04.03

Towards sentience

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1. Introduction—addressing complexities

Complexities and indeterminacies are some of the issues that designers must confront when dealing with landscape phenomena—and the foremost concerns when engaging with fluid dynamics that affect a landscape's geomorphology. While it is possible to design infrastructures and interventions that alter such landscapes, responsive technologies provide a method of real-time adaptive management, creating methods that curate and choreograph evolving ecological relationships. The result is a design methodology that has the ability to engage the inconsistency and spontaneity that exists between ecology and infrastructure that does not require precision in modeling and simulation.

Historically, when the son of the father of relativity, Hans Einstein, approached his father about his keen interest in leaving structural engineering to study and research sediment transport, he was dissuaded, citing the very study as intractable and that he should do something less complex (Einstein, 1937–1972).

Towards Sentience, a graduate design thesis, and other various research experiments, sponsored by the basement laboratory of the Responsive Environments and Artifacts Lab (REAL) at Harvard University's Graduate School of Design incorporates the design of responsive systems to test adaptive infrastructures within a geomorphology table (see Figure 4.3.1). These experimental tests aim to simulate the potential of responsive infrastructures to modify the behaviors of riverine landscapes and their fluvial morphologies—including land accretion, vegetal proliferation, and species colonization.

The precision required to precisely compute the complexity of fluid dynamics in real time may be outside the grasp of current scientific knowledge and computing power; however, the utilization of a physical hydrological model can capture the essence of a river's alluvial processes. The physical model provides a tangible model that simulates sediment transport through analog interactions between synthetic sediment densities and rates of water flow. Using real-time sensing, the indeterminate becomes latent (see Figure 4.3.2) and becomes enmeshed through the introduction of technology as a new form of ecology, and eventually a nascent form of *nature*.

The addition of real-time sensing and response creates new layers of perception that are immediately acquired and understood in relation to a specific moment or occurrence of change. However, despite this heightened level of observation, sensing is limited to fully perceive the projective morphology of riverine landscapes, as every moment is infinitely iterative, as it is asymptotic (see Figure 4.3.3). Despite this, the complexities of a hyper-real feedback loop (see Figure 4.3.4) produces new understandings of the immediate context, such as new directions of water flow as observed in an early study model, the *Depositor* (see Figure 4.3.5) or the emergence of temporal landforms that is in constant flux with the *Attuner* (the responsive model of *Towards Sentience*) (see Figure 4.3.6). These manifested forms are usually not latent to human understanding or even through the nature of delayed analyses brought upon by postprocessing. In turn, delayed understanding becomes a hindrance to the potential manifestation of unseen landforms and land types.

Though lacking the precision of data, real-time sensing and monitoring enable the facilitation of the emergence of new morphological forms across a constantly shifting landscape, specifically those of riverine systems, which at the same time is brought upon by the epoch of anthropogenic processes and the already-seemingly technology-augmented hyper-reality we are in.

2. Theoretical—mergence of nature and technology

As the machine's senses are different from that of a human, its perception is modulated by the translation of such perceived phenomena happening in the *natural* realm of reality into the realm of the virtual through sensing and actuated response (see Figure 4.3.7). The infinitely iterative process is eventually reapplied back into the initial state of *nature* to create a neo-incarnate.

The compounding process is as follows:

> Nature (Reality) → Virtual →
> Neo-nature (new reality) → Virtual
> → (Neo)Neo-nature . . .

For some this transformative process creates an image of a degrading environment and produces the perceived notion that nature is in danger owing to technological augmentations. This problematizes and undermines the undiscovered value of such emerging neo-natures, hybrids that are produced through technology. It further oversimplifies the complexities produced co-dependently by ecological processes and technology—where the proliferating ubiquity of novel systems are immediately deemed bad, without consideration that its existence is an indication of a productive and sustaining system.

However, one can argue that technological advancement has always been in dialectic with nature. Framing the processes of nature through a Marxian perspective, it can be deduced that production is a continuing process, which alters the forms of nature by humans aided by technology. As such, the producer

> can work only as *Nature* does, that is by changing the form of the matter . . . he is constantly helped by natural forces . . . the producer changes the forms of the materials furnished by *Nature*, in such a way as to make them useful to him.
>
> Marx and Engels, 1845/1947

Humans have altered objects from nature through labor to produce useful things in order to facilitate and fulfill our needs to thrive as species, whether or not we are conscious of the ecological impact we are causing and altering. The shift is inevitable, as we continue to create new technologies in order to mitigate landscape phenomena for our benefit.

Today, new technologies, specifically those that augment the environment with its mergence with the virtual realm, have become an extension of our being. Digital connectivity is more and more becoming a part of our own neo-nature. A disconnection from this phenomenological and responsive infrastructure brings upon a new sense of anxiety, which can be disabling. Though created by man, it can be unsettling when these creations become uncontrolled and informalities begin to occur. The idea of man's inability to tame his own creation reverts our perception of these neo-natures as "unnatural" and exoticizes their existence as being the "other."

3. Experimentation and projection—toward neo-nature

Towards Sentience incorporates the design of a responsive infrastructural model, which attunes the projective alluvium of the geomorphology table through a series of real-time sensing and responsive manipulations as a way to curate successive sediment accretion—constantly altering and modifying the riverine landscape, privileging the evolution of ecological processes over static constructions.

When deployed in the one-to-one landscape, the machine intends to learn from initial site conditions of typically degrading engineered channels (the LA River, as explored in the thesis), but also from the modifications it will produce independently with its sensor systems, and co-dependently with sensed data of environmental phenomena. The responsive infrastructure aims to become sentient, learning from its environments, iteratively honing in on specific operational processes, as an opportunistic ecological agent, which strives to:

erode existing concrete lining, and understand the new material as part of the sedimentation process (see Figure 4.3.8 and 4.3.9);

attenuate flows of water and sediment in order to accrete new temporal landforms;

infiltrate the subterranean landscape to potentially recharge existing aquifers and create new ones (see Figures 4.3.10 and 4.3.11); and

seed the potential successive planting that would endure the projective new nature of such channels (see Figure 4.3.12).

Sentient-*ly*, it will attune the fluvial landscape—to a level of degree that man is incapable of processing in order to respond and modify the landscape in real time. Projective-*ly*, responsive infrastructures could be created by landscape architects and designers to aid themselves to address human incapabilities in order to negotiate complexities that occur in real time, which necessitates immediate responses. These necessitated responses are usually slowed down or hindered by subjective policies that govern landscape processes. This new ability also enables our relationships with nonhuman agents throughout all terrestrial landscapes.

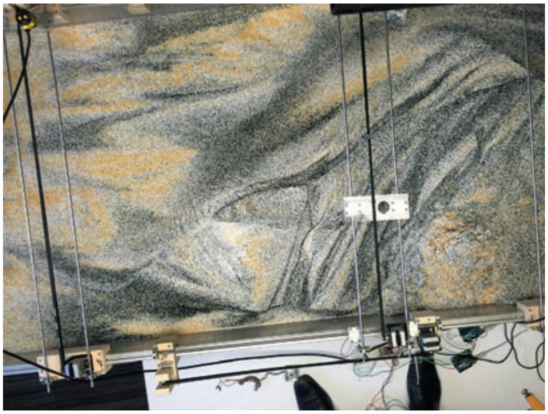

FIGURE 4.3.1 Image of the geomorphology table—utilized as the site of intervention for multiple experiments

Photograph: Bradley Cantrell

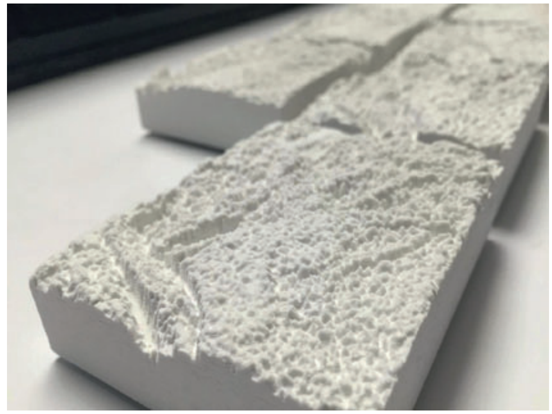

FIGURE 4.3.2 Temporal 3D-printed soil samplings scanned from the geomorphology table, which were produced at an instant creating a neo-nature

Models: Leif Estrada; photograph: Robert Tangstrom

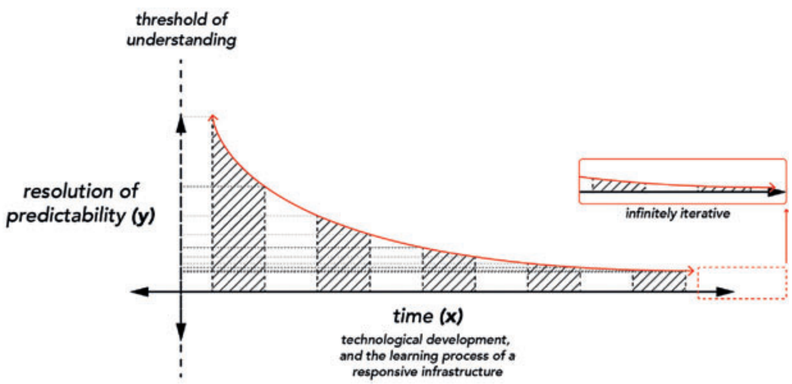

FIGURE 4.3.3 A conceptual diagram, based upon the idea of an *asymptote*, showing the resolution of phenomenal predictability in relation to time (the development of technological precision and a responsive infrastructure's understanding of its context)

Diagram: Leif Estrada

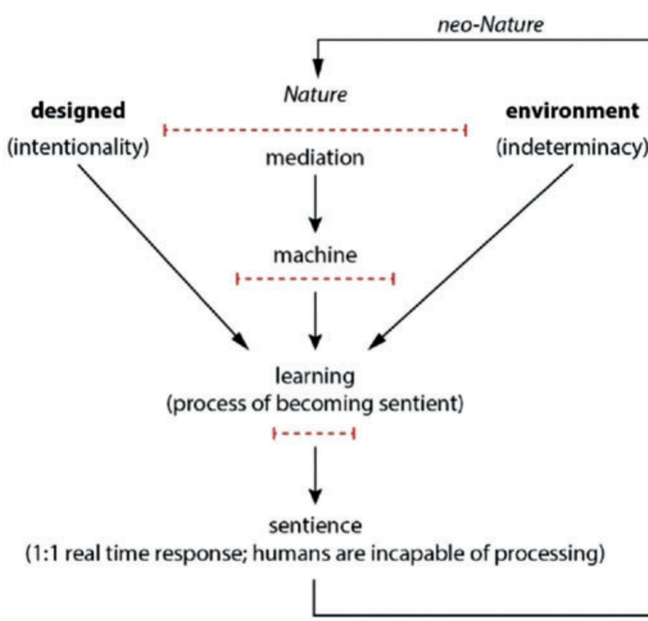

FIGURE 4.3.4 Feedback loop diagram showing the machine's learning, narrowing the gap between intentionality and indeterminacy

Diagram: Leif Estrada

Through the introduction of new imagined sensor systems the emergence of new forms of construction and maintenance within the landscape are enabled, which has never been possible without the machine's new dimensions of sentience. Such manifested forms created by the compounding process of the neo-nature would further bring upon a disorientation as to what was once natural. This phenomenon would cause the rejection of the current dichotomy created by "man-made" technologies and "idealized" notions of idealized and untouched natural processes.

Our ability to conceptualize and create hybrids of biotic and abiotic systems facilitates the evolution of neo-natures. Technological design is consistently introduced to "tame" biologic systems to human will. To legitimize these interventions, humans find and extract any economic and practical capacities. However, despite levels of human control, there is always a moment in which a system will reach its limitations. As such, these limitations will produce our new perceptions of nature. A shift concerning ecology and nature in what has been the accepted norm is inevitably upon us.

FIGURE 4.3.5 **Depositor, an experimental real-time responsive model programmed to interrupt the flow of water, instantaneously redirecting it to percolate down a new fluvial direction, affecting its geomorphology**

Model and temporal images: Leif Estrada, https://vimeo.com/152837202

FIGURE 4.3.6 Attuner, a real-time responsive model that monitors and modifies the alluvial morphology of sedimentation based on the fluvial flux of water, resulting in land accretion. It constantly learns from its environment and context through a feedback loop

Model: Leif Estrada; photograph: Robert Tangstrom, https://vimeo.com/166623512

FIGURE 4.3.7 An imagined machinic-sensory of the Attuner, modulated by the translation of the perceived phenomena happening in the natural realm of reality into the realm of the virtual

Drawing: Leif Estrada

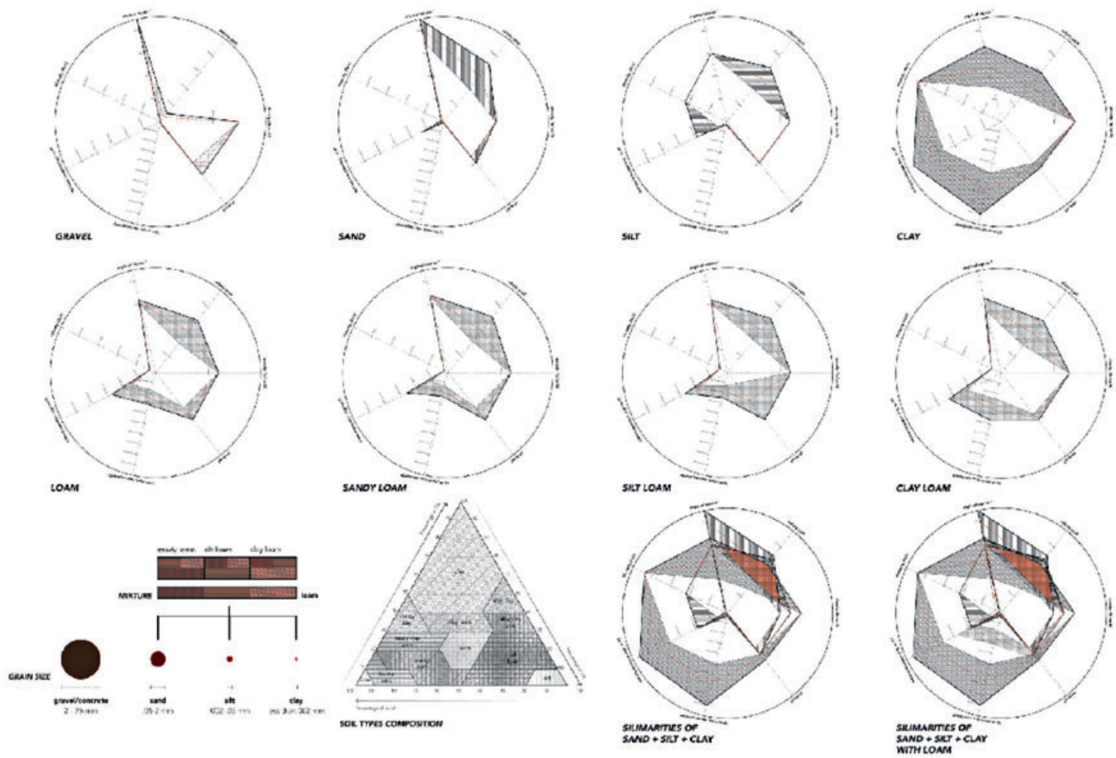

FIGURE 4.3.8 Soil analyses presented as an attribute matrix, analyzing the varying soil compositions that would potentially accrete in the projective succession of the LA River as the concrete substrate is degraded

Drawing: Leif Estrada

FIGURE 4.3.9 Engineered soil samples. The following "sediments" were used in the live-modeling of the fluvial morphology of riverine systems, which are based upon the weights of the corresponding compositions of varying soils that were analyzed: gravel, sand, silt, clay, loam, sandy loam, silt loam, and clay loam

Soil mixtures: Bradley Cantrell and Leif Estrada; photograph: Robert Tangstrom, https://vimeo.com/166623512

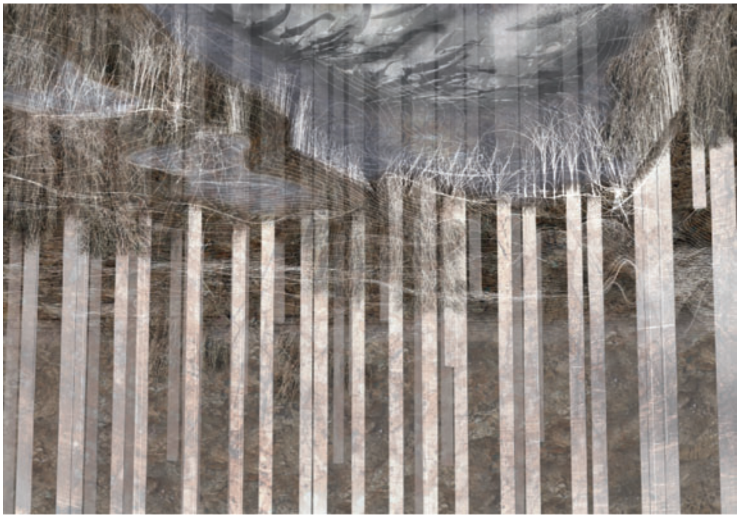

FIGURE 4.3.10

Attuner, imagined as real-time responsive injection piles charging existing and new aquifers seen from below the water table as a swaziometric perspective

Rendering: Leif Estrada

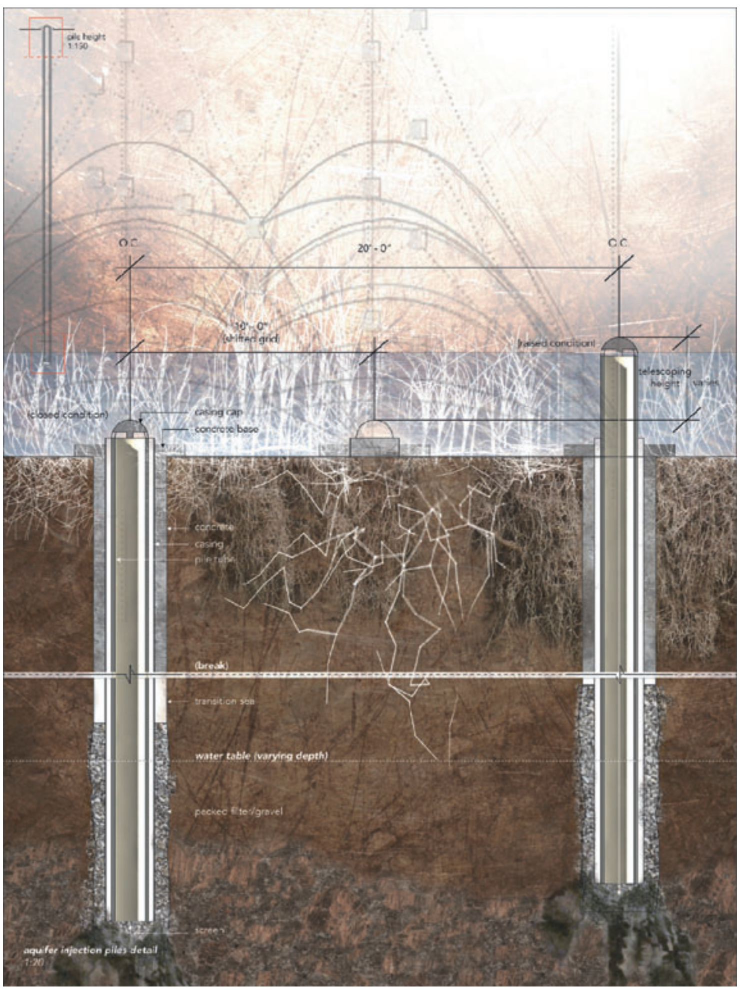

FIGURE 4.3.11

Attuner, injection piles detail shown in multiple conditions

Drawing: Leif Estrada

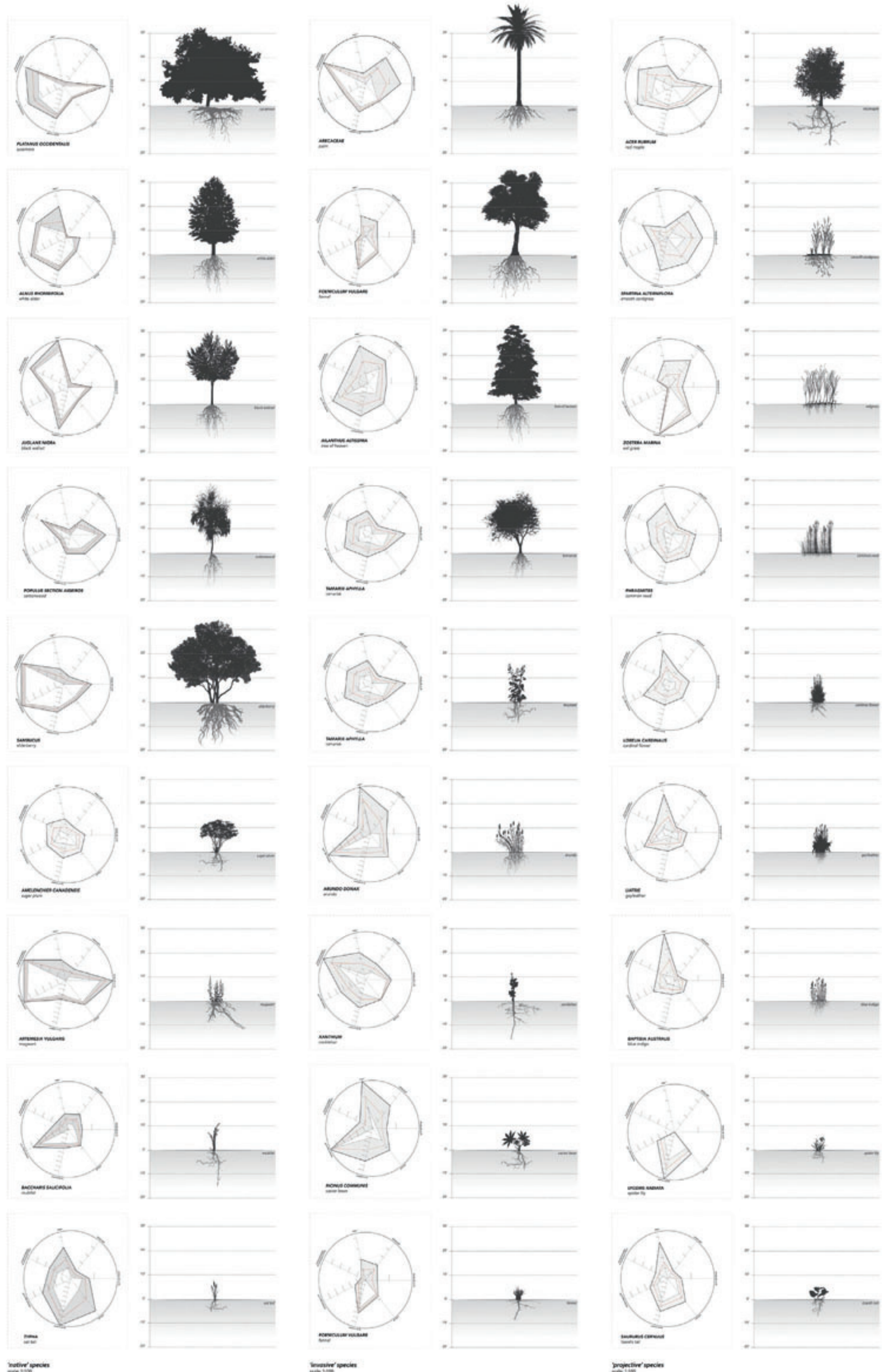

FIGURE 4.3.12 Species analyses, showing each plant's ideal attribute, which can be overlaid with the soils analyses

Drawing: Leif Estrada

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