Sympoietic Structures: Enfolding Ecological Inputs into Core-Studio Curricula

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This paper explores environmental morphology in the first-year design studio pedagogy with an interest in proposing new fundamentals based on *sympoiesis* and the enfolding of ecological inputs into design processes. This pedagogical research acknowledges the influential history of disciplinary autonomy on first-year design curricula and attempts to open that history to a pedagogical future wherein multi-modal, multi-disciplinary ecological inputs become integrated drivers for both form and organization.

First-year design curricula are often driven by abstraction, internal logics, formal processes and a general tendency toward the autonomous aspects of architecture as a discipline. While these features of the first-year studio are catalytic they increasingly beg partnerships with inter- or extra-disciplinary operations in order to engage external worlds and environmental agencies. Looking across works on biology and ecology by Maturana and Varela, Margulis, Dempster and Haraway one finds a parallel discussion of autonomy and inclusiveness in the form of autopoiesis and sympoiesis. While autopoiesis describes closed systems and self-making, sympoiesis describes open systems and making-together. Interestingly, these autonomous and inclusive forms of making are not mutually exclusive but, as Haraway suggests, autopoietic and sympoietic processes can be mutually reinforcing and nested within each other.

Learning from this discourse, Sympoietic Structures looks at multi-phase project strategies wherein first-year students can use different environmental drivers to condition form at the meso-scale of architectural bodies and the macro-scale collective organization of those bodies. These first-year strategies involve defining relationships between environmental drivers and scales of operation. In addition, they involve creative ways by which environmental drivers can be parametricized in order to create process-based architectural entities that are serial and morphologically specific. Serialization allows first-year students to iterate, test and evaluate form and performance while morphological specificity helps them learn about feedback loops between process inputs and spatio-formal outcomes.

> *Sympoiesis* is a simple word; it means "making with." Nothing makes itself; nothing is really autopoietic or self-organizaing.
>
> —Donna J. Haraway, *Staying with the Trouble*

SYMPOIETIC STRUCTURES

Sympoietic Structures explores environmental morphology in first-year design studio pedagogies with an interest in new fundamentals based on sympoiesis and enfolding ecological inputs into form and organization of architecture. While first-year design curricula are often driven by abstraction, internal logics, formal processes and a general tendency to foreground autonomous aspects of architecture as a discipline, these features of first-year pedagogy increasingly require partnerships with inter- or extra-disciplinary operations in order to engage external worlds with environmental agency.

This pedagogical work seeks to form mutually constituting relationships among internal architectural languages of form and structure and external living and non-living ecological media such as plant life, soil, water, and solar inputs. (Figure 1) Our interest here is in composites, open systems and enmeshments of architecture and ecology at multiple scales as principles of core design. In order to explore new fundamentals for the integration of disciplinary and interdisciplinary media into architectural design, this research focuses on theories of complex systems and phenomena that consider the cross-pollination of internal and external logics, inorganic and organic material, organisms and ecosystems, parts and wholes, structure and adaptation, bodies that are hybrids, and change over time.

AUTOPOIESIS AND SYMPOIESIS

Underwriting the studio pedagogy are multi-generational dialogues on biology and ecology across works by Maturana and Varela, Lynn Margulis, Beth Dempster and Donna Haraway. These dialogues explore questions of autonomy and inclusiveness through the concepts of autopoiesis and sympoiesis in living systems or, in the case of Haraway, living and non-living systems. Autopoiesis or "self-making" is generally understood in terms of the autonomy of organisms to reproduce

Figure 1. Sympoietic Structures: Co-Evolving Architectural and Ecological Systems, Detail of Scenario Graphic. Jack Lyons.

the internal systems that, in turn, reproduce themselves as distinct entities from their environments. [1] As Maturana and Varela put it, organisms (or autopoietic systems) are unities in space defined by "boundaries as surfaces of cleavage from the background". It is, however, complicated in the sense that autopoietic systems are distinct but not separated from their environments, to which they remain energetically open. At the other end of the closed-to-open systems spectrum, lies sympoiesis or "making together." Proposed by Dempster and explored by Haraway, sympoietic systems are open, collective, unpredictable, flexible and participatory.

In an essay titled, "Sympoietic and Autopoietic Systems: A New Distinction for Self-Organizing Systems," Dempster creates the term sympoiesis in order to develop a heuristic model for understanding the complexity of living systems. [2] This model is intended to give insights and applications for sustainable thinking across other complex yet synthetic systems such as economies, societies, cultures, and polities. As it was written by Dempster, a thesis student at the University of Waterloo School of Planning, it also has applications to urbanism, planning and environmental design. She expresses concern that models for living systems tend to be based on organisms and, in turn, rely on autopoietic concepts such as reproducibility, predictability, self-generation, defined boundaries, organizational closure, efficiency, autonomy and homeostasis. Dempster finds this reliance on the presumed autonomy of the organism limiting as a heuristic model for understanding complex systems and introduces an ecological approach in comparison to an organismic one. [3] Ecological models bring a variety of new and alternative phenomena into the heuristic process for rethinking architecture in the Anthropocene period and, once introduced, have cascading effects on architectural logics that transition can the discipline out of autonomy and into inclusiveness. For example, Dempster's terms for ecosystemic thinking in the formulation of sympoietic systems include such concepts as evolutionary processes, amorphous reproduction, unpredictability, dynamic tension, lack of boundary, adaptability, flexibility, and dramatic change.

Perhaps most critically for our purposes, Dempster's thinking emphasizes diversity, openness to "internal and external structural coupling," and "potentially infinite temporal trajectories." These are profound notions for architecture which often relies on tectonic and material self-consistency, internal logics of organization and assembly, stasis, endurance, and fixity over time. What is more, architecture can often be critiqued for establishing and maintaining boundaries in both the construction of architectural objects and the formulation of the discipline itself. Through Dempster's work, we may begin to formulate an architecture that is open to ecological media, radical change over time, environmental agility and co-evolutionary feedback loops with living, geological, amphibious or atmospheric systems that must no longer be necessarily outside of architecture in both the built and discursive senses.

While sympoietic systems appear to be scaled for analogous applications to urbanism and planning, their relevance to architecture emerges when one transitions out of the traditional binaries that underwrite architecture such as building/environment, object/context, figure/ground or inside/outside and into exploring architecture as act of systemic hybridization wherein diverse media co-inhabit and co-evolve with each other in mutually-reinforcing relationships of parts that become wholes and wholes that become parts.

Dempster's work constructs a theory of sympoiesis that is generally (or perhaps merely polemically) in opposition to autopoiesis, thus potentially distinguishing organisms from ecosystems and, for our heuristic purposes, architectures from environments. Yet Haraway sees them as phenomena that are not in opposition. She writes that autopoietic and sympoietic systems are engaged in processes of "foregrounding and backgrounding different aspects of systemic complexity" and that they "are in generative friction, or generative enfolding, rather than in opposition." [4] Interestingly, these autonomous and inclusive forms of making are not mutually exclusive but are, as Haraway suggests, mutually reinforcing and nested within each other. This seemingly subtle discursive development in

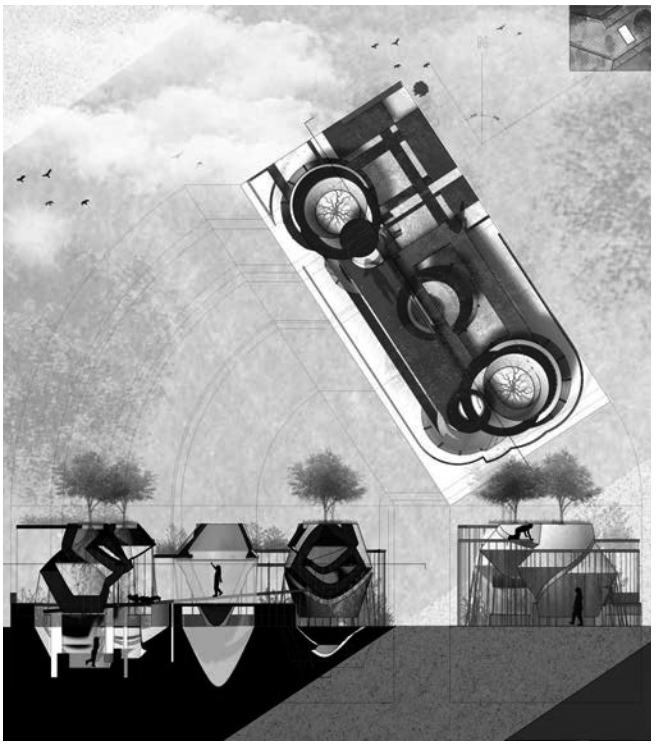

Figure 2. Hybridizing Architectural and Ecological Systems. Shani Zana.

Haraway's work is profoundly enriching for architecture's relationship with the environment. It allows for the notion that architecture has deeply developed disciplinary operations that can coexist with its accelerating need to ecologically engage the embodied worlds within which it is in mutually forming relationships. Ecological inclusiveness need not be mutually exclusive with architectural operations but, rather, these two phenomena can begin to mesh with each other in ways that form new and intensive structures of socio-ecological or enviro-architectural hybridization. (Figure 2)

BODIES, HYBRIDS AND HOLOENTS

The studio begins with three kinds of bodies: vegetal bodies, water bodies, and human bodies. In this studio curriculum bodies are defined as composite entities of disciplinary and inter-disciplinary materials. Vegetal bodies are composites of plant life, soil, vessel, structure, and ground. Water bodies are composites of water, vessel, structure, and ground. Human bodies are composites of people and architectural structurings such as stairs and ramps. Each kind of composite body is explored by first-year students in a serialized format wherein bodies are both generated and analyzed as comparative anatomies of similar and different iterations of forms that perform. In addition to modeling and making forms and composites, students are asked to use digital tools to harvest technical information about what they are creating in the service of understanding quantities of ecological media and architectural resources. Students explore the weights and volumes of soil versus water versus flesh while coming to know the volumes and surface areas of materials that would comprise or be consumed by their forms. What often emerges from these serial studies are merged or mutually constituting languages of support, containment, surface, volume, lattice and other strange hybrids of form and structure. (Figure 3)

Environmental inputs that are brought into these composite yet semi-autonomous bodies-without-sites tend toward those that can be, in a sense, parametricized such as trunk diameter or height, root ball diameter, root depth and spread, and weight of soil in the case of vegetal bodies or catchment, leveling, channeling, and weight of water in the case of water bodies. Enfolding environmental inputs at the meso-scale of architecture allows students to work with them as procedural drivers that affect architectural fundamentals such as morphology, surface, structure, dimension and orientation. While these inputs come from without, they are formulated to drive the iteration of what Gins and Arakawa might call "architectural bodies," yet with their permission for an ecological twist, from within. [5] Or perhaps they are what Haraway might allow us to call "holoents" or "whole entities."

As Margulis formulated the concept of holobionts (whole beings) to describe something more than symbiotic relationships comprised of separate symbionts (beings-together), we see the emergence of notion that symbionts are perhaps not separate beings but, rather, composite beings that are made whole by virtue of being made multiple. [6] For example, rather than thinking of a bobtail squid and the bio-luminescent bacteria that live within it as two separate organisms, holobiont-thinking would say that they are in fact a single organism whose squid-bacteria hybridity is the very thing that makes it whole. Haraway neologistically transforms holobionts (whole beings) into holoents (whole entities) and, in so doing, allows for the possibility that they may be composites of living and non-living media, organic and inorganic material, or biologies and technologies. [7] This, in turn, opens the door to architecture's participation in what we might perhaps call cyborg ecologies.

It is crucial here that architectural discourse and design, which has had a long and complicated relationship with the problem of self-consistency versus hybridity, engage what it is to become holoent in order to become ecological. Grotesques and their status as ancient anticipations of architecture's hybridization with ecological media aside, architecture excels at creating hybrids within categories such as mixing uses, materials or members in a structural system. But to fully and sympoietically become holoent is to form ontological hybrids whose constituents cross categories of being. Haraway suggests that holobionts and holoents "make each other through material semiotic involution" or through what Margulis called "the intimacy of strangers." [8] This is a potentially radicalizing prompt for architecture in multiple ways. It can encourage architecture to not only look inward to its familiar disciplinary

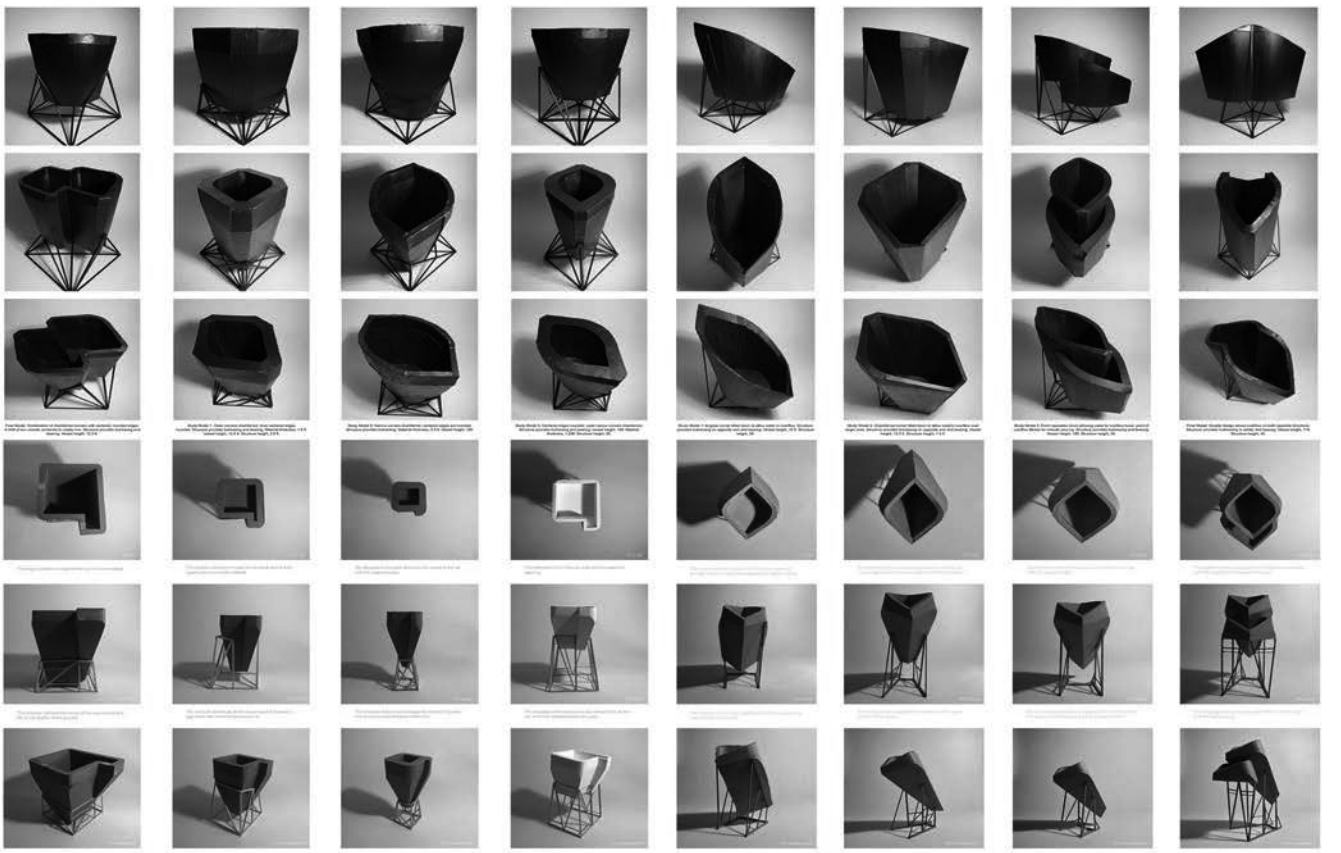

Figure 3. Sympoietic Structures: Vegetal Body and Water Body Model Taxonomy. Wengelyn Munoz and Shantala Mehta.

terms and operations but also outward for ecologically innovative forms of hybridization. It presumes that the material and the semiotic are always already in mutual forming relationship with each other to the extent that there are, perhaps, no "each others" but, rather, composites. It suggests that involution is just as much a model for development as is evolution. Indeed, as both Haraway and the team of Hustak and Myers have discussed, evolution is an act of folding outward and away from while involution is one of inward and into. [9] In an involutionary model of development entities do not simply advance competitively by distinguishing themselves from each other, but also do so cooperatively by involving themselves with each other. Thus the wasp and the orchid both evolve away and involve toward each other and so to could architectural and ecological systems if each became open to the other's categories of material and semiotic existence.

HOLARCHIES AND AGGREGATE AGENTS

In the studio pedagogy that is intertwined with the research in this paper, students are encouraged to consider the importance of the meso- or middle-scale as the scale of composite-thinking and the format for developing middle-scale wholes, hybrids or "holoents" in which neither architectural nor ecological materials can be extracted from their mutually-constituting relationships with one another. Projects temporarily suspend the relational binary of hierarchies versus heterachies in order to explore holoarchies or systems in which, as Lynn Margulis has discussed, wholes (holons) at one scale of operation become parts to other wholes at another scale of operation. [10] These parts could be living beings or, expanding on Haraway's use of the term holoent, these parts could be "symbiotic assemblages" of "biotic and abiotic" [11] entities and, for us, this could mean ecological and architectural assemblages.

John Holland discusses a similar phenomenon in his formulation of Complex Adaptive Systems (CAS). Using diverse and pan-disciplinary examples that range from bodies to cities to immune systems to ecologies, Holland develops an agent-based approach to systems wherein agents that are both active and adaptive combine together to form aggregate agents. [12] Agents at one scale aggregate to become meta-agents and another scale and, in turn, meta-agents aggregate to become meta-meta-agents at yet another scale.

Cells become neurons that become nervous systems. Cells become antibodies that become immune systems. And while these initial examples of aggregate agents appear to focus on self-consistency, Holland goes on to develop diversity as a fundamental property of his theory of CAS, from rainforest ecosystems to urban economies. Like Dempster and Haraway's

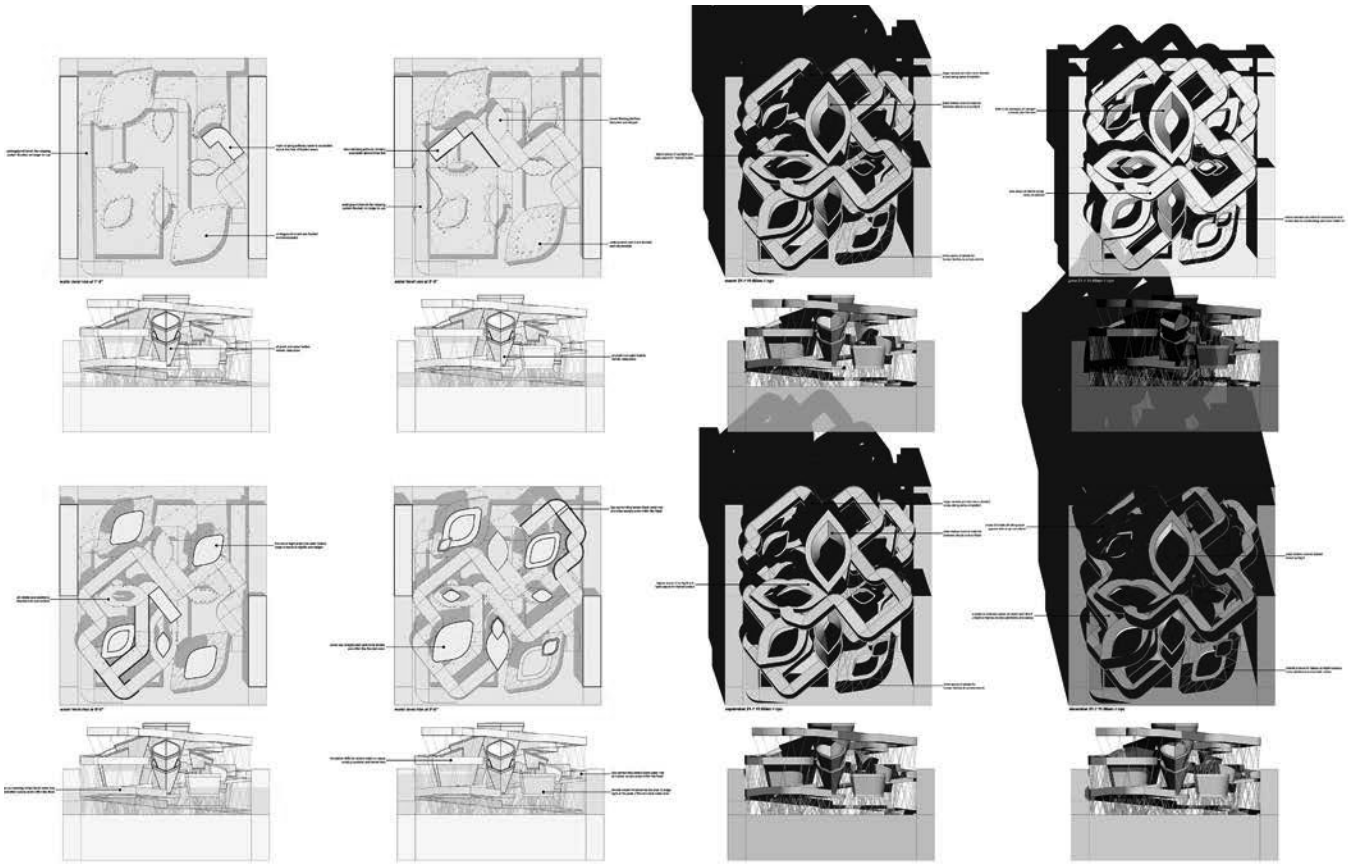

Figure 4. Sympoietic Structures Water Level and Solar Shading Taxonomy. Wengelyn Munoz.

sympoietic systems and Margulis and Haraway's holobionts, holoents, and cyborgs, Holland's CAS demonstrates that openness, fluidity, and hybridity is critical to the sustainability of systems across scales and disciplines. What is more, sustainable systems are always already cross-pollinating composites of diverse organic and inorganic media.

As we consider the scalar fluidity of the composite-bodies that comprise our sympoietic structures, we can ratchet down to the micro-scale of specific engagements among human and more-than-human formings or up to the systemic aggregation of composite-body collectives and their organization in plan and section in sites with ecological inputs operating at the macro-scale. Environmental or climatological scenarios become contexts for first-year students to explore, engage and imagine buildings as multi-scalar collectives (holoents, holoarchies, assemblages, aggregate agents) for the co-existence and co-evolution of architectural and ecological interests. These sympoietic structures are meant to be systems that are not closed but, rather, are open to, anticipatory of, and enriched by environmental change over time. Students integrate solar inputs, rainfall, growth and co-habitation into complexes of interior and exterior spaces of formal, informal, human and more-than human experience. (Figure 4) What is more, these sympoietic structures are sited at city-water edges in order to ask students to consider radical change to architecture's relationship to ground – a ground that we may no longer take for granted as water levels rise and dry sites become amphibious sites. Architecture must assume a proactive and anticipatory stance on its near-future capacity to co-exist with new forms of inundation.

SCENARIOS

For first-year students learning the fundamentals of section, integrating different states of site such as dry, flooded, and inundated guides their sectional thinking in terms of pushing architecture up as well as developing sections that integrate multiple levelings for different states or degrees of environmental crisis at the city-water edge. Through sectional design and non-human narrative graphics we acknowledge a looming kind of environmental crisis while asking the students to help us imagine a future where architecture is both above the existing ground and, in a sense, becoming a new kind of synthetic ground that must itself be prepared to host soil, plant life, water supplies, programs, and multi-species co-habitations in permanent or periodic ways. Semi-detached from the ground, architecture takes on very specific forms of being from within and without while ground is both liberated and challenged to become a landscape of pooling, channeling, absorbing, slowing, engaging, and evading.

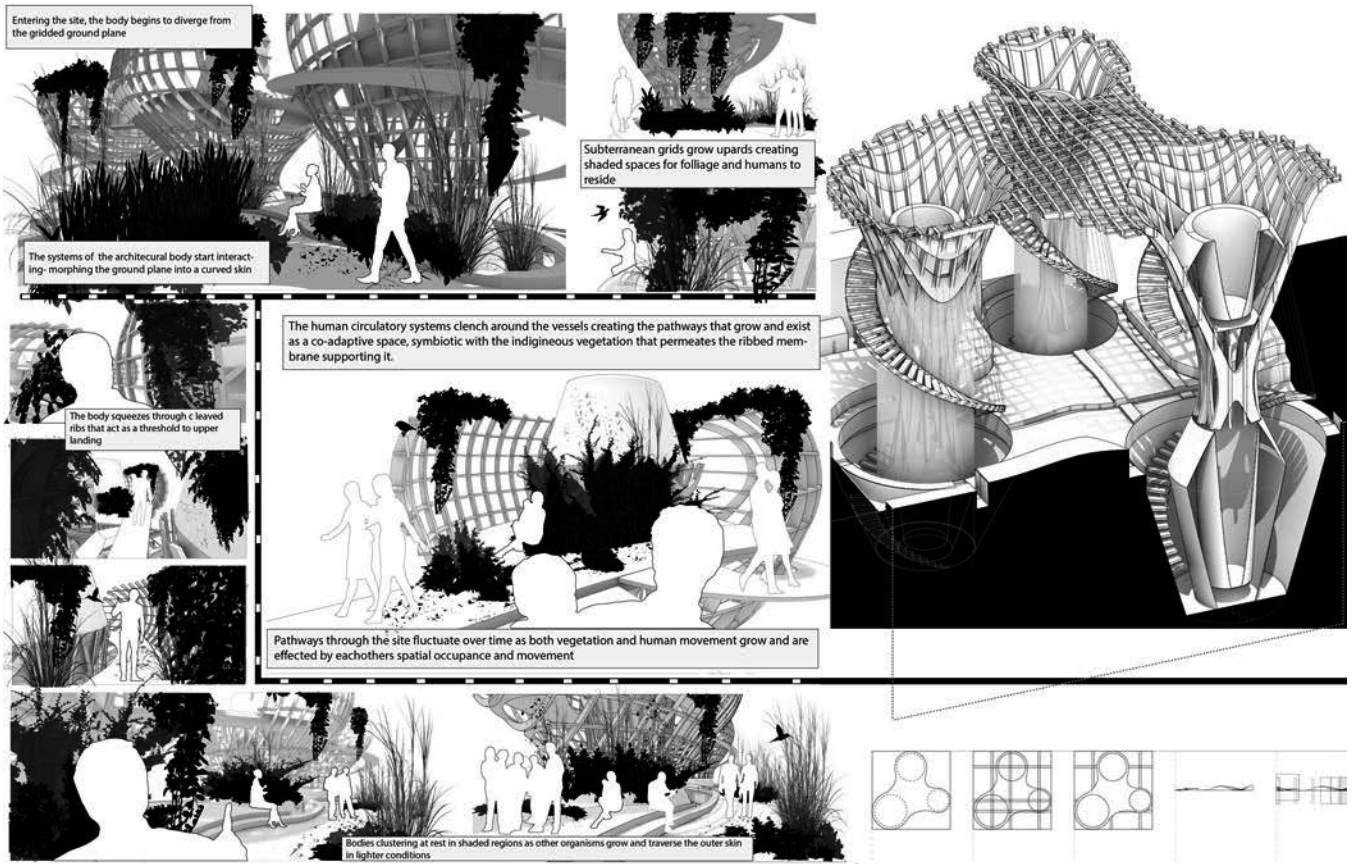

Figure 5. Sympoietic Structures: Systems of Architecture, Vegetation, Water, Circulation and Ground Evolve Together over Time. Jack Lyons.

This new and diversified relationship between building and ground is critical to architecture's becoming-ecological. Projects reject the traditional notion that ground is to be invaded by architecture and held in its service. Architecture can no longer simply presume that ground is there for it, to support it, stabilize it, bear its loads, receive its masses, leech its chemicals, and absorb its runoff. The architecture must, in a sense, empathize with the ground, tread lightly, surgically break its surface, and, at times, become ground itself. It must "make with" the ground as opposed to merely and routinely "make on" or "make in" the ground. In turn, the ground must partner with the architecture, reciprocally take on architectural operations, and participate in the mutual formation of a cyborg ecology wherein the territories of the organic and the inorganic are becoming open to each other. (Figure 5)

Open exchanges across architecture and ground engage fundamentals such as form, organization, plan, and section as well as new fundamentals such as environmental inputs, composite bodies, holoarchies, and sympoietics. Yet the studio ultimately asks students to consider time, change, multiplicity, uprooted relationships, and near-future scenarios within which open architectures and composite structures of individual and collective environmental morphology may pro-actively perform. This pedagogical research and its implementation acknowledge that architecture must shift its heuristic models from autonomy to inclusiveness, self-consistency to diversity, boundary-making to permeability, stasis to fluidity, hierarchical or heterarchical to holarchical, and focus on its present to focus on its future agency in ways that form hybrids of architectural and ecological material.

ENDNOTES

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4. Donna J. Haraway, *Staying with the Trouble: Making Kin in the Chthulucene.* (Durham: Duke University Press Books Press, 2016), 61.
5. Madeline Gins and Arakawa, *Architectural Body* (Tuscaloosa: The University of Alabama Press, 2002), 63-72.
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