment, the paper proposes a theoretical model arguing for a reinterpretation of both the nature and the task of digital tectonics in order to reclaim the embodied experience in the digital age. Digital tectonics becomes an existential project that must be designed within its mutual determining relationship with the historical-cultural construction of the body-self.

Keywords. Digital tectonics; tectonic expression; embodiment; empathy; posthumanist body.

1. Introduction: The Tectonic and the Digital

Since the end of the 20th century, two oppositional subjects of architecture have been developing in parallel-the tectonic and the digital. On the one hand, the tectonic, as one of the key concepts in the architectural history of the 20th century, presents a demand for the authenticity of the building form. From a genealogical and historical perspective in architecture, the term tectonics originates from a tendency to resist to the superficiality of the image culture, consumerism and the society of the spectacle in general. By proposing a return to embodied experience, as well as its roots in phenomenology, the tendency focuses on material properties, structural logic, and construction process (Pallasmaa, 1996), and their expressive nature in association with human perception. On the other hand, in opposition to

the return to material, the digital turn of architecture cultivated a tendency towards the virtual dimension of the living environment. Scholars and practitioners embraced the concept of posthumanism in the digital discourses, exploring new understandings on embodiment and materiality in architecture (Mitchell, 1996; Grosz, 2001; Picon, 2004; Bratton, 2009).

While the digital turn dissolves the ontological fundaments of the tectonic by challenging the material nature of human body and the living environment, its produced "exciting visual imagery" is simultaneously criticized as only confined to "the utopian world of the screen" (Leach, 2002). Even though digital technologies had also been utilized widely to explore advanced building construction method for realizing complex forms since the beginning, many of its contemporaries criticized the inconsistency between the form and the structure in those early experiments, such as Frank Gehry's Guggenheim Museum in Bilbao. In general, these criticisms indicate that the separation of digital design and construction causes the inconsistency of form and structure so as the elimination of human body in perceiving the building form.

Emerged from the efforts to mediate the oppositional relationship between the tectonic and the digital, the concept digital tectonics was adopted by many scholars and practitioners in the early 2000s to explore design methods that are based on the capabilities of then newly evolved digital tools to model the material properties of building components. One of the essential aim of these explorations is to transform the production process of architecture away from the mechanism of industrial reproduction to a new production mode sought to reconnect architects and construction and reinstate architects as the master-builder in the digital age. For example, in Philip Beesley's teaching and research based on early computer-aided design technology (CAD), digital tectonics is regarded as a generative design method of assembling building components in the software environment to drive form-finding process. It forms a methodological turn of design, aiming to translate traditional tectonics into shape grammars, and to iteratively manipulate the connectivity between the components to generate constructible form in a bottom-up way (Beesley and Seebohm, 2000). In doing so, it mediates computer-generated curvilinear form with the rules and limitations of building construction to some extent, challenging the traditional definition of tectonics and filling the gap between the tectonic and the digital.

However, as many criticisms have pointed out, the early experiments of digital tectonics only celebrated a new paradigm of design thinking which brings material back to the core of computational morphology, but failed to explicit the expressive nature of the digitally produced tectonics in responding to the embodied human experience (Chupin, 2004).

If, as Greg Lynn has stated, the practices during the digital turn of architecture share a similar perception of form as curvilinear and continuity (Lynn, 1993), the integrated model of design-to-construction of digital tectonics would have paved a methodological and technological path for exploring new construction logic and tectonic form, which could solve the problem of material connection and load transmission within the continuous variations of the curvature of the building form instead of traditional beam-column system (Turnbull et al., 2004). Even Kenneth

Frampton himself admitted in an interview in 2003 that curvilinear form, or the digital style, is not inherently contradictory to tectonics, by making a comparison between the works of Frank Gehry and Enric Miralles (Frampton, Allen and Foster, 2003). However, one question remains: is there a cultural implication in these newly evolved digital tectonics to form the embodied human experience so as the authenticity of tectonic expression? If yes, then what would it be? If not yet, what would be the task of design to cultivate one. To answer those questions, the paper will begin with a review on the theoretical discourses about the essence of embodiment in association with the expressive nature of tectonics.

2. Embodiment in Tectonic Expression

In pursuing the authenticity of the building form, tectonics have been always addressed in correlation with structure and construction. According to Eduard F. Sekler, the relationship between the three could be explained as such: structure, the intangible concept, is realized through construction and given visual expression through tectonics (Sekler, 1964). Later, scholars reveals that although tectonic form essentially roots on structural performance and construction process, it usually goes beyond the pure technique correctness (Nervi, 1965; Frampton, 1996). And, it is the expressive nature of tectonics, which is associated with the embodiment of human perception, that forms the tension among tectonic form, structural performance and construction process.

The expressive nature of tectonics is built upon an embodied relationship between the perceived object and the perceiving subject. From early philosophical enquiry and its later influenced German aesthetic study in the 19th and 20th century, and further to the contemporary neuroscientific findings of "mirror neuro", empathy is always the key concept in addressing the constructive mechanism of the embodied perception of tectonic form.

In the preface to Gottfried Semper's book Style, Harry Francis Mallgrave has unfolded the history of tectonic expression, in parallel to the historical formation of the concept of empathy. According to Mallgrave, the concept of empathy originates from the philosophical enquiry by Arthur Schopenhauer and is firstly introduced into architecture through the work of the German architect Carl Botticher. In that period, empathy was understood as a symbolic reading of the structural dynamics of building form. Influenced by Botticher's work, Semper later constructed an animist view on tectonic expression-tectonics is not referring to any passive form, but an active organism expressing its resistance to the gravitational force of the structural load. And it is Semper's vitalistic understanding on tectonic expression that influences Friedrich Theodor Vischer exploring his theory of tectonics in correlation with intrinsic nature of human perception. And, Friedrich's son, Robert Vischer firstly articulated the mechanism of the animist reading of tectonic form by introducing the term empathy (Einfuhlung in German)-projecting "own bodily form into the form of the object", in his doctoral thesis in 1873 (Mallgrave, 2004).

Robert Vischer's doctoral thesis becomes the foundation for the further investigations of the concept of empathy in German aesthetic study through the

19th and 20th centuries, and influences subsequent scholars including Heinrich Wolfflin. But, it is only through the development of neuroscience in the late 20th century that would the internal mechanism of empathy have been fully revealed in a scientific manner. In the neuroscientific perspective, empathy is explained by the perceptual mechanism within the mirror-neuron system of the brain. Mirror-neuron system is firstly discovered by Vittorio Gallese and his colleagues at the University of Parma in Italy. It reveals the essential role of human body in forming empathic experience. In the empathic perception controlled by mirror-neuron system, the perceiving subject projects her/his body into a nonhuman object and simultaneously retrieves the pre-reflective experience back to the self (Clark, 2016). Mallgrave, in collaboration with Juhani Pallasmaa and others, introduces the mechanism of the mirror-neuron system into architecture, to articulate the perceptual relationship between human body and tectonic form. When standing in front of the twisting columns in the Portuguese church of the Monastery of Jesus in Setubal, the visually perceived structural dynamics within the column would activate a kind of twisting tension within the muscles of the perceiving subject (Mallgrave, 2013). In other words, when perceiving the structural dynamics within the building, the subject unconsciously projects her/his body into the tectonic form, and simulates its internal loads and supports with her/his own muscles.

The neuroscientific mechanism of empathic perception reveals necessity of the correlation between human body and tectonic form in constructing the embodied experience of the building form. In return, tectonics could be regarded as a potential media to intensify the embodied experience by designing the tectonic form in analogy to the form of human body. The argument could be traced back to Sekler's comparison between tectonic expression and artistic expression-tectonic form could be utilized to intensify the perception of structural dynamics just as art form is able to intensify the experience of the hidden reality. Although neither body nor empathy is directly addressed in Frampton's Studies in Tectonic Culture, his reference to Maurice Merleau-Ponty and the phenomenology of perception does confirm the importance of the embodied analogy in his understanding on the expressive nature of tectonics, not to mention Frampton's insightful discussion on the anthropomorphic conception of the joint in the works of Louis Kahn and Carlo Scarpa (Frampton, 1996).

3. The Posthumanist Nature of Digital Tectonics

The methodological shift cultivated by the invention of digital tectonics not only brings back the logic of construction to the early stage of digital design, but also reinstate material property as part of the source of design creativity. The AD issue Digital Tectonics edited by Neil Leach, David Turnbull and Chris Williams in 2004 particularly aims to dissolve the contradiction between the digital and the tectonic by forming an interdisciplinary design approach within the dialog between architecture and structural engineering. Taking figures like Antonio Gaudi as a historical reference, most of the essays in this issue have explored the possibilities of combining digital morphology with material property, integrating digital-generated form and structural principles in a bottom-up design process

(Leach, Turnbull and Williams, 2004). In this process, tectonics are not fully determined by designers as a way of assemble materials together for the purpose of a specific structural requirement or structural expression, but naturally formed and formulated in a self-generative way based on material property.

In this posthumanist mode of digital design, the self-generation process of structural form naturally prevents the involvement of human intuition, thus has no determinative relationship with the intuitive perception of structural stability in correlation to human body. Then, when human body is eliminated from the creation process, the created structural form would also prevent human subject to perceive the internal structural dynamics through the mechanism of the bodily empathy. Just as Patrik Schumacher argues in his theory of tectonicism, digital tools allow architects to operate on continuous variation to generate fluid and differentiated structural form, which usually resists human interpretation. Therefore, as he concludes, the task of tectonic articulation would be to represent the complicated dynamics of loads and supports for human subject (Schumacher, 2017). However, without the associative relationship between the tectonic form and the form of human body, it is still questionable that whether the semiotic representation of the structural dynamics of digital tectonics is adequate to activate the embodied experience of the building form.

Furthermore, in promoting the structural turn of digital design, the AD issue of Digital Tectonics have simultaneously revealed the posthumanist nature within the self-generative design process, but what is not fully explored by the issue is how the development of digital construction technologies intervenes the relationship between human body and the tectonic form.

When traditional craftsmanship is replaced by the contemporary digital technology for construction, CNC machines and rapid prototyping methods provide entirely new directions for creation as well. From ancient times to the Middle Ages, buildings were constructed by artisans and master builders working on the actual construction site. Through the process of making, the intuitive dialog between human body and material is regarded as part of the source of design creativity. Since Alberti's time, drawing as the notational tool has separated the architect from the actual process of construction (Carpo, 2011). Later, through further divisions of labor in the modernism movement, on-site building construction was replaced by industrial prefabrication and assembly lines. In these stages, although the construction of a building is completely dissociated from human body, the conception of the building form is still embodied with human subject. In contemporary, with industrial robots as the revolutionary construction platform in the digital era, the architectural profession is experiencing another paradigm shift from traditional crafts and industrial reproduction to a new production mode combining human with machine, fundamentally questioning the traditional understanding of creativity within the interactive feedback loop of human body and material.

In this human-machine collaboration, applications of digital tools and robotics are not limited to the realization of the pre-conceived form by human subjects, but can be involved directly in the creation process and become a source of creativity in itself. Specifically, and related to this research, tectonic form is not fully designed

and determined by human and thereafter realized by machine, but possesses the characteristics of the automatic machine itself.

Fabio Gramazio and Matthias Kohler use the term digital materiality to describe the transformation of the nature of tectonic form under the informational intervention of automatic machines. Within the integrated mode of information exchange between digital design and construction, the logic of digital tools can be directly projected into the building form. Tectonics no longer only includes structural or material properties, but also has the characteristics of the digital morphology contained by the construction machines (Gramazio and Kohler, 2008). Meanwhile, the intervention of automatic machines also questions the origin of tectonic form. Greg Lynn once discussed the patterns produced by a CNC milling machine automatically and left on the curvilinear surface, arguing its origin not as an intended surface decoration, but as a tectonic expression that is formed naturally from the construction process of the machine (Lynn and Leach, 2004).

In a short summary, in this digitally framed process of making, the essence of creativity is no longer limited to the mere energy and contours of the human body, but now including an array of intelligent machines capable of extending human intentions outward, away from the body. No longer is the human the only author of the design of tectonic form. Machines are also part of the design subject, forming a new mixed subjective in the creation process. This evolution has resulted in another posthumanist tendency whereby human body have gradually lost its direct association with the construction and thus the creation of tectonic form.

4. Digital Tectonics and the Posthumanist Body

The posthumanist tendencies of digital design and construct evolves within a broader context of posthumanism, whose essential idea of human-machine symbiosis also calls for a fundamental reevaluation of the body itself. Then, by questioning the biological nature of human body, it could add another layer of dynamicity and uncertainty to the understanding of the correspondent relationship between the tectonic form and the form of human body.

In his article "Construction History: Between Technological and Cultural History", Antoine Picon argues that the mediating effect of human body in forming empathic experience is neither natural nor stable, but based on the historical construction of the perception of the body-self. And it is through the historical construction of the form of the body-self that tectonic expression is deeply connected to the cultural contexts of historical periods. In addition, Picon raised a question that whether the cyborg culture evoked by contemporary digital subjectivity and prosthetic technology has any relation to the dissociation between form and structure in the early projects of the digital turn in architecture (Picon, 2005). Although the question hasn't been fully unfolded in Picon's essay, it indeed reveals a necessity to rethink the expressive nature of tectonics in association with the transition of the understanding of human body from humanism to posthumanism.

Found in ancient Greek, Renaissance and early enlightenment period,

humanism is an epistemological paradigm emphasizing the completeness of human. In contrast, the posthumanist thinking, which could be defined in a more dynamic view, is trying to challenge the fundamental assumptions about the stability of human nature. Regarding to the understanding of the body-self, what posthumanism proposes is that neither the self nor its material carrier-the body-is static and completed. Cultivated within the study of cybernetics around 1940s, and later influenced by the poststructuralist philosophy in the second half of the 20th century, the posthumanist thinking tends to recognize the form of human body as something being constantly reconstructed through existential synthesis with the living environment.

Furthermore, the posthumanist understanding of the body-self is also built upon the fact that tool, with its mediating effect, frames various interventions between human and environment. Tool can be regarded as the extension of the body-self to alter human nature and to enhance human capability. In early 1960s, NASA scientists Manfred E. Clynes and Nathan S. Kline used the term cyborg to articulate the way of equipping "tools" as the body extension to enhance human's capability of adapting to the external space (Clynes and Kline, 1960). Later, in the mid-1980s, the term cyborg was further circulated in association to the interrogations of the relationship between human and technology. Since then, the term has been appearing in various scenarios including the scientific, the artistic, the fictional, the intellectual, and so on. For example, in film, cyborg is a kind of expression about the situation that "man witnesses himself being progressively dehumanized" and "become an insensitive machine" (Picon, 2000). While, in philosophy, such as what Donna Haraway proposed in A Cyborg Manifesto-Science, Technology, and Socialist-feminism in the Late Twentieth Century, the term has been profoundly addressed in the exploration of gender issues (Haraway, 2016).

In general, different versions of the posthumanist thinking, as those mentioned above, are all indicating a understanding of the dynamic nature of the form of human body-body could be constantly transformed by its technocultural context. And essentially, the development of the understanding is also indebted to dissolution of the boundary between the virtual and the physical existence of human being and brings back the idea of body-environment incorporation based on information exchange (Gandy, 2005). Then, in this context, the posthumanist understanding of human body could also possess its relevance to the contemporary development of digital technology. According to Katherine Hayles, "for the human is the tradition of liberal humanism; the posthuman appears when computation is taken as the ground of being, a move that allows the posthuman to be seamlessly articulated with intelligent machines" (Hayles, 1999).

For example, the digital medias today have allowed human to be seamlessly connected with the environment through data exchange. Then, as William J. Mitchell argued in the 1990s, with digital aids in contemporary living scenario, the human subject shouldn't be only referring to the biological body and its sensory organs, but also the digital medias that have the capabilities of performing as the virtual extension of the body, with which human being could "sense and act at a distance but that also remain partially anchored in their immediate surroundings"

(Mitchell, 1996; Picon, 2015). In this way, digital technologies could completely reconstruct the perception of the body-self. They could establish "the fantasy of action, communication, and connectedness at-a-distance, the fantasy of an alternative or virtual existence that may bypass the gravity and weightiness of the body" (Grosz, 2001).

If, in the view of architectural phenomenology, "the unique form of the ever-present body" is the fundament for constructing all experiences (Merleau-Ponty, 1967; Bloomer and Moore, 1977), then the technocultural context of the digital age would have been constantly reconstructing the form of the body-self, would have destabilized the instantaneous experience of the tectonic form as a reflection of the form of body-self, and would have eventually altered the way, in which human subject experiences the building form.

In the context of posthumanism, the body-self could be interpreted as being constructed historically and culturally by the living environment. Then, we could conduct a reverse engineering on Picon's argument about the latent relationship between cyborg culture and the disassociation of form-structure. To be sure, it remains uncertain and needs further historical investigation that whether the perception of the body-self in the cyborg culture of 1980s had any influence on the nature of the tectonic expression of the buildings in the early 1990s. However, digital tectonics, as the foundation of constructing the visual appearance of contemporary living environment, would certainly possess the capability to influence back on the perception of the body-self, then offering the possibility of reconnecting tectonic form and the form of human body in the posthumanist scenario, even though it still requires further experiments and explorations in the perspective of design.

5. Conclusion and Discussion: Digital Tectonics as An Existential Project

In the humanist understanding of tectonics, the task of tectonic expression is to enhance the formal correspondence between tectonic form and the form of human body, and to intensify the empathic perception of the structural dynamics in order to construct the embodied experience of the building form. Within the posthumanist mode of digital design and construction, the task of tectonic expression would have to be revealing the unperceivable form of the structure that involves the process logic of the automatic machines, trying to compensate the disconnection of human body and tectonics by visually providing a semiotic representation of the structural dynamics. Now, built upon the understanding of the dynamic nature of the posthumanist body, we can argue for a new task of tectonic expression that is to historically and culturally construct the perception of the body-self in order to directly rebuild the connection between the tectonic form and the form of human body in the digital age.

To achieve it, we need to establish a theoretical model interpreting digital tectonics as an existential project. In the first layer of the model, the nature of digital tectonics should not be understood as merely a methodological approach to reconnect digital morphology with structure property and constructability, but also a perceptual media to empathically reveal the structural dynamics in order to

construct the embodied experience of the building form. Then, on the basis of the technocultural context of the digital age, the nature of digital tectonics requires a reevaluation of the humanist understanding of the embodied perception that is deeply indebted to the correspondence between the tectonic form and the form of the biological body. Built upon the posthumanist discourses, the nature of digital tectonics should be rooted in a mutual determining relationship between the tectonic form and the form of the body-self. As an existential project, digital tectonics "educates" the human subjects about how body is constructed and existed in the living environment through empathic perception. Meanwhile it is being perceived empathically through the mediation of the newly perceived form of the body-self. In this simultaneous reciprocity, we would eventually find a new connection between the tectonic and the digital in the posthumanist perspective.

Acknowledgement

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