Complexity as a Creative Force in Design
Variegation, Heterogeneity, Diversity

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Abstract

This paper describes an experimental project that attempts to use complexity as a creative and vital force within the design process. The project seeks to release architecture from its conventional role as a static urban backdrop and to transform it into a vital, dynamic, and active participant within cities. The project, entitled “Energy Farm”, was instigated by the 2005 International Open Design Competition for a “Performing Arts Island” located within the Han River in Seoul, Korea. Through the exploration of the site and program elements as an interacting matrix of fields, forces, and flows (energy, program, water flow, infrastructure, etc.), our proposal emerged as a variegated landscape marked by its capacities to produce its own energy, interweave heterogeneous threads of structure and program, and instigate a diverse set of scenarios in which physical and virtual realms coalesce. Architecture, in its unique capacity to bridge these realms, can release the rich computational potential of complexity into the physical realm. Within this scenario, architecture becomes a creative and vital agent for productive change with profound social, political, and ecological implications.

Introduction

Complexity theory, according to Stuart Kauffman, “… deals with systems with hundreds or thousands of interacting parts and tries to understand the collective emergent properties of the dynamical behavior of such systems” (Kauffman 2001). In laboratories and experimental workshops across the planet, digital simulations stream across computer screens testing, analyzing, and drawing out the explosive potential of this hypothesis. Research is focused on its implications within diverse yet interacting territories such as the biosphere and the econosphere, interweaving physical and virtual computation into a rich broth of creative potential. Kaufmann himself suggested that such possibilities, “could hint that matter, energy, and geometry might be able to interconvert” (Kauffman 2000, 264-265). Vast categories of knowledge are being reinvestigated through the framework of complexity. As such, the underlying principles governing dynamic and complex life systems (cells, cities, weather system, astrophysics, etc.) are being rewritten with new territories for design research opening up.

Philosopher Manuel DeLanda suggests that what is occurring is a “radical
conceptual change.” He illustrates these concepts through an example in the material sciences where “scientists had to stop viewing metals in static terms, that is, deriving their strength in a simple way from the chemical bonds between their composing atoms, and begin seeing them as dynamical systems” (DeLanda 2006, 2). Similarly, we believe that the fields of architecture, landscape, and design must begin to view our built environments, not as static compartments of mass, but as complex, emergent, and dynamical systems in and of themselves (Figure 1).

DeLanda’s discourse on material logics and the philosophy of matter has provoked a productive dialogue within our research studio. His essay “Uniformity and Variability” (which reveals the history of technology through civilization’s development and exploitation of materials) raised a particular awareness of the interconnected nature of all matter: “any complex system, whether composed of interacting molecules, organic creatures or economic agents, is capable of spontaneously generating order and of actively organizing itself into new structures and forms” (DeLanda 2006, 3). In his introduction, DeLanda reveals the new found, “importance of studying the behavior of matter in its full complexity. This awareness has, in turn, resulted in part from the creation and experimentation with materials which involve a heterogeneous meshwork of components, such as fiberglass and other composites, as opposed to the simpler and more predictable behavior of uniform, homogenous materials such as industrial-quality steel” (DeLanda 2006, 1). He convincingly argues that our past “quest for uniformity” (through the increased homogenization of materials involved in our core industrial practices) has produced a climate in which we have come, “to view heterogeneity and variation as something to be avoided, something pathological to be cured or uprooted” (DeLanda 2006, 8). In this process he argues that while some efficiency was gained within production and assembly-line processes, much has been lost within creative practices such as architecture, landscape, and urban planning. While these professions have gained expertise in constructing with material organizations, which are equal in all directions and invariant, their capacity to deal with non-isotropic materials such as composites is lacking. DeLanda calls for the need to, “nurture again our ability to deal with variation as a creative force, and to think of structures that incorporate heterogeneous elements as a challenge to be met by innovative design” (DeLanda 2006, 7).

**Variegation as Creative Agent**

Experimental Processes

Our “Seoul Energy Farm” proposes...
a complex intermeshing of variable interacting agents. Three interacting fields of the ground, the space frame, and the sky-pins compose a differentiated yet synthetic landscape that is capable of finely controlling and generating a series of varied environments (Figure 2). Though a synthetic set of parameters, this proposal works to create difference at the micro scale of inhabitation. These fully responsive sets of site systems respond, fluctuate, transform, and produce according to environmental or energy needs of program and inhabitation. The parametric tools of design become energetic agents in the conception and activation of the space.

Sanford Kwinter’s description of an epigenetic landscape holds particular relevance: “The complex relief features of the epigenetic surface are themselves largely the expression of a prodigiously complex network of interactions underlying it…No change in any single parameter can fail to be relayed throughout the system and to affect, in turn, conditions all across the event surface” (Kwinter 1992, 62). In the case of our architectural proposal, this “event surface” encloses and interconnects subsidiary and supporting programs of parking and services as well as ancillary spaces such as shopping, restaurants, and public spaces. The ground peels away to reveal the inner realm of the artificial ground—a fully constructed, artificial, land-filled island that periodically floods. Program acts as a dynamic field, organizing itself according to the possibility of flooding. It is distributed according to safe / higher ground. At lower ground open air theaters, playing fields, and bike trails dot the edge of the island (Figure 3, 4).

Structured over the ground, a large space frame provides the support and structure for the larger performance programs that sit suspended above ground. Central masts of translucent polymer and carbon support a tension net structure of glass and steel. The polycarbonate space frame structures the protected and

![Figure 2. Seoul Energy Farm – exploded axonometric of systems and structure.](image)

![Figure 3. Seoul Energy Farm Site Plan – Dynamic program variations are arrayed across the island site.](image)

![Figure 4. Sectional variation occurring across the island site: A diversity of seasonal and 24hr daily uses is propagated through controlled flooding from below, and variable light, sound and energy conditions from above.](image)
insulated performance space, Figure 3. Seoul Energy Farm Site Plan – Dynamic program variations are arrayed across the island site.

An escalator system within each carbon tube supplies the performance spaces with its audience and acts as a viaduct. Piercing the ground the space frame and the sky-pins and residential and commercial towers provide the island with the necessary density to cultivate a rich and vibrant urban space. The three dense towers, while not called for in the competition brief, would provide critical 24-hour energy to the island through the introduction of housing, hotel/tourist, and commercially-oriented programs.

Figure 5. Seoul Energy Farm – Sectional perspective through the hyper-carbon space frame structure. The suspended Opera House is visible in the distance.

Figure 6. Seoul Energy Farm – Elevation of composite structures: Space frames suspend the performing arts halls, and the three towers (hotel, apartments, and office) activate the island throughout the day and year.
Complex Intersections

The quest to simulate and reproduce complex and evolutionary processes and material logics in architecture is not new. While the search for guiding theories in the fields of the advanced sciences (morphogenesis, fluid dynamics, advanced mathematics, etc.) has proven to be formally productive, it has also demonstrated its limitations in a number of significant ways. In many instances so-called “architectures of complexity” are mere static indexes (inert illustrations of an idea, process, or force) and avoid any productive association with the actual “real-time” intricacies of a given condition or phenomena. In contrast, our research explored the possibility of generating real-time dynamic indexes through the intermeshing of architecture with the field of advanced robotics.

In this project, robotic “sky-pins” arrays were suspended from the large-scale space frame structure (Figure 5). Robots are small autonomous mechanisms capable of sensing, interacting, and learning from their surrounding environments. They were exploited for their latent ability to self-organize into larger, more diverse ecologies of energized matter. As clusters, modular fields and spawn intricate urban-scale networks.

Architect Patrick Schumacher foresees: “the possibility that most (if not all) architectural space will become responsive and be animated through intelligent kinetic capacities. Each space will have a series of sensors which allow the occupational patterns within the space to be registered and fed back into the intelligent responsive structures. This can operate on many scales and levels. I think what emerges is a new era within architecture or between architecture and some other disciplines” (Schumacher 00). Within our proposal, the organization of these larger systems becomes a negotiation between the collective tendency towards systemic stability and the impact of local conditions including variable site programming, weather conditions, and energy generation. In every way the Energy Farm was conceived as a dynamic, open, and dissipative system. Sanford Kwinter defines this type of organization as, “an evolving system, like a pot of coffee or the local weather, that has energy (information) flowing out of it, and likely into it as well ... Indeed, forms are not fixed things, but continuous metastable events” (Kwinter 99, 59). Furthermore, the rib structure deployed across the Energy Farm is arrayed with sensors, motors, and attractors (Figure 7, 8). These robotic “sky-pins” nest themselves within the armature and provide all the necessary nutrients for the structure. It was our desire that their performative nature would provoke, in Stuart Kaufmann’s words, “the mysterious but utterly natural hopefulness in which an increasing diversity of broken symmetries in the universe creates the diversity of structures and processes that

Figure 7. Seoul Energy Farm – The interacting sky-pins: an emergent system which reveals patterns of self-organization. The assemblies collect, store, and then selectively redistribute energies.
can constitute and identify ramified and ramifying sources of energy, detect those sources of energy, create devices and processes that couple to those sources of energy, and generate yet more diversity that propagates macroscopic order even further” (Kauffman 2000, 114).

This interconnected programmable system is capable of transmitting light, sound, and energy to the piazza below. In addition to deflecting and redistributing water for summer evaporative “mist” cooling, the pins provide air filtering and UV ray filtering. A series of microclimates is generated on the surface of the island, as the sky-pins shade, retransmit light, protect or expose the surface below. At night, the sky-pins orient to the artificial lights of the city and redistribute stored energy on the ground as needed.

Advanced computer technologies have enabled these variegated and heterogeneous landscapes to emerge and flourish. Most importantly, technology has become integral to the design process. New techniques and applied methodologies have compressed the previous distance between design, visualization, and production permitting the fluid transition between phases and blurring the boundaries of different techniques, disciplines, and methodologies.

“The Work-in-Progress” Conclusion

This paper describes an experimental project that attempts to use complexity as a creative and vital force within the design process. The project implicitly seeks to release architecture from its conventional role as a static urban backdrop, to become a vital, dynamic, and active participant within cities. We are reminded of what Immanuel Kant suggested in his seminal text, Critique of Judgment: “An organized being is then not a mere machine, for that has merely moving power; but it possesses in itself formative powers of a self propagating kind which it communicates to its materials though they have it not of themselves; it organizes them, in fact, and this cannot be explained by the mere mechanical faculty of motion” (Quoted in Kaufmann 2000, preface). Through the exploration of the site as an interacting matrix of fields, forces, and flows (energy, program, water flow, infrastructure, etc.), our proposal for the Energy Farm emerged as a variegated landscape marked by its capacities to produce its own energy, interweave heterogeneous threads of structure and program, and instigate a diverse set of scenarios in which physical and virtual realms coalesce (Figure 9, 10). Architecture, in its unique capacity to bridge these realms, can release the rich computation potential of complexity into the physical realm. Within this scenario, architecture becomes a creative and vital agent for productive change with profound social, political, and ecological implications.
Figure 9. Seoul Energy Farm—the “Inter-conversion” of matter, energy, geometry.

Figure 10. Seoul Energy Farm – Layered urban composite illustrating the variation, heterogeneity and diversity propagated by the proposal.
References

DeLanda, Manuel. (2006). Uniformity and Variation: An Essay in the Philosophy of Matter. (Published online at: http://www.t0.or.at/delanda/matterdl.htm, 5/5/06)


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