

# Posthumanist Responsive Architecture: Environments That Care

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"...the nature of both mind and spirit must be corporeal"— *Lucretius, De Rerum Natura*

In the following discussion I explore posthumanist ethics as a strategy for working with responsive architecture and attempt to relate this theoretical context to a series of projects developed within my own practice. The projects are designed with the intent of finding renewed, mutual relationships between occupants and environments.<sup>1</sup> Fulfilling impressions of kinetic architecture that were the subject of visionary designs throughout the past century, an emerging new generation of building systems proclaim expanded qualities of a new 'instrumental' architecture defined by its performance. [Hensel, Menges 2008]<sup>2</sup> Responsive functions engage a broad contemporary debate that has tended to replace anxiety about instrumentalism with optimism about expanded qualities. However it might be claimed that new generative and parametric design practice have yet to engage significant critical consequences of affective design. How does this architecture affect us? Kinetic mechanisms offer significant scope for manipulating the environment, but current strategies for resistance and for introducing sensitivity and 'consequence' accompanying this expanded power appear slight. Contributing to this emerging practice and, I hope, offering critical strategies, I am attempting to develop rudimentary emotional response functions within built environments within my own design work. Within the affects of emotion and empathy, I am pursuing distributed physical environment that might react to the state of occupants within the space, offering responses based on revulsion and attraction. My work involves practical technical development of innovative interactive sculptures and

architectural components at Waterloo's Integrated Centre for Visualization, Design and Manufacturing, Kinetic mechanisms based on digitally fabricated textile assemblies, actuation systems and micro-processor-based control systems using open-source coding and design are enabling technologies.

Past generations of 'responsive' architecture have been contested, subjected to substantial ethical debate. In debates of this past century the concept of an instrument was often negatively associated with 'functionalist' rationales that seemed responsible for erosion of the dignity and freedom of individuals. Those voices<sup>3</sup>, which span some three generations of this past century, tend to align with preceding critics of the Industrial Revolution in suggesting that treating architecture as an 'instrument' comes at a cost, just as the expanded powers achieved by Alfred Arkwright's spinning machines and Henry Ford's assembly lines arguably came at the cost of individual freedom. Perhaps inevitably, today's renewed examination of interactivity treads on similar contested ground. Distinguishing a new generation of interactive architecture, sophisticated functions are emerging that respond to building occupants and surrounding environments, increasingly based on technical innovations that employ distributed communication and control systems, lightweight actuators and sensors integrated within component-based envelope systems. In turn, these new building components are supported by emerging design methods involving cycles of dynamic visualization and prototyping of complex systems, and by emerging design tools employing new generative and parametric design practices. However, while impressions of kinetic architecture have

been the subject of visionary designers throughout the past century, it might be said that the ethical implications of new 'responsive' architecture are only beginning to engage critical debate. Recent prominent discussions exemplified by Kolarevic and Malkawi's *Performative Architecture*<sup>4</sup> offer building performance as a guiding design principle, adopting new performance-based priorities for the design of cities, buildings, landscape and infrastructures. This emerging architecture places broadly defined performance above form making, and use digital simulations and fabrication strategies in pursuit of comprehensive approaches to the design of the built environment. Immanent, dynamic, open: the qualities focused by voices such as Kolarevic, Leach, and Spiller are marked by a striking optimism about the expanded powers of performance-based architecture. The visionary schemes offered by avant-gardes exploring kinetic modes have tended to remain transcendently positive in such discussions, yielding total visions that appeared to hold only the limits of technical innovation as their restraint. A collective manifesto is implied aspiring to the creation of high-performance architectures that emulate complex natural systems, shaped as flexible 'manifolds' supporting diverse action. With reasonable-cost, durable mechatronics now integrated within many Western industries, restraint now appears indeed slight. Current strategies for critical judgement introducing sensitivity and 'consequence' accompanying this expanded power of mechanisms for manipulating the environment appear in the very early stages of development, seemingly remaining within the long shadow of twentieth-century technological optimism and rooted within the centuries-old humanist tradition.

Yet in contrast to this apparent consensus, design strategies and ethics of related design traditions within the past two centuries have been fraught with argument. Has distance from earlier paroxysmic debates over eugenics and behaviour-programming relaxed the taboo of approaching humanity as mechanism? Have the formidable powers of new digital parametric tools and complex-behaviour modeling methods renewed confidence in the engineering of nature?

When preceding generations of engineers and designers developed analogies that held architecture to be operable like a complex instrument, their arguments tended to be divided. In their famous

1830 debate, Etienne Geoffroy Saint-Hilaire and Georges Cuvier, leading biologists and founders of the Museum of Natural History in Paris, examined the basis of nature. Against Cuvier's rear-guard defence of a Great Design determining individual species anatomy, Geoffrey argued that anatomy determined how a species behaved, opening the door to speculations about nature divorced from theology. Geoffrey implied that there was no particular 'transcendent' destiny involved in individual functions, only concrete and 'immanent' functions that would create particular opportunities for behaviour. The argument of these two biologists threatened foundations of their culture. In turn, similar debates between 'transcendent' and 'immanent' qualities has continued beyond Darwin's conceptions of natural selection and genetic mutation. A recent hinge for this debate is arguably the entry of Michael Foucault's *Discipline and Punish* within architectural discourse a generation ago. Foucault dwelt on the oppressive machinery of prisons and madhouses and, perhaps fatally, linked those institutional building types to the spatial mode of radiant symmetries and axial constructions. By implying that symmetrical, crystalline systems of unified geometry in urban architecture were tantamount to Fascism, Foucault's power analysis lent fundamental hesitation to the continuous project of the Enlightenment. Insidious qualities embedded within such total visions have widely remarked in post-modern generations of discussion.

In striking contrast to such a critique, a reverently transcendent vision of creation was evoked in American designers such as Louis Sullivan and his pupil Frank Lloyd Wright, building a vision of architecture embedded with the symphonic forces of nature. This

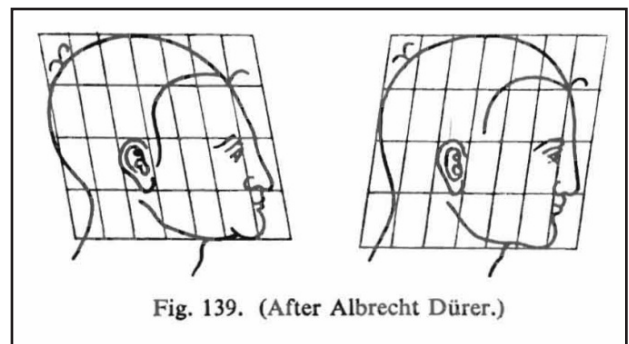


Fig. 139. (After Albrecht Dürer.)

1. D'Arcy Wentworth Thompson Proportional systems of human physiology, 'After Albrecht Durer', D'Arcy Wentworth Thompson, *On Growth and Form*, 1917

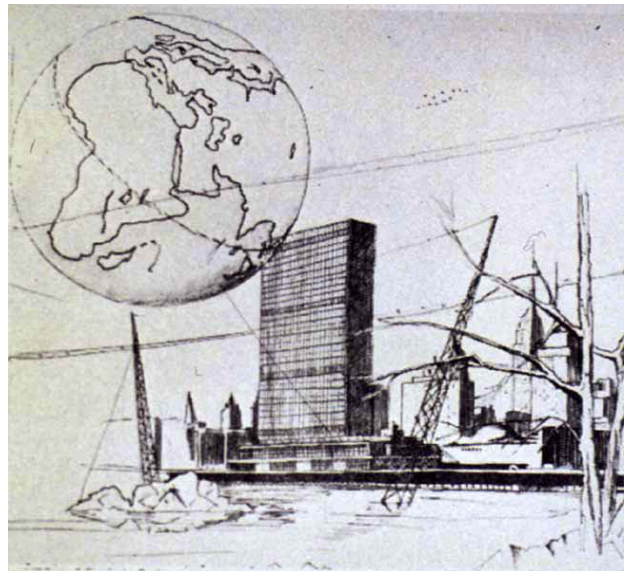
late nineteenth-century organicism followed directly from Haeckel's illustrated opus *'Art forms in Nature'*, which illustrated Darwin's vision of the practical evolution of species. Building a new kind of stewardship from this immersion in complex systems of nature, D'Arcy Wentworth Thompson's 1917 opus *On Growth and Form*<sup>5</sup> offered methods for manipulation of dynamic forces. While that author's benign influence on design has been repeatedly cited, the political application of his methods to 'improving' human species through eugenics is also poignantly evident. In a similar vein, the mid-century systems-biologist Conrad Waddington's mid-century conception of an epigenetic field<sup>6</sup> extended Thompson's biomathematics into an environment organized by intermeshing form-creating forces.



2. Conrad Waddington *Cell fate switching in an epigenetic landscape, portrayed by Conrad Waddington: dynamics of developmental selection represented as landscape with hills and valleys. The lowest points in the valley correspond to distinct, stable phenotypes within wide repertoire of fates (Waddington, Epigenetic Landscape, detail; Strategy of the Genes, 1957)*

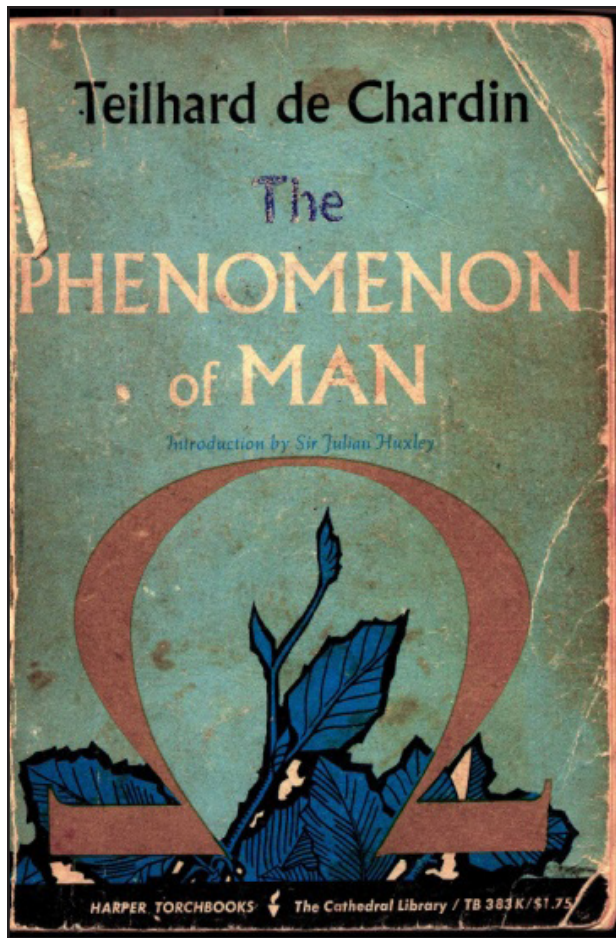
Waddington's pragmatic tone might not advertise transcendence, but his vision of an environment that shapes and channels every action appears overarching. Similarly, prominent voices within a mid-twentieth century generation of designers held the spectre of an orchestrated environment of integrated systems in extraordinary confidence. When

Buckminster Fuller proposed his 'operating panel for Space Ship Earth' beside the United Nations<sup>7</sup>, he envisioned networked global markets and enlightened individual human agency as a social and political fundament, while B. F. Skinner's mid-century brand of behaviourist psychology attempted to engineer happy, productive subjects. This transcendent, crystalline territory seems exemplified by Fuller's radiant 'geoscope', a floating spherical instrument panel connecting to vast networked global systems, focusing the entire world into a coherent, unified vehicle for organized operation.



3. Original concept sketch of Geoscope, R. Buckminster Fuller, 1962, illustrated in Fuller, *Critical Path*, St. Martin's Press, 1981

The geologist and theologian Teilhard de Chardin developed a compelling historical argument that I believe offers resolution of this contested ground. Working between 1920 and 1956, the latter date of his death of release of his heretical writings by the Catholic church, de Chardin voiced a remarkable hope for emerging qualities of integrated, coherent world organization rooted in the voluntary organization of overlapping networks of individuals. Increasing multiplication and overwhelming density of networks created coherence that might in turn result in a 'noosphere' of collective consciousness. [image 4] Poignantly, De Chardin hoped that this consciousness would be accompanied by an emerging 'prodigious affinity', a tangible collective sympathy acting at global collective scale.



4. Teilhard de Chardin, *The Phenomenon of Man* (Harper, 1956)

## PROJECTS

A series of my own projects have followed de Chardin's invitation to pursue 'empathy' embedded within the built environment. Within the affects of emotion and empathy, I hope to develop paradigms for distributed physical environment that might offer behaviour based on revulsion and attraction, reacting to the emotional state of occupants within the space. Interaction within my current projects strays into parasitic modes involving self-serving injection and consumption on the part of the environment. Current work focuses on integrating control systems with decentralized responsive intelligence. The work is based on a program of gradual development moving from individual figures composed of hybrid organisms toward immersive architectural environments that include lightweight interior-linings and exterior shading and filtering assemblies. □

This immersion pursues substantial involvement. In the terms of figure-ground relationships the figures I compose are riddled with the ground.

Kinetic mechanisms based on digitally fabricated textile assemblies, actuation systems and microprocessor-based control systems using open-source coding and design are enabling technologies. The physical assemblies in these projects employ a series of natural laws involving energy flow, nutrient cycling and dynamic balance expressed in distinct functions. For example, the snap-fit of a plastic tongue into a mating socket needs just enough friction to grip its mate while staying flexible enough to avoid collapsing the whole surface. The design approach to sub-units is in pursuit of a balance of refinement and economy. This approach is circumstantial and dominated by quite flexible, practical judgment, far from a picture of perfection. The textile strategies I use make intensive labour for adjusting individual parts impractical. There are tens of thousands of parts, so tooling and fabrication motion used in making each piece is compounded. This requires an economy of means.

The primitive cycles of opening, clamping, filtering and digesting in the artificial assembly are inflected by some of the same natural forces that make a coral reef work. Building upon simple motions embedded within individual elements, accumulated actions produce turbulent wave-like reactions.

A number of my installations have been inserted into natural environments. They work to catch and inject matter, accumulating density and eventually forming into a hybrid turf. Like ill-fitting clothes, this work has an uncomfortable relationship with its natural host. The relationship of these object-assemblies contains layers of violence: the violence of a foreign colony imposed on a living host; the forces of dismembering and consuming; the force of will, violating the ethical boundaries that maintain nature as an untouched sanctuary.

*Hungry Soil*, a sculpture installed in Toronto in 2000, was conceived as a cousin of benign geotextiles that would shelter and accelerate plant growth. Captured large-scale organic matter fertilizes the system. Thin-gauge spring-wire is bent into wishbone-shaped units that interlink to make an octohedral space-truss. Expansion of the skeleton truss yields a foam-like mesh spanning large

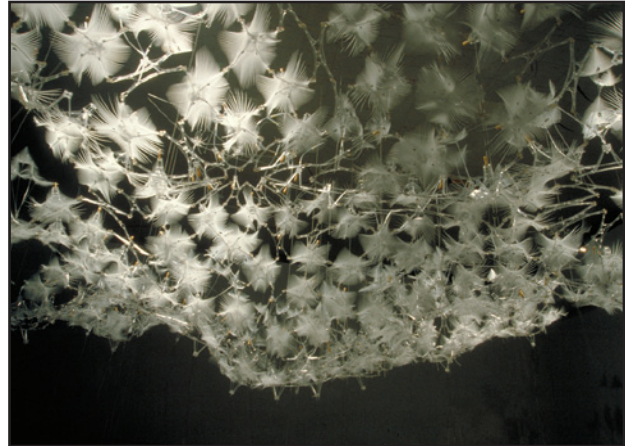


5. *Hungry Soil*, BCE Place Toronto, 2000

volumes with minimal mass. Slide-lock details accompanied by simple compression-collars formed from biodegradable polymer tubing provide a universal system. Clips integrated in the wire skeleton provide attachment points for collection bladder-needles and twin barb-traps. These active elements saturate the mesh in a dense three-dimensional array. A lurking quality results.

The system was derived from the artificial skin replacement system for burn therapy developed by Toronto's Apotex Industries. In that system, a biodegradable gauze is seeded by gel capsules coated with human skin cells engineered for replication and bathed in nutrient solutions. Regenerated skin grows over the affected area, and the scaffold that holds the seed elements is eventually dissolved and absorbed. *Hungry Soil* envisions a similar approach to landscape regeneration. Springing barbed details encouraging accretive massing and clumping, a slow process of ingestion. Protruding hooks and latex bladders equipped with hollow needles imply mechanical operations on drifting organic matter: capture, injection, ingestion. The work was conceived during a time of personal study of the Kindertransport, organized transport of Jewish children from Germany to the United Kingdom in 1938-9. Details of the Soil work relate to blood and earth imagery, and levels of mechanical repetition raised questions of exchanges between imperial organizations.

*Orgone Reef* extends the simple wire details of *Erratics Net* by pursuing hybrid three-dimensional elements that gradually pull, push and pump materials within and environment. The sculpture, in-

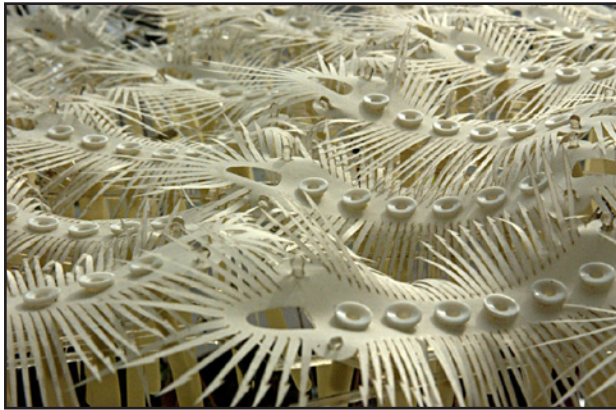


6. *Orgone Reef*, University of Manitoba, 2002

stalled at the University of Manitoba in 2002, is conceived as an artificial reef that could support a living skin. The project is a hybrid geotextile, a new class of materials used for reinforcing landscapes and buildings. The details of this structure are designed to catch and hold the things they contact, accumulating a thick, porous mass. The project functions with aggression, clamping and cutting into neighbours, draining and digesting the things contacted and converting this material into fertile soil. The structure would help a scarified landscape heal and grow new layers.

Several kinds of rhombic pyramidal structural tiles make this textile, connected by vinyl links that allow flexing and shifts in local relationships. The interlinking system creates a billowing space-truss that alternately arches upward and hangs in catenaries, adapting to locations of intermittent suspended supports. A primary tile, repeated hundreds of times within the topography, includes a pyramidal skeleton that supports a deeply serrated mylar filter configured to provide one-way trapping flows within a fluid medium. Fronds of adjacent tile filters intermesh, yielding a coarse felted membrane.

Cutting patterns are designed to release embedded stresses within roll-formed mylar, producing oriented curling of frond-rows within the filter material. Curled elements are arranged in opposing pairs, producing passive mouth-like pores that encourage passage in one direction while resisting reverse passage. This hybrid osmotic function is employed as a design principle at varying scales within the installation. Motions telegraphing through the matrix



7. *Cybele*, Cambridge, 200: Detail of interlocking cellulose burr units

allow this system to function as a distributed pump acting upon the environment.

*Cybele*, installed in Cambridge Ontario in 2005, is a self-assembling framework made of delicate laser cut components connected and oriented by miniature rare-earth magnets. A barbed cellulose membrane covers the structure. The membranes ride upon individual snap-fit acrylic frames and create a continuous topography. The rhombic tessellation of this system is reinforced by intertwined felting created by intermeshing of the serrated cellulose material. Through flex and movement in the system the system knits itself together. Tiles are supported by a precarious scaffold akin to a tangled forest canopy whose structure is concentrated at upper and lower levels. Upper spring-clip wire mounts are configured for insertion into quarter-points of the cellulose tiles. Lower tripod sets include paired needle-stakes that work in concert with a lead counterweight encouraging free rotation prior to settling into final orientation. These details encourage jostling, flexible negotiation between tiles and support formation of densely interwoven felt in the upper layer. Each tile carries a brace of suspended elongated bladders. Funnel-shaped openings for each bladder are oriented upward, for drainage and collection. Salts prime the bladders, anticipating dilution and exchange.

*Implant Matrix* was a diffused cloud of interlinked elements that accumulated to make a building skin, mounted in 2006 in Toronto. A lightweight polymer skeleton was cloaked with a quilted mylar tilework



8. *Implant Matrix*, Interaccess Gallery, Toronto, 2006

fitted with layers of miniature valves and clamping mechanisms. Distributed microprocessors, arrays of whisker-sensors and shape-memory alloy actuators provided a networked control system for the matrix. These elements were arranged in chained, rolling swells that made subtle grasping and sucking motions. The composite motion created billowing 'peristaltic' pumping that filtered humidified air and collected organic matter within the matrix surface.

The skeleton was formed from hundreds of slender rhombic cells laser-cut from acrylic sheet. This matrix contained a regular array organized as a planar diagrid. At intervals, an additional tile was introduced and created points of three-dimensional hemispherical swelling. These nodes offered compressive shell strength that allowed them to act as toughened gussets within the membrane system, providing points of concentrated structural connection for the assembly as a whole. Additional distortions and fissures in junctions between assembled tilework sections resulted from a collaborative assembly method coordinated among numerous builders.

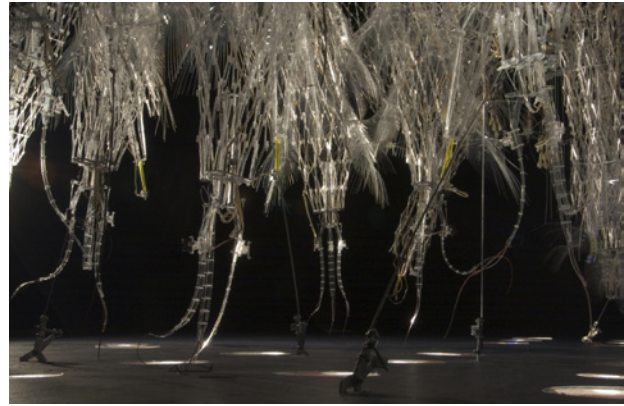
The cells contain flat profile struts with integrated snap-fit tabs and slots that accommodated transverse stiffeners and junction plates. Each cell contained a meshwork membrane pump unit powered by shape-memory wire actuators. These membrane pumps were composed from thin mylar sheets and contained hinged mouth details that functioned in a similar manner to folded paper mechanisms in pop-up books. Long ciliated fringes containing miniature barbed hooks extended the outer surfaces of these filter membranes and encouraged tangling with adjacent units, making a continuous felted surface.

A second filter layer was suspended below the skeleton, attached by spacer-struts containing variable-

angle hemispherical rare-earth magnetic joints. Quilted mylar tiles derived from the *Orpheus Filter* system were used for this installation. Similar to the *Orpheus Filter* system, a quasiperiodic Penrose tessellation organized these tiles, and a universal geometry of junction holes permitted rotation and layering of the units. A thicket of activated whiskers was mounted within this layer. Fields of secondary glands and collection pores populated the surfaces of the filter. Injector glands contained silicone bladders fitted with long probes for passage of salt deposits into trapped host bodies. Small trapping pores were set to operate with suspended hair triggers hanging alongside the whisker systems. Extended feet for these elements used detailing akin to legs on a water spider, distributing weight and riding on the meniscus of the filter surface.

The whiskers responded to touch with convulsive contractions that were powered by shape-memory actuators pulling along the axis of the wound music-wire whisker cores. When viewers touched a whisker, changes in electrical resistance were sensed by capacitance sensing circuits within sub-control circuits connected to main node controllers. These controllers would respond with actuation signals that would initiate sequences of opening and closing mouths within local clusters of membrane pumps. Additionally, the controllers emitted communication signals to adjacent nodes in neighbouring pump colonies that initiated secondary responses. Ripples of movement resulted from this sequence of signals. The main control boards used simple Peripheral Interface Controller 'PIC' microprocessor hardware. Each board controlled several dozen actuator and sensor elements in parallel chains, and a communication system using modular connectors and twisted-pair circuitry provided communication functions for coordinated responses through the entire installation.

*Hylozoic Soil* is a large environment that formed part of the Montreal Beaux-Arts Museum's 'E-Art' exhibition in 2007. The sculpture offers patterns of motion by mechanical components that respond to occupants' movement within the environment. Occupants move within the *Hylozoic Soil* structure as they would through a dense thicket within a forest. Microprocessor-controlled sensors embedded within the environment signal the presence of occupants, and motion ripples through the system in response, pulling trickles of air through the mesh



9. *Hylozoic Soil*, Montreal Museum of Fine Art, 2007: Detail of actuated sensors at column bases, with mounting clamps.

and drawing stray organic matter through arrays of filters. The microprocessor-controlled system includes *Arduino* hardware extended by new control boards, shape-memory alloy actuators and space sensors arranged in a distributed interactive system. Lightweight lattice and geodesic organizations form a structural core, employing digitally fabricated lightweight scaffolds that house distributed networks of sensors and actuators. The structures are designed at multiple scales including custom components, intermediate tessellations composed of component arrays, and general structural systems.

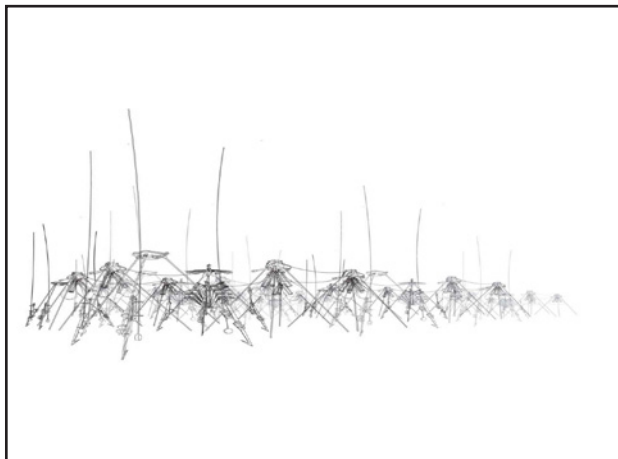
The structural core of *Hylozoic Soil* is a flexible meshwork assembled from small acrylic chevron-shaped tiles that clip together in tetrahedral forms. These units are arrayed into a resilient, self-bracing diagonally organized space-truss. Curving and expanding this truss work creates a flexible grid-shell topology. Columnar elements extend out from this membrane, reaching upward and downward to a radical minimum by employing optimized form-finding design methods. Strategies include use of efficient tensile forces and textile systems in mesh and shell forms and derivation of three-dimensional forms from thin, two-dimensional sheets of material. Space-filling tessellations and nested components derived from sheet goods contribute to this hybrid economy. Some eight cubic feet of acrylic polymer, fifty pounds of copper wire, aluminum sheet and handfuls of specialized alloys are expended, while the expanded space formed from these materials occupies some four thousand cubic feet.



10. Hylozoic Soil, Montreal Museum of Fine Art, 2007

Similarly, the control system offers complexity in its behaviour while avoiding large centralized computing. The distributed arrays of inexpensive miniature microprocessors achieve coherent behaviours through their distributed communication network. The intensive repetition of small information packets in the communication network and mass-manufacture of miniature physical components in the physical sculpture are similar in their approach, offering a heterogeneous whole.

The most recent installation within this series is titled Basal Lamina, and is currently being prototyped for further development. This assembly attempts to move toward an explicit relationship with the natural environment within an urban site that contains passages of sod and pavement. Basal Lamina is conceived as a nearly-living artificial turf,



11. Basal Lamina, Champ Libre Montreal/Pratt Institute, New York, 2008-9: Detail view of part assembly

spreading out in a narrow swath spanning a full city block. This assembly would create a shallow layer covering sterile ground, assembled as a deliberately weak interconnected network to gradually evolve in response to situational parameters and human occupancy. Faint signal-lure lights, microprocessor-controlled burrowing agents and space-filling filter packs provide a matrix that harvests energy and accumulates stray matter to be eventually taken over by new weed-filled growth. The skeletal tripod-field comprises approximately one thousand unit-clusters. It will form a continuous lattice outfitted with faint signal-lure lights, microprocessor-controlled burrowing agents and space-filling filter packs. The matrix accumulates stray matter and will eventually be taken over by new weed-filled growth.

The construction is characterized by extreme economy and minimal material use. Physical computing circuits using distributed configurations harvest trickling power and accumulate increments sufficient to emit small pulses of light and vibrations at regular intervals. Vibrations are amplified by leverage and resonance in order to create tangible and legible motion within automated mechanical burrowing elements, while significant multiplication and selective focus and amplification details provide legibility for the lighting elements serving both as indicators of the system's 'health' and as lures that encourage human proximity. Large-scale movements generated by the beneficial human interaction, integrated with increments of wind vibrations will further power the automated burrowing functions. Human participation will also provide beneficial spreading of the lightweight filter material populating the structure, and 'feed' the matrix with small residues of organic matter carried in by air currents and thermal plumes cloaking each visitor.

The fragile, minimal physical skeleton and physical resonance-behaviours of this surface could serve as a counter-form to the surging activities of adjacent sidewalk and traffic circulation. Organic power sources embedded within the installation have a finite life and extremely constrained actions. A pattern of simple public contributions akin to medical therapy could foster faint conditions of collective cultural empathy. During the four month duration of the installation, the vinegar electrolyte within several hundred bladder units will be renewed by a pattern of weekly injections. These periodic



depletions and renewals of the organic battery will establish definite 'lifetime' intervals, gradually shortened by the increased corrosion of the electrode elements. This will be signalled by the light emitting diodes, whose patterns provide constant indication of the system's welfare. As the basal matrix's activity subsides, the process of natural growth takes over.

### Further Steps

From previous projects involving static, site specific landscape-based field installations, the projects described within this essay have evolved towards immersive interior environments that interact with human occupants and that form active, accretive synthetic environments. Previous generations of this work were light-duty installations capable of generalized kinetic effects. Close collaboration with mechatronics engineers permit a new generation of sculptures to emphasize subtle motion that approaches a kind of mechanical 'empathy' connoting emotion.

Over the course of this next phase, several short term goals will be pursued: networks and systems composed of complex parts assembled into coherent artificial 'organisms', discrete mechatronics offered by shape-memory alloy actuator development, new methods for analyzing and creating movement, translation of movement data into digitally automated mechanism design, innovative techniques for creating large volumes out of small amounts of material, implementation of digital fabrication and advanced modeling, and simulation and visualization techniques. In next generations of this work, this expanded sensitivity will be further developed in terms of durability and field testing, supporting intensive public interaction and exposure to the sun, wind and rain. The long term goals of this research suggest future building linings and skins that can provide local mechanized reaction to subtle changes in the building's occupation.

This work draws on existing work in the area of mechanism synthesis and pattern languages.<sup>9</sup> Traditional approaches to understanding human movement is the starting point for investigation into methods of coding movement quality into a suitable space on which a metric can be defined in order to support distinct 'emotion' based sensing and kinetic response systems. Design for emotion is a comparatively new practice that draws especially

on gaming practices and marketing paradigms, extending traditions of behaviourism established over the past half century of research in psychology and neurology. A central design practice that is established within emotion studies remains quite primitive, preoccupied with individual figures, and facial gestures divorced from surrounding environments. Limited work relating to environments has, however, proceeded including universal colour schemes, textile patterns, and general 'body language' postural systems. Laban dance analysis offers a relatively rich vocabulary for describing the quality of mechanical movement and for exploring novel control strategies. The quality of motion will be classified in terms of the main descriptors of Laban analysis including time, space, flow and weight.<sup>□</sup> Work on automated reading and generation of Laban notation for applications in dance and in simulation<sup>□</sup> will provide support for this research, and context will come from work exploring the relationships between the dynamism of dance and architecture.<sup>□</sup> The work will draw upon the evolutionary psychologist Paul Ekman, who developed the Facial Action Coding System which systematizes emotional expression into 'Action Units', allowing labelling and recognition of emotions based on individual muscle movements. This accretive approach to muscular combinations has been translated into in computer-based recognition of emotions using Facial Action Coding System metrics, demonstrating that - basic emotional expressions appear to exist in all culture as innate and non-learned instincts. In turn, current research extends emotional responses into a systematic understanding of 'body language', where entire musculature and skeletal position is directly related to emotional stimulus and response. The psychologist Nico Frijda: has conducted research into 'action tendencies' rooted within the body, suggesting that emotions are broadly-based mental states which influence specific situational processing, particularly constraining appropriate appraisals & actions. These sources will be used to inform a general approach that attempts to embed emotion-connoting and affecting kinetic responses within immersive textile environments.

I hope, by describing these projects, to provide notes that might serve as an emerging practice for interactive systems. In contrast to instrumental systems that work in reliable service to human domains, the basic relationship here is prosthetic, employing alien appendages to nature's body. Prosthetics are always accompanied by some tinge of

revulsion. An artificial heart causes the host body to recoil and attempt to reject the intruder, no matter how 'good' the addition is for the host's health. New burn technologies involving delicate nutrient-infused lattices that strengthen the skin and allow new skin to grow depend on drugs to mute the rejection impulses that we react with. A dynamic that integrates revulsion as well as attraction might lead toward mutual relationships.

These projections are large, and translate into action that risks violence. De Chardin's goal of a 'noosphere' of collective consciousness accompanied by tangible collective sympathy remains a poignant utopian vision. Inevitably, a project that pursues synthetic collective consciousness is, no less than earlier transcendent reaches, utterly fraught. Yet these projects might, I hope, demonstrate certain steps that engage the affects of emotion. These terms imply steps toward paradigms for distributed physical environments pursuing 'empathy' embedded within the built environment. These environments might affect their inhabitants by caring.

## ACKNOWLEDGEMENTS

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## ENDNOTES

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