The Emerging of Spontaneous Materiality under Limited Digital Control

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This paper focuses on a new form making method of spontaneous materiality under limited digital control, as a supplement to the trending method of digital materiality. A specific emphasis is placed on the connection between material selection and sensational expression in the contemporary information and digital technologies era. Spontaneous materiality refers to the alteration of material attributes by natural forces. The current techniques of digital materiality rely on accurate digital control and inhibit from the intervention of any unpredictable material variable, which shows excessive scientific calculations and a loss of artistic articulation in design. In the new form making method proposed here, intentional yet limited digital control sets the material framework where the combination of soft and hard materials takes place. With the influence of gravity and spatiotemporal accumulation of selected materials, the fusion of softness and hardness brings a coexistence of different material states and qualities in one object. Thus an integration of shape and matter produces a blurring boundary between physical material and digital form, and more importantly, a sensational experience with expectational slippages of vision and touch. Additional to the ongoing discussion of computation, this design research expands the potential of computation by restricting its influence.

Keywords: *Spontaneous materiality, limited digital control, sensational expression, sensuous quality, illusion*

INTRODUCTION

Background

The production of architecture is moving towards a novel convergence of computation and materialization in response to the trend of industrial revolution (Menges 2012). With the rise of digital materiality, virtual computational design is facing a challenge of integrating complex design information in the physical realization of architecture. Numerous explorations have been tried to bring artificial yet scientific control to digital materiality. State of such works varies on two major trajectories: algorithmic modeling and morphogenetic-material design.

The current techniques of algorithmic modeling deal with customized cutting, sculpting, and forming of conventional materials with digital fabrication equipments. The work of Fabio Gramazio and Matthias Kohler is representational in applying dig-

ital coding to the fabrication of physical assemblies. Although efficient in construction, it relies on a limited set of material rules that allow process-based control and inhibits from the intervention of any unpredictable material variable. As a result, the final product lacks novel material expression.

Morphogenetic-material design pushes formal and material manipulation more on the quest of Postmodernism for differentiation, variation and choice (Mario 2013). One is to employ computational tools to seek behavior and performative capabilities of existing materials. Another is to create new materiality via biomimetic solutions. They share a common character of designed digital materiality. For the former, self-assembly, as Skylar Tibbits suggests, is using customized elements to design systems that build themselves with more complexity and intelligence than traditional building structures (Tibbits 2012). And aggregation, as karola Dierichs and Achim Menges state, differing from the approach of self-assembly, puts an emphasis on the interaction of loose elements other than fixed parts in the behavior of a system (Dierichs and Menges 2012). For the latter, Neri Oxman investigates materially heterogeneous objects utilizing data-driven material modeling closely bound to the theory of biology (Bader et al. 2016). Both approaches raise a doubt about dependency on the precise computational control over unintended natural formation in morphogenetic design.

The amount of accuracy required in material science is similar to the material assembly in digital fabrication, which puts forward a question of whether architectural design is about strict technological control or loose artistic articulation. As Sanford Kwinter points out: No computer on earth can match the processing power of even the most simple natural system (Menges 2012). Computational learning is powerful in probing new reality of materiality, however, an appropriate balance between digital control and natural formation in materialization should be advocated as a strategy confronting the potential danger of overwhelmed technology and science as well as inviting the power and possibilities of mother nature.

Spontaneous Materiality

Either imbedding digital coding in the fabrication of large material assemblies or moving from material's microscopic structure to system's macroscopic morphology. Much emphasis is put on the quantifiable aspects of modeling or materialization, while qualities falling out of numerical explanation are neglected. Additionally, multi-sensory experience enabled by combined objective and subjective judgements of material qualities is overlooked by visual-biased contemporary architecture (Juhari 2000).

Thus, this paper probes the possible means of breaking the technical and scientific enclosure of algorithmic modeling and morphogenetic materiality by inviting the natural and sensuous qualities of materials. Specifically, keeping the material at its raw state, introducing limited digital support just enough to let the materials form themselves spontaneously, natural properties of materials would then be maintained, elaborated or reorganized, which includes color, texture and opacity. Aided by digital technology, spontaneous materiality has the potential of acquiring fresh treatment of conventional material or reaching enhanced materiality, accompanied by subjective associations and sensuous experience.

Additionally, this is an attitude towards a material revolution that was marked with the trait of novel and unexpected materiality under limited digital control, empowering designers to combine technological control and material purity across spatial and temporal scales. This paper aims at proposing a new form making method of spontaneous materiality as a supplement to digital materiality.

Muti-sensory Experience

Multi-sensory experience is perceived by Juhani Pallasmaa as a significant trait of architecture (Juhari 2000), which offers an ontological basis for the design method advocated here. Multi-sensory experience is interrelated to simultaneous spatial participation. Referring to conventional architecture, the multi-perspectival or simultaneous space offers us opportunities as inside observers with embodied

sensations. In other words, abundant peripheral visions with carefully chosen materials, colors and textures arouse strong subjective associations for observers, encouraging an intimacy and bodily involvement (Juhari 2000). Based on this ontology, spontaneous materiality sets the tone for a design method coupled with multi-sensory experience to stimulate spatial creativity and artistic variety in architectural practice.

Among all senses, tactility establishes the foundation for slowness and intimacy (Juhari 2000). Against ocular-biased culture, Pallasmaa embraced the concept of haptic and sensuous architecture for the rejection of instant imagery and distant impact (Juhari 2000). Unconsciousness of the significance of touch detaches us from a world full of mystery, discovery and engagement.

So for the design research that is going to be introduced here, a closer contact with materials is the starting point to evoke unpredictable slippage between vision and touch, then extending matter's innate abilities to produce unexpected formal and material complexity.

EXISTING PROJECTS

A small group of designers is developing approach similar to spontaneous materiality through a close collaboration between digital technology and materials. P-wall, as shown in figure 1, a project by Andrew Kudless combines digitally built elastic formwork and plaster. Computer-generated pattern of points set the anchoring points for the elastic fabric. Then, the liquid plaster is poured into the formwork, leading to an expansion of the fabric under its weight. Areas with less constraint in the pattern of supports sag deeper and wider, causing irregular bulges. By using the force of gravity Kudless is able to let plaster to behave as plaster, forming the shape under the guidance of subtle pressure points.

Figure 1
P-wall

Figure 2
Raspberry Fields

Another project that innovatively explores spontaneous materiality in natural decay is Raspberry Fields by Jason Payne, as shown in figure 2. He arrays numerous thin wood shingles on a surface outdoor and deliberately orients the grain to encourage the curl that happens naturally from the weathering process. In the meantime, he colors the backside of the shingles. Over time, the façade goes from ordered to rumpled and wild with ever-changing array of vibrantly-toned yet simultaneously-decaying colors. Further, the global pattern of the curl is guided by the curvature of the underlying surface, which Payne digitally sculpts to encourage extra chaos.

In both cases, embracing and amplifying the effects of material variations as they innately will develop in natural state, could be considered as part technique and part attitude in form making process. The design philosophy, immersing spontaneous ability of the material with a mixture of geometric control and stylistic manipulation, expands a way of novel architectural engagement, and establishes an association with both cultural and natural world.

METHODOLOGY

A special material choice of my design research presented here is starting to explore the potential of sensational expression in material by using spontaneous materiality under limited digital control. The natural combination of heterogeneous material means to create unexpected material alteration, and more importantly, generates formal complexity with certain structure support. The support system under materials follows digital rules, so even newly created materiality shows chaos due to the fusion of materials, order appears to be seen from the support system underneath. The coexistence of chaos and order is an artistic representation in one model, which is marked by subtle tension between vision and touch of the newly created materiality.

At first, the base materials selected are categorized into two groups: the soft and the hard. Soft material is cotton, and hard material is cement. The seemingly contradictory attributes of softness and hardness are meant to set the tone for unusual effects to happen when combined in one model.

Secondly, a certain framework is designed to support the soft material by using steel wires. By mimicking the generative pattern of tree trunks, which follow the rules of natural growth, a series of digital frameworks are designed on design project of Catia platform and modeled out using steel wires, as shown in figure 3. For large-scale modeling, 3d printing of the frameworks can be used.

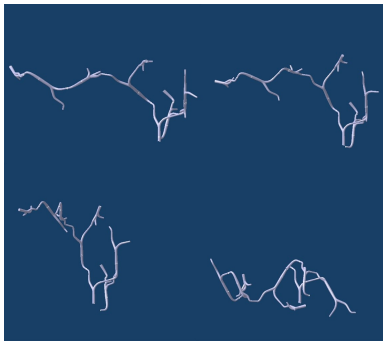
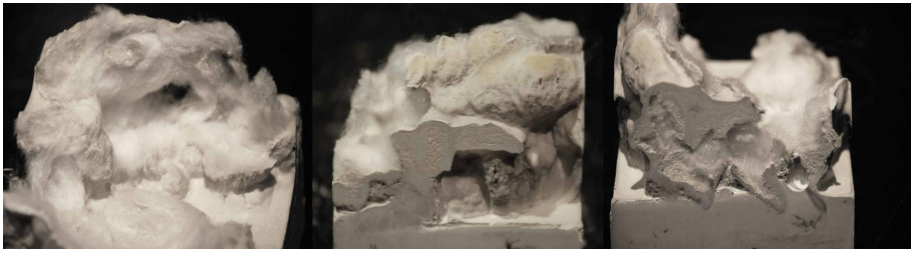


Figure 3
digital tree trunks

Figure 4
cotton bounded on steel wire

Then, cotton materials are bound on the digitally constructed steel wires, as shown in figure 4. Thirdly, a cubic substrate is built as the mold for the mixture of cotton and cement. A series of cotton-steel wire objects are put into the cubes and then poured with cement powders and water. After curing for one night, the cement powder consolidates between the gaps of soft cotton naturally by force of gravity, making an object with varied states of material combina-

Figure 5
(a, b, c) an object combined with softness and hardness



tion, which displays a gradual change of solidification from softness to hardness. Consequently, one object becomes a coexistence of different states and qualities, as shown in figure 5a, 5b, 5c.

Finally, a digital representation of the model result further expands the potentials of computation. The work engages a unique process of form generation that uses imagery taken from the physical model to produce buildings with a mix of landform characteristics. The first step is to take a photo of the model surface with a confounding state of softness and hardness, as shown in figure 6, and secondly convert it into displacement bump image and insert it into Mudbox to sculpt out polygonal geometry, as shown in figure 7, which turns out to be a partial digital representation of the formal and textural reality of the model. Ultimately, the textural form of the building is softened or hardened to produce changes in blurriness that visually resemble photographic effects but are actually qualities of the form itself. For example, see figure 8.

These subtle formal and textural differences aim to draw occupants into closer forms of attention. The relationship of building to artwork in a museum setting is an appropriate case to explore distracted forms of architectural attention; museumgoers typically pay close attention to artworks while being oblivious to the architecture. Rather than reverse this relationship through sculptural building forms, this study aims to create subtle tensions between expectation and reality. Specifically, much of the building form is developed to produce appearances that are obscure form a distance and therefore compel occupants to move and investigate visual effects. This creates a landscape marked by slippages of what is expected and what is actually there: in the concrete traits of the building's form, texture, and materiality.

Figure 6
photo of the model surface

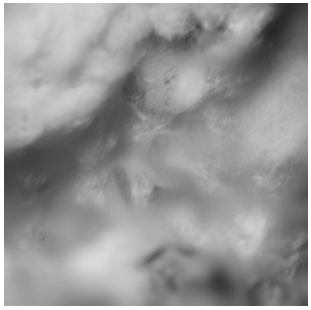


Figure 7
polygonal geometry by Mudbox

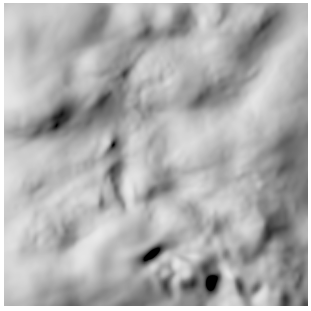
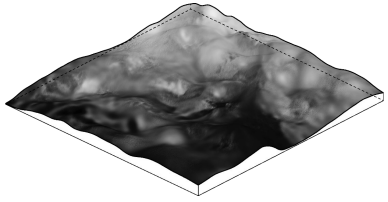


Figure 8
digital form with landform characteristics



RESULTS AND DISCUSSION

The outcome of the design research is qualitative. By combining soft and hard materials at their raw state, using digitally constructed tree trucks as the supporting system, heterogeneous qualities can be maintained in one object. A variety of opacity, color, texture and haptic qualities are mixed and elaborated to reach an enhanced materiality with a gradual change of solidification from softness to hardness. The formation process of heterogeneous materials in one object shows spontaneous behavior. The digital control is limited as the supporting system to give some order. The result turns out to be qualitative and multi-sensuous, specifically in this case, creates a slippage of expectation between vision and touch. And finally as the digital representation of the model result showed, this design research not only proposes an effective way of physical form making, but also offers an opportunity of sculpting digital form using the imagery taken from the physical model as a source. With the digital form replicating and enhancing the quality of the original physical form, the method of spontaneous materiality has the potential of generating a positive design cycle in an united physical and digital world.

The special material choice of my design research presented here is an attempt to explore the potential of sensational expression in material by using spontaneous materiality under limited digital control. The combination of selected materials displays a range of formal and material alterations within one object with spatiotemporal behavior, which is marked by subtle tension between expectation and reality of the newly created materiality.

As in the case of combining softness and hardness, the purpose is to create an illusion between the actual and sensual quality of the object. Real quality in this case unveils itself through touch, and sensual quality can be obtained from vision. The cognitive gap between these two qualities generates illusion. The visual illusion obtained through this making study intends to create a slippage of expectation. For instance, when softness is the impression from first sight, unexpected hardness prepares a sustained complexity, by which the observer extracts the whole perception through touch. The affect of equivocation depends on the control of intimacy between the observer and the object.

CONCLUSION

Unlike the existing methods of digital materiality, which deals with either singular material or heterogeneous materials framed by accurate digital skeleton in one system, spontaneous materiality brings possibilities of unintended materiality with mixed properties of heterogeneous materials, following the laws of nature. Material, apart from the capacity to compute as information, should not be neglected of its ability of sensational expression.

Consequently, to avoid the drifting towards an overwhelmingly digital controlled society, a spontaneous materiality design approach challenges the conventional form making by limited digital control and contributes to a material-related sensational expression in architectural culture. Additional to the ongoing discussion of computation, it expands the potential of computation by restricting its influence.

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