

LANDSCOPE | Interpreting Environmental Consciousness

by

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Master of Architecture

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Author's Declaration

I hereby declare that I am the sole author of this thesis.

This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

This thesis proposes a way in which architecture and the built environment might work to integrate human consciousness and natural process. A theoretical design entitled **Landscape** is presented as a responsive, sustainable landscape that offers understanding of nature through active observation, interpretation and transformation of the environment. The design proposal is situated at the edge of Hamilton Harbour, Ontario, Canada, adjacent to the existing facilities of the National Water Research Institute. Two extended studies accompany the design proposal. The first, **Water**, presents a poetic exploration of cosmic, responsive, and connective qualities of water relating to nature and technology. The second study, **Connected Fields**, focuses on the visionary American engineer Buckminster Fuller and his 'Geoscope' project, a geodesic dome designed to act as a monitoring and control centre for global material and resource flows. This section also includes a discussion of general conceptions of the world, focusing on key twentieth-century conceptions of the Biosphere, Gaia, and the Noösphere. Historical theories of environmental perception are discussed including Gestalt psychology and technical systems of observation. Drawing upon this cultural material, the thesis attempts to open boundaries that separate nature and technology, encouraging a complex, mutually dependent relationship between these traditionally separate realms. The general pursuit is a cybernetic and virtual model for environmental and ontological hybridity, involving an evolution of consciousness at both individual and global scales.

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Dedication

In memory of my father, Keith Humphrey.

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Geoscope

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Creating Natures: Merging Technology and the Organic

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The Hybrid Condition: A Conscious Complex

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Introduction

An aerial photograph of a landscape, possibly a coastal or rural area, with a grid of white lines overlaid on the right side. The grid consists of irregular, interconnected lines that form a complex, web-like pattern. The landscape below shows green fields, brown earth, and some structures. The overall image has a halftone or dithered texture.

“Environmental homeostasis on a global scale is now necessary to survival. Creative imagination, artistic sensibility, can be seen as one of our basic, collective, self-regulating devices that help us all to register and reject what is toxic and find what is useful and meaningful in our lives.”¹

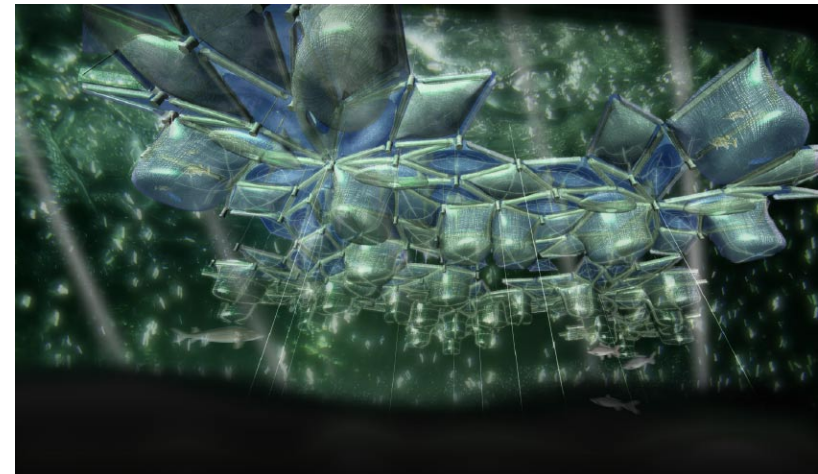
*—Gyorgy Kepes, *Arts of the Environment**

Introduction

This thesis proposes a way in which architecture and the built environment might work to integrate human consciousness and natural process. A theoretical design entitled Landscape is presented as a responsive, sustainable landscape that offers understanding of nature through active observation, interpretation and transformation of the environment. The design proposal is situated at the edge of Hamilton Harbour, Ontario, Canada, adjacent to the existing facilities of the National Water Research Institute. Two extended studies accompany the design proposal. The first, Water, presents a poetic exploration of cosmic, responsive, and connective qualities of water relating to nature and technology. The second study, Connected Fields, focuses on the visionary American engineer Buckminster Fuller and his 'Geoscope' project, a geodesic dome designed to act as a monitoring and control centre for global material and resource flows. This section also includes a discussion of general conceptions of the world, focusing on key twentieth-century conceptions of the Biosphere, Gaia, and the Noösphere. Historical theories of environmental perception are discussed including Gestalt psychology and technical systems of observation. Drawing upon this cultural material, the thesis attempts to open boundaries that separate nature and technology, encouraging a complex, mutually dependent relationship between these traditionally separate realms. The general pursuit is a cybernetic and virtual model for environmental and ontological hybridity, involving an evolution of consciousness at both individual and global scales.

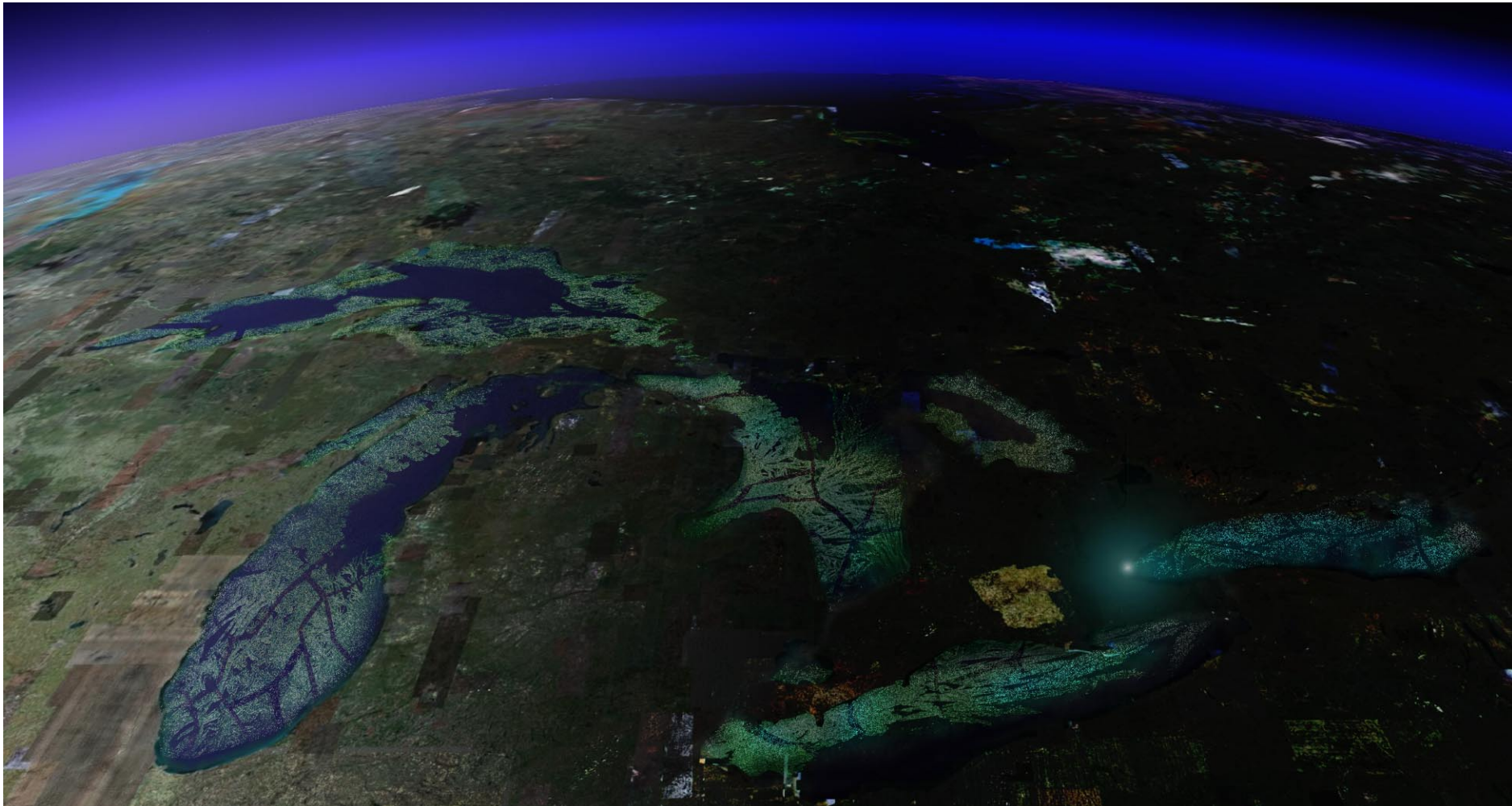


0.1 | Hybrid Fields, Above Water



0.2 | Hybrid Fields, Below Water

0.0 | Scope of the Great Lakes (Previous 2 Pages)



0.3 | Hybrid Fields, Expansion Across the Great Lakes

Context | Instruments of Landscape

"All machinery is derived from nature."²

"The eye does not always give a true impression."³

– Vitruvius, *The Ten Books on Architecture*

The Landscape environment is conceived as a kind of interface for its own transformation, fostering constant change and growth. It is as an interactive environment that responds both to occupants and to natural process. This environment can be characterized as a dynamic manifold consisting of nested arrays of individual connective cellular components that rearrange and reconnect to form higher orders of organized systems and environments. The system collectively forms transitory and transitional environments between land and water, urban and natural systems, and environment and mind. The calling for such an environment has developed in observing two principle factors of the natural environment with which we are familiar today; liminality and crisis. These enter the discourse of environmental concern simultaneously. The liminal, or connective, quality of natural systems has made us question the boundaries we create, developing a globality of thought. Locality seems to no longer exist in this new environmental context. Thus all dilemmas and problems extend to the global scale. A mistrust, however, of human judgment and creation exists, persisting in the field of design. The apparent degradation of our 'natural environment' is caused by our introduction of 'unnatural' or synthetic processes and systems, mostly associated with urban, infrastructural and industrial development. We thereby perpetuate a separation of our selves from nature. Ironically, this separation is the factor most detrimental to our selves and our environment. This culturally manufactured perception of our place in the world produces a continuous rift within our own development as individuals through the apparent separation of our biology from our craft.

In confronting contemporary environmental crises associated with global ecological degradation, there is a need for a new understanding of nature, and thus, a reorientation of our place within the environment. This brings about a reorientation of the role of the artist and designer. This topic has been pursued in the writing of Gyorgy Kepes⁴, the Hungarian-born painter, designer, educator and art theorist. His work has pursued aesthetic and creative thought ranging from the New Bauhaus to Gestalt. To Kepes, creative imagination and sensibilities are not bound within individuals as they are integral to the formation of our surroundings. With this in mind, Kepes points to art being a crucial component in confronting environmental crises. As such, creative imagination and artistic sensibility can play a key role in developing what is considered a dynamic, self-regulating sustainability. The perception and conception of the built environment are integral to its construction. Yet, as we pursue an interest in describing natural boundaries toward the goal of their protection, we find such 'divisions' to be dynamic regions and entirely new environments unto themselves. How are we then to proceed to uphold our understanding of the dynamics of the natural environment if our cultural divisions act as definitive obstructions? We must now re-conceive these borders and partitions. This is not a calling to remove definition. On the contrary, it is a remaking of boundaries into reflexive and living concepts and places unto themselves. These do not separate, but support, do not divide, but connect. Having assisted the development of our cultural understanding, boundaries and definitions can now re-enter the liminal condition we observe in nature, such as to inform and generate places and ideas that are simultaneously natural and artificial. Much of the work in this thesis comes across issues of boundaries being clear, but artificial creations. The scalar, temporal and spatial divisions are numerous:

Individual|Community
 Architecture|Landscape
 I|We|They
 Inside|Outside

Real|Virtual|Imaginary
Part|Whole
Organism|Environment
Human|Nature

Coming to terms with the synthetic quality of definitions is essential if we are to also create equally artificial means of crossing them. Further, our physical boundaries are to engender an equal reflexivity. Responsive architectures and landscapes can be interstitial connective systems, merging existing environments with ourselves. It is to this effect that Kepes writes in *Arts of the Environment*:

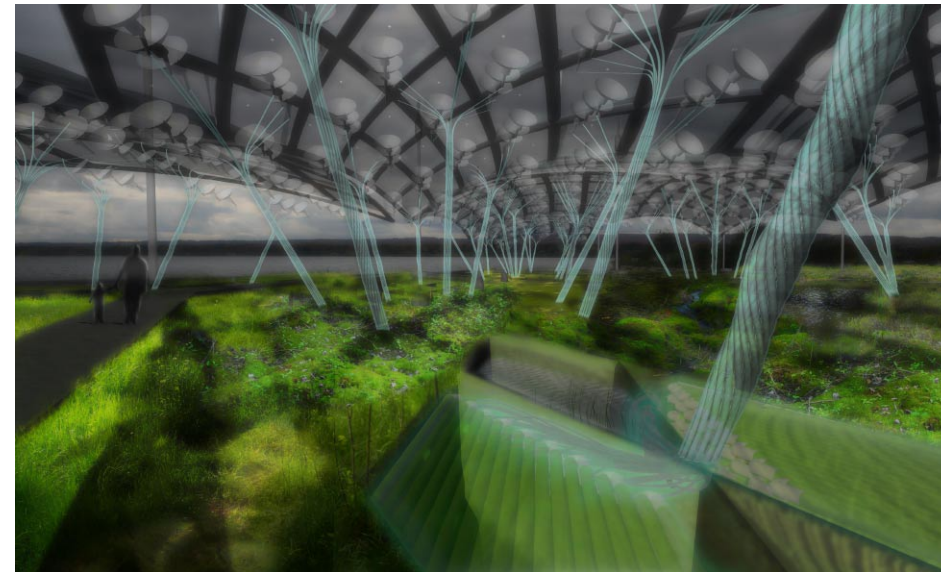
“Every physical form, every living form, every pattern of feeling or thought has its own unique identity, its boundaries, its extension and its wider context; it contains or is contained by another pattern; it follows or is followed by another pattern. The unique identity, discrete shape, and nature of a space-occupying substance are shaped by the boundary that separates it from and connects it to the space outside.

...

But the world is not made of discrete fixed entities. The boundaries that separate and connect them are fluid. The world’s infinitely complex fabric is in a process of never-ending transformation; biological forms, social groups, human feelings and understandings undergo continuous changes. They may merge into larger, more encompassing, more complex configurations or fall apart into smaller, simpler constituents. Perception psychologists, investigation the dynamics of visual figure-ground relationships, discerned a dynamic hierarchy of gestalts—perceptual patterns moving toward larger, more inclusive patterns. Our present relationship to our environment is at the threshold of such a process of reorientation. New circumstances have now forced us to see that we can no longer think of ourselves as separate and independent from our environment; rather, together they form a new, higher gestalt.”⁵

From the transformation of static boundaries to dynamic connectors a great sense of complexity emerges as we must now adapt our cognitive function to interpret this compound environment. Thus, this new in-between condition, the hybrid of physical realms, is to envelope our perception, as our observed environment merges with the real, imagined and future environs. Our consciousness of our place could form the environment itself.

The material of architectural construction and the built environment too must evolve as a principle work of artistry, thought, and craft. Historically associated with the construction of boundaries and walls, architecture can now operate as well as a dynamic system of interconnection, and a generator of cognition. The material of architecture must not only transform, but must embody transformation itself.



0.4 | Hybrid Field Environment



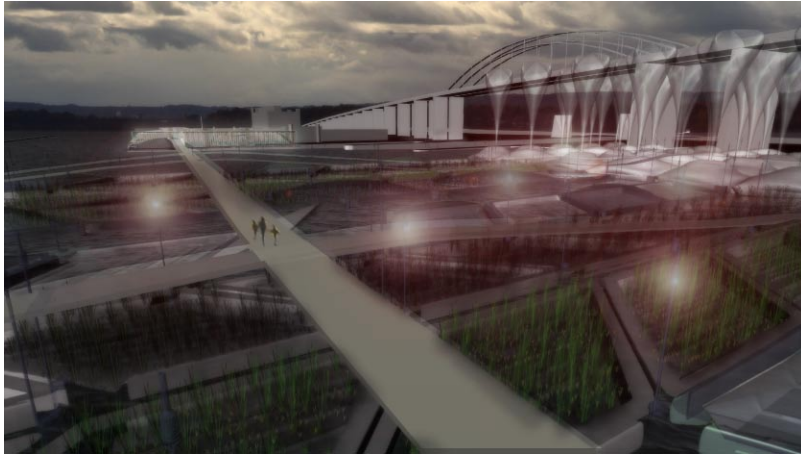
0.5 | Interpretive Centre | Perceptual Filter

The Landscape is a cognitive filter for reinterpreting and reforming our understanding of environment, and offering new ways of shaping and organizing space and place.

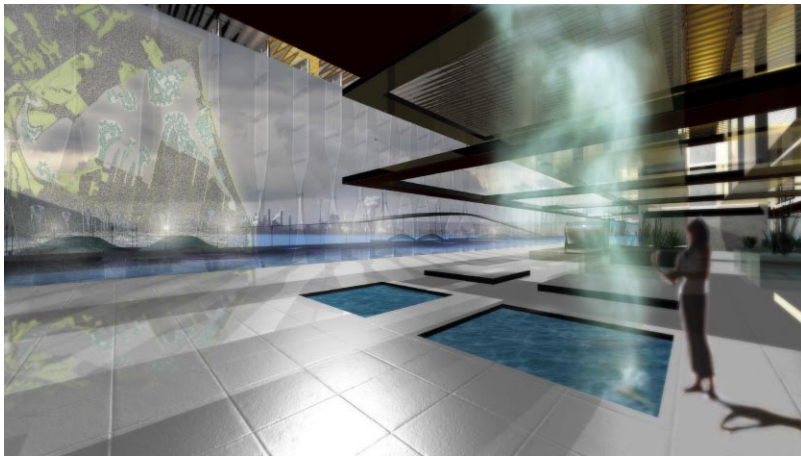
"[Architecture is becoming] a responding, bodiless, dynamic, interdependent structure answering to man's changing needs and growing controls. The flexible, mobile, transparent lightness can contribute significantly to man's liberation from the fixed space enclosure that separated him from nature's wealth of events."⁶

It follows that a truly responsive architecture that is to reconnect humanity to natural phenomena must occupy the environment itself. Such an environment proliferates the internal cognitive realm, through its perception and interaction. The Landscape proposes a particular means of doing this by becoming an evolving, re-organizing field influenced by a hybridization of human cognition and ecological process. It is a system of Hybrid Fields, floating constructed wetland cells that operate individually and collectively at different scales and functional gestalts. Further, the system ties back to a programmatic architectural facility, an Interpretive Centre sited at the National Water Research Institute in Hamilton Harbour, Ontario, Canada. The Interpretive Centre acts as a central monitoring station for the landscape. It relays collected information from each of the cells as the collective landscape treats wastewater from various sources in the region. The Interpretive Centre provides a public interface to visitors to understand their relation to both cultural and natural processes. In turn, however, the data collected informs future iterations and transformations of the arrangement of these cells. Both computer-driven optimized patterns, and further arrangements tested by both scientist and visitors within the facility alter the organization of the landscape.

The Landscape finds itself in a context lying between publicly interactive 'park', and 'instrument' of environmental control. It is formed between landscape and object, field and figure. The design of this liminal landscape must in turn use tools and techniques that reflect and embrace this condition of the connective in-between. To this end, we can turn to the writings of Denis Cosgrove, a cultural geographer who's work focused on landscape and representation. His work discusses the liminality



0.6 | Hybrid Fields, Facing North to the Interpretive Centre



0.7 | Interpretive Centre Interior, Looking Back to the Hybrid Fields
A display of natural water-based phenomena is set against the backdrop of an immense display system, mapping the processes within the Hybrid Fields.

of the geometries used to describe landscape. In *Liminal Geometry and Elemental Landscape: Construction and Representation*, Cosgrove describes the condition that exists between global and local as it is reflected in the practices of observation and mapping. Cosmography, geography and chorography⁷ refer to the relation of vantage point to field of study. Cosmography places the individual at the centre of the universe, thereby generating a view of the star field, home to the spiritual in its all encompassing but infinitely distant presence. Geography positions us statically above the earth, offering a two dimensional view of our sphere as interconnected but overlapping terrains. Chorography returns us to the earth's surface such that the horizon acts a reference, and viewpoint and space are both relative and subjective.⁸ This particular vantage point, to Cosgrove, offers the greatest place of the imaginative and creative role of the individual. To this end, the Landscape seeks a level of simultaneity of all three modes of representation. In this design chorography is the most visceral, geography is virtual (as represented in the Interpretive Centre) and cosmology is mental. Each perspective, however, affects and merges with the other. Inherently, geometry is found to be fluid within this proposal. In much the same way, the roots of the word 'geometry' itself are founded in fluidity, as revealed in Cosgrove's discussion of its derivation in Egypt's redrawing of the boundaries of the Nile:

"Geometry's Egyptian origins, according to classical wisdom, lay in the requirement to redraw the boundaries of property after the annual Nile flood. Thus geo-metry—the measure of earth—is a primary act of constructing landscape out of the elemental confusion of water and earth, a fusion paralleled by human confusion: that bewilderment produced by wilderness, which reason seeks to tame in its acts of bounding and enclosure."⁹

We might suggest geometry's relation to the imagination through its equal relationship to the wild. Geometry as a tool for abstraction and cultural construction allows us to understand nature through its being a reference or gauge. To this, James Corner, landscape architect and theorist of the office Field

Operations, describes the significance of tools of mapping and representation. He points to the interdependency of landscape and its image. Within *Eidetic Operations and New Landscapes*, Corner defines eidetic in reference to the perception of the environment as “a mutual conception that may be picturable but may equally be acoustic, tactile, cognitive, or intuitive.”¹⁰ As such, eidetics are interlinked with perception, and further, with creative human thought. In this context, the instruments of environmental perception are deeply rooted with the conception of the environs, and further, their control:

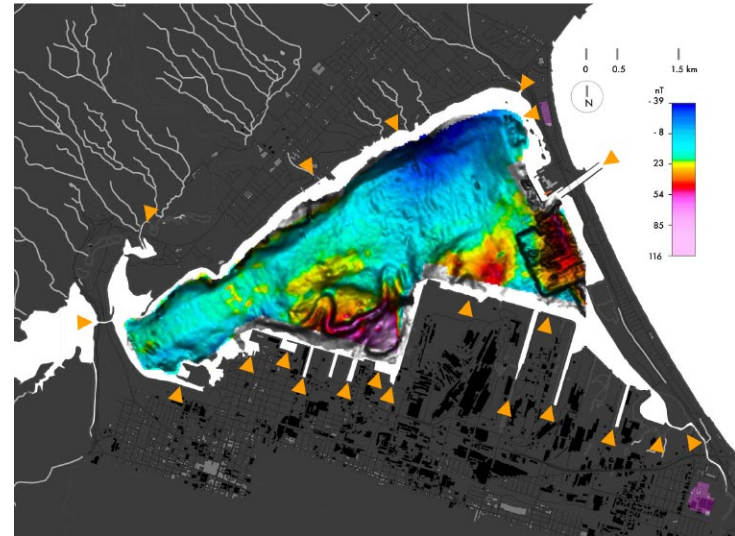
“Total vision affords a powerful set of instruments to not only describe the world but also to condition and control it. Just as there is no innocent eye, there is no neutral or passive imaging, meaning that landscape, too, as image, is neither inactive nor benign.”¹¹

We return, then, to definition itself, as landscape is a possible conception based on two other words, ‘landskip’ (landscape as an artificial creation, mostly visually based, perceived often iconically) and ‘landschaft’ (landscape as occupied place, its significance developed over time through its engagement).¹² Both conceptions bind ‘idea’ and ‘place’ through its active interpretation. The image informs both representation and generation of environment.

“The ancient Greeks recognized the image aspect of ideas, as in the term eidos, which conjoins “idea” with “something seen.” This is why imaging, understood as idea formation, is integral to the conception and practice of landscape. In landskip, the making of picture participates in and makes what is to be pictured, whereas in landschaft the formation of synaesthetic, cognitive images forges a collective sense of place and relationship evolved through work. ... space by itself is neither sensible nor imaginable, but is instead created in the act of imaging. Such eidetic constructs effectively bind individuals to a collective and orient them within a larger milieu.”¹³

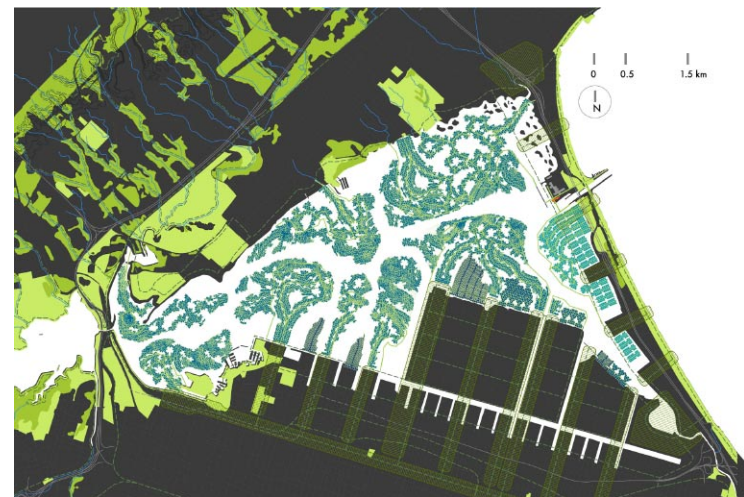


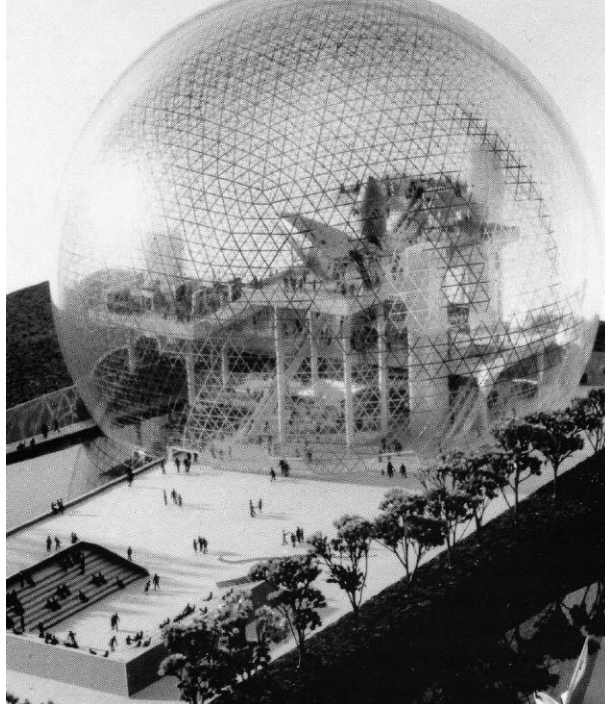
0.8 | Hamilton Harbour, Satellite Photograph



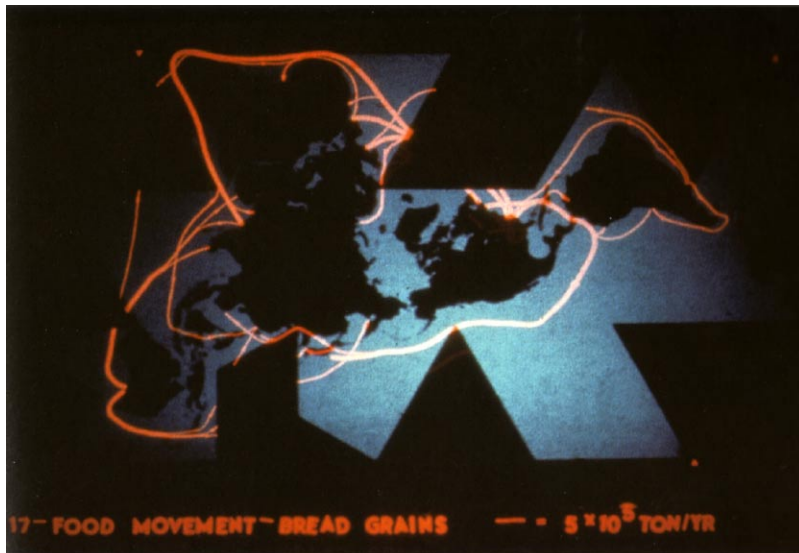
0.9 | Hamilton Harbour, Magnetic Imaging

0.10 | Hamilton Harbour, Hybrid Field Development





0.11 | Geodesic Dome at Expo '67
Fuller's dome at Montreal World Expo was originally planned to be a full-scale, operational Geoscope.



0.12 | Geoscopic Display Unfolded

Such a system binding environmental visualization and control is represented in the central precedent to the Landscape; Buckminster Fuller's Geoscope. This project was to be a centralized observation and control system for 'Spaceship Earth'. This theoretical geodesic dome would operate under the precepts of cosmology, geography and chorography simultaneously. While one operates the system, they are at the centre of the sphere, presented with a spherical image of the complete earth and the immediate exterior environment, visible through the thin lattice structure of the sphere. Further, creative input was the central means of control, as those inside would play the 'World Games', deciding upon and testing modifications to global resources flows. The effects of these modifications would be computed and displayed inside the sphere. The goal was to generate social equity and equality across the landscape of the earth through the monitoring and management of all resources in unison.

An unfolding of the Geoscope is a central operation that leads to the conception of the Landscape, such that it may reconfigure and expand across the globe. The synthesis between the environment and system of environmental operation allows a simultaneity of experience of this hybrid habitat. Further, it creates a totally new landscape, in which it becomes publicly open to interpretation and reorganization.

Structure | An Assembled Array

The organization and structure of this book presents clusters of material forming a connected constellation. The various lines drawn between these elements form new images of the world it presents. Though organized sequentially with the design featured first, the conceptual structure of this work places the design at its centre. The work is principally focused on a design that emanates from two streams of research comprised of phenomena, systems and precedents that are related to Water, and a review of cultural history and theory of the Connected Fields of research looking at models for viewing the world as a whole. Within the main chapters, however, is an array of related but segmented material, offering a widened view of some particular systems, works and theories relating to the development of our contemporary built environment. This approach finds itself in architectural (and to another degree, philosophical) discourse within a tradition relating to the conception of space and architecture, and the education of the architect. This discourse begins with Vitruvius' *The Ten Books on Architecture*. This classic work of architectural method initially acts as a set of instructions for making architecture yet also gives value to a diverse range of additional topics. Ranging from the natural to the spritual, Vitruvius opens architectural discourse into natural phenomena and a larger spectrum of arts. Vitruvius suggests, then, that architectural education is to include an equally wide range of knowledge from techniques of construction, to the culture of cities, to cosmological perceptions of the time:

“Let him be educated, skilful with the pencil, instructed in geometry, know much history, have followed the philosophers with attention, understand music, have some knowledge of medicine, know the opinions of the jurists, and be acquainted with astronomy and the theory of the heavens.”¹⁴

A more recent approach to design that combines environmental and artistic concerns is relayed in Lawrence Halprin's *RSVP Cycles*. This work delivers a more intense focus on environmental quality brought about in a method of dynamic design. In this, inhabitants are integral with the active making of place. This is achieved in Halprin's principle design method of 'Scoring', similar to musical or dance notation but applied to spatial constructions. Halprin offers a system to relate a multiplicity of natural and cultural systems in parallel through a collective event-based artwork. The book focuses on its method more directly, as it can apply to a diverse set of concerns, far beyond what could be described within the written work itself. A concurrent thinker to Halprin, Gyorgy Kepes, again comes of interest, as his own work sought reconciliation of human creative intervention and natural process. In his work *Arts of the Environment*, Kepes links sciences of perceptual psychology and personal creative artwork under the same context of environmental formation. This work expands architectural discourse further in seeking a balance of the physical and mental constituents of our built environment.

This thesis continues to follow and align itself with such works, however, not only in its material, but in its assembly and presentation. Again, the elements have been, in many cases, separated for their individual comprehension. This is to reveal threads that bind these varied topics, precedents and thinkers surrounding the context of the design. In many ways, the context, representation of material and design itself merge in their development. To this end, Marshall McLuhan's famed media/book/work *The Medium is the Massage* represents this amalgamated genre of design. McLuhan's presentation, however, directly juxtaposes, layers, and combines images and text such that his central tenet "the medium is the message" is embodied in the work. In this manner, McLuhan alludes to the excitement and intensity of the new communicative media within the world, while offering the simultaneous warning of the potential obfuscation of content. In contrast, the works within this thesis, though easily related and overlapping, have also been pulled apart (often as a deliberate synthetic act) such as to better reveal some of their

connections. This encourages new linkages to be developed by the reader. A similar approach is found in a contemporary work, using, however, more closely packed writings of both parallel and repulsory ideas. Melded in complex prose Gilles Deleuze and Felix Guattari's 'Rhizome' aims at generating a field of thought in a spreading conceptual network. This opening essay of *A Thousand Plateaus* is simultaneously a critical work of social structures that follow this natural root model, but also the conceptual structure of the book. In this way, there is a reversion and inversion of nature and artifice, as nature is the medium, which is the message, which is artificial.

Though a full description of these literary works and their own structures is far beyond the scope of this thesis, these examples set up their own context in which this thesis has been composed. More importantly, though, is its content that reflects the broad range of thought and techniques principle to architectural discourse. It is focused, however, on specific technologies, systems, and theories that have become pertinent to the proposed design and its larger environmental context. This said, this matrix of ideas and constructions continuously expands by the very nature of the connective topics that are covered. This returns us to the importance of perception and imagination to act creatively within this range of integral but separate topics. Specific technologies rise once again alongside cosmic models of our earth, while each informs an understanding of the other. The construction of the built environment requires these two streams to fuel knowledge and imagination of what was, is, and is to become of our environs.

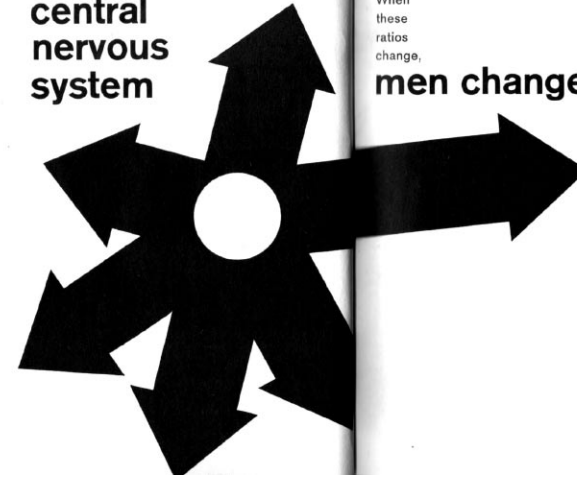
electric circuitry,

an extension of
the
central
nervous
system

Media, by altering the environment, evoke in us unique ratios of sense perceptions. The extension of any one sense alters the way we think and act—the way we perceive the world.

When
these
ratios
change,

men change.



0.13 | Medium is the Massage



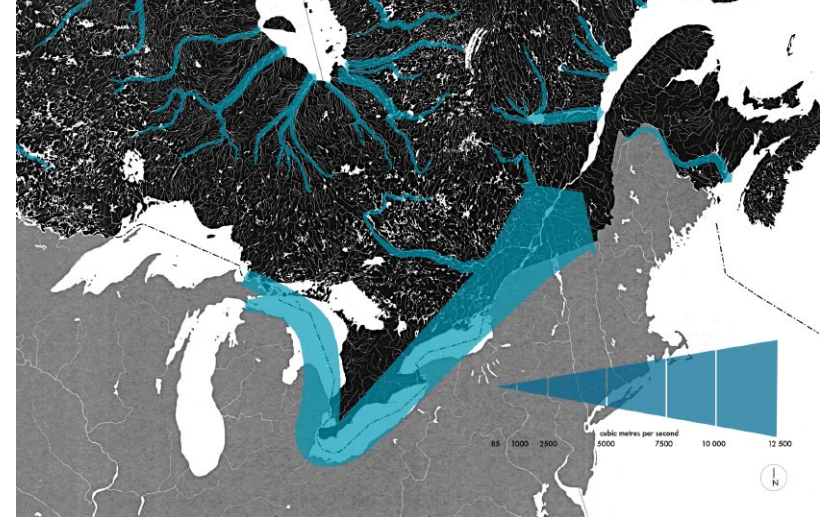
0.14 | Rhizome Space

Content

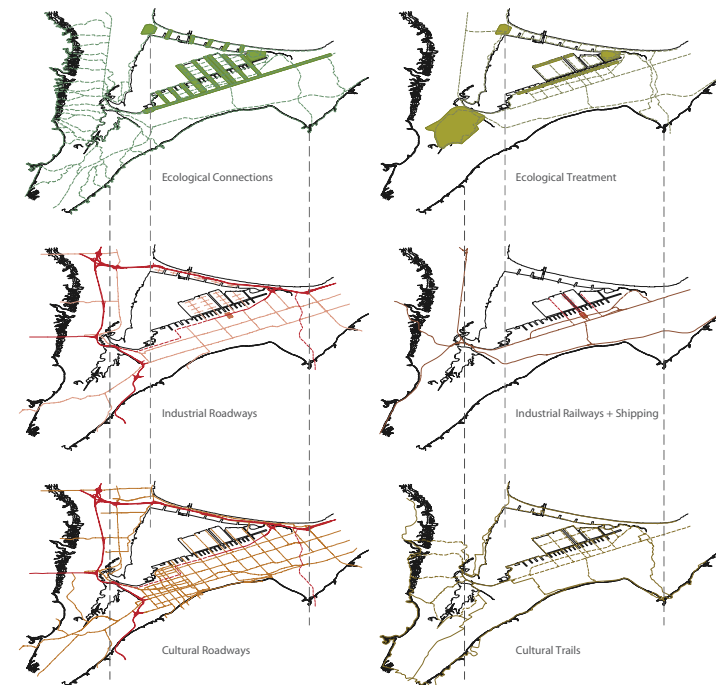
The central component of this thesis, the Landscape, is a combination of instrument and environment. It emerges from the condition and processes inherent to the varying scales of the site, along with two primary streams of research that are presented in the following chapters of the book. The design of the Landscape is shown first through the representation of its site, and its subsequent development as a landscape system of environmental transformation. Water becomes a connective medium between the phenomena, precedents and systems that have informed the design. Connected Fields present a focused overview of theory and cultural history related to the perception of the world as a living and thinking whole.

Landscape

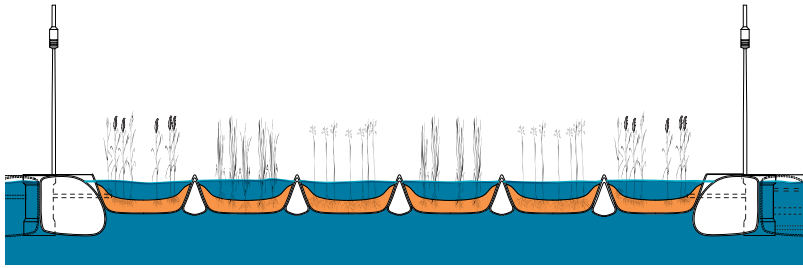
The physical environs of the Landscape's location are paramount to its creation as they derive a focus through the locality of the site. Acknowledging and utilizing the artificial creation of the site's conceptual boundaries are an integral part of the design. In this manner, it is the definition, representation and interpretation of the multiple scales of the environment surrounding the design that inform the design itself. Thus, in observing and mapping the surrounding hierarchical context, the design also relays information about the state of our connected cultural and natural environments. It further assists conscious decisions about how these environs might merge to become a sustainable but dynamic unity. The site for this theoretical project stretches to a North America wide scale, including the transboundary basins of water that expand from the border between the United States and Canada. More specifically, however, the Landscape takes form in Hamilton Harbour, at the western corner of Lake Ontario. The project is implicated in ongoing concern and debate over the health and quality of lake based ecosystems and their connection to industry. Within this, we connect to



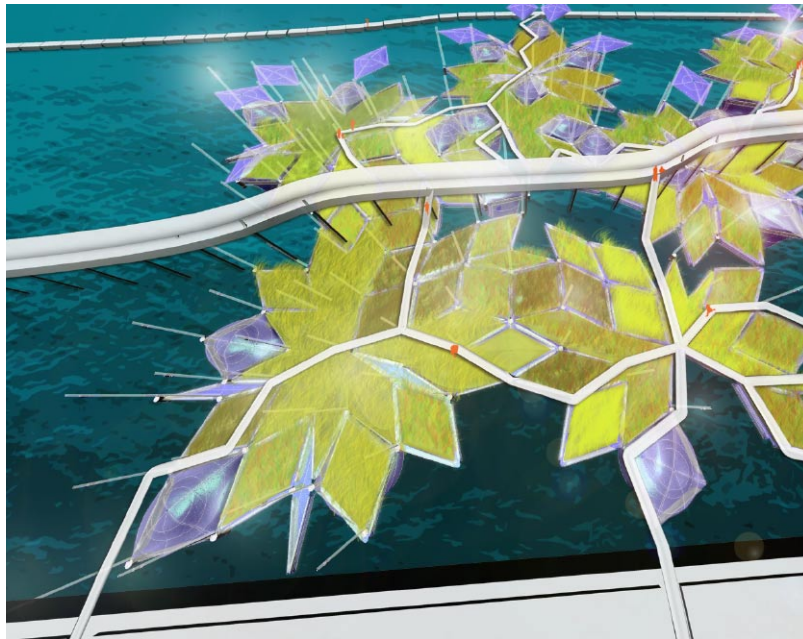
0.15 | Great Lakes Water Flows



0.16 | Leland Dadson's Instrumental Matrix | Composite Infrastructure



0.17 | Typical Hybrid Field Cell Section



0.18 | Hybrid Fields | Cellular Topography
The cellular system of wetlands presents a new thickened inhabitable boundary, terrain and filter, existing between water, land, and air.

0.19 | Hamilton Harbour Canal Section and Hybrid Fields



the National Water Research Institute (NWRI), situated in the facilities for the Canada Centre for Inland Waters (CCIW). This complex is located in Canada's most polluted industrial harbour; a result of the heavy industry in the area, including intensive steel production mills located on the city of Hamilton's industrial harbour. The NWRI fittingly acts as one of the primary government facilities monitoring environmental quality. It is thereby integral to the region's Remedial Action Plan (RAP), seeking a restructuring of the harbour, as well as the extensive bioremediation of polluted waters and adjacent lands. This initiative is manifest in various cultural and landscape oriented projects, with the largest expenditure of the RAP being in the development and expansion of the city's wastewater treatment facilities. The NWRI's impact on environmental networks, however, also reaches nationally and globally, as it is connected to Canada's Ecological Monitoring and Assessment Network (EMAN) data management system. Further, it is host to the United Nation's Global Environmental Monitoring System Water Programme (GEMS/WATER). This site and facility thereby provides the ideal location for an interrelated building and landscape design to relay information about water-based environmental quality to both scientists and visitors.

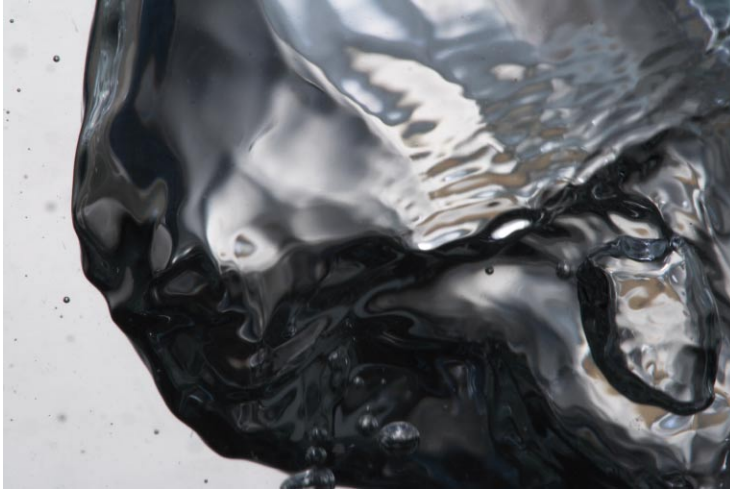
The design proposition stems from an understanding of landscape as a unified realm of ecology and culture. It is an adaptation of Buckminster Fuller's Geoscope as a system to display flows of cultural and natural resources, in which a game is played that integrates human consciousness with ecological transformation. The Landscape is thereby an informative building and remedial landscape design. Sited on the pier supporting the CCIW, the Interpretive Centre provides a public face to the operations and research held at the NWRI. Growing from this are the Hybrid Fields, an evolving complex of reconfigurable constructed wetlands, supported by a system of cells floating in the harbour. The Hybrid Fields assist the purification of wastes from various effluent sources including urban and rural runoff, combined sewer overflow and, in time, municipal and industrial wastewater. This system utilizes another project as a framework

and infrastructure, being Leland Dadson's Instrumental Matrix; a proposed redevelopment of the industrial sites in Hamilton and the land adjacent to the harbour. The Instrumental Matrix shares common goals of becoming an integrative industrial ecosystem, allowing cultural, ecological and industrial processes to function synergistically in a reconstructed network. The actual configuration and propagation of the Hybrid Fields, however, relates back to the Interpretive Centre. This proposed facility is to house its own computerized game for the tiling and patterning of the landscape cells, based on evolving rules generated using data collected from both test-scaled and full-scaled Hybrid Fields. This program demonstrates the performance of each cell and the overall system. This integrative building and landscape design is to engender the making of responsive environments and architectures allowing a co-operation of natural process and human cognition. In turn, this growing, intelligent environment is to proliferate a deeper environmental consciousness.

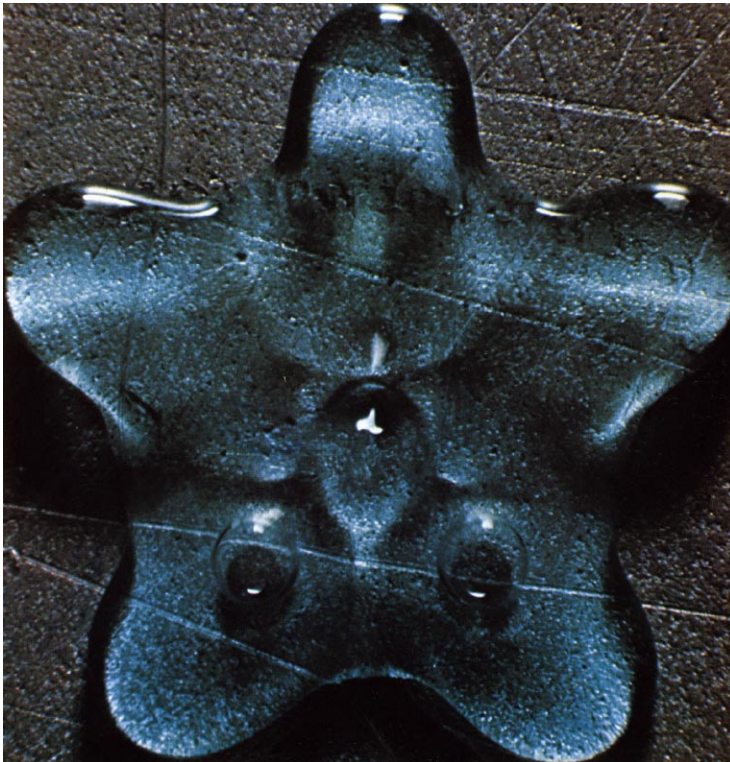
Water

As the fundamental medium of life, water is ubiquitous about our planet while simultaneously a medium of such rare qualities that it enters the realm of the cosmic. The only compound to exist naturally in all three physical states, it is fundamental to supporting life, as it provides both the connected environment in which we live, and the form and function of earth's biota in the fluid morphologies that exist throughout the biosphere. It is thereby a connective and responsive material that adheres all living beings to one another while supporting the environment in which they live. Landscape architect Ian McHarg refers to Lawrence Henderson as he pursues water's primary involvement with the evolution of our living environment:

"It is the union of carbon and hydrogen that produces the hydrocarbons. Hydrogen, the first element, the primeval atom, is the basis of physical and thus biological evolution. It is important as a constituent of water as it is a partner in the hydrocarbons. It is the hydrogen bond in



0.20 | Water Form



0.21 | Cymatic Shapes
Drops of water pulsate as polygonal and overlapping figures when excited by vibration.

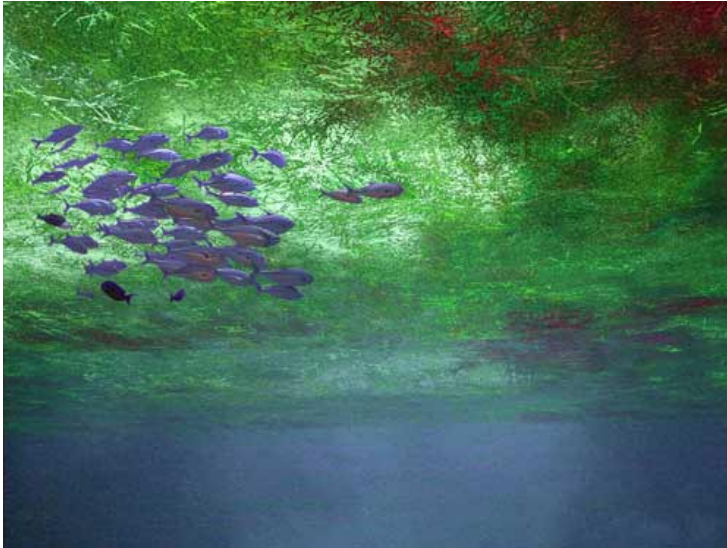
the water molecule which provides the essential qualities of the latter, 'its great surface tension, cohesiveness, high boiling point, high heat of vaporization. 'And those are the attributes that Henderson used to identify water as the most fitting of the attributes of the environment''¹⁵

To this end, we can observe the unique and universal phenomena that are exposed in water's response to living forces. It is precisely these properties of which Theodor Schwenk speaks in his work *Sensitive Chaos*. Herein, Schwenk describes the almost mystical qualities water holds along with air. He uncovers water's formative abilities as well as its subtle, sensitive attributes that connect us wholly to our encompassing fluid environment:

"The first is the activity of water in all metabolic processes in the great organism of the earth and in each separate living creature. The second is its close connection with all rhythmical processes in time and space. The third comes to light in our observation of the sensitivity of boundary surfaces, indicating that water is a cosmic sense organ of the earth. All three functions—functions which are well known to us in the world of living organisms—form a whole."¹⁶

"The third of the above mentioned qualities of water, its sensitivity, is the opposite of the metabolic process. Even as a substance, in the liquid state, it is in the nature of water to be sensitive to the smallest stimuli, which results in effects that can be clearly observed."¹⁷

"Not only does water give to the human being and to all living nature the basis for existence in a living body, but it pictures—as though in a great parable—higher qualities of man's development. Qualities such as the overcoming of rigidity of thought, of prejudice, of intolerance; the ability to enter into all things and to learn to understand them out of their own nature and to create out of polarities a higher unity; all these are aims of human striving which we can recognise also in the qualities of water."¹⁸



0.22 | Plant Anima Project, by Aniko Meszaros
A genetically designed plan-based floating landscape.



0.23 | Overhoff-Halprin Fountain
A 'scored' performing sculpture allows visitors to modify the experience and appearance of the work.

Within this context of fluid transformation we can observe the simultaneous appearance of figures and fields in liquid phenomena. From these patterns and forms, a relationship of water is established with living systems, as it informs the development of natural and synthetic systems, generated by water as a force of life. This medium of metamorphosis then suggests a way to design cultural environments that allow us to communicate with the complex animated fields created by water.

Connected Fields

Like the intersection of radiating waves in a pond, many fields of discussion, research and theory seem to combine, overlap and reinforce one another in a complex array emerging from the conception of Buckminster Fuller's Geoscope. The simultaneous technocratic and environmentalist milieu in which the project was developed has supported the development of many new forms of design. In starting with the Geoscope itself, we can derive many ideas about Fuller's hopes and desires for the world, but indeed also a growing global need for enhanced perceptual systems to view the world in itself. Fuller's Geoscope points to responsive architectures that react to mental, physical and combined environmental input. The Geoscope and the associated discourses stemming from systems theory and cybernetics, attempt to confront the very 'globality' that arises within post-war communication and transportation networks crossing the globe.

Buckminster Fuller's Geoscope was a project focused on creating a better understanding of our global environment. It was to become, in turn, a control centre of our cultural resource-based processes. At the point of its inception, these were beginning to be understood to be directly linked to the earth's own natural processes. Fuller's project was a design for a geodesic dome, the interior of which was to be lined with aerial images of the earth in its entirety, simultaneously displaying flows of economies and natural resources. It thereby interconnects ecological processes,

cultural systems and human consciousness. It is precisely this interconnectivity that becomes of interest in the parallel areas of research and design that orbit the centrality of the Geoscope.

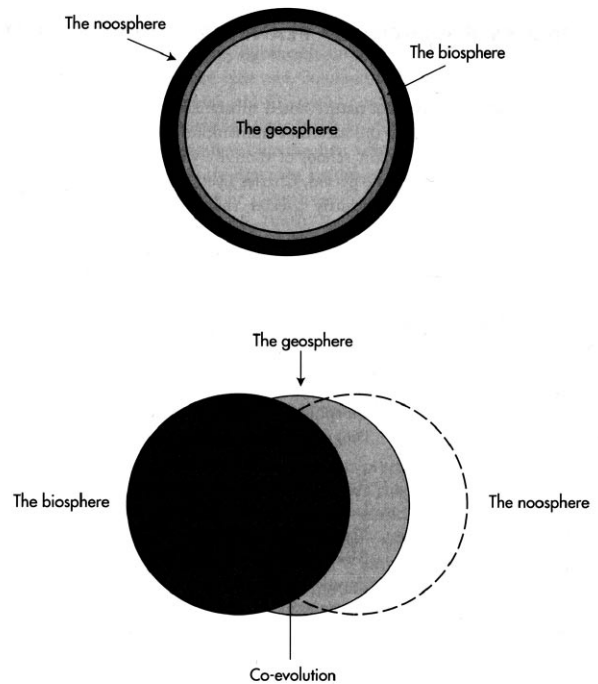
“The particular Geoscope that we think about a great deal is 200 feet in diameter. The reason that we have chosen that 200-foot size—which is about twice the diameter and eightfold the volume of the world globe at the New York World’s Fair—is that if we use the aerial mosaic contact photographs taken by the Air Force at the lowest standard flight level, and put the whole world inventory of contact-size photographs together as a continuous spherical surface mosaic picture, they will make a 200-foot diameter globe. In the 200-foot-diameter spherical aerial mosaic we can see men’s houses—but we can’t see men. In a sense we can recognize man because we recognize his farm and his house. On a 200-foot globe, pasted up with an aerial photo mosaic, you could see all of humanity’s highways, railways, towns, and houses. Any human could identify his home on such a sphere.”¹⁹

The emergent connective fields of research surrounding the Geoscope’s inception inherently begin with large-scale cosmic theories that describe our place within our overlapping constructed and natural environs. These ‘spheres’ of thought strangely mimic some of the idealized medieval astronomical models of the universe founded in perfect, nested orbs. Yet these new representations of our world again hark back to a spiritual mode though founded in pure sciences. The Biosphere, Gaia, and the Noösphere all speak of interrelated systems that connect living and non-living dynamics, and point to an organism-like holism of the earth.

“The recognition and isolation of a new era in evolution, the era of noogenesis, obliges us to distinguish correlatively a support proportionate to the operation — that is to say, yet another membrane in the majestic assembly of telluric layers. A glow ripples outwards from the first spark of conscious reflection. The point of ignition grows larger. The fire spreads in ever-widening circles till



0.24 | The Geoscope in New York



0.25 | The Earth’s Spheres

finally the whole planet is covered with incandescence. Only one interpretation, only one name can be found worthy of this grand phenomenon. Much more coherent and just as extensive as any preceding, it is really a new layer, the 'thinking layer', which, since its germination at the end of the Tertiary era, has spread over and above the world of plants and animals. In other words, outside and above the biosphere there is the noosphere."²⁰

It is through the generation of complex of models of the earth, media of representation become paramount in their communication and comprehension. Thus, theories of perception of the environment are of great importance. Reviewing perceptual psychology, rooted in the development of Gestalt theory, we observe the senses as they pertain to a relationship between the world and our everyday experiences. Gestalt theory further addresses some common interests of responsiveness, connectedness, and holism that are latent in the discussion emanating from the Geoscope. The relevance of Fuller's project again comes to light, as it evocates a merging of our own perceptual capacities with technological modes of observation. The proliferation of systems of communication and our dependence on such media have been pursued by Marshall McLuhan. Though he offers many warnings of the perception induced by the simultaneity of experience this new media affords, McLuhan's words also have ironically made him a guru of our developing technocracy. From the combined complexity that is created by our systems and technology of perception, and our connected understanding of the earth, problems arise of defining, mapping or representing in this global context. Ian McHarg, concerned with mapping the dynamics of ecologies, their own internal transformations, and their fragility, becomes a valuable resource in the pursuit of communicating the complexity of the natural environment our heightened perception affords.

"In an electrically configured society all the critical information necessary to manufacture and distribution, from automobiles to computers, would be available to everyone at the same time. Espionage becomes an art

form. Culture becomes organized like an electric circuit: each point in the net is as central as the next.

Electronic man loses touch with the concept of a ruling center as well as the restraints of social rules based on interconnection. Hierarchies constantly dissolve and reform."²¹

The models of our environments that arrive to us defy boundaries as they become more intertwined with our perception of nature. One such derived model for the understanding of this continuous, uncentred space is found in discussions by Gilles Deleuze and Felix Guattari, namely the 'rhizome'. This acts as a model for networks of systems, real, imaginary, or virtual alike, as these realms become interlinked. From this dynamic interplay of real and virtual space, these constructed images of reality become the reality itself, as discussed by Jean Baudrillard in his work *Simulacra and Simulation*. Herein, Baudrillard describes a hyperreal environment that is created through the interweaving of the cosmic models we create of our earth.

"Today abstraction is no longer that of the map, the double, the mirror, or the concept. Simulation is no longer that of a territory, a referential being, or a substance. It is the generation by models of a real without origin or reality: a hyperreal. The territory no longer precedes the map, nor does it survive it. It is nevertheless the map that precedes the territory—precession of simulacra—that engenders the territory, and if one must return to the [Borges] fable, today it is the territory whose shreds slowly rot across the extent of the map."²²

Within this conjoined set of realities, we also find ontological realms combining. Notions of 'being' and 'place' merge with their technological and systemic counterparts. From this, the discourse on cybernetics, a theory for control, self-regulation and communication in living systems and machines suggests an amalgamation of these spheres of thought. Cybernetic systems utilizing feedback loops between beings and places lead us to contemplate the construction of entirely new living systems and

environments. Pursuing this line of thought, Donna Haraway pioneered the precept of the cybernetic organism, or ‘cyborg’. Such entities challenge not only precepts of ontology, but bring into question social constructs of gender, race, and cultural hierarchies. But a further temporal ambiguity arises, as outlined in Brian Massumi’s *Parables for the Virtual*, as boundaries between human and computer as well as ‘being’ and ‘becoming’, are rendered into a fuzzy haze.

“A cyborg is a cybernetic organism, a hybrid of machine and organism, a creature of social reality as well as a creature of fiction. Social reality is lived social relations, our most important political construction, a world-changing fiction.

...

Liberation rests on the construction of the consciousness, the imaginative apprehension, of oppression, and so of possibility. The cyborg is a matter of fiction and lived experience that changes what counts as women’s experience in the late twentieth century. This is a struggle over life and death, but the boundary between science fiction and social reality is an optical illusion.”²³

We can then return to Pierre Teilhard de Chardin’s development of the Noösphere, as we perceive our technological and mental development to be part of natural process. Complexity itself appears to be a fundamental driving force of life, intertwined with the development of consciousness. This process of developing organized complexity, or ‘negentropy’, counters a natural and universal tendency toward chaos as it establishes a new paradigm for life’s evolution. Through this, we must equally confront our own self-conscious nature if we are to understand the generation of consciousness as it is generated in the formation of complexity, and the cognition of our constructed environments.

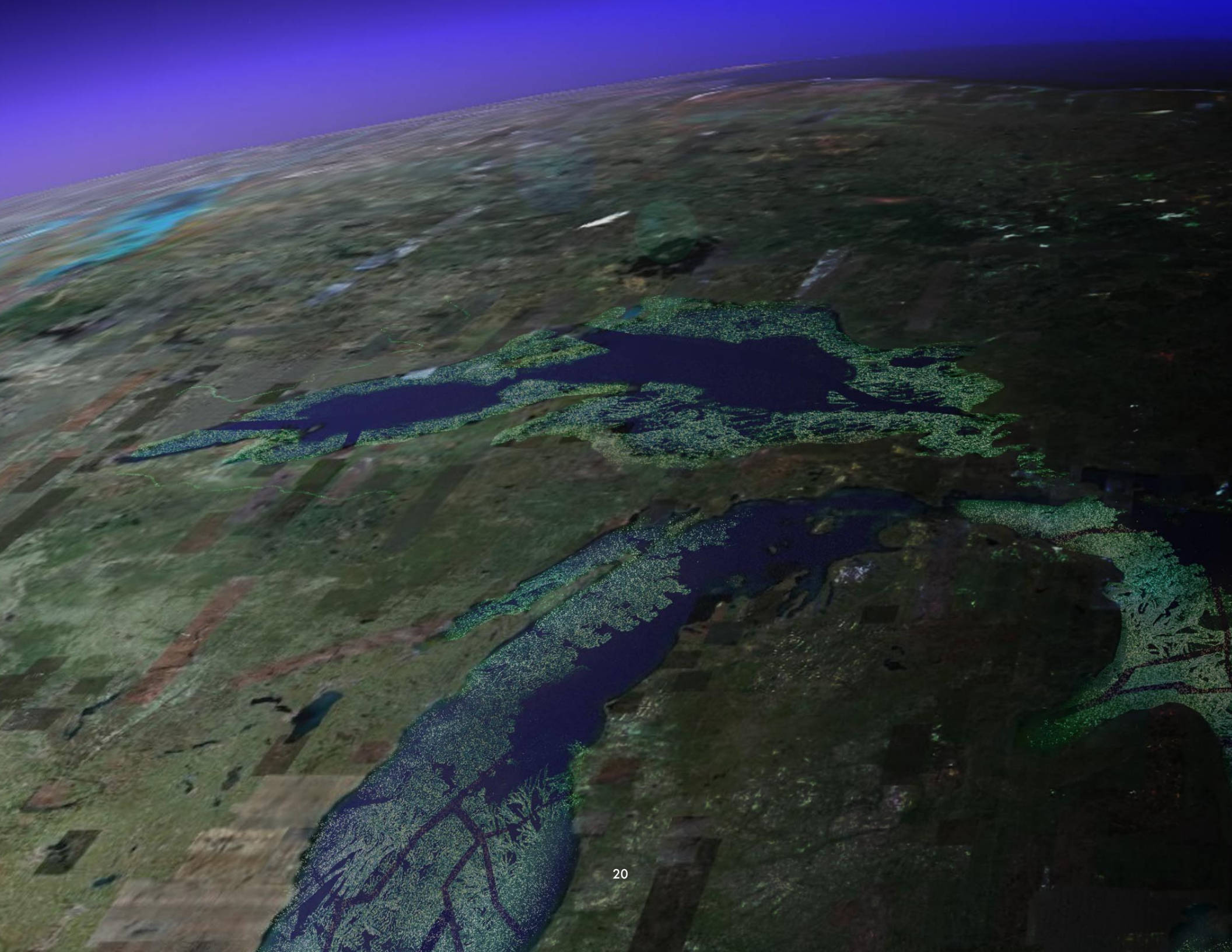
“Perhaps the greatest conceptual contribution of the ecological view is the perception of the world and evolution as a creative process.

...

In this energy is employed with matter through living

processes. The energy is temporarily entrapped; it will inevitably be lost to entropy but it will also be replaced. Meanwhile the living creatures persist, evolve and in their beings and their modifications to the earth, act to raise matter to higher orders. This tendency, which is the sum of all life and all time, and the orderings which these have accomplished, is described as negentropy. Perhaps it can be given the more affirmative and colloquial title of creation—the world’s creativity.”²⁴

1. Gyorgy Kepes, *Arts of the Environment* (New York: G. Braziller, 1972), 6.
2. *Vitruvius: The Ten Books on Architecture*, trans. Morris Hicky Morgan (New York: Dover Publications, 1960), 284.
3. *Ibid.*, 175.
4. Kepes, *Arts of the Environment*.
5. *Ibid.*, 3.
6. *Ibid.*, 11.
7. Denis Cosgrove, “Liminal Geometry and Elemental Landscape: Construction and Representation,” in *Recovering Landscape: Essays in Contemporary Landscape Architecture*, ed. James Corner, (New York: Princeton Architectural Press, 1999), 106.
8. *Ibid.*, 107.
9. *Ibid.*, 105.
10. James Corner, “Eidetic Operations and New Landscapes,” in *Recovering Landscape: Essays in Contemporary Landscape Architecture*, ed. James Corner (New York: Princeton Architectural Press, 1999), 153.
11. *Ibid.*, 155.
12. *Ibid.*, 158.
13. *Ibid.*, 161-2.
14. *Vitruvius: The Ten Books on Architecture*.
15. Ian L. McHarg, *Design with Nature* (Garden City, N.Y.: Doubleday, 1971), 48.
16. Theodor Schwenk, *Sensitive Chaos: The Creation of Flowing Forms in Water and Air* (London: R. Steiner, 1965), 80.
17. *Ibid.*, 82.
18. *Ibid.*, 99.
19. R. Buckminster Fuller, *Utopia Or Oblivion: The Prospects for Humanity*. (New York: Overlook Press, 1969), 116.
20. Pierre Teilhard de Chardin, *Activation of Energy*, trans. René Hague (London: Collins, 1970), 31.
21. Marshall McLuhan and Quenti Fiore, *The Medium is the Massage* (New York: Bantam Books, 1967), 92.
22. Jean Baudrillard, *Simulacra and Simulation* (Ann Arbor: University of Michigan Press, 1994), 1.
23. Donna Haraway, *A Cyborg Manifesto: Science, Technology and Socialist-Feminism in the Late Twentieth Century* (Routledge, 1991), 149.
24. McHarg, *Design with Nature*, 53.



Landscape

An aerial photograph of a wetland landscape. The terrain is a mix of dark green, brown, and light green, indicating different types of vegetation and water levels. There are several winding channels of water, some appearing as thin lines and others as larger, more prominent features. The overall scene is a complex, textured mosaic of natural elements.

The Landscape, a theoretical design project, is a contemporary proposition that recalls the Geoscope's effort to become a monitoring, visualizing, projecting, and cybernetic system, interconnected with both cultural and natural transformations. It is to be situated at the National Water Research Institute (NWRI), part of the Canada Centre for Inland Waters (CCIW), in Hamilton Harbour in Hamilton, Ontario, Canada, as the facility itself is associated with the United Nation's Global Environmental Monitoring System for Water (GEMS/Water) and is connected to Canada's Ecological Monitoring and Assessment Network (EMAN). The project combines both an Interpretive Centre and Hybrid Fields of synthetic floating constructed wetlands and wastewater treatment facilities. This proposition calls for a responsive relationship between the work done at the NWRI, the displays and performances held at the Interpretive Centre, and the public engagement and functioning of the Hybrid Fields. This is to be realized through a system of feedback created between building and landscape. Monitored information about water flow and concentrations of chemicals are to be reinterpreted by scientists at the NWRI and visitors alike, as it is projected both within the Interpretive Centre, and made visible in the landscape itself. This data in turn informs a public computer program projected within the Interpretive Centre to assist visitors and scientists in understanding the function and organization of the wetland cells. The landscape, then, becomes an artificially intelligent, collectively-arranged system by hybridizing natural and synthetic processes of organization. As such, the Landscape encourages an expanded environmental consciousness through the integration of visitors with the emerging consciousness of the environment.



Connected Terrains: The Great Lakes, Hamilton Harbour, CCIW

Presented here is an overview of the interconnections across nested scales of environments, especially between aquatic systems and cultural modes of communication, transportation, and energy transfer. This act of systematic observation and mapping is to lead to the development of the proposed design but is also to be central informative material within the design itself. The information about the environment is to become the environment by passing through a cognitive filter. In this way we achieve a curious disengagement by systematizing our environments, but also achieve a deeper understanding of place through a newly achieved empathy with the world.

Water comes to the forefront of our interests, acting as a way to uncover the complex relationships that exist between our environs and ourselves. John Todd reveals water's significance as temporal and spatial connector, but further alludes to it's quality and purity being crucial to the conditions supporting life:

"As a substance water is something of a scientific freak, having the rare property of becoming denser as a liquid than it is as a solid. This behavioral property is the one of reasons life is possible here on Earth. If, like other substances, the solid state were denser, lakes would freeze from the bottom up, into great blocks of ice, and would never melt. The whole planet would be a ball of ice. The waters of the Earth maintain in balance all of the chemical elements of the planet and all its gasses. All land-bound life evolved from this life-giving source.

...

If, as the Russian biologist Vernadsky claimed, water is life, the quality of water, in many ways, determines the quality of life. Yet, as author Kirkpatrick Sale has noted, the water of life rapidly is becoming the water of illness, debilitation, carcinoma, and death."¹



1.2 | Canada & United States Transboundary Basins

1.1 | North America Illuminated (Opposite)

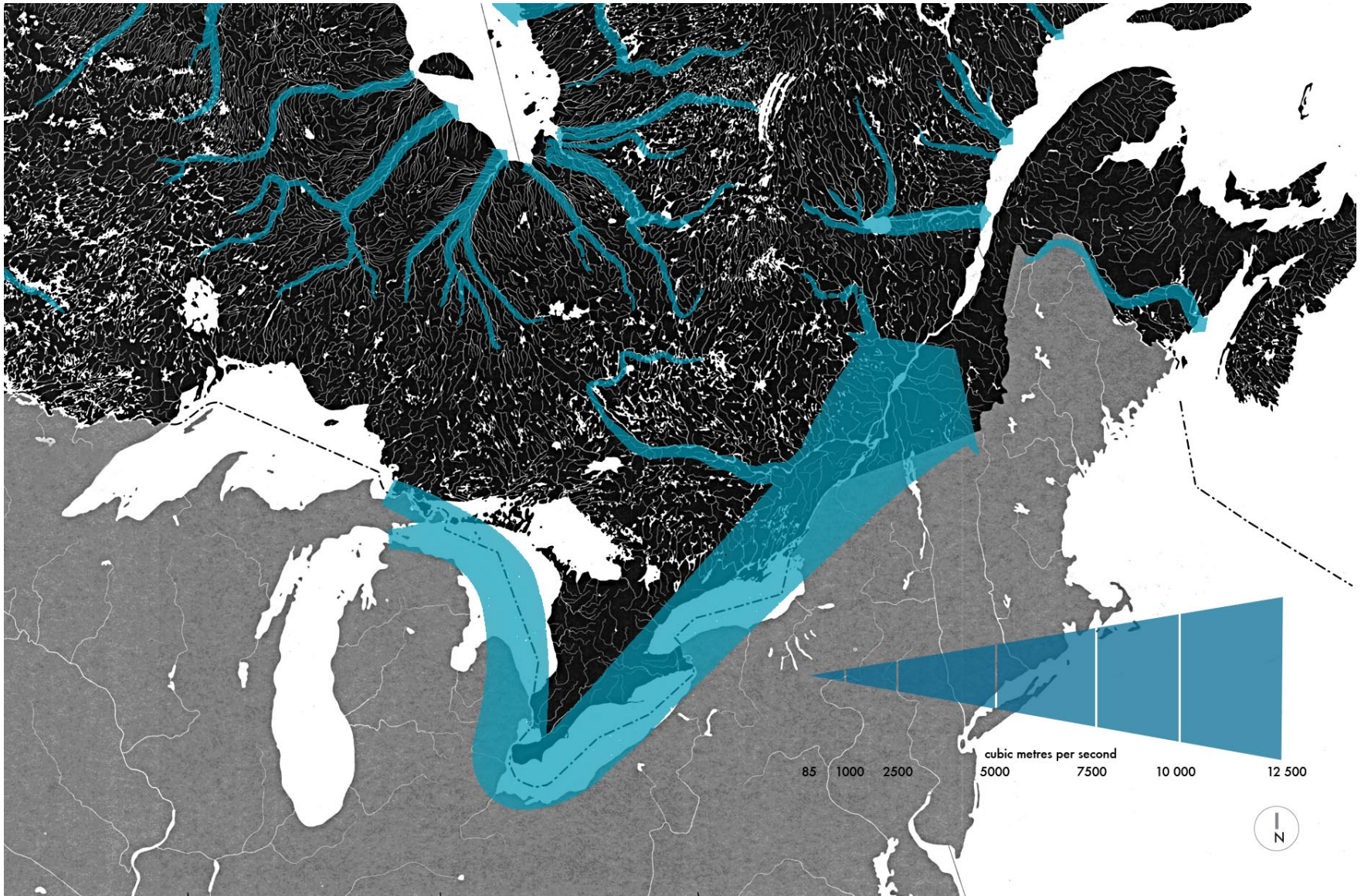
1.0 | Hybrid Fields, Expansion Across the Great Lakes
(Previous Two Pages)

The Great Lakes

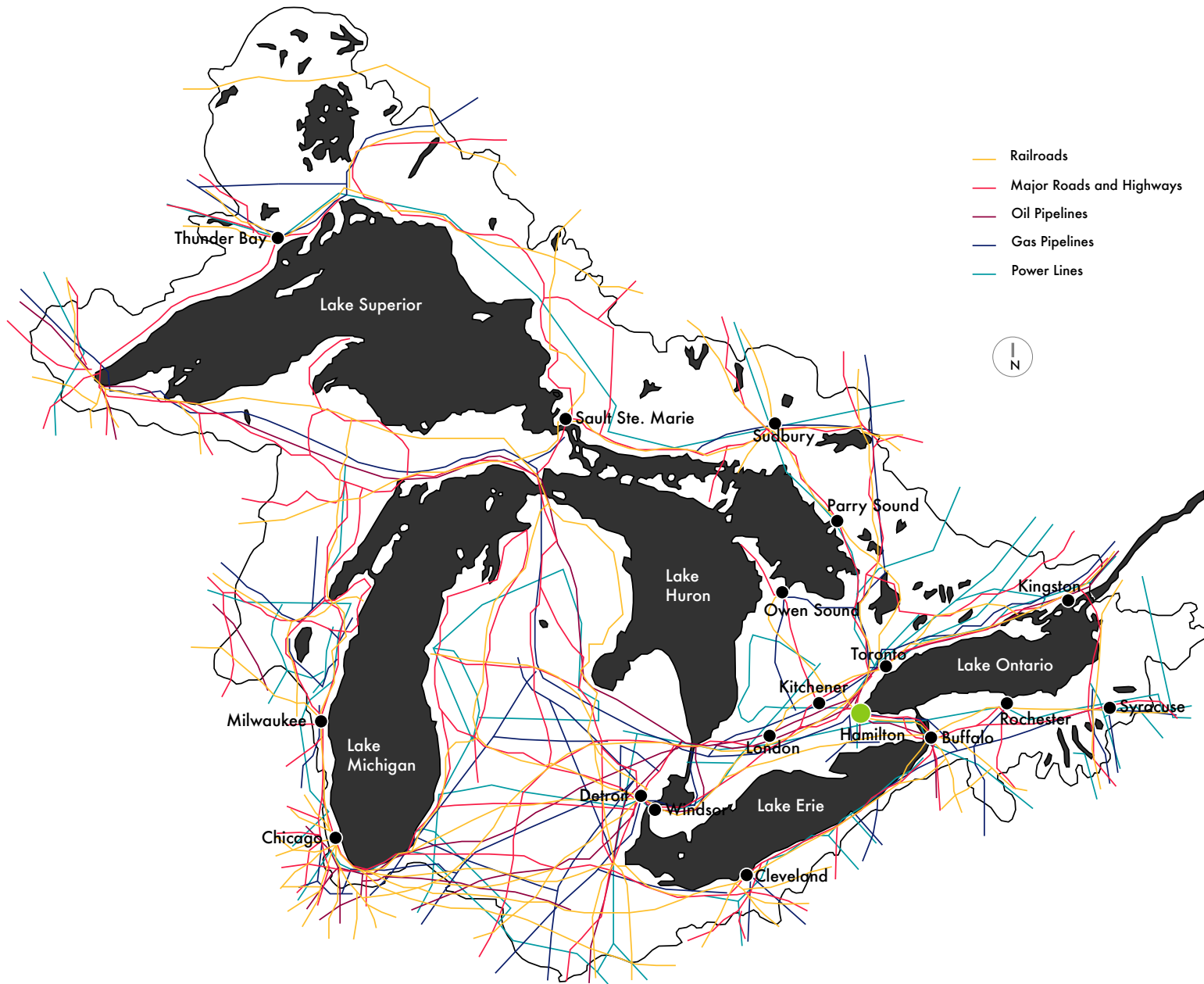
Canada holds 7 percent of the world's renewable supply of freshwater and 20 percent of the world's total freshwater resources,² with the region of the Great Lakes acting as the repository for 20 percent of this precious resource. Though the quantities of these waters seem enormous, this perception of abundance is quickly altered upon learning that only 1 percent of the Great Lakes water is renewed each year by precipitation, the remainder has been left from the melting of glaciers from the last ice age.³ Because of this, extensive measures are being taken between Canada and the United States to ensure the preservation of these waters, in terms of both quantity and quality of that available. While various efforts of monitoring and conservation are underway, new cross-border governing bodies are being established to develop appropriate policy, such as to maintain this resource, and further encourage and support similar policies of environmental protection in countries abroad. The International Joint Commission, for example, has been in place since 1909, as it was established under the Boundary Waters Treaty of that year. This governing body seeks to resolve disputes between the U.S. and Canada as an impartial and independent body⁴, reflecting the need for what are effectively 'political ecotones', to form and grow in our interconnected world. The issues further expand to a worldly scale as global environmental concerns have developed especially concerning climate change, thought to be responsible for increasing fluctuation and lowering of water level in the Great Lakes, compounding the seemingly local crises into what may be international catastrophe.



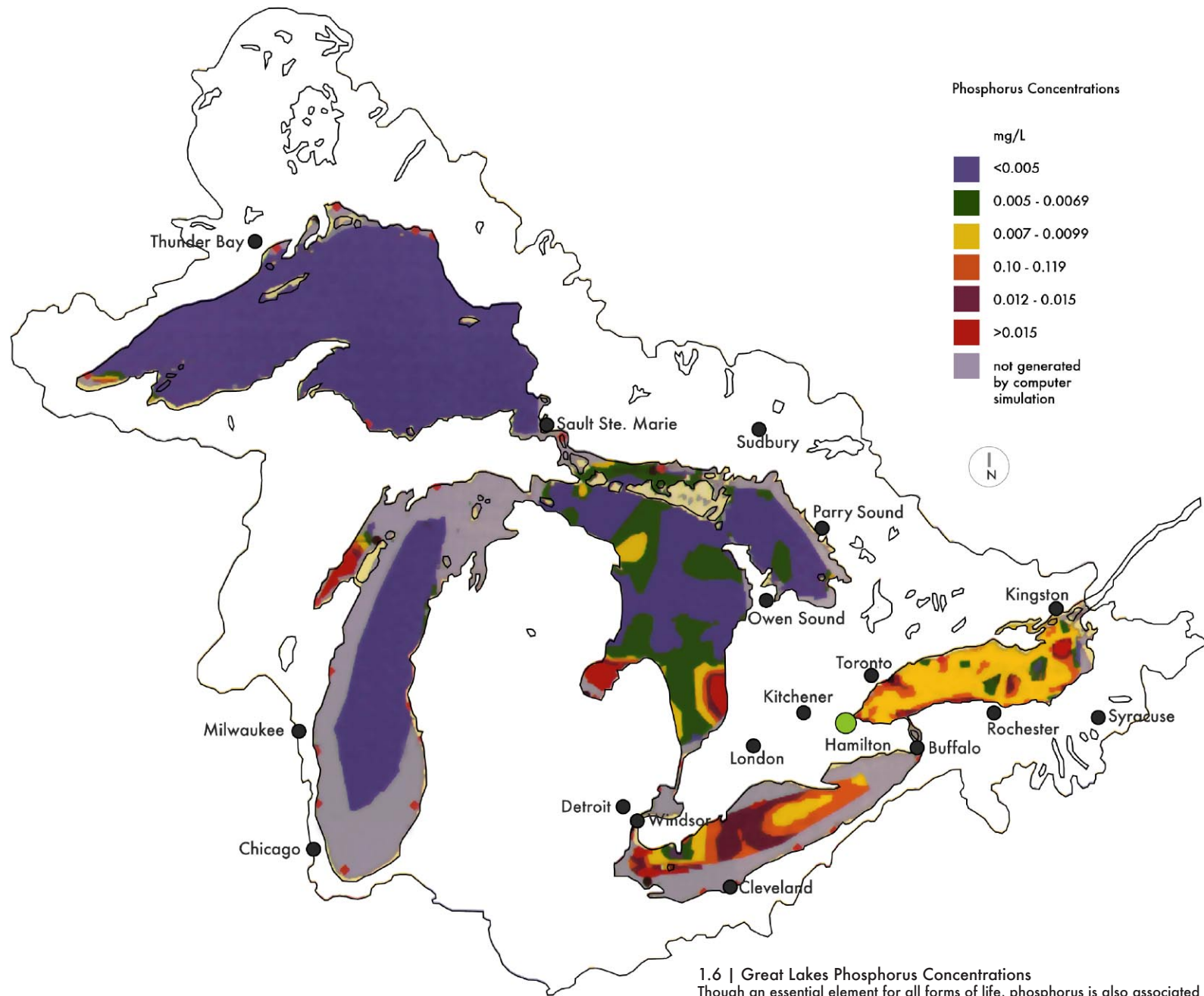
1.3 | The Great Lakes



1.4 | Great Lakes Water Flows
 Drainage patterns through and around the Great Lakes.



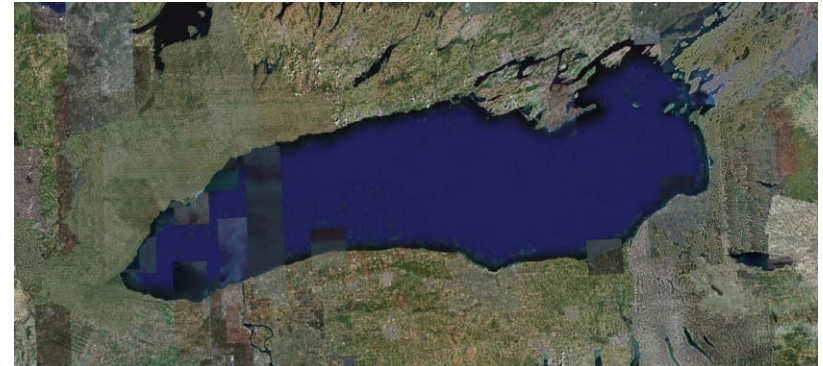
1.5 | Great Lakes Cultural Connections



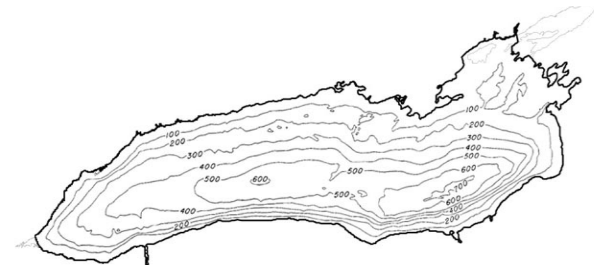
1.6 | Great Lakes Phosphorus Concentrations
 Though an essential element for all forms of life, phosphorus is also associated with problems of eutrophication and algal blooms in aquatic ecosystems as excess amounts are introduced into waters adjacent to areas of intense urban, industrial, or agricultural land use.

Lake Ontario

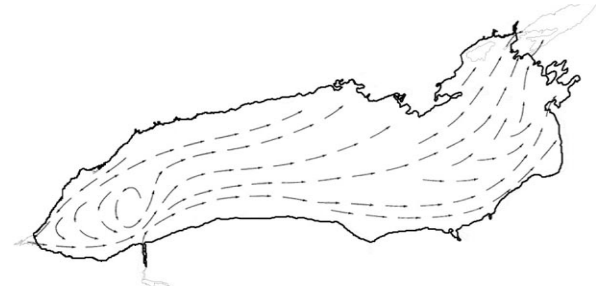
Within the 36 conservation authorities associated with Conservation Ontario, are 10 million residents, accounting for 90 percent of the province's population.⁵ These agencies continually deliver programs to ensure proper environmental resource management. In much the same way as the surrounding watersheds feed the Great Lakes and connect to water quality within the lakes, so too must these authorities share a common network and goal of monitoring and even improving environmental health.



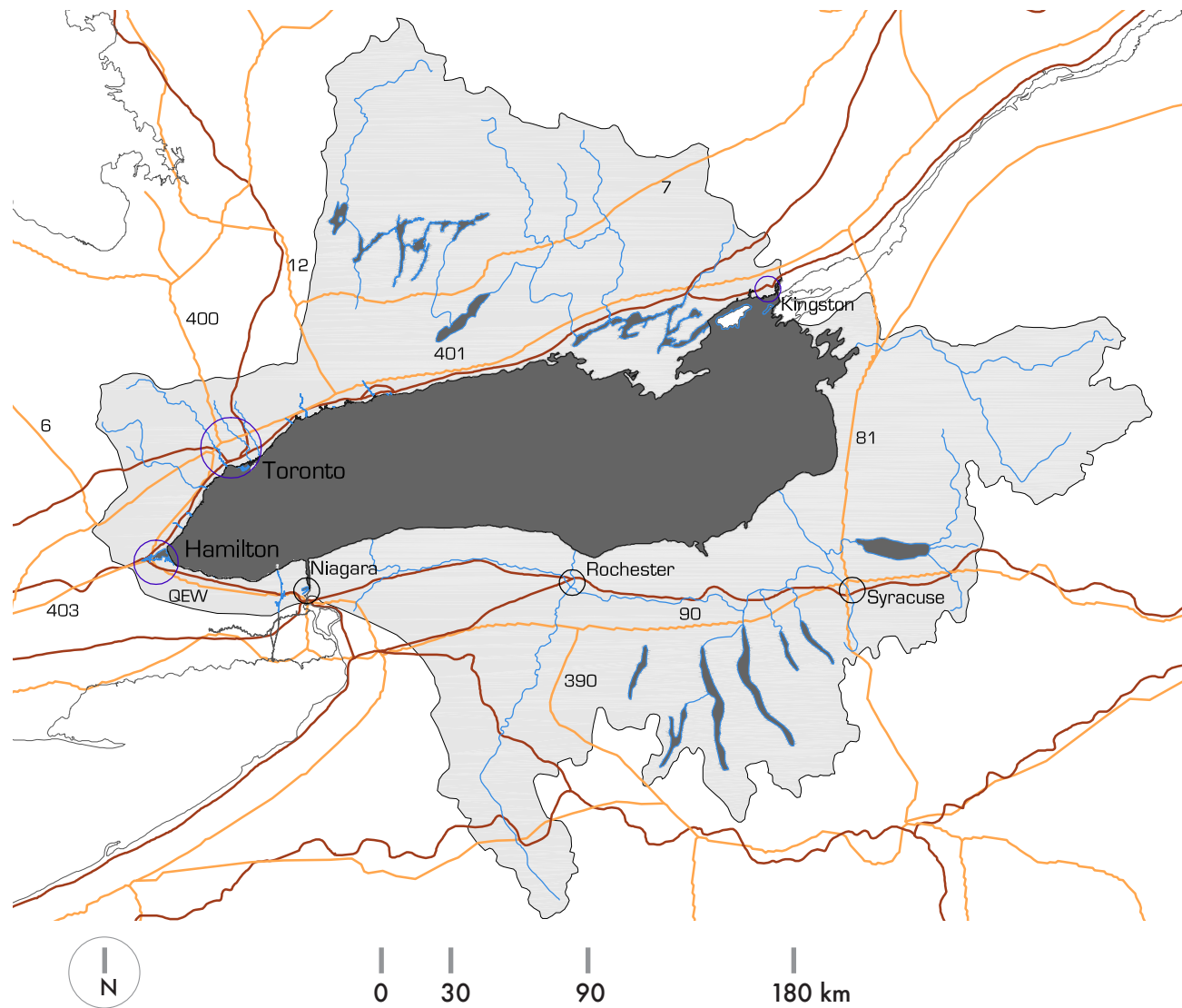
1.7 | Lake Ontario Aerial



1.8 | Lake Ontario Basin Depth



1.9 | Lake Ontario Surface Flow Patterns

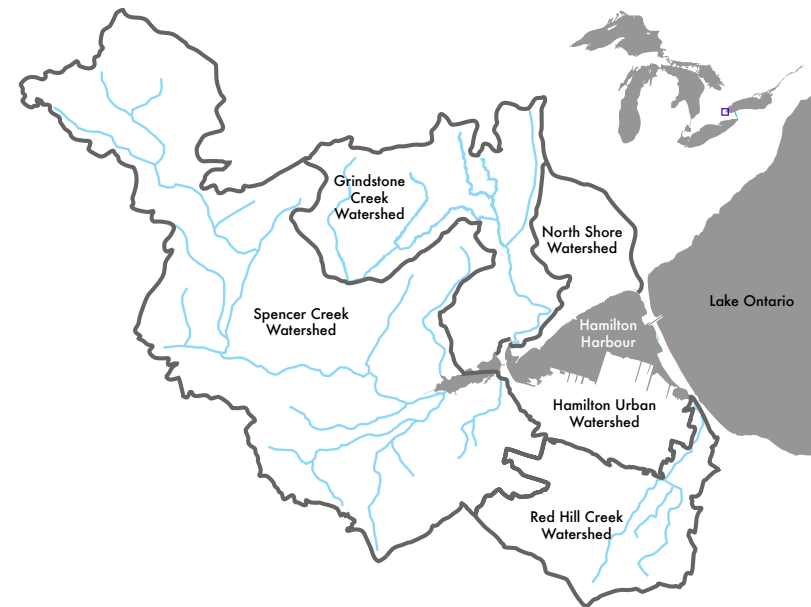


1.10 | Lake Ontario Cultural Connections
 Linking networks of expressways (orange) and railways (red) shown between population centres, within the region of the Lake Ontario watershed.

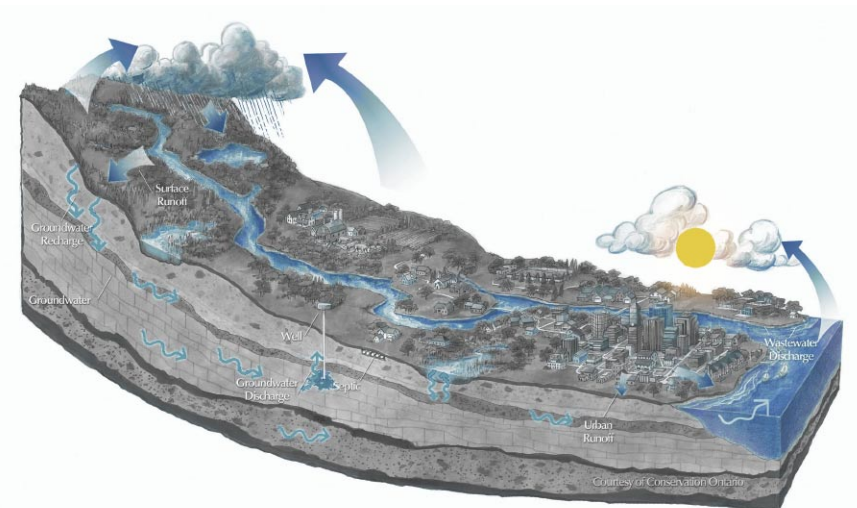
Hamilton Harbour

The area surrounding Hamilton Harbour represents a principal diametric opposition of natural and synthetic forces that has dominated the formation of large industrialized urban centres since the rise of the industrial revolution. A great spectrum of juxtapositions exists in the region, with one of the most extreme conditions being that which exists between the extensive natural or renaturalized areas (as found to the west in Cootes Paradise) and Hamilton's intensive industrialized landscape that protrudes into the Harbour. This development in particular, of a projecting artificial land formation, supporting Hamilton's primary industries, has been integral to the city's economic development, and the simultaneous cause of ecological degradation within the region. Leland Dadson, who's own design proposal for the region that encourages a symbiosis of the formative environmental forces that seem to be at odds, discusses the currently opposed relationship existing between Hamilton Harbour's natural and cultural systems:

*"The city of Hamilton, Ontario has been examined as a quintessential industrialized environment; immeasurably scarred by an economic engine instrumental in the foundation and growth of its urban form. The protective enclosures of the harbour, and the escarpment, that once sheltered abundant ecological resources, historically defined Hamilton as an auspicious site for human settlement. Decades of misuse of these resources by steel and iron industrial firms have, however, seriously damaged the environment. In addition, chronic mismanagement of industrial and public resources has resulted in a suffering economy and a stifled culture. Remnants of Hamilton's pre-settlement ecology are found in the Niagara Escarpment and related stream valleys which connect the city to larger ecological structures within the Lake Ontario Basin. The regeneration in Cootes Paradise, west of the bay, represents the wetland condition the once thrived within the entire harbour. An immense yet sublime industrial presence now dominates the shoreline and harbour."*⁶



1.11 | Hamilton Harbour Surrounding Watersheds

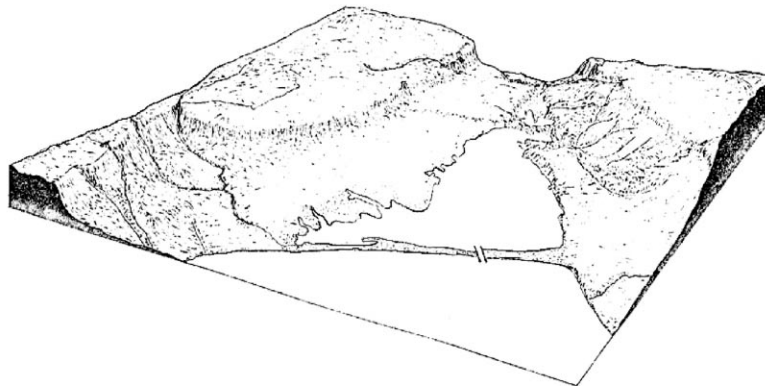


1.12 | Watershed Diagram

A general diagram depicting watershed and watercycle relates directly to the rising escarpment and lower urban and industrial lands entering the bay.



1.13 | Hamilton's Development
A birdseye view of the city of Hamilton from the harbour, circa 1894.



1.14 | Hamilton Harbour Topography

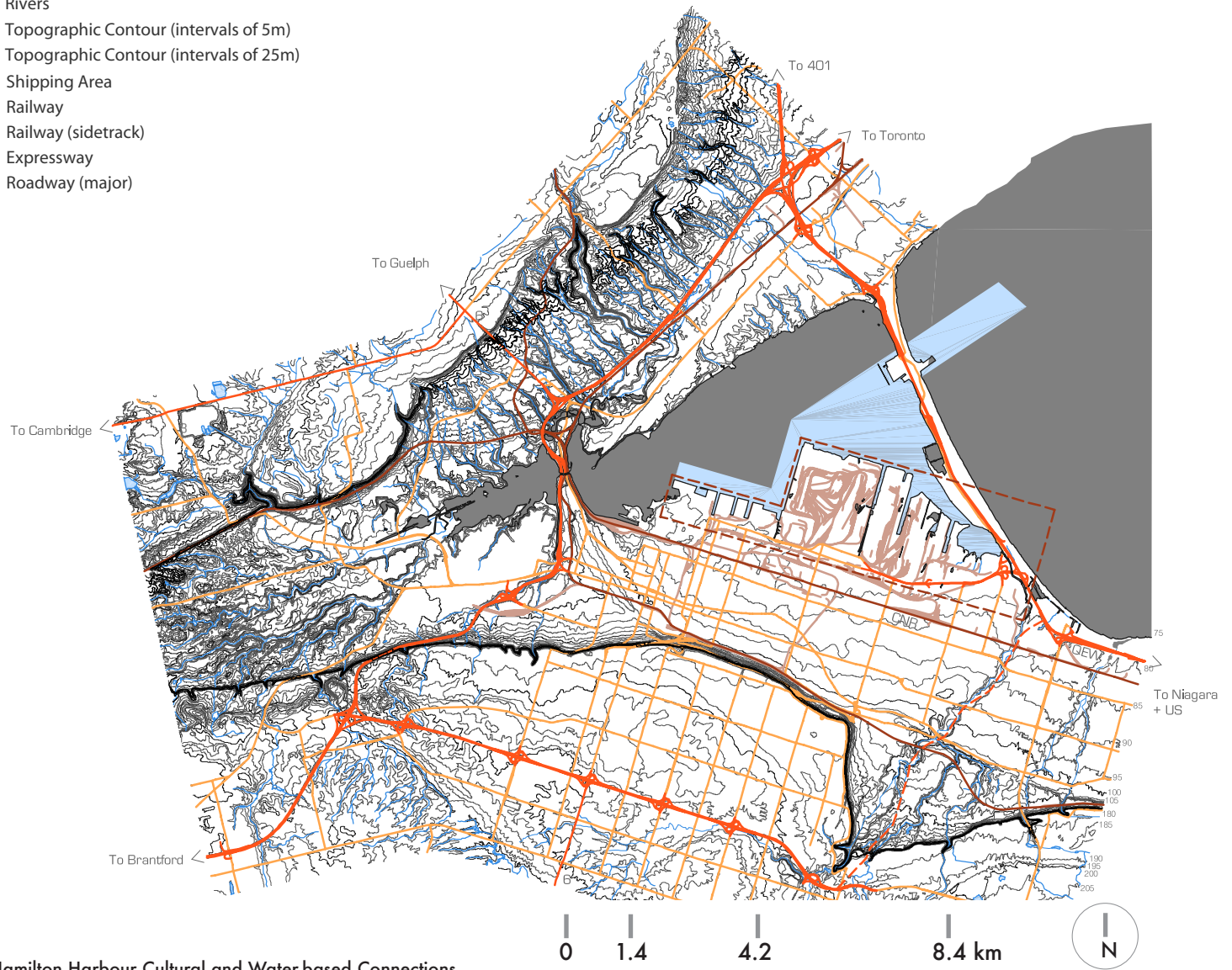
The harbour is located at the southeast corner of Lake Ontario, and fed by three primary watersheds, being Spencer Creek and Redhill Creek (under the Hamilton Conservation Authority), and Grindstone Creek (under Conservation Halton). This boundary further outlines the major municipalities of Hamilton, Burlington and Dundas, as well as portions of Ancaster, Flamborough, and Stoney Creek. Many of the local ecological cycles, systems and connections are affected by the form of the harbour's drainage basin, as habitation, migration patterns of wildlife, and the regional hydrological cycle, local ecology and microclimate are all tied to this unique terrain. Thus, observing the fluid processes of the region reveals the true interconnections that currently exist between natural and cultural systems, for the movement of water, air, wildlife and people all contribute to and define the interchanges and exchanges that make the waterfront system.⁷ Though not always perceivable, it is the dynamics of the harbour that have defined and continue to alter the shape, function and experience of the environment, as understood in the relationships between biological, climatic, and economic cycles, to name a few of the rhythmical processes of the region:

"While the rhythms and cycles which underlie the natural environment may take much longer to become visible to human eyes, they, none the less, make the physical landscape an active and vital one. Natural processes have had, and continue to have, a significant impact on the development of Hamilton and its region. Equally important, however, is human-induced change in the physical landscape. Natural rhythms in landscape evolution are often interrupted by human practices such as farming and urban development. The interruption can, in many cases, produce disastrous consequences. In the Hamilton area, the most urgent examples of human-induced environmental degradation are the pollution of the Great Lakes and the impacts of acid rain."⁸



1.15 | Hamilton Harbour Aerial
Grey tones indicate regions of urban and industrial development, shown to be directly adjacent to the shorelines, creating hard edges between water and land.

- Rivers
- Topographic Contour (intervals of 5m)
- Topographic Contour (intervals of 25m)
- Shipping Area
- Railway
- Railway (sidetrack)
- Expressway
- Roadway (major)



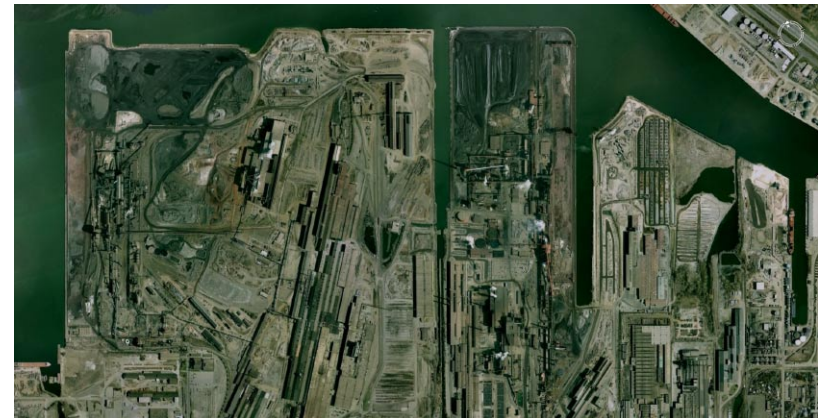
1.16 | Hamilton Harbour Cultural and Water-based Connections

Context of the Harbour

The geography, topography, and geology of the region is responsible for the propagation of both its ecological and industrial development, as the materials and land form of the region has supported its diverse use and modification. The harbour is situated at the base of the Niagara escarpment, wherein a range of rare and localized species of flora have grown into this unique topography. Below this, the city of Hamilton extend from the escarpments base into the harbour. Though the immediate area surrounding the bay supports this diversity of plant and wildlife species, the influx of human settlement has offset the region's ecology, as a result of the resource, recreation and industrial and shipping-based activities the harbour's geography and geology affords. As an intersection of diametrically repelling environments, Hamilton Harbour sets a tone of theatricality through its multiple layers of flows and activities created by the contrast of ecological and urban networks. Shaped as an immense amphitheatre facing the proscenium of the James N. Allan Skyway Bridge and the backdrop of the open Lake Ontario beyond, this is a place of juncture and juxtaposition. Still, there is the urge if not the mandate to align and reconcile these opposed worlds visible in the region, and bring about an amalgamation of contrast and harmony in this dramatic panorama. Shown here are some of the principle features and locations of the harbour, sharing the same dramatic topography, but somehow worlds apart.



1.17 | Hamilton's Steel Mills



1.18 | Hamilton's Steel Mills, Aerial



1.19 | Hamilton Harbour, Aerial



1.20 | Hamilton Harbour Panorama



1.21 | Lake Side Powerlines



1.23 | Woodward Avenue Wastewater Treatment Plant



1.22 | Lake Side Powerlines, Aerial



1.24 | Woodward Avenue Wastewater Treatment Plant, Aerial



1.25 | Cootes Paradise - A Reinstated Wetland



1.27 | Northeast Shoreline - Habitat Restoration



1.26 | Cootes Paradise - A Reinstated Wetland, Aerial



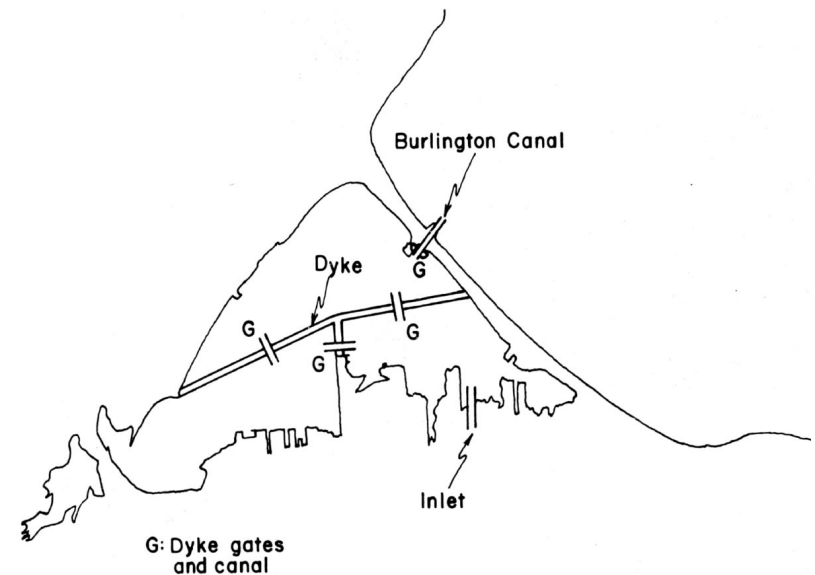
1.28 | Northeast Shoreline - Habitat Restoration, Aerial

Contaminating the Harbour

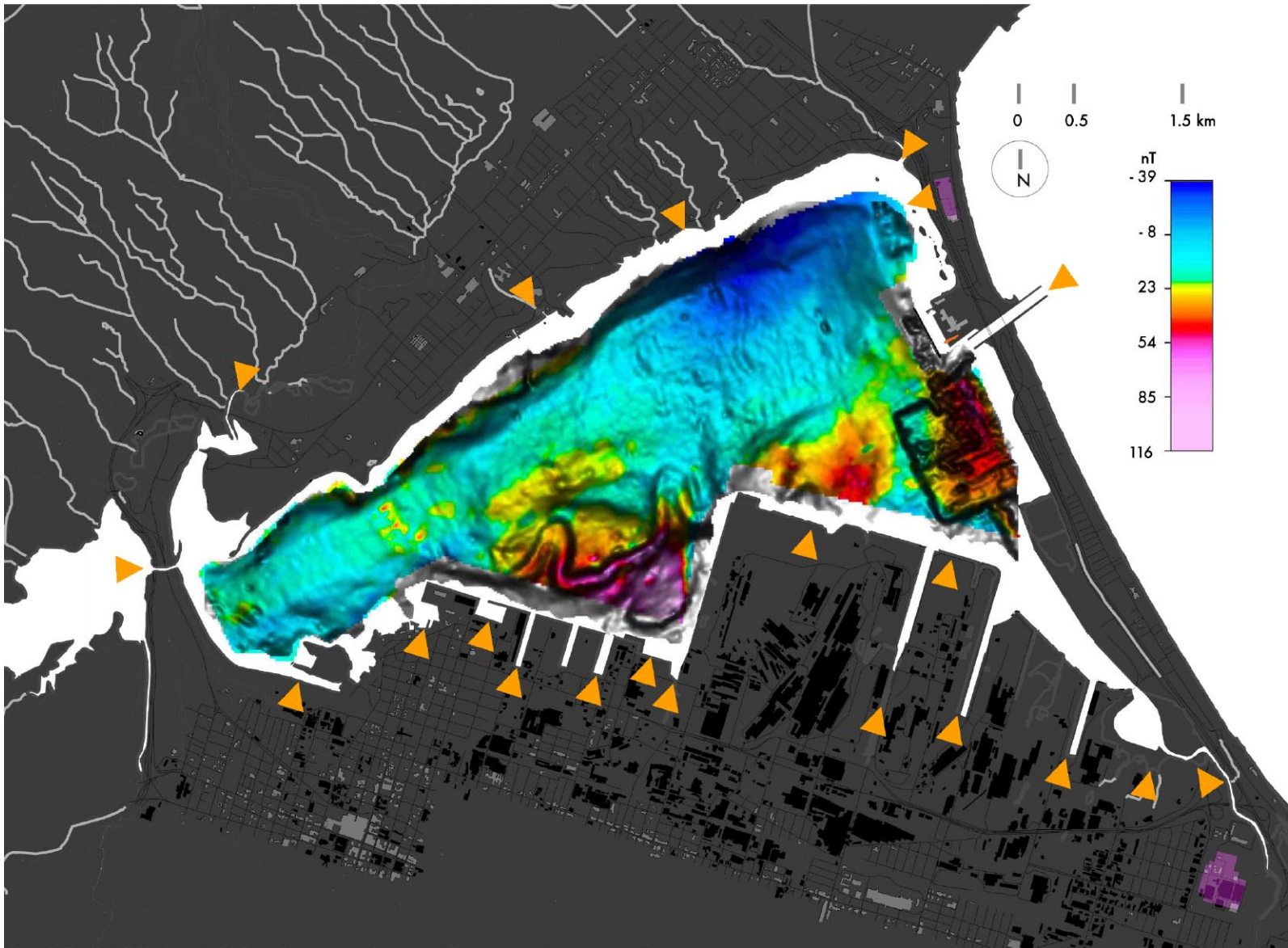
In 1987, the International Joint Commission listed Hamilton as one of the 17 Canadian ‘Areas of Concern’ (AOC) after failing to meet the objectives of the Great Lakes Water Quality agreement of 1978.⁹ From this concern the Remedial Action Plan for Hamilton Harbour (RAP) was constituted for the region. This project aims to improve the quality of the harbour environment utilizing an ecosystem approach for redevelopment and remediation, as well as instill a policy of zero discharge of persistent toxic substance into the harbour from the region’s extensive industry. The plan is then to establish sustainable communities¹⁰, and be delisted from as an AOC by the year 2015. Much of this work is related to ongoing improvements to wastewater treatment facilities, which in conjunction with combined sewer overflows, account for 50 percent of the flow into the harbour, and the remainder resulting from watershed runoff. This work is currently the most extensive in terms of time and funding, as it accounts for upwards of \$ 543 million of the \$ 650 million dedicated to the project from 2000 to 2015.¹¹ Combined with further initiatives of urbanization and land management, toxic substance and sediment remediation, fish and wildlife preservation as well as ongoing public access, education and information through research and monitoring, the RAP sets out to transform the region into an integrative holistic habitat.



1.29 | Hamilton’s Steel Mills at Dawn



1.30 | The Harbour as Waste Reactor
 A previous model from 1967 for transforming the bay to treat toxic effluent, compartmentalized by dikes, developed with the intent of the region internally and naturally adapting to the effluents from the industrial lands.



1.31 | Harbour Magnetic Imaging
 A magnetic scan of Hamilton Harbour reveals concentrations of materials, especially iron, correlating almost directly with the most toxic regions of the harbour, and the sources of pollutants.

Canada Centre for Inland Waters and the National Water Research Institute

The Canada Centre for Inland Waters (CCIW) home of the National Water Research Institute (NWRI) is Canada’s premiere location for the research and testing of water-based systems, both natural and human-made. It is located in Hamilton Harbour, aside the Skyway Bridge, connecting Burlington to Hamilton—a location that sites the facility between suburban development, industrial lands, remediated natural wetlands, and the open waters of Lake Ontario. This places the facility quite literally at the centre of many of the country’s leading environmental concerns, including the state and presence of the natural environment, industrial production and pollution, and natural reserves of fresh water. It is then fitting that the NWRI is also home to Canada’s Global Environmental Monitoring System for freshwater (GEMS/WATER) of the United Nations Environment Programme. This location, then, acts as an appropriate site to question the interactions we might have with both natural systems and technological systems, and further, our impact on the resources that support life.

Canada Centre for Inland Waters – Research and Services

ENVIRONMENT CANADA

National Water Research Institute

- Sustain water resources for future generations
- Scientific knowledge tapped “when the unanticipated arises”
- Emphasis on toxic chemical pollution and movements of contaminants among the air, land and water components within ecosystems

Lakes Research Branch

- Focus on environmental problems, toxic chemicals



1.32 | Hamilton Harbour and the CCIW
Indicated in red, the CCIW sits at a vantage point allowing it to observe the entire harbour that surrounds.



1.33 | CCIW Birdseye



1.34 | CCIW Facility



1.35 | CCIW Hydrology Labs

Rivers Research Branch

- Pollutants, hydraulics, ice dynamics

Research and Applications Branch

- Methods for sampling and chemical analysis
- Hydraulics lab
- Environment Canada, Government, Universities and Private interests

International Programmes Group

- Synthesize environmental data and environmental predictions
- GEMS/WATER
- UN and World Health Organization Collaborating Centre for Surface and Ground Water Quality

Research Support Division

Program Liason Unit

- Computing, drafting, library, financial services
- Links NWRI to public, media, universities, research institutes

Inland Water Directorate

- Ontario region, management and protection

Water Planning and Management Branch

- Connection to International Joint Commission
- Water quantity and lake level issues
- Water management under "Canada Water Act"

Water Resources Branch

- Network of stream flow, water level, and sediment stations
- Data Collection

Water Quality Branch

- Collects, interprets, disseminate information about the quality of surface water
- Federal interest
- State of the Environment Reporting

Canadian Wildlife Services

- Ontario wildlife management
- Monitor organochlorine levels, pesticides

National Laboratory for Environmental Testing – NLET

- Contracted work, chemical analysis
- Advanced techniques for measurement
- Robotics technology and other means of acquired the maximum amount of information from analysis

FISHERIES AND OCEANS

Bayfields Institute

- Fisheries research and management
- Hydrographic surveys, chart production, small craft harbours, ship support

Great Lakes Laboratory for Fisheries and Aquatic Sciences (GLLFAS)

- Research component

Ecotoxicology Division

- "Ultra Trace Laboratory" to analyze priority persistent organic contaminants present in regional lakes biota

Fish Habitat Studies Division

- Factors affecting fish production
- Nutrients, phytoplankton and zooplankton interactions in whole lake ecosystems

Fisheries and Habitat Management

- Federal Policy, liason with Ontario Ministry of Natural Resources

Canadian Hydrographic Services

- Nautical charts and related publications

Chart Production Division

- Maintains over 200 nautical charts for the region

Field Surveys Division

- Collects data for chart production

Development Division: Tides, Current and Water Levels Division and Technical Services Division

- Network of gauging stations



1.36 | CCIW at Dawn



1.37 | CCIW Aerial



1.38 | James N. Allan Skyway Bridge



1.39 | Burlington Canal Lift Bridge

Ship Division

- Fleet of 3 major ships, 45 large launches and 52 smaller boats

Small Craft Harbours

- Manage 500 + federal recreation and commercial fishing harbour facilities in Ontario, Manitoba, Saskatchewan, Alberta and the North West Territories

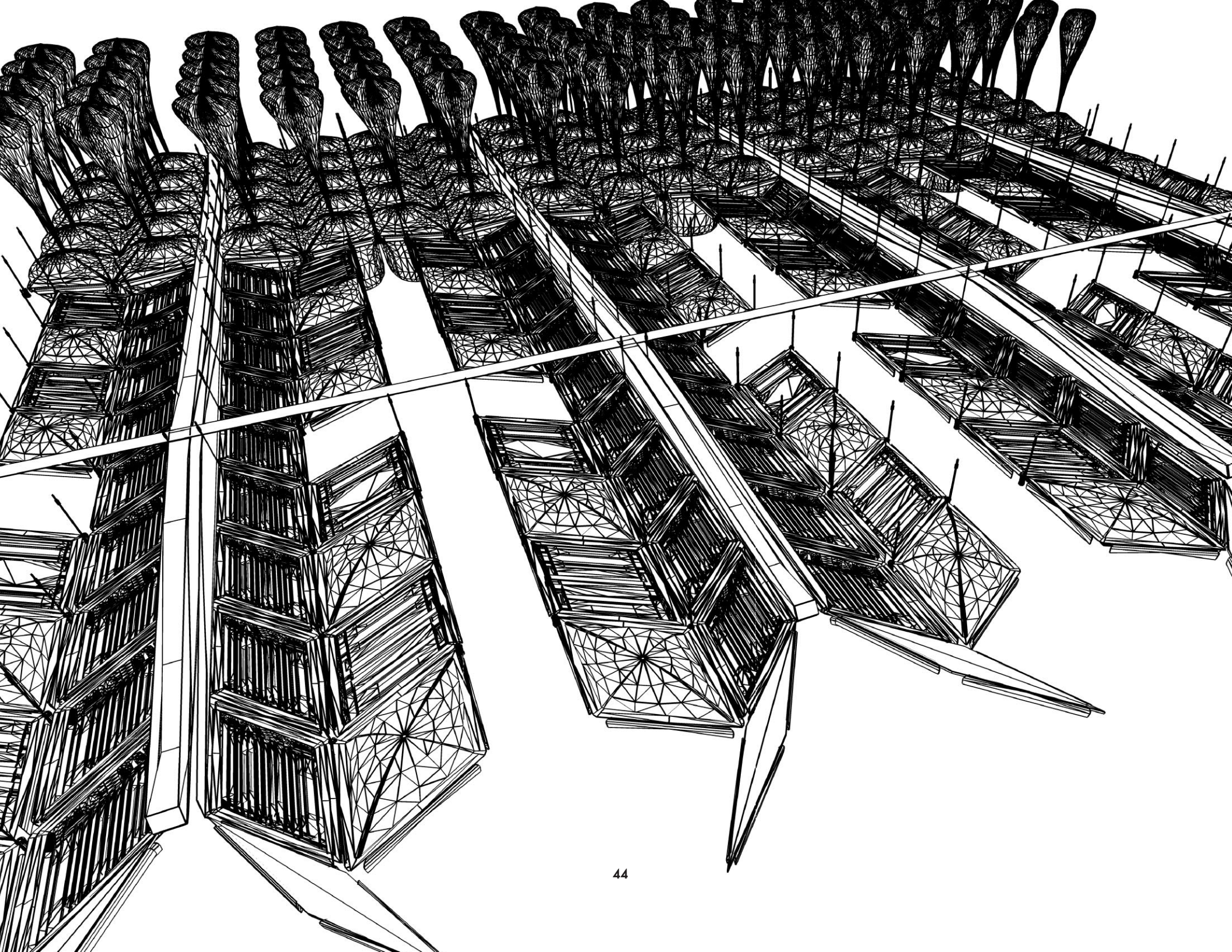
Property Management Section

- Leases and licenses, supervising harbour managers

Program Planning and Implementation Section

- Construction, maintenance and dredging for safe use by fishermen and boaters
 - Anticipatory planning of harbour development and maintenance facilities

1. John Todd and Nancy Todd, *From Eco-Cities to Living Machines: Principles of Ecological Design* (Berkeley, Calif.: North Atlantic Books, 1994), xvi.
2. *Water and Canada: Preserving a Legacy for People and the Environment* (Ottawa: Government of Canada, 2003), 1.
3. "H2Ontario," *The Globe and Mail*, June 27, 2007, sec. C.
4. *Water and Canada*, Government of Canada, 9.
5. "H2Ontario," *The Globe and Mail*.
6. Leland Thomas Dadson, "Instrumental Matrix: Regenerative Systems in Hamilton, Ontario," (master's thesis, University of Waterloo, 2005), 3.
7. *Ibid.*, 36.
8. Michael J. Dear and J. J. Drake and L. G. Reeds, eds., *Steel City: Hamilton and Region* (Toronto: University of Toronto Press, 1987), 4.
9. *Hamilton Harbour Remedial Action Plan: Stage 2 Update 2002 Summary*. (Hamilton, Ontario: Hamilton Harbour RAP Office, 2003), 4.
10. *Ibid.*, 3.
11. *Ibid.*, 21.

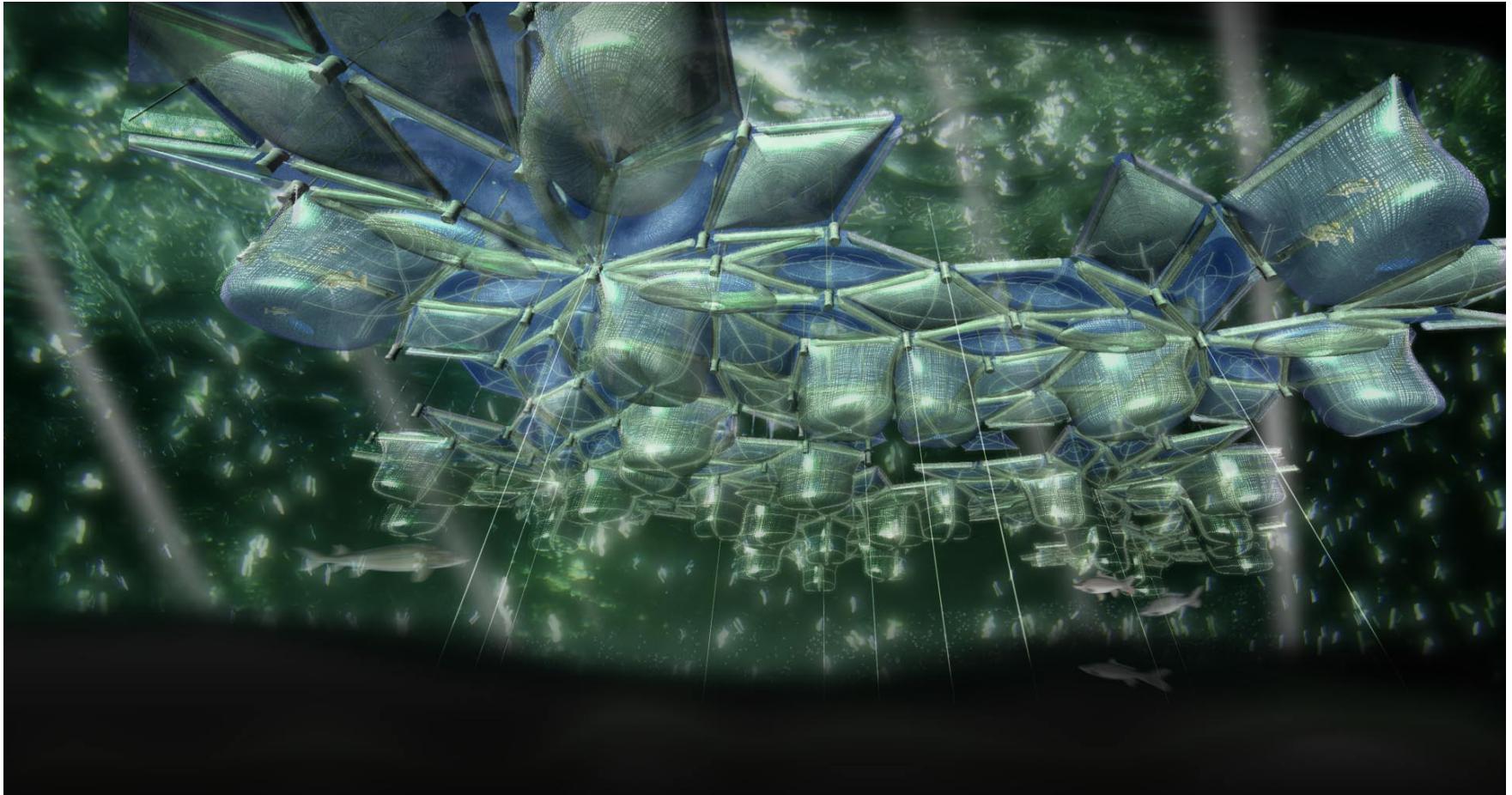


Hybrid Fields

“We have now become aware of the possibility of arranging the entire human environment as a work of art, as a teaching machine designed to maximize perception and to make everyday learning a process of discovery. Application of this knowledge would be the equivalent of a thermostat controlling room temperature. It would seem only reasonable to extend such controls to all the sensory thresholds of our being.”¹

—Marshall McLuhan, *The Medium is the Massage*

The development of the Interpretive Centre and responsive cellular constructed wetlands, or Hybrid Fields, is manifest from the theoretical and design precedents of hybrid natural and technological systems that allow greater connectivity between these systems and the inhabitant or cultures occupying these combined landscapes. The Interpretive Centre, on the site of the NWRI, is to house interpretive displays as well as an interactive computerized game projected within the facility, acting as an organization system for the arrangement of the bio-remediative wetlands that stretch across the waters below the bridge. These wetlands functions as wildlife habitats and a bio-filtration system to handle some of the water-based effluent from the industrial sites to the south. The game will run in parallel to other programs within the NWRI, utilized for both the monitoring and development of the function and geometric organization of the wetland cells. Through the co-operative development of these programs, visitors and scientists will be able to better understand the functioning of the wetlands, and develop a body of knowledge and theory surrounding the interaction of the natural and synthetic systems at work. Further, these integrated computer programs will assist with the arrangement and future configurations of the cells themselves, such that users are informed by the data relayed from the Hybrid Fields, as well as the direct experience of these landscapes. As such, the combined Hybrid Fields and new facilities of the NWRI suggest an intelligent and responsive model for the continuous integrative observation, design and transformation of the environment.



2.1 | Hybrid Fields, Below Water



2.2 | Hybrid Fields, Above Water

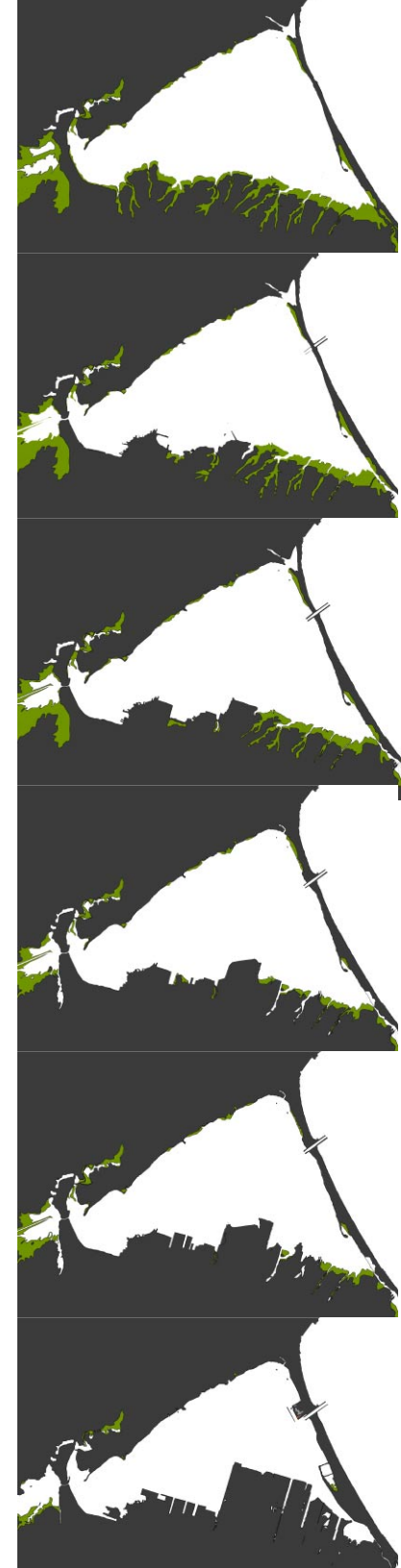
Hamilton Harbour | Shoreline Development

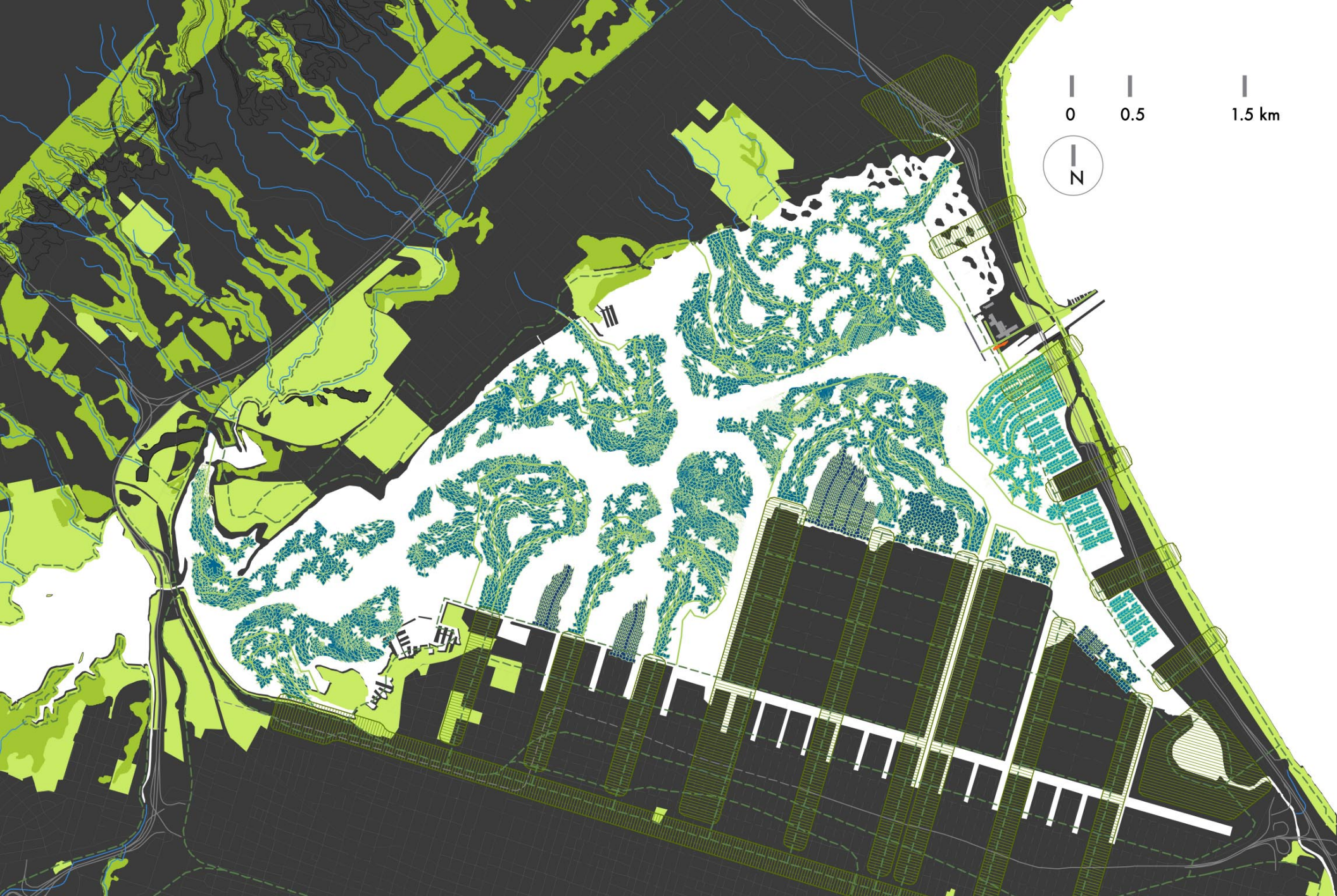
The development and expansion of the Hybrid Fields is to emanate from Leland Dadson's design proposition for a redevelopment of Hamilton's harbour and industrial lands' infrastructure; the Instrumental Matrix. In as much as the Hybrid Fields physically emerge from the framework the Instrumental Matrix provides, so too does it grow from a similar foundation of hybridization and integrative interaction of cultural and natural systems. Relating directly to the Lanscope's evolution, Dadson describes the climatic state to be achieved through the succession of his own design:

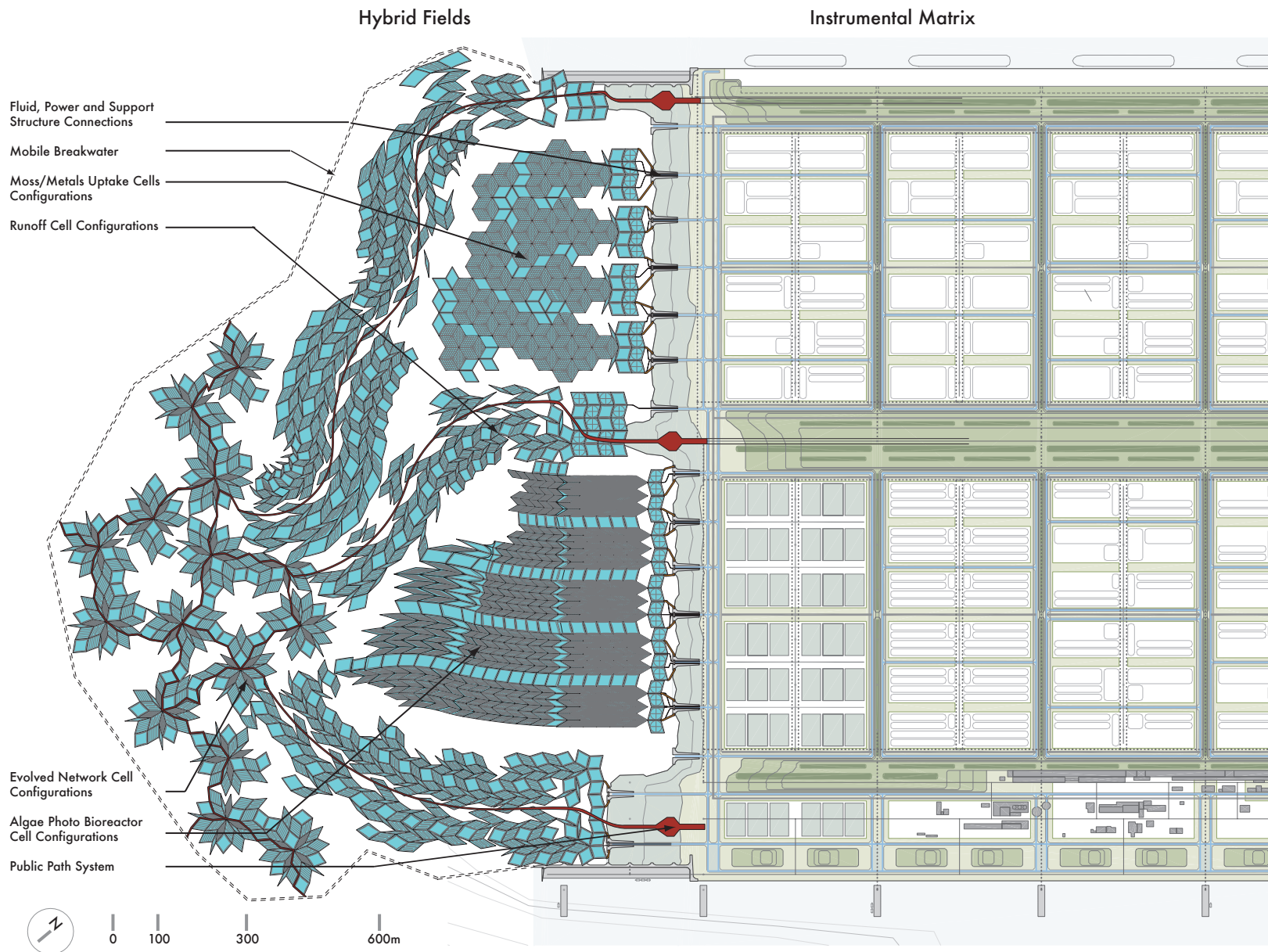
"This thesis proposes an urban framework for Hamilton in which human, industrial and natural process can coexist in close proximity. Once developed, the city could serve as a model for sustainable urban habitation in which material and energy cycles must be 'closed' and self-sustaining. The specific arrangements proposed in this study suggest that potentially detrimental activities such as waste production and heavy industrial manufacturing need not be pushed to the periphery of society. This model does, however, require restrictions in that all actions must contribute positively to local and regional ecosystems. Ultimately, this recasting of industry could suggest new possibilities for human sustainability in a symbiosis between city 'wild' and natural 'wild'."

2.3 - 2.9 | Hybrid Fields Harbour Development

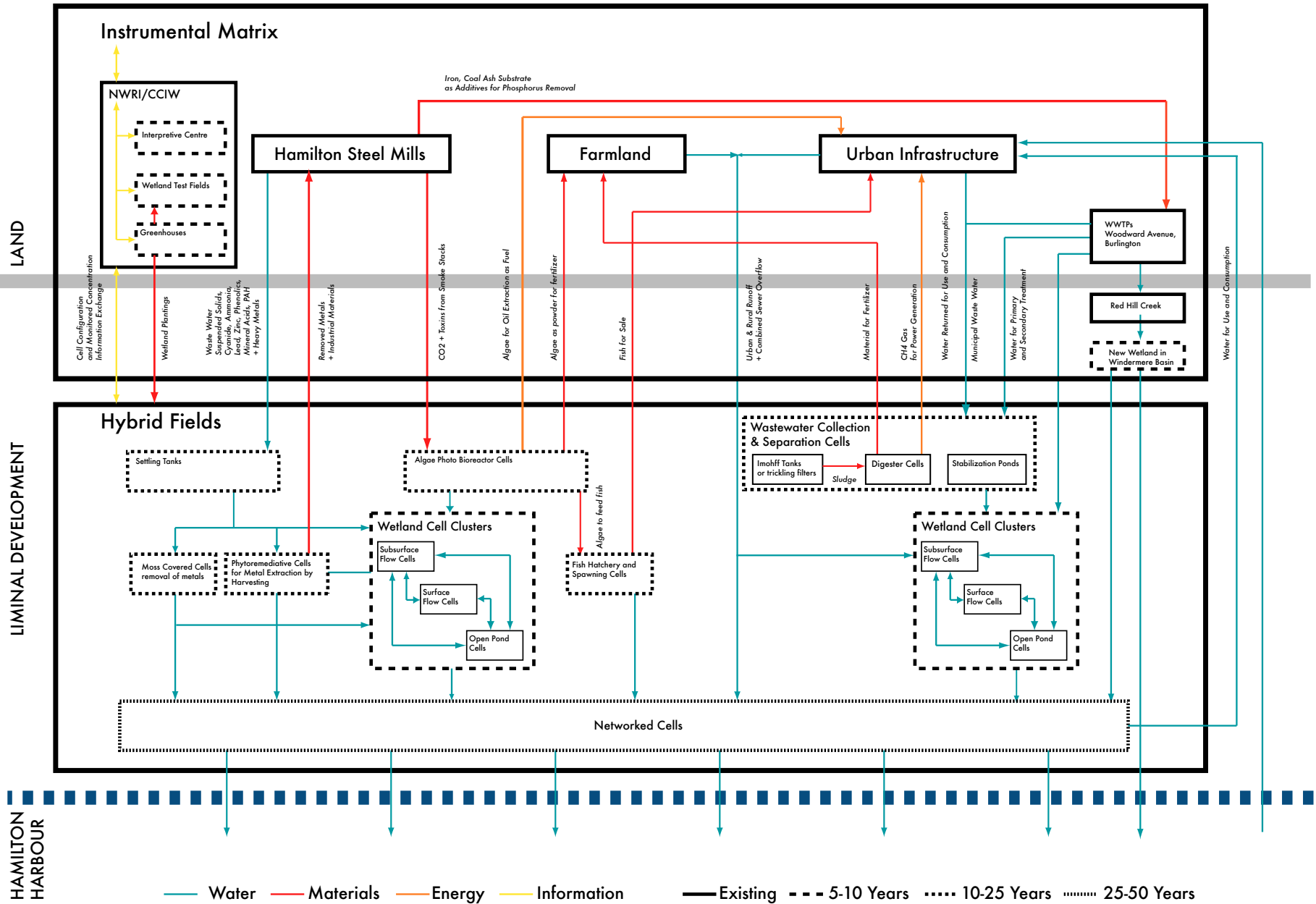
The sequential evolution of the shoreline in Hamilton Harbour, viewed as snapshots from 1840, 1909, 1923, 1938, 1952, present day, and the proposed future development (opposite page) utilizing the Instrumental Matrix as an infrastructure for the Hybrid Fields spreading throughout the harbour.



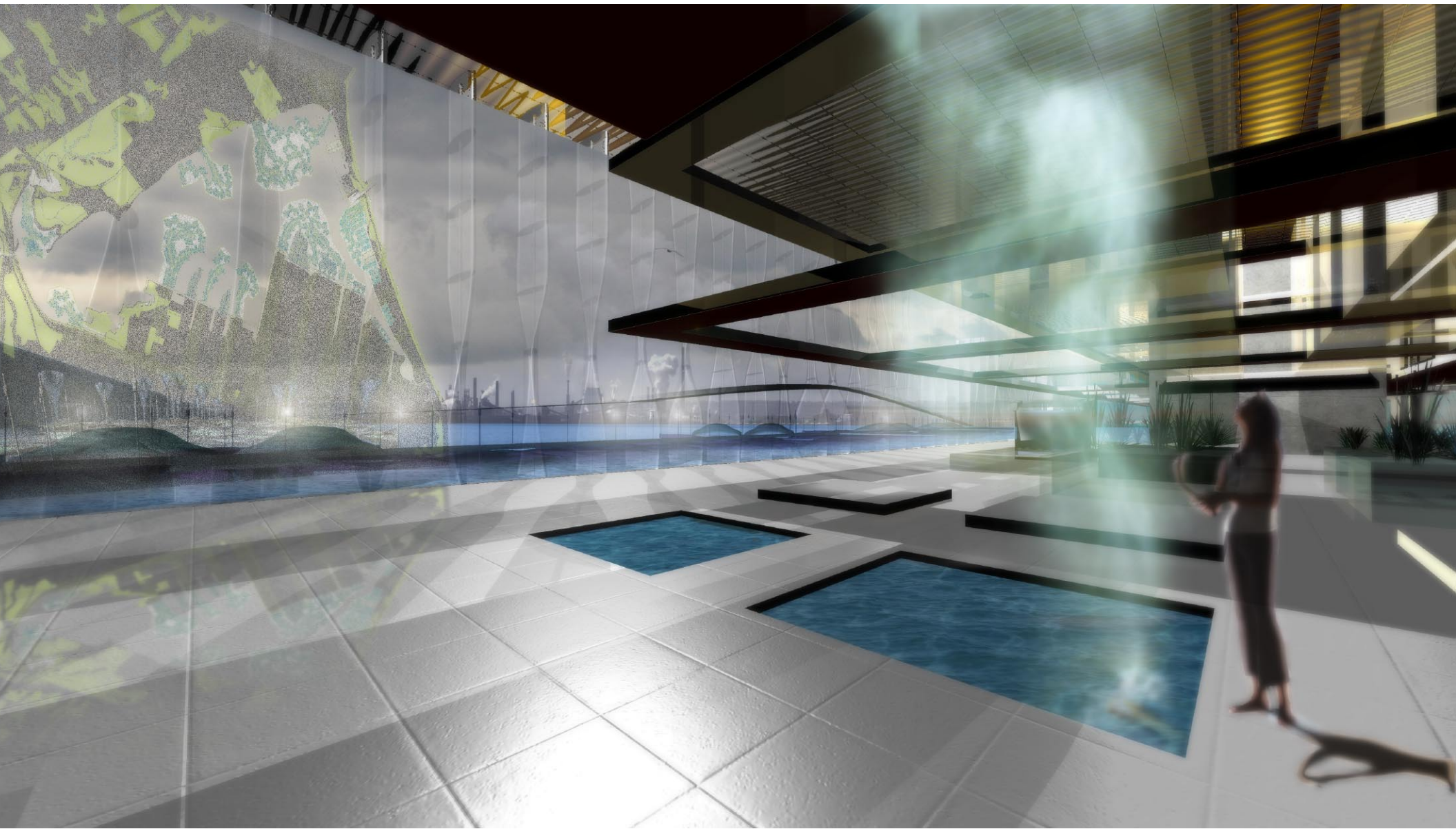




2.10 | Hybrid Fields and Instrumental Matrix, Stelco Pier Plan
The water-based network of the Instrumental Matrix connects to the Hybrid Field cells extending from the pier into the harbour.



2.11 | Hybrid Fields and Instrumental Matrix, Flow Diagram
 The Hybrid Fields act as a filter and connector between land and open water.



“Projections are not in relation to the real, but anticipate the real.”³

–Jean Baudrillard, *Simulacra and Simulation*

Building | Project and Projection

The Landscape’s Interpretive Centre is a place to explore and experience the interconnections that exist between ourselves, our local environment and the entire biosphere. An experience of both temporal and spatial scales is to be conveyed through the exhibits and the projected Hybrid Field cellular tiling game, making evident the connections between our actions, global transformation, chemical processes, and the stability or instability of ecological and cultural habitats. The facility houses interpretive public programming for visitors to the NWRI. Conceived as a series of spatial and visual layers, the Interpretive Centre becomes a transitional zone between the CCIW and the adjacent Hybrid Fields. An arrayed network of displays occupies the majority of the building, providing a means of informing visitors of the operations and research of the NWRI as well as the larger environmental and cultural context connected to the harbour, and further, the water-based systems connected to this expanded environment. This matrix of artwork, research and information allows visitors to see across the display, to make personal interpretations about the relationships to the surrounding environs. This system of displays hovers above segmented installations of fluid phenomena and natural water-based systems. Both areas allow a view to the large interactive illuminated translucent wall, displaying information about the operation and function of the Hybrid Fields and the evolving responsive game that allows visitors to test wetland cell configurations for themselves. Beyond this glazed face are the test-scale versions of the Hybrid Fields, with the functioning constructed wetland system visible in the distance, in front of Hamilton’s industrial harbour. Overlooking the panorama of the harbour itself is the Interpretive Centre’s theatre, in which the culminating interpretations of these layers of information and installations may come together in lectures and performances.

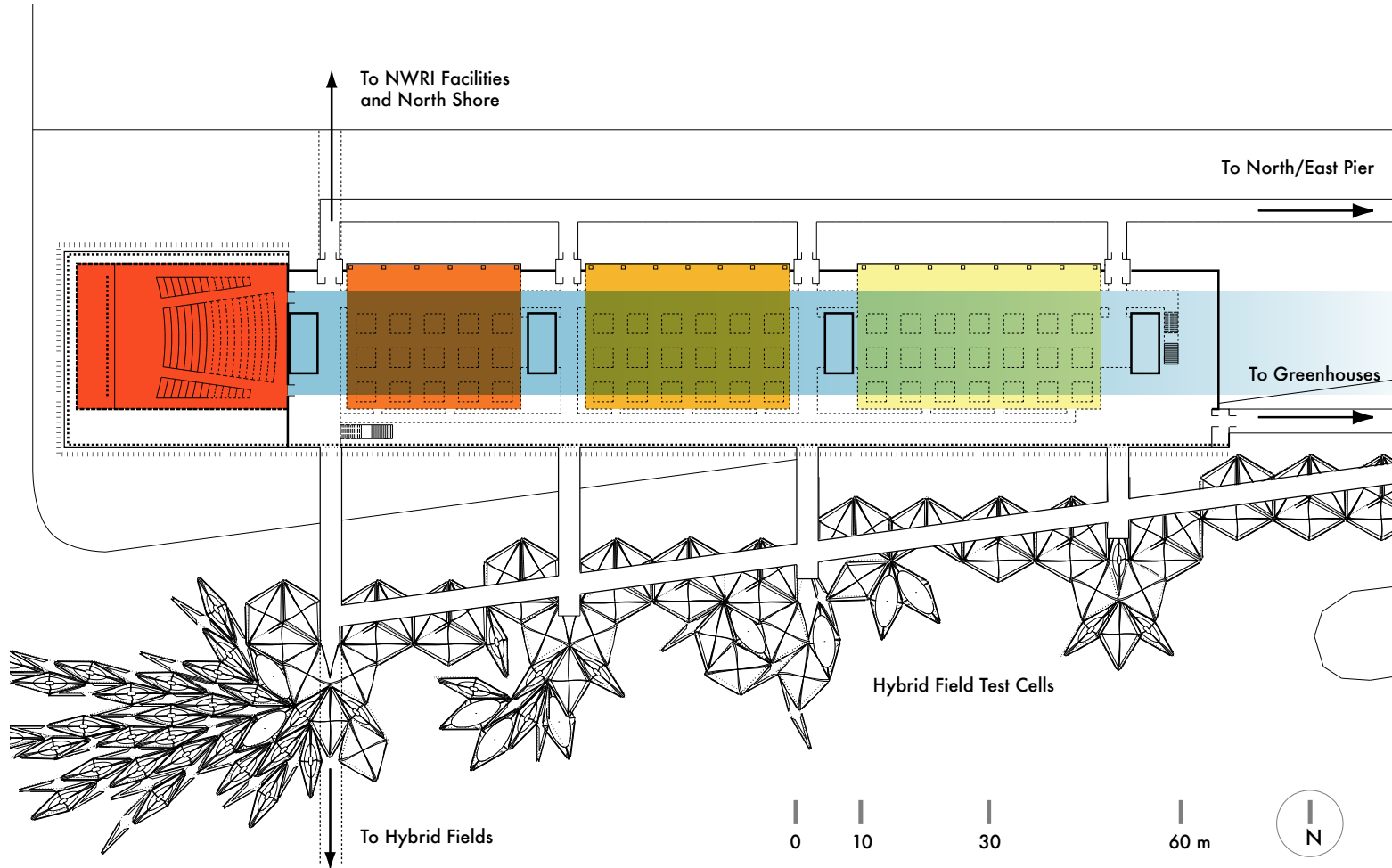
Theatre:
Lectures, Displays
and Performances

**Projected
Landscape:**
Testing and
Transformation of
the Hybrid Fields

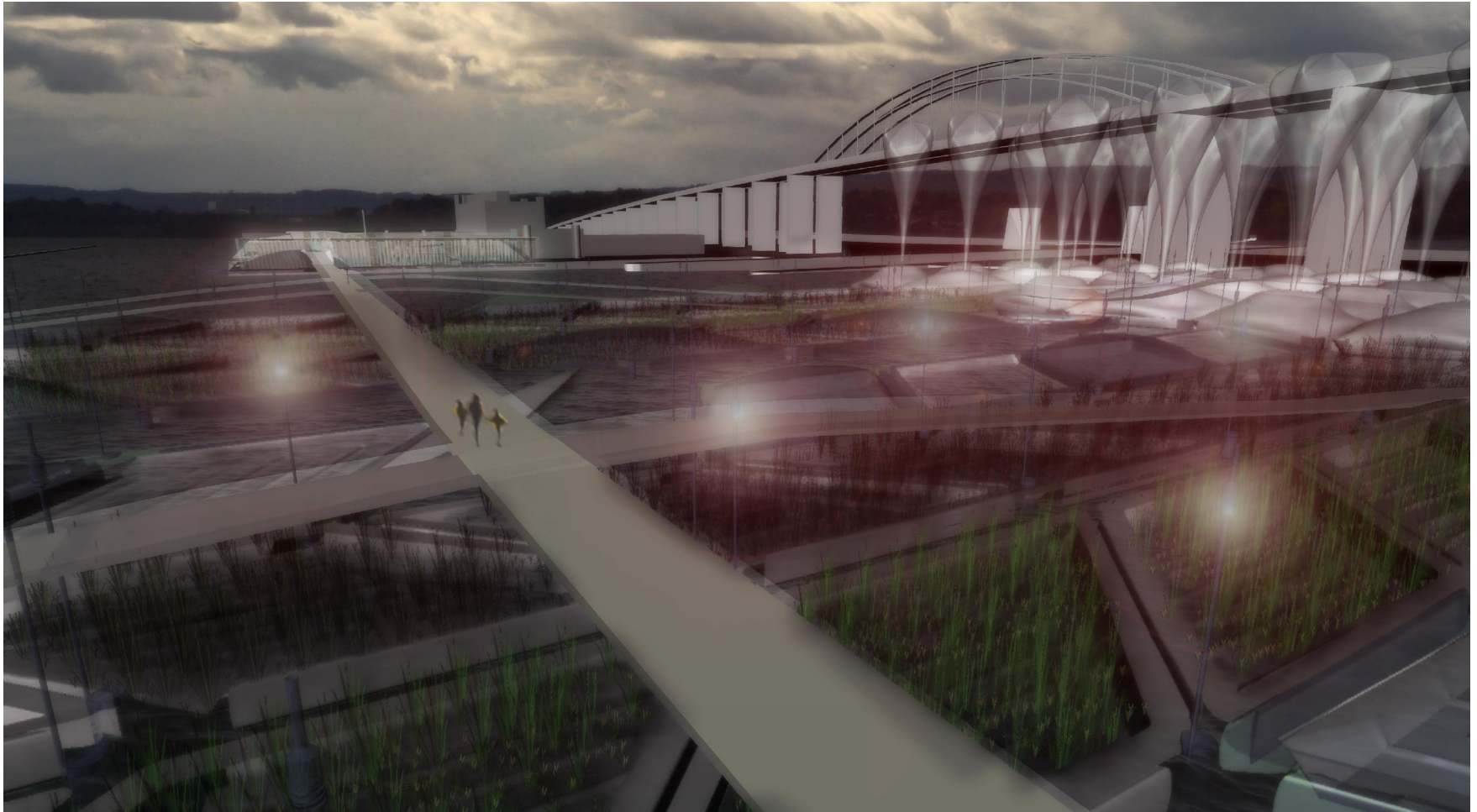
**Monitored
Landscape:**
The Hybrid Fields,
Connections to the
Environment

NWRI/CCIW:
Research and
Environmental
Initiatives in the Region

Water:
Phenomena, Natural
and Technological
Systems (Ground Floor)



2.13 | Interpretive Centre, Conceptual Programmatic Plan



2.14 | Hybrid Fields, Facing North to the Interpretive Centre
An overarching system of paths connects to the NWRI and Hybrid Fields while rising and dipping to provide both panoramic views and perspectives into and below the cells.





2.15 | CCIW Key Plan

An early developmental stage of the Hybrid Fields emerging from the existing harbour conditions, during which the NWRI Interpretive Centre and test facilities play a vital role in the organization and proliferation of the wetland cells.

2.16 | CCIW Site Plan

Filtered water flows through both test-scaled and full sized Hybrid Fields, mixing with the harbour's currents and becomes part of the fluid exchange in the canal between the harbour and Lake Ontario.

Site

The Landscape's building project is sited adjacent to the Skyway bridge, on the thin sand bar separating Hamilton Harbour from Lake Ontario. This locates the project between some of Canada's most intensive industrial lands, as with the steel mills to the south, and the rehabilitated natural wetlands the north-west. At this location stands the Canada Centre for Inland Waters, home to the National Water Research Institute. This facility is part of a large network of global operations and systems monitoring the environment, in this case focused on the connectivity that exists between water, ourselves, and the natural environment. The Interpretive Centre overlooks the canal connecting the harbour to Lake Ontario, on the southern edge of the CCIWs pier. The area is highly active with terrestrial and marine activity alike; a location ideal for observation of the surrounding environment. The Interpretive Centre then fittingly looks out to the panoramic vista of water, industry, natural features and the hybrid fields to which it is connected, while housing related and co-dependent examples of ecosystems and fluid phenomena in the interpretive spaces of the building. Alongside the facility are connecting bridges and paths traversing the test-scaled Hybrid Fields, as well as connecting across the canal, to the developing constructed wetlands. A further path reaches eastward to the pier stretching into Lake Ontario on the other side of the bridge, projecting the scope of the project outward to the Great Lakes.



Lake Ontario

Climate and Wind
Monitoring Station

Electric Power
Transmission Lines

Burlington Canal
Lift Bridge

2.17 | Harbour Canal Section, Facing South



Skyway Bridge

Hybrid Field Digester
and Methane Extraction Cells

Hybrid Field Wetland Cells
and Hamilton Harbour

0

25

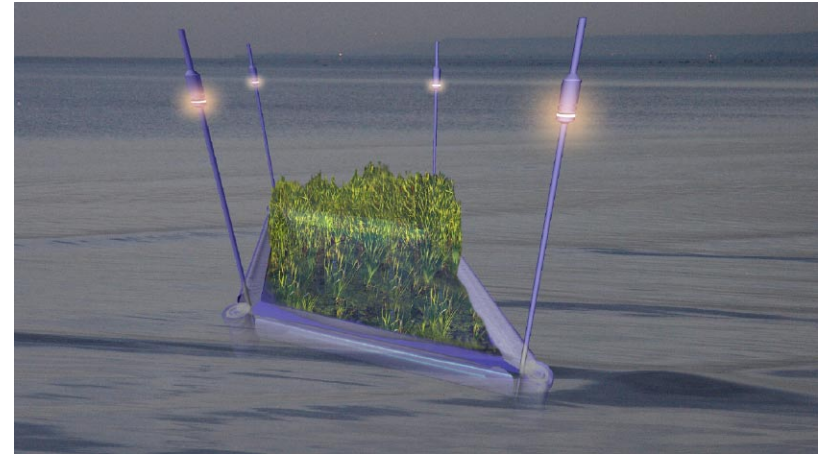
75

150 m

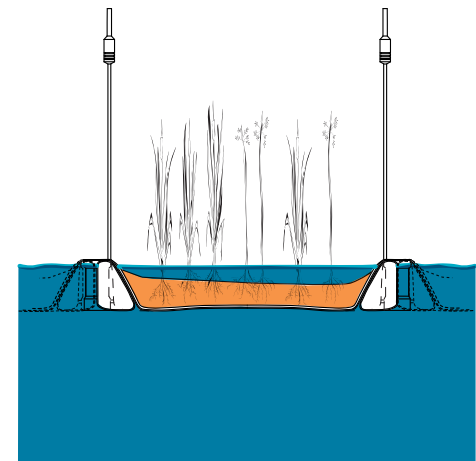
Cellular System

The system of constructed wetlands is not to be immediate or permanent, but is to evolve and grow. Based on a system of rhombic tessellations, the fields involve 5 diamond forms allowing for a multitude of cellular types, ranging from imhoff and settling tanks, to cells for methane gas extraction, as well as anaerobic and aerobic wetlands. Together, these cells pattern to give varying configurations as well as a varied topography. Configurations are then to be tested and scaled up at the newly proposed facilities, while the large scale constructed wetlands are to provide monitored feedback, therein allowing for a reflexive relationship between the scales of the environment, and its design

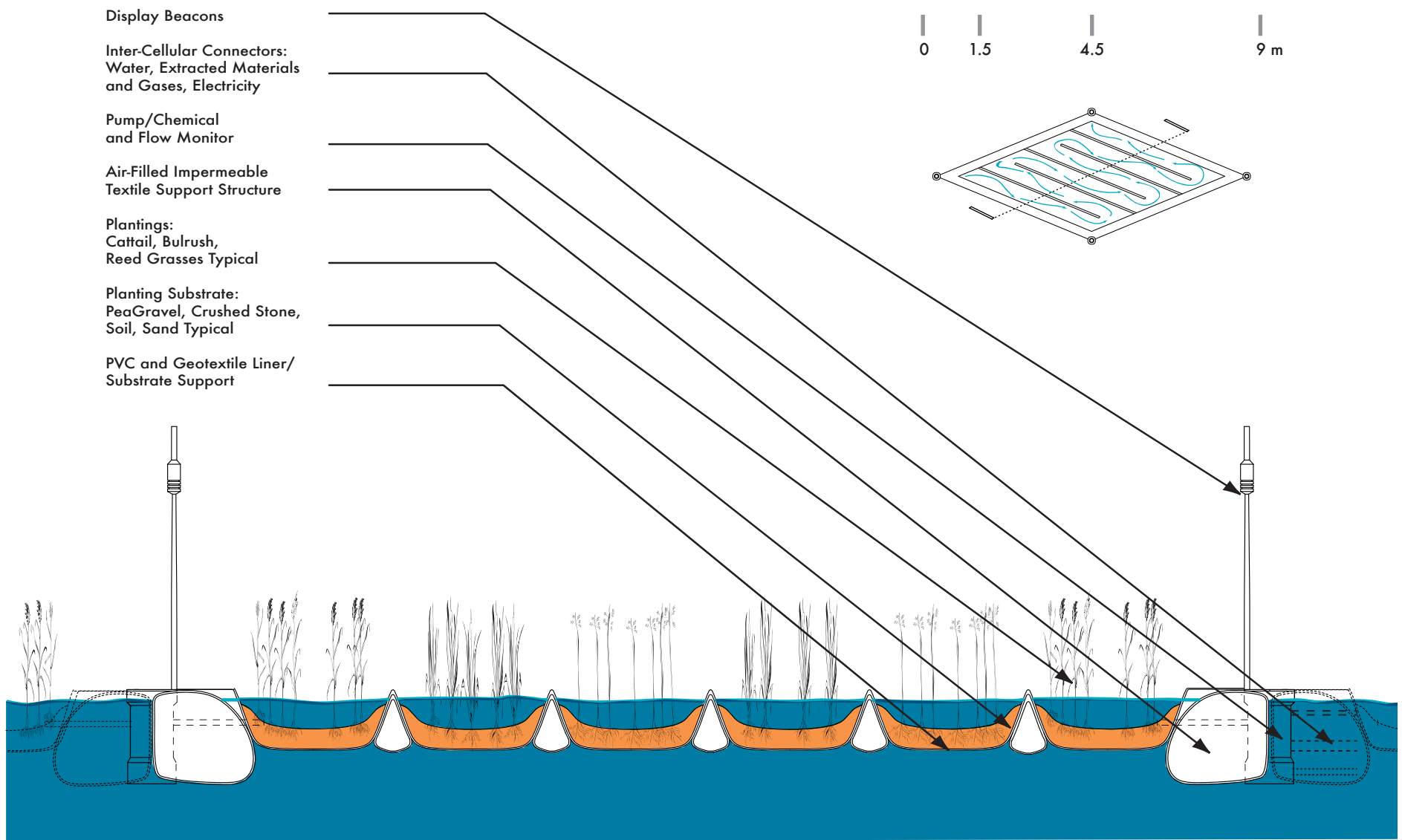
The particular form of these cells, being sheared squares in plan, firstly provides a simple and rational means of developing the interior structure of the cells, such as with varying circulation patterns, but further provides a system for the construction of complex networks. Within in these amalgamated structures, transfers of materials can occur in multiple directions across the system, and large numbers of cells can converge into more specially arranged conglomerations for specific treatment needs. Observable here is a typical single wetland cell of which large conglomerates are formed. Each unit can be removed or repositioned, and connects to other cells via the connecting nodes at the corners, capable of supporting solar-powered pumps, and monitoring systems for relaying information about water flow and concentrations of both toxic and benign substances, including suspended solids, nutrients, pathogens, metals, and other substances. Also, the conditions of the environments within the cells are monitored, as they are deduced through common methods of testing biological oxygen demand (BOD) and chemical oxygen demand (COD). This information is both collected at the proposed facility at the NWRI, as well as displayed publicly through illuminating beacons. The information is in turn used to inform the modifications of the rules of a computerized tiling programs used by visitors and scientists of the research centre to test the organization and operation of the cells.



2.18 | Typical Wetland Cell, Perspective



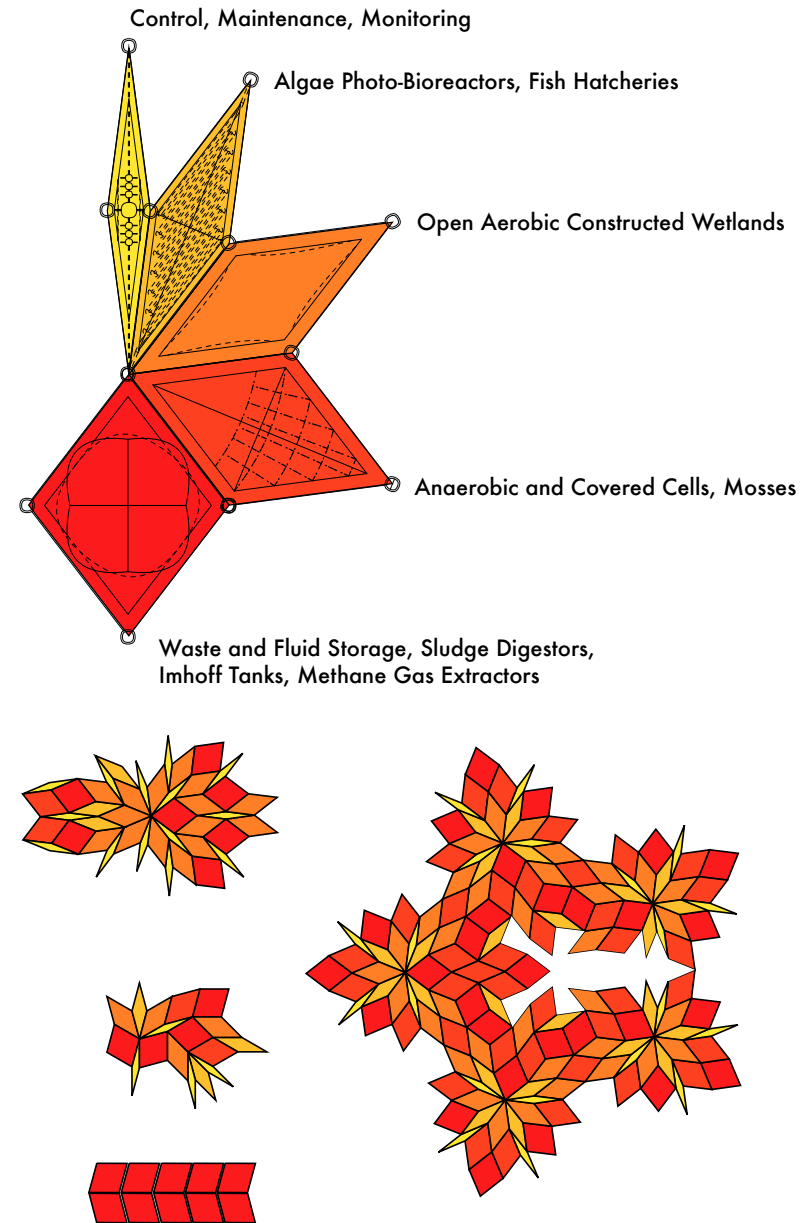
2.19 | Hybrid Field, Test-Scale Cell Section

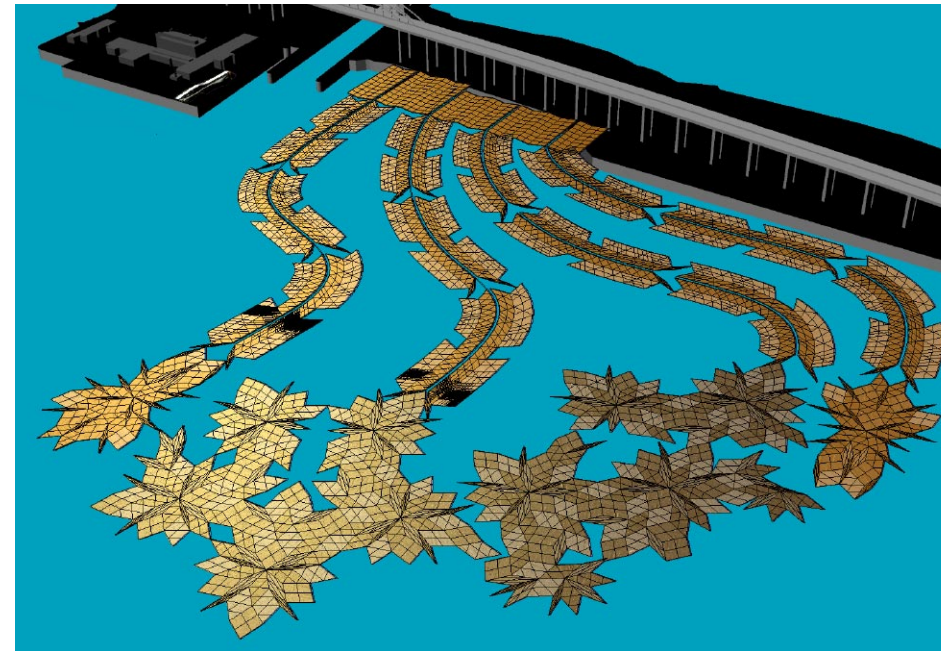
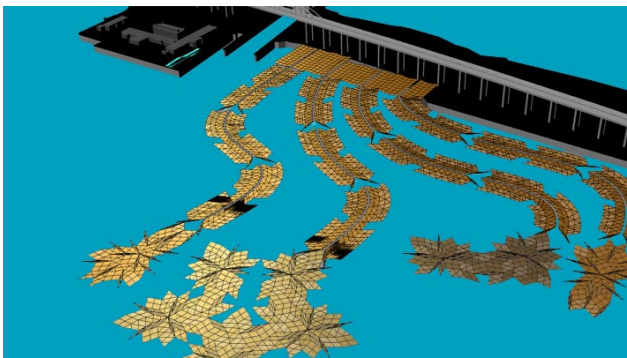
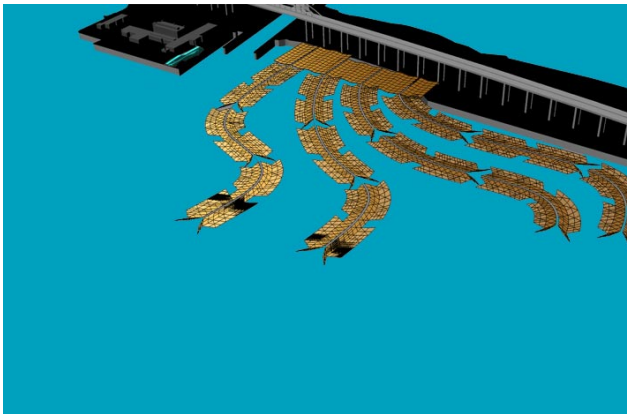
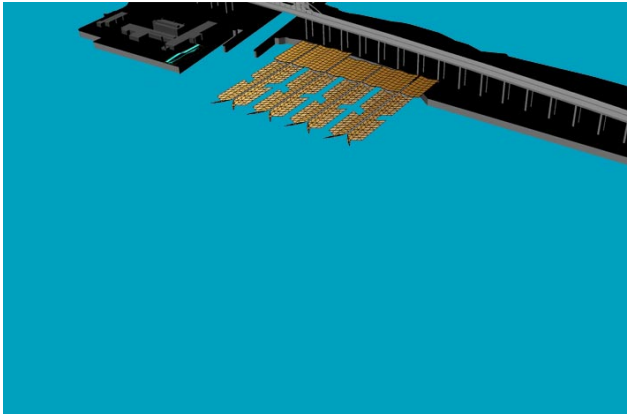
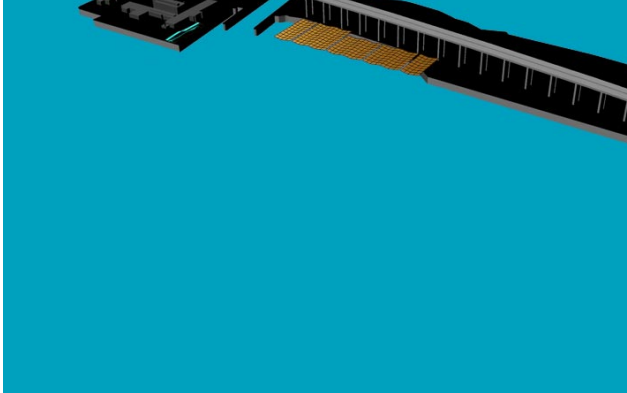


2.20 | Hybrid Field, Full-Scale Cell Section

Programming the Landscape | Cellular Tesselations

The Interpretive Centre collects data from Hybrid Fields of synthetic floating constructed wetlands and wastewater treatment facilities, within which, monitored information about water flow and concentrations of chemicals are to be reinterpreted by scientists at the NWRI and visitors alike. The Interpretive Centre is to house a computer program playable as a game by visitors to the facility that parallels the programs used by scientists of the NWRI as it relates to the geometric formation and ecological function of the Hybrid Fields. Specifically, it is a tiling game, using multiples of 5 rhomboid shapes (with smaller angles of 15°, 30°, 45°, 60° and 75° respectively) based on similar forms found within the proposed landscape design. Players will arrange the tiles in a pattern of their choosing using the shapes provided. A score will be generated from these arrangements according to the level of difference between adjacent cells. As such, a score of 1 is given to two adjacent tiles of the same shape, while a 15° beside a 75° tile will yield the highest score of 5, with other scores being generated by those combinations in between. The initial aim of this rule set is to encourage variety in the patterns themselves. Players' iterations of patterns can be saved and viewed again, thereby giving the means to compare the scores given, as well as evaluate the aesthetic and organizational qualities of these arrangements, including their symmetries and asymmetries, repetitions and other emergent patterns not initially perceived by the players. Further, more complex rule sets to be later developed and applied to the game based on the data collected from the constructed wetland cells. Through the parallel experiences of the 'real' constructed wetlands, the data collected from their cells, and the generation of patterns of these cells within the proposed game, the Landscape is to provide a meeting point for the way in which visitors and scientists experience and modify place and nature. To this end, a co-operative system of environmental design could evolve from the overall complex, as evolution, cognition, and creativity transpire both naturally and artificially.

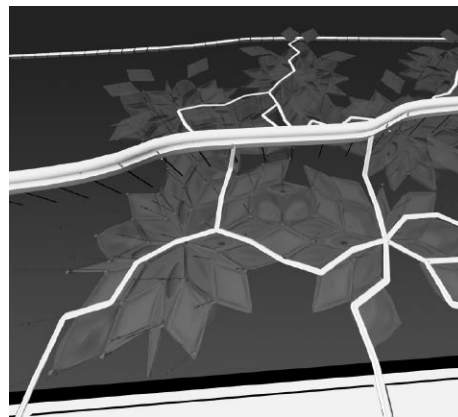
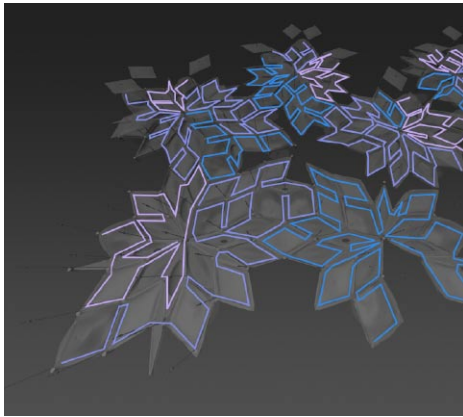
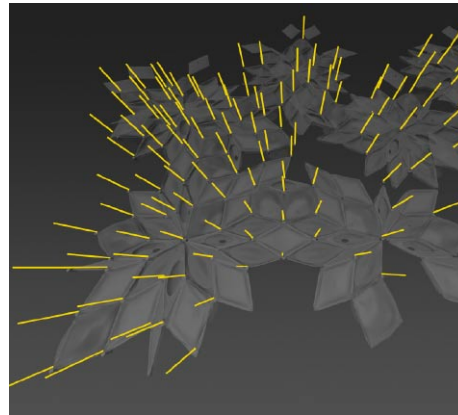
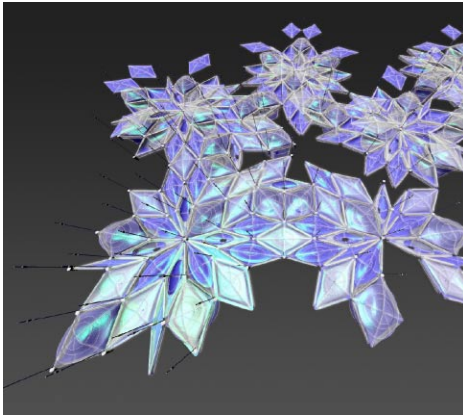
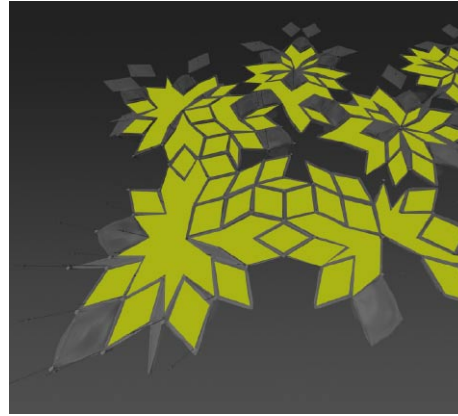
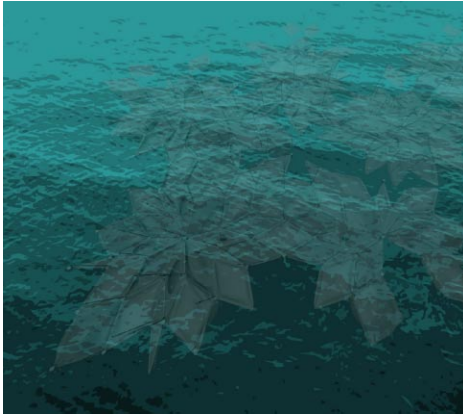




2.21 - 2.25 | Wetland Evolution

As the fields are developed by an interaction between monitored information and the resulting decisions made for the alteration of individual cells and their configurations, both consciously and generatively, new forms and patterns might emerge and evolve within these hybrid landscapes. Shown here is an evolution from configurations of cells supporting typical linear processes found in constructed wetlands, gradually reforming into networked configurations, connecting multiple flows to a larger conglomerate structure.

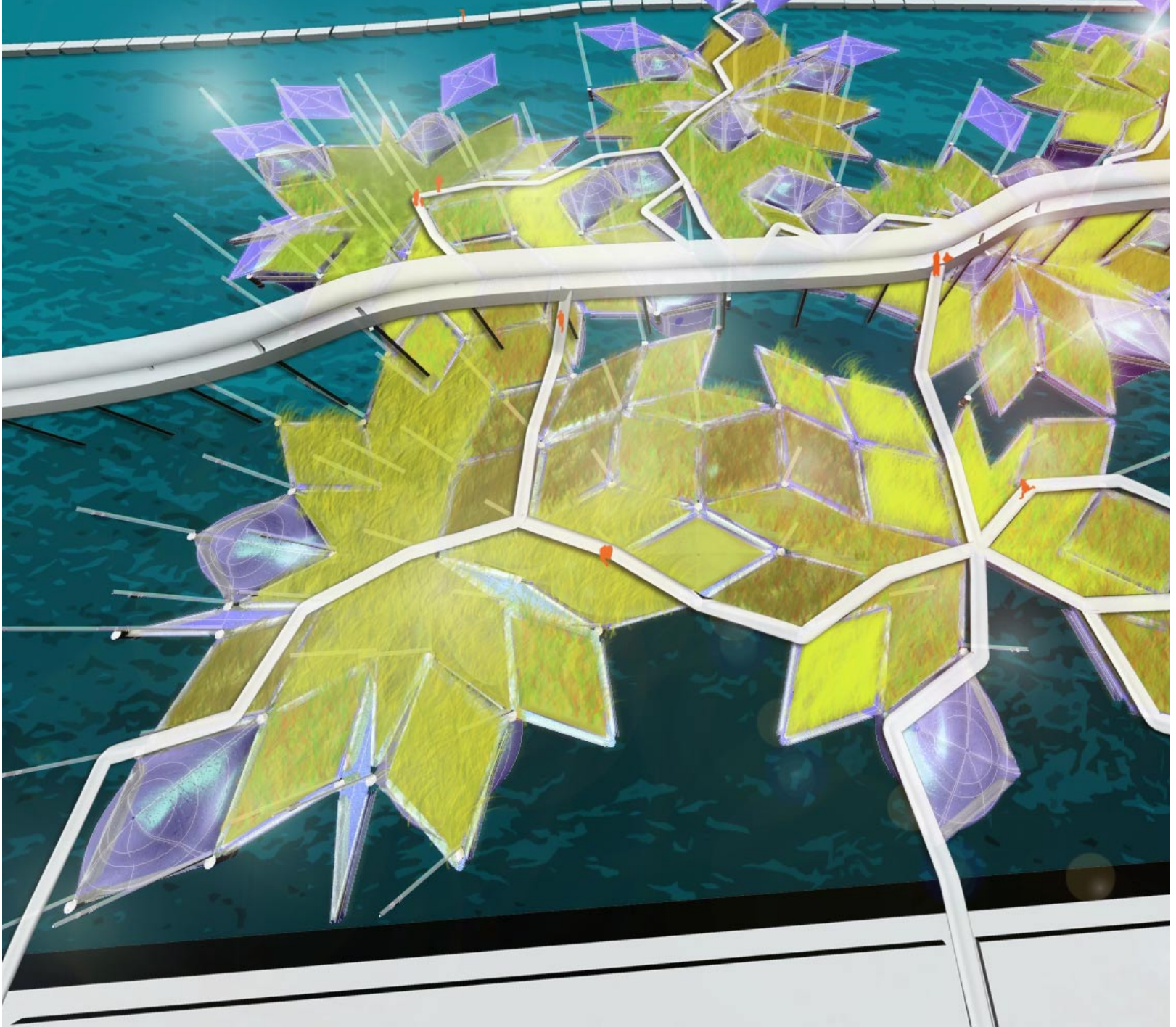
2.26 | Examples of Hybrid Field Cell Types and Configurations (Opposite Page)

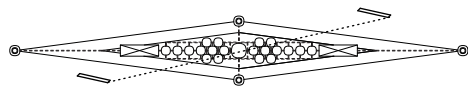


2.27 - 2.32 | Hybrid Field Layers

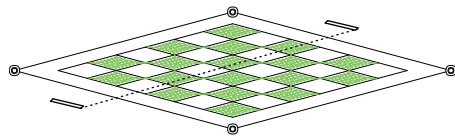
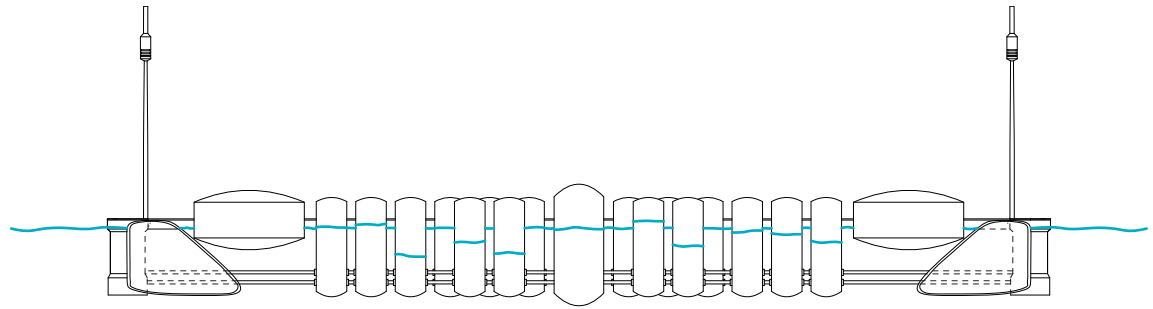
The Hybrid Fields are composed of layers of systems, constructions and information, as shown from top to bottom and left to right: The water as supporting medium for the system; the floating cells, acting as vessels for other components; varying water flow patterns through the cells; varying planting patterns, connecting and grouping cells into larger ecologies; data collecting nodes support display beacons revealing concentrations of chemicals and velocity of flows through a combination of colour, velocity and intensity of light; a network of paths for the maintenance, monitoring and viewing of cells.

2.33 | Hybrid Field Layers Combined (Opposite)

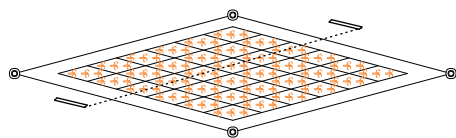
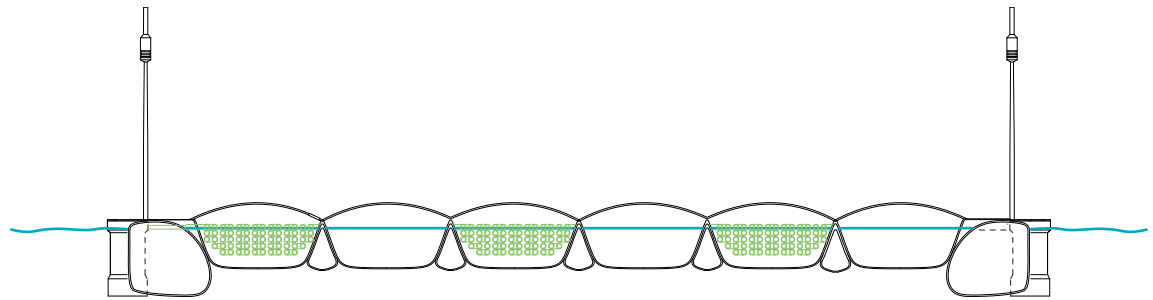




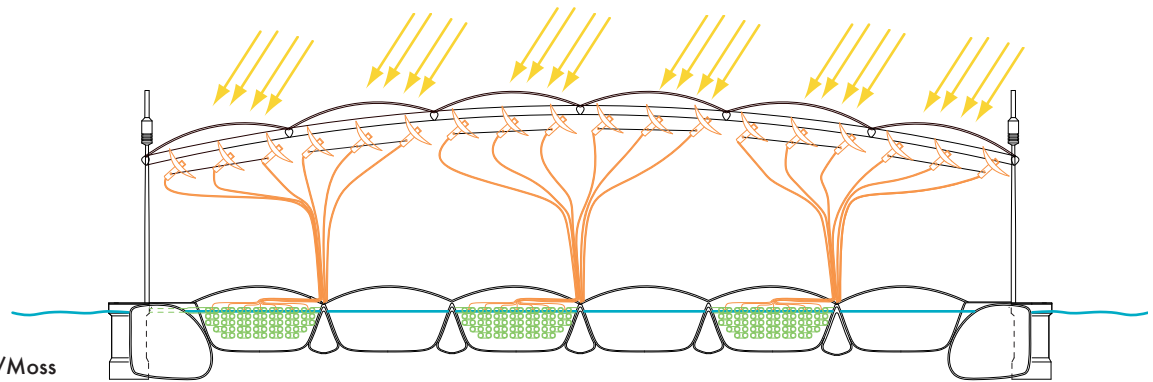
2.34 | 15 Degree Cell - Sampling/Monitoring

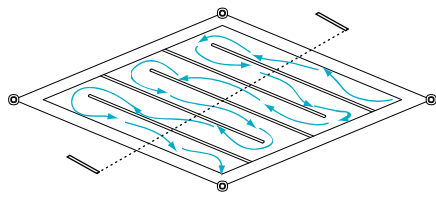


2.35 | 30 Degree Cell - Algae Photo Bioreactor

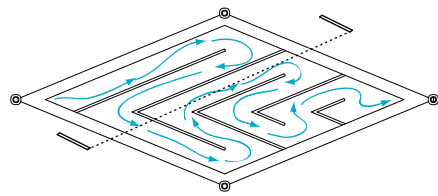
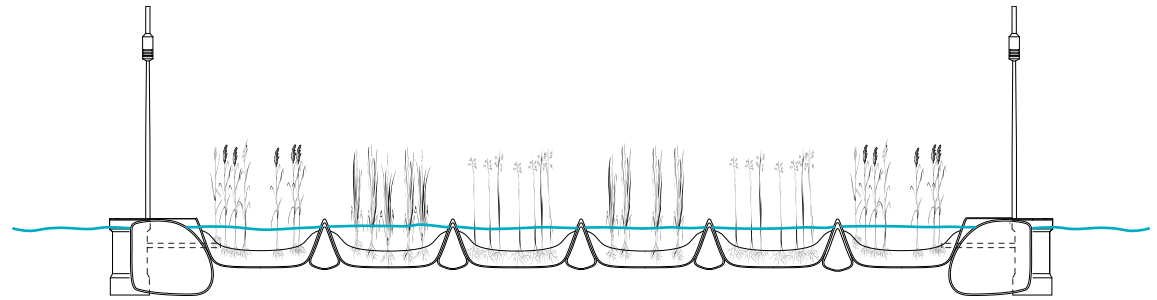


2.36 | 30 Degree Cell - Algae Photo Bioreactor/Moss

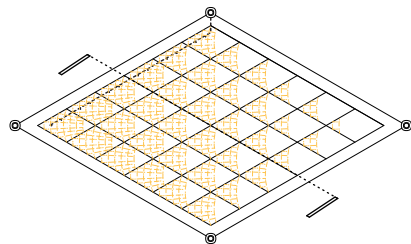
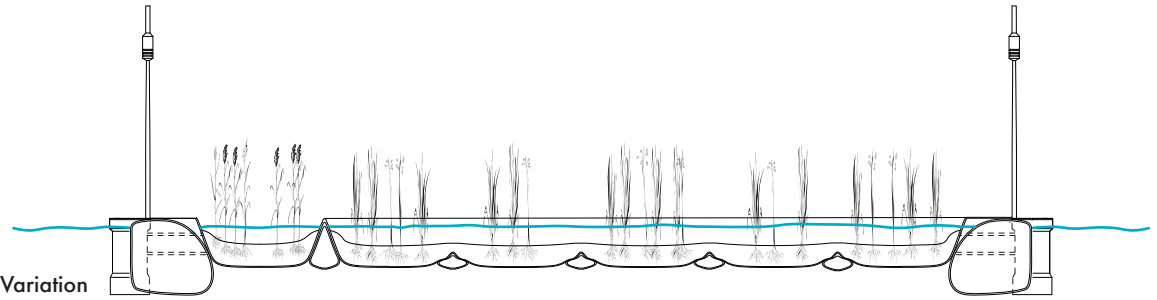




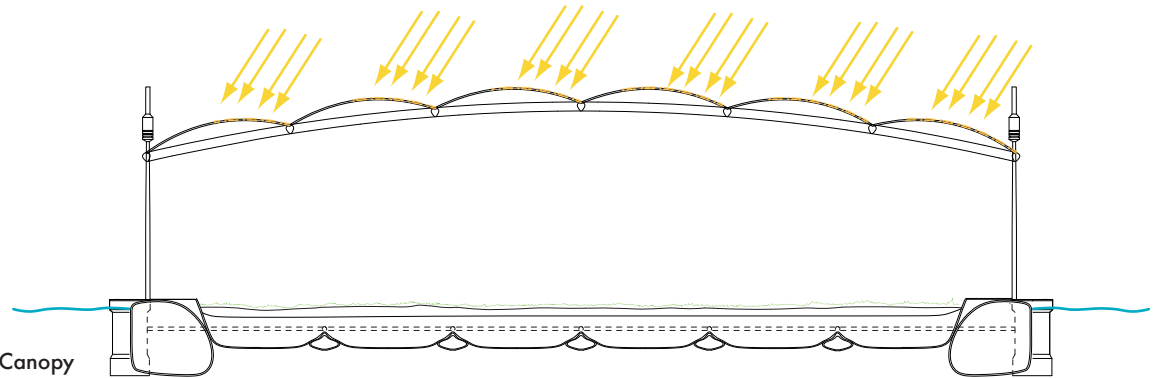
2.37 | 45 Degree Cell - Aerobic Wetland

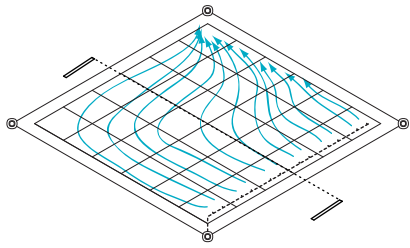


2.38 | 45 Degree Cell - Aerobic Wetland, Flow Variation

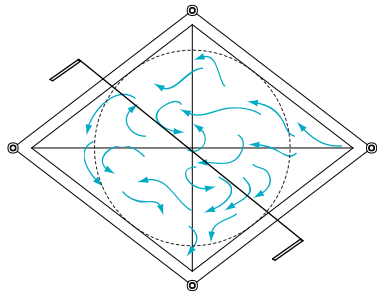
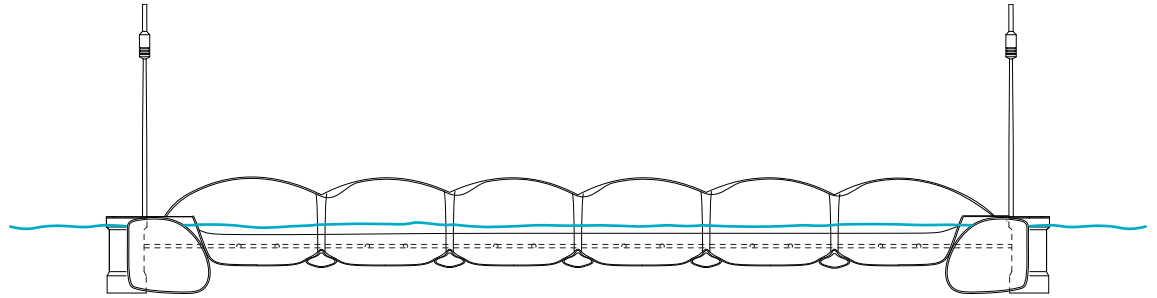


2.39 | 60 Degree Cell - Moss with Photovoltaic Canopy

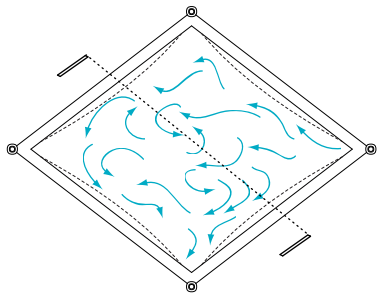
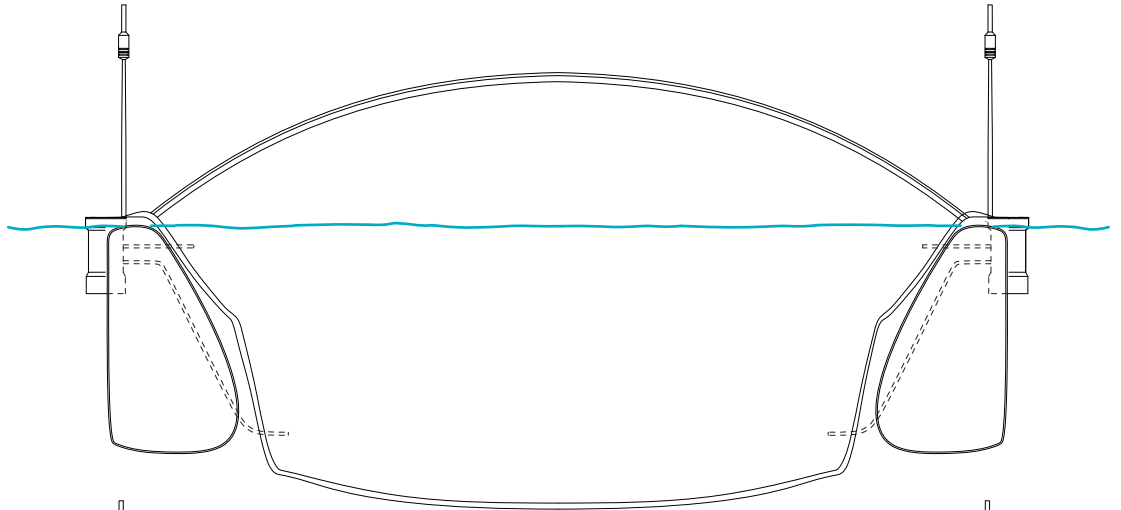




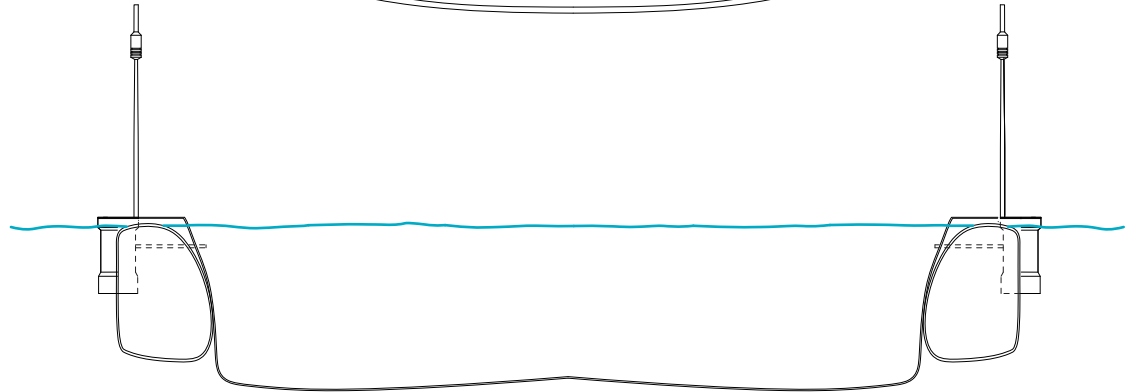
2.40 | 60 Degree Cell - Aerobic Wetland

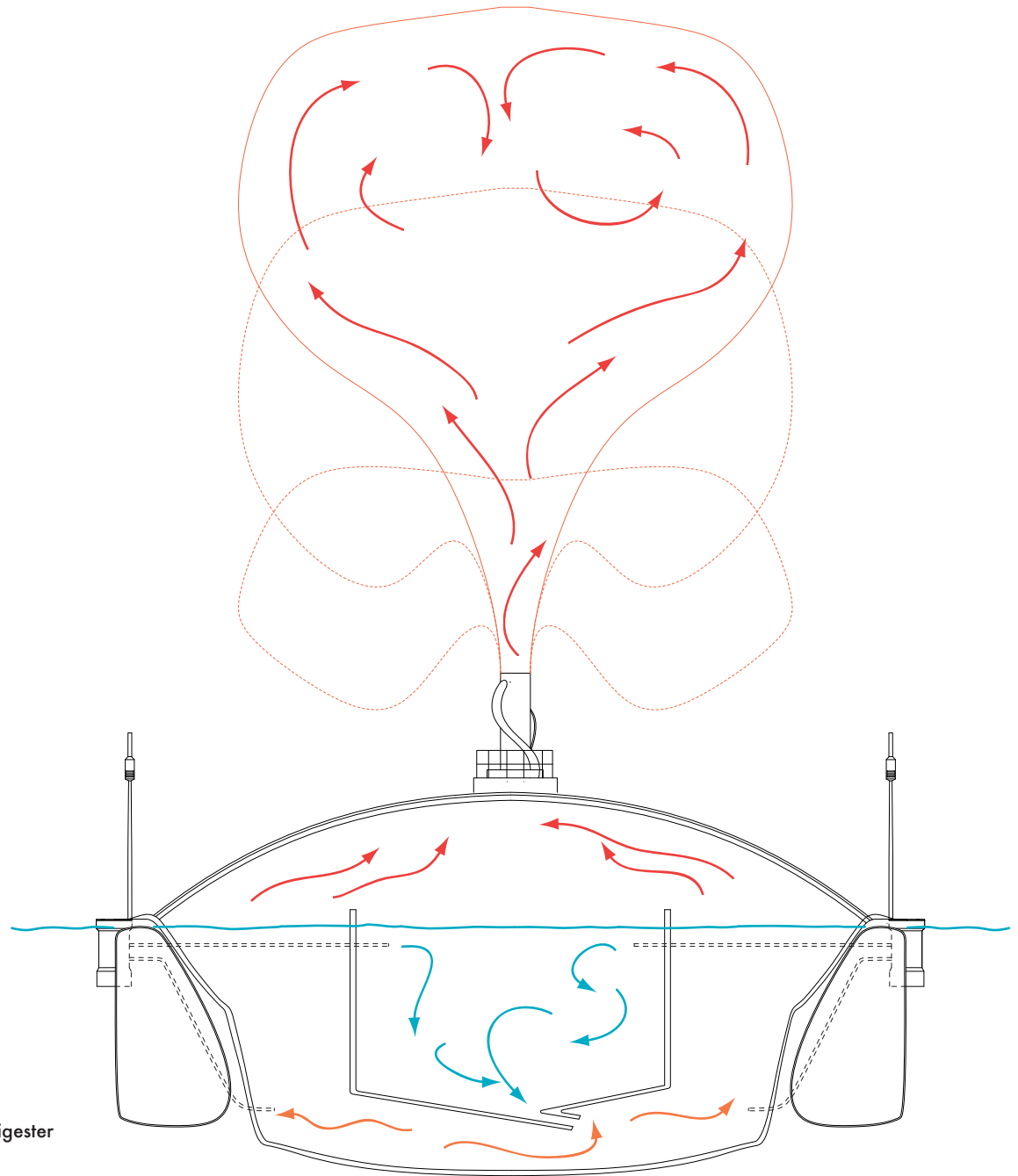
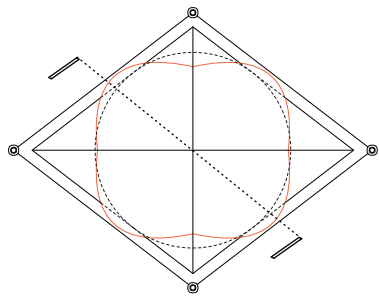


2.41 | 75 Degree Cell - Storage Tank



2.42 | 75 Degree Cell - Open Pond/Settling Pond

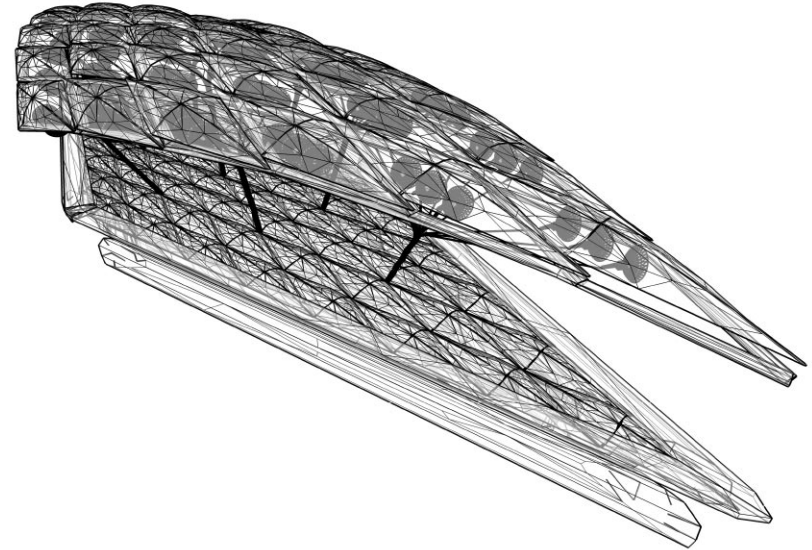




2.43 | 75 Degree Cell - Sludge and Methane Digester

Cellular Evolution

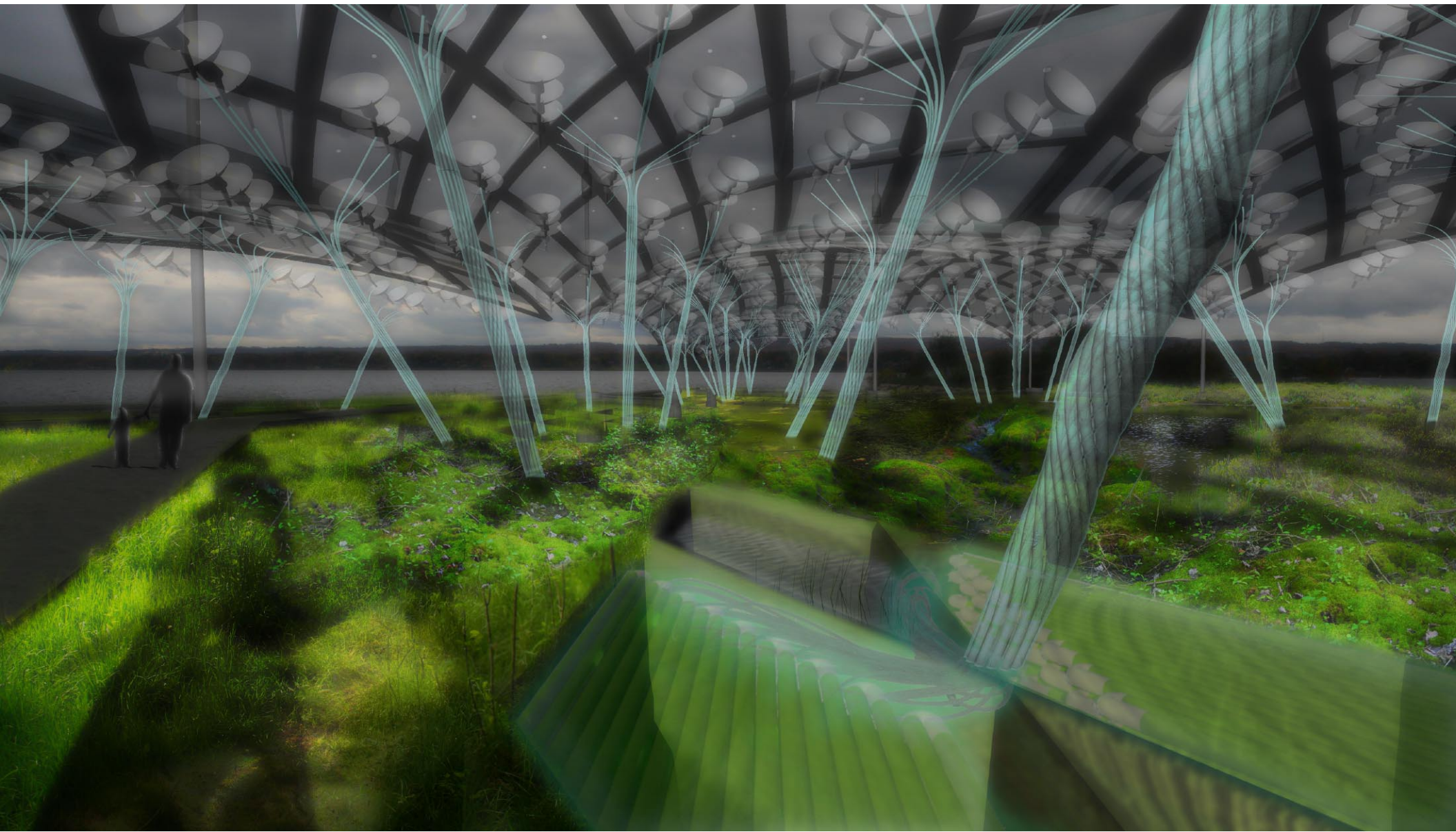
While the overall system of Hybrid Fields is to grow and expand, the individual cellular units are to evolve in conjunction with changing monitored information, and alterations to the larger infrastructure. In this way, the taxonomy of cell types, and in turn cell configurations, is to expand allowing for more specialized means of processing wastes and producing energy and materials for the enveloping natural and industrial ecosystems. In this way, a succession can take place within this hybrid landscape toward adaptive cell structures and arrangements such as to improve the internal and external environments of these living vessels. In parallel, the experiential qualities of these environments are also to grow, such as to create an enriched understanding of their function, and their relationships to one another and the region. The qualitative, immersive, and ambient aspects of this cellular evolution is, then, to develop in synchronous with their form and function.

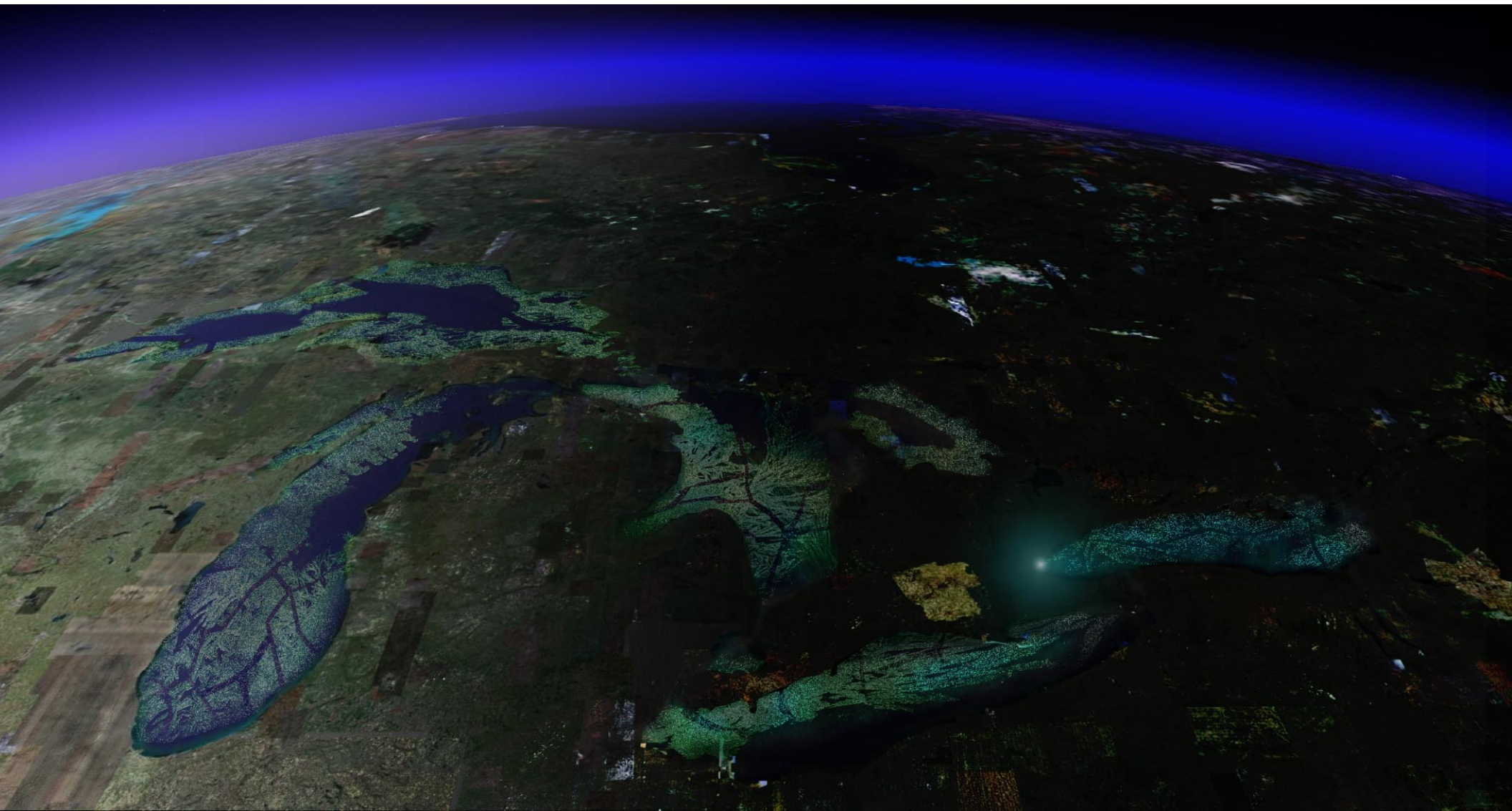


2.44 | Composite Algae Photobioreactor/Moss Cell

2.45 | Cybog (Opposite)

A view into assemblage of specialized algae photobioreactor cells, wherein solar collectors connect to luminous trees of fibre optic cables bringing light below the moss-covered surface to the manifold of translucent algae tubes.





2.46 | Expanded Fields
The Hybrid Fields as they might begin to grow and occupy populated and industrial regions surrounding the Great Lakes.

“Imagine you go out at night in the depths of the countryside. There is a clear dark sky, no light spillage from civilization, it is a cold damp night, and as your eyes become accustomed to the darkness you gradually see little points of light – the stars. These points of light shimmer (because of the dampness and coldness in the air)

If you listen carefully, you can imagine them singing to each other, forming little choirs that sing together. You, of course, are another of these stars, and you also sing. As you move, the other stars come into focus and form constellations: there are clusters that cohere for the moment, and that then dissolve as you move on. The songs continue, you hear choirs of the constellations. The feeling is of overwhelming joy, beauty, wonder, oneness.”⁴

—Ranulph Glanville, architect and cybernetician, describing an environment conditioned by Gordon Pask’s Conversation Theory

Expanding the Field

The landscape aims to be a visionary environment, and a possible generator of new landscapes to sweep the horizon. It is formulated as a cybernetic interface operating in the boundary zones between the real and virtual, physical and imaginary, and natural and technological. These realms having been formed by artificial boundaries, require us to construct equally artificial means of crossing them. The Hybrid Fields have been developed within these intersecting spheres, and thus their representation and potential creation falls into an ambiguous realm between the contextual information of the site, their physical manifestation from this, and the new perceptual data that emerges from the landscape system. Though this design proposition may be rooted in the technological and conceptual framework of its precedents, it seeks a greater reconciliation with the natural world through visceral, sensitive and immersive experience. As such, the exploration of the design and its development, as a simultaneous organism and environment, living between the real and virtual, evolves in such parallel realms of media and material. It is this experiential mode of exploration of the site and the design that has provided a desire for the understanding and reconciliation of these separate worlds. Through this, it is atmospheric qualities that strangely produces a common ground in which imagination and observation can unite. The very conceptual framework of ambience, being both immersive and qualitative offers a new layer to the visions of technology Fuller’s Geoscope provides, as it relates direct personal experience to the cosmic. This project is then much less a statement of our place in the world, and is not about giving particular meaning to our relationship with the natural environment. Instead, through both the design process and its realization, the Landscape aims to continually develop a state of wonder within the complexities of our environs.

1. McLuhan, *The Medium is the Massage*, 68.

2. Dadson, *Instrumental Matrix*, 69.

3. Baudrillard, *Simulacra and Simulation*, 122.

4. Ranulph Glanville, “Robin McKinnon-Wood and Gordon Pask: A lifelong Conversation,” <http://www.venus.co.uk/gordonpask>, quoted in *Cyber_Reader: Critical Writings for the Digital Era*, ed. Neil Spiller (London: Phaidon, 2002), 77.



“Environments are not passive wrappings, but are, rather, active processes which are invisible. The groundrules, pervasive structure, and over-all patterns of environments elude easy perception. Anti-environments, or countersituations made by artists, provide means of direct attention and enable us to see and understand more clearly. The interplay between the old and the new environments creates many problems and confusions. The main obstacle to a clear understanding of the effects of the new media is our deeply embedded habit of regarding all phenomena from a fixed point of view.”¹

—Marshall McLuhan, *The Medium is the Massage*



3.0 | Aquarium Space (Opposite)

The interior of an aquarium filled with minute air bubbles, creating a moving boundary within.

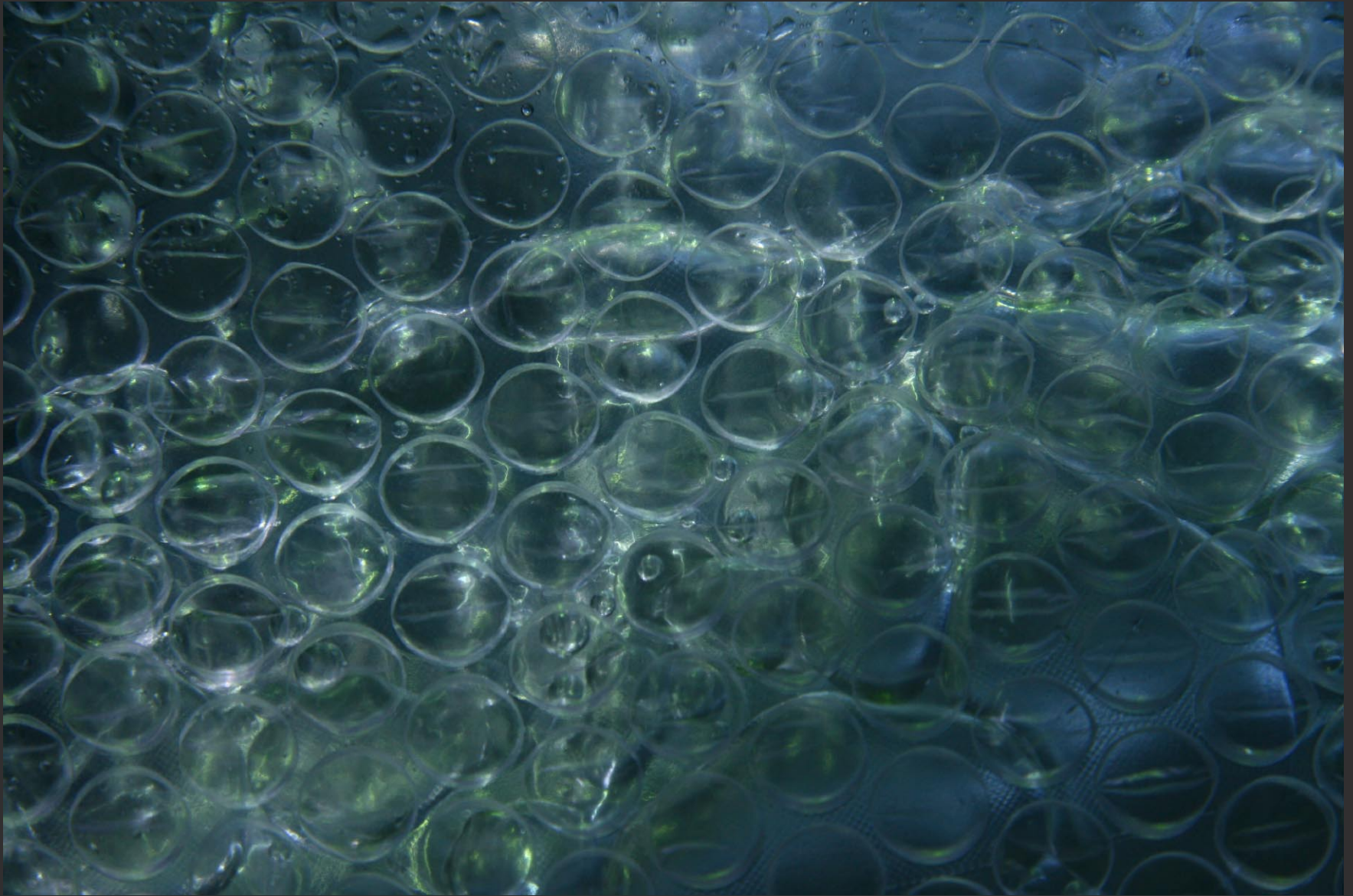
3.1 | Projected Environments (Above)

Real environments projections on the dynamic aquarium as screen.

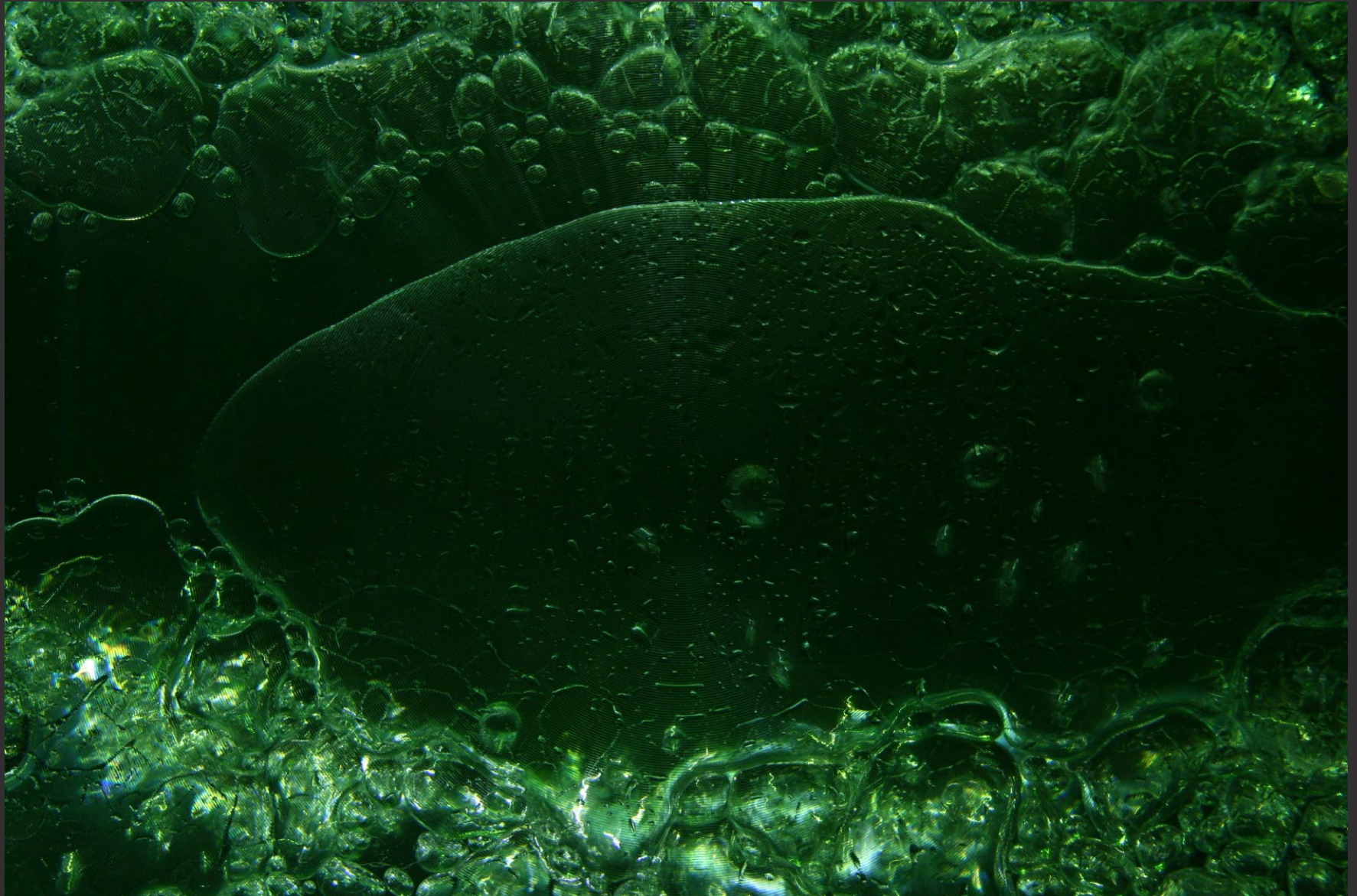
3.2 | Fluid Screen (Left)

Microscopic airbubbles provide a surface for projection and illumination.





3.3 | Cellular Terrain



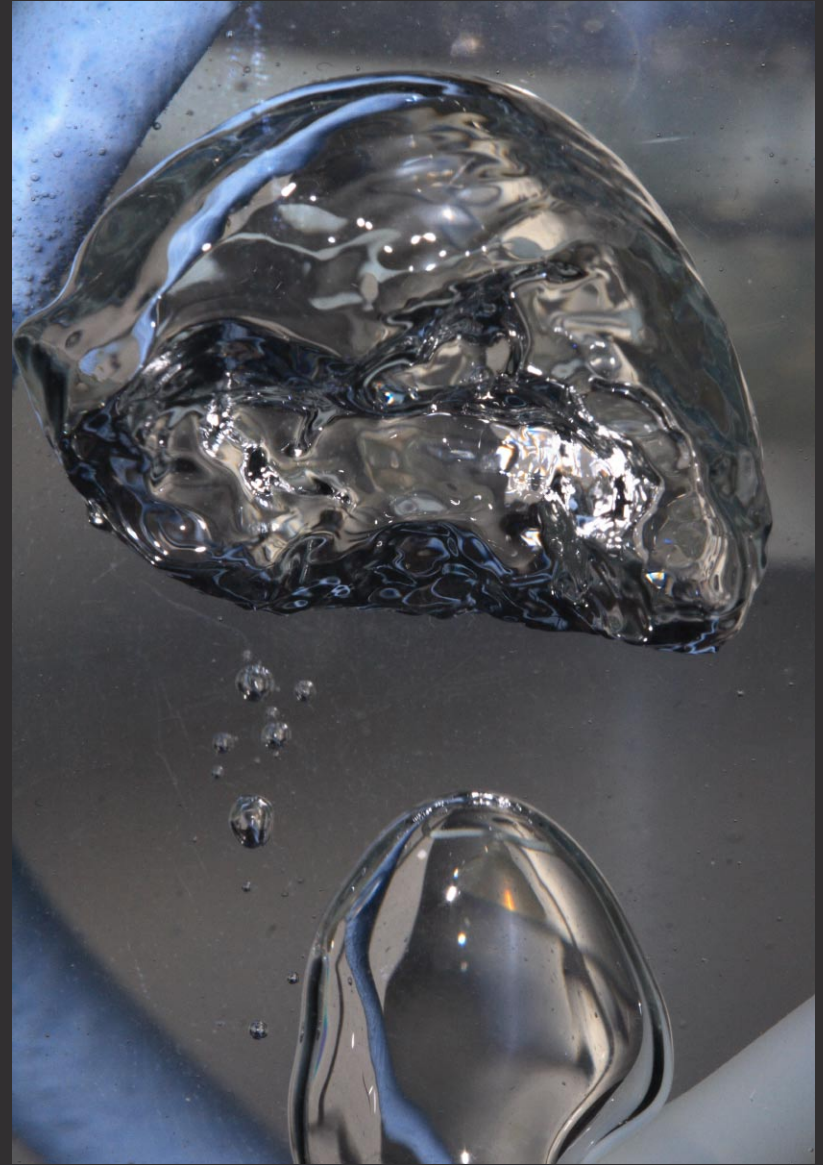
3.4 | Defractive Lens



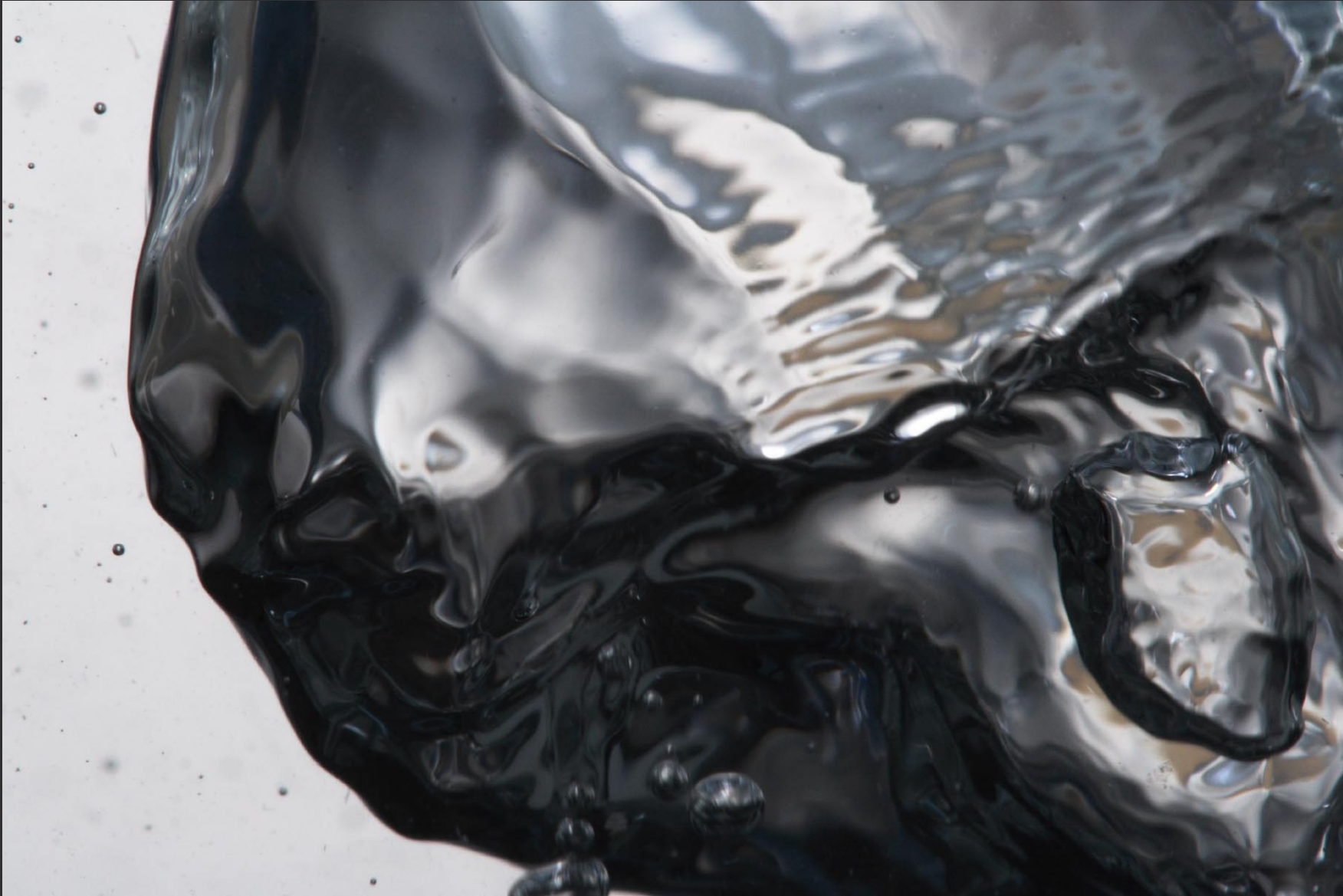
3.5 | Water Form 1



3.6 | Water Form 2



3.7 | Water Form 3



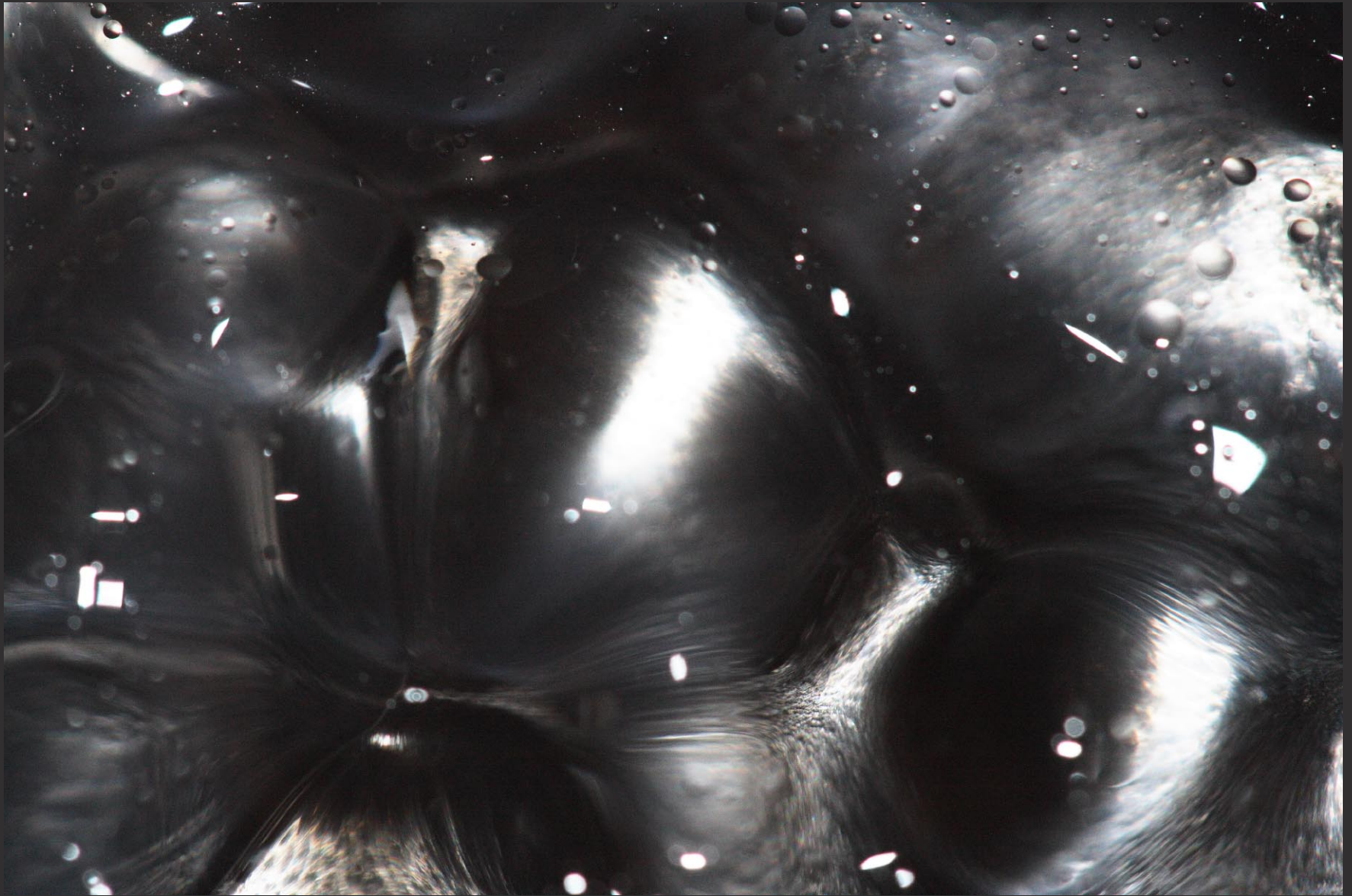
3.8 | Water Form 4



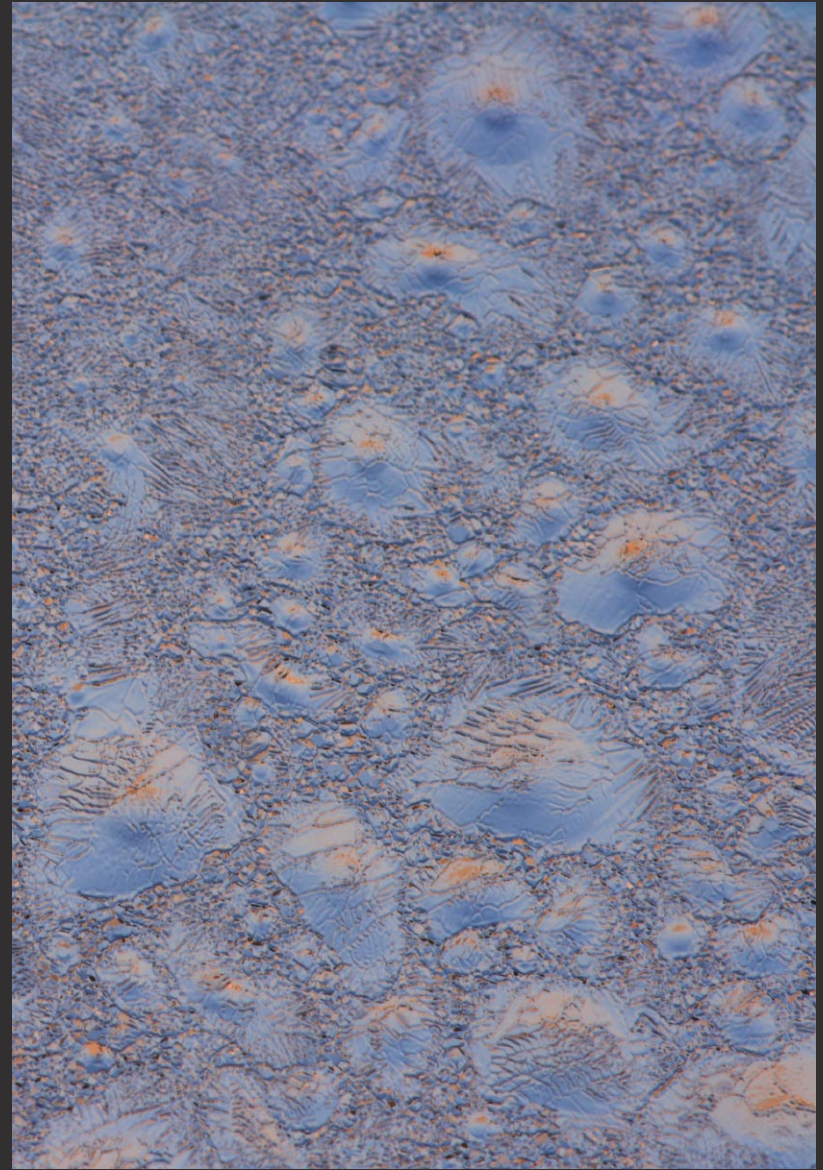
3.9 | Cymatic Surface 1



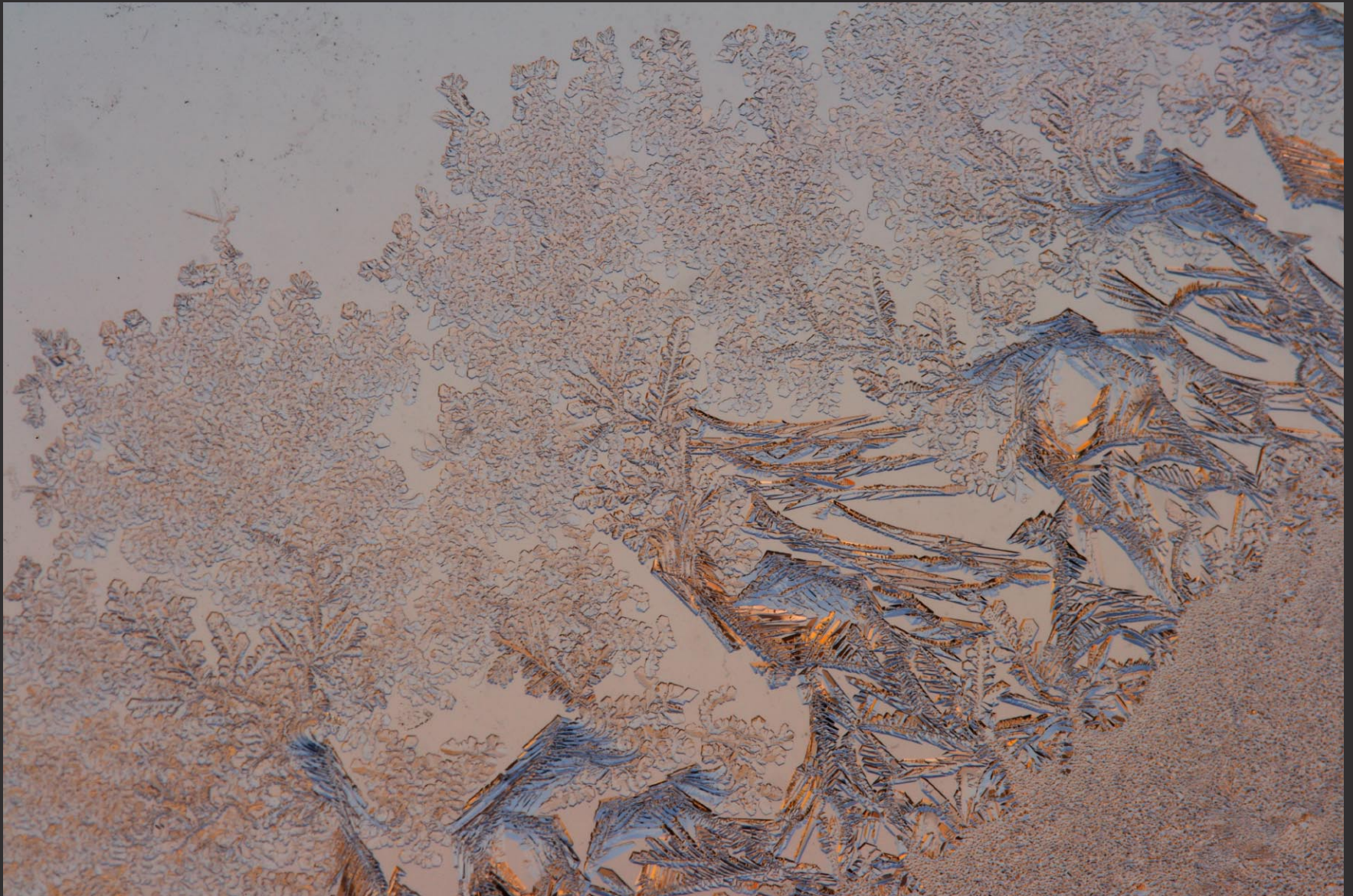
3.10 | Cymatic Surface 2



3.11 | Cymatic Surface 3



3.12 | Ice Pattern 1



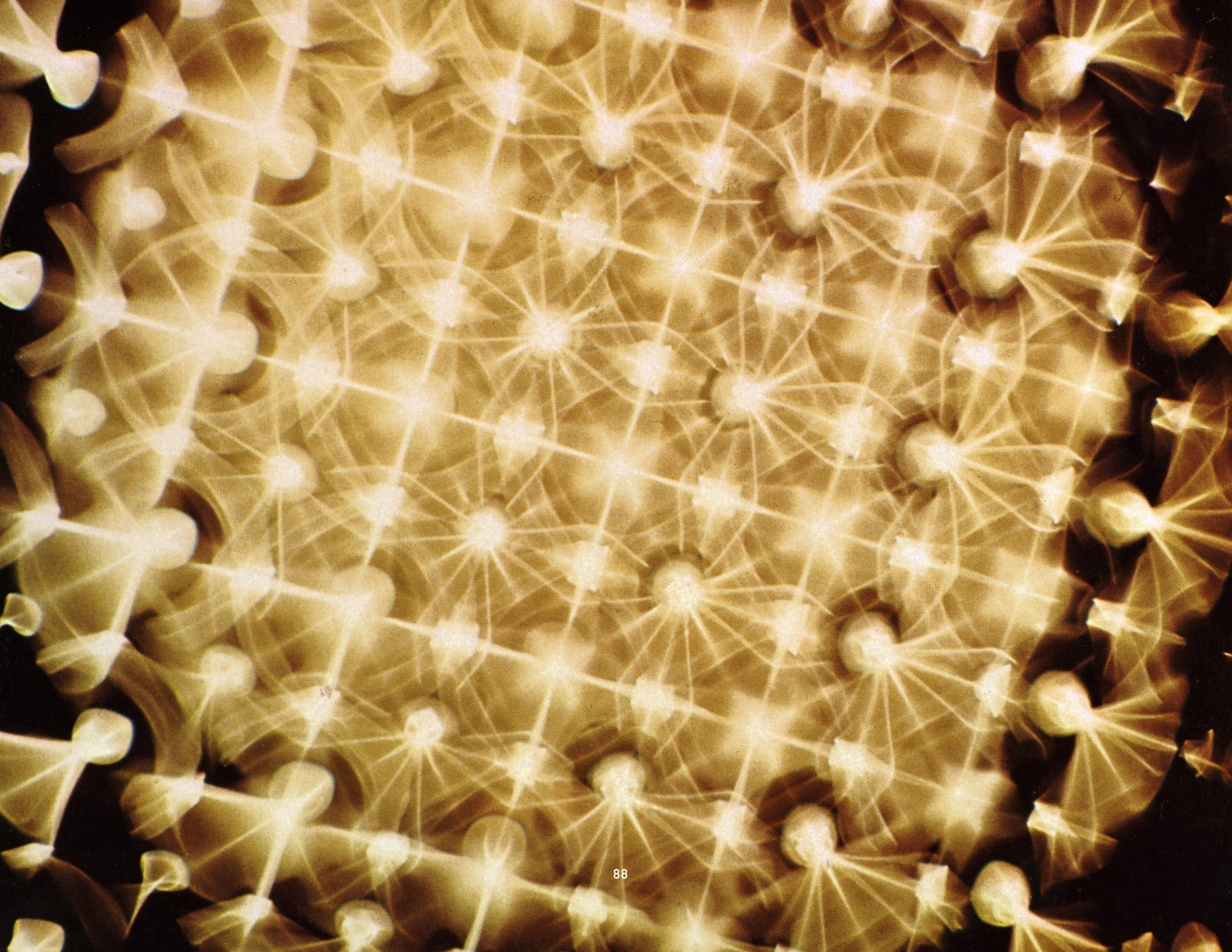
3.13 | Ice Pattern 2



Water

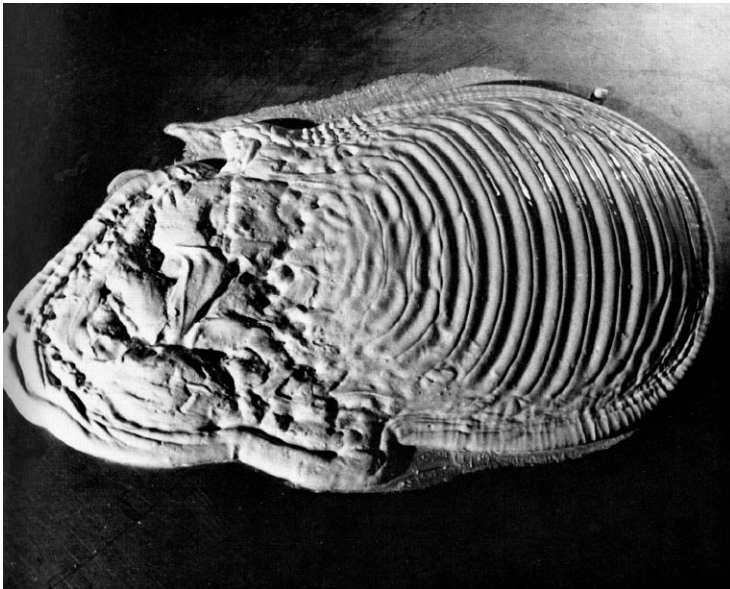


Water can be observed in terms of its natural properties, but further, phenomenologically as a ubiquitous, cosmic source of life. This connective compound is revealed to be a sensitive material, as explored in the work *Sensitive Chaos*, by Theodore Schwenk. From this we turn to a collection of systems and processes, from natural to artificial to hybridized, all associated with the use, cleansing and understanding of this dynamic resource, including the liminal realms of nature, wetlands, wastewater treatment plants, constructed wetlands, Living Machines, algae photo bioreactors, and industrial ecosystems. Following this are several designs and visionary projects that look at ways in which water and natural phenomena can be used in creating atmosphere, ambience and aesthetics, while being combined with technologies for the interaction with nature and its manipulation. These examples explore ways of designing environments to generate and enrich knowledge, and produce higher states of understanding and wonder in the environment.





3.16 | Air Bubbles
 Tiny air bubbles drifting through water, approaching the form of a sphere.



3.17 | Viscous Vibrations
 Waves generated by vibration of a viscous paste, producing a concentrically patterned topography.

3.14 | Water (Previous Two Pages)

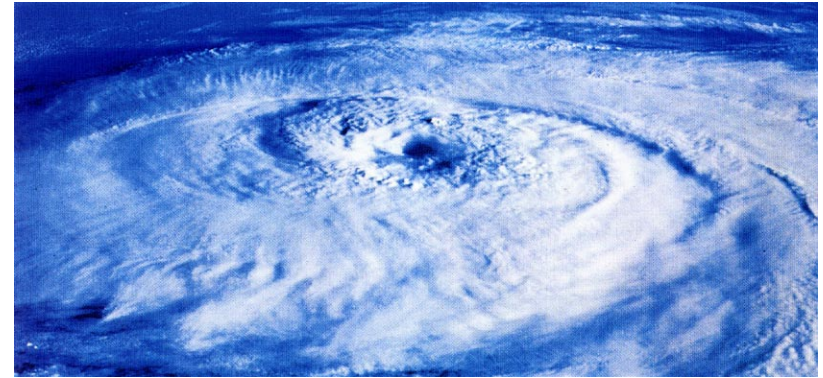
3.15 | Fluid Field (Opposite)
 An photograph of a regular pattern in liquid generated by Hans Jenny using Cymatics; a process of generating form and pattern in fluids using sound vibrations.

Fluid Patterns, Poetics and Phenomena

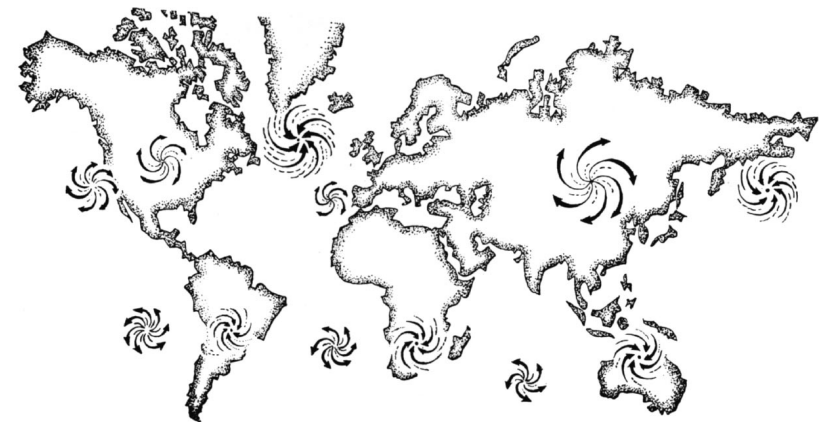
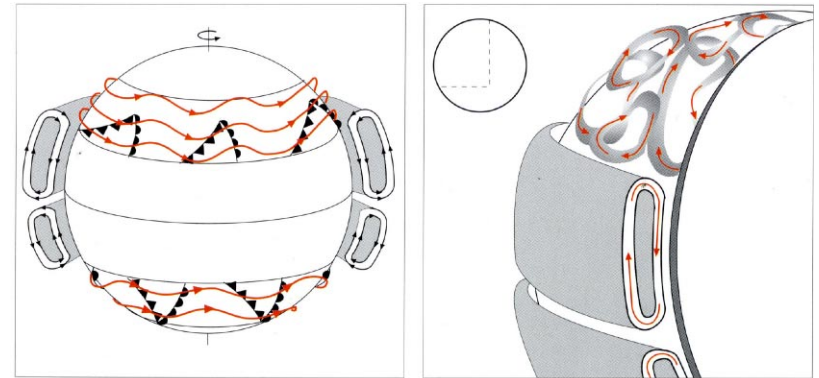
Figure and field are inherent to water, developing from the medium's response to energy and movement, as though it in itself senses and lives. Some of the emerging phenomenological qualities of water may be observed in the following photographs and diagrams of fluid forms and environments which have been paired with quotes from Theodor Schwenk's *Sensitive Chaos*. These poetic phrases offer elegant descriptions of the phenomena of fluid dynamics, balanced with a view into the conceptual and spiritual connections existing between water, air, life and the cosmos. Taking us back to some of the positivistic and holistic thinking of the 1960s, today Schwenk offers insight into the greater values that exist of water and air (arguably the most valuable elements of life), beyond the purely materialistic thinking prevalent in our current concerns for the preservation of natural resources. Through this material, we can perceive water's striving for wholeness in its attempt to achieve the form of a sphere, from the scale of the water droplet, to that of the entire earth. As such, we find principles of fluid movement woven together with much larger, cosmic guiding forces in a stream of meditative prose describing waves, vortices, natural patterns, and the development of organic forms.

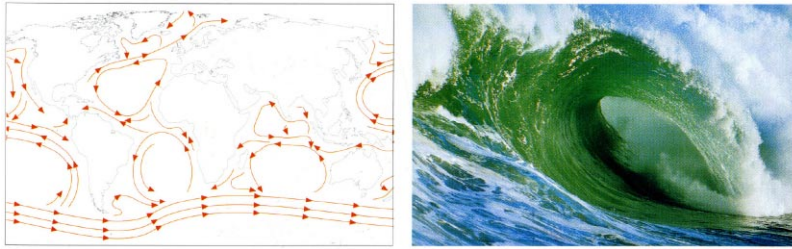
"The more man learned to know the physical nature of water and to use it technically, the more his knowledge of the soul and spirit of this element faded. This was a basic change of attitude, for man now looked no longer at the being of water but merely at its physical value."²

"Wherever water occurs it tends to take on a spherical form. It envelops the whole sphere of the earth, enclosing every object in a thin film. Falling as drop, water oscillates about the form of a sphere; or as dew fallen on a clear and starry night it transforms an inconspicuous field into a starry heaven of sparkling drops."³



"Not only are the loops themselves arranged in rhythmical succession but they change their position rhythmically. The Gulf Stream has a rhythmical form in space, and it is also subject to a rhythmical process in time through the changing position of its loops."⁴

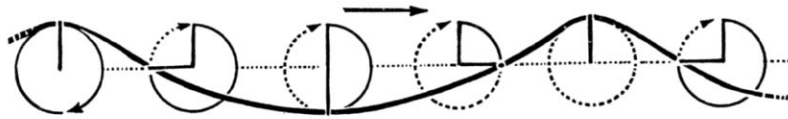




3.21 | Oceanic Currents



3.22 | A Wave Flowing at the Beach



3.23 | Wave Movement

Typical wave movement does not produce a current, but instead can be observed to move in circles.

3.18 | Spiraling Chaos (Opposite, Top)

The forces of a hurricane demonstrating the immense power and circulation fluids may become.

3.19 | Earth's Wind Patterns (Opposite, Middle)

The earth's poles and rotation produce the complex patterns of movement of air and water across the globe.

3.20 | Positive and Negative (Opposite, Bottom)

Varying air pressures produced by varying temperatures of land and water masses yield global currents.

"Two things are necessary for this rhythmical movement to come about: the water itself and some other activating force. The actual form of the wave is the result of the interaction of opposing forces, in interplay with one another. The wave is the newly formed third element, arising between the polarities—for instance of water and wind—and appears at their surface of contact. Thus water is like a sense organ, which becomes "aware" of the smallest impacts and immediately brings the contrasting forces to a moving rhythmical balance."¹⁵



3.24 | Cloud
A high cloud mass takes on a form very much like a living organ.



3.25 | Atmosphere
Clouds lower to caress the landscape, imbuing mood and immersion.

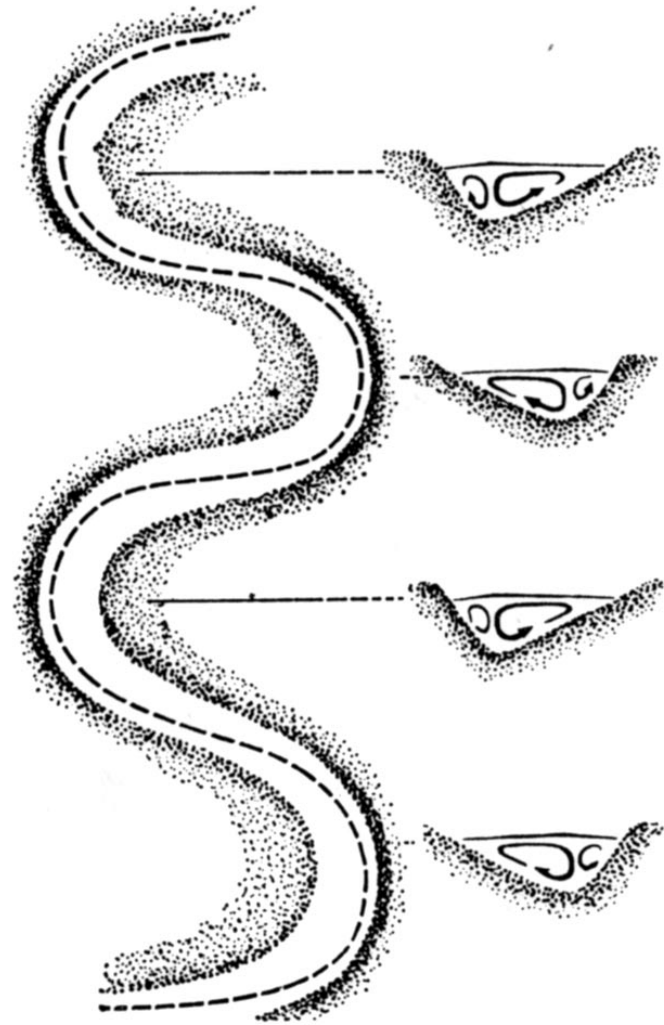


3.26 | Cool Waters

*"We see here an archetypal principle of flowing water that wants to realize itself, regardless of the surrounding material. The surrounding material can be on the one hand the hard rock of the mountains, the ice of the glacier with its little channels formed by the water from melting ice, or again, scree, gravel or soil. On the other hand it can consist of warmer or colder water."*⁶



3.27 | Fractal Ice



3.28 | Stream (Above)
Sections through a stream or river reveal the dual and opposing spinning directions of spiraling currents within.

3.29 | Eddying (Left)
Alternating vortices form in a jet of liquid.



3.30 | Gradual Stream Separation

"It never flows straight ahead. Are these meanderings in the very nature of water? What causes water to follow such a winding course? Its endeavour to complete the circle is here only partially successful, as it cannot flow uphill back to its starting point. Right at the beginning of its circulatory movement it is drawn downhill and in following this downward pull it swings alternately from side to side."⁷

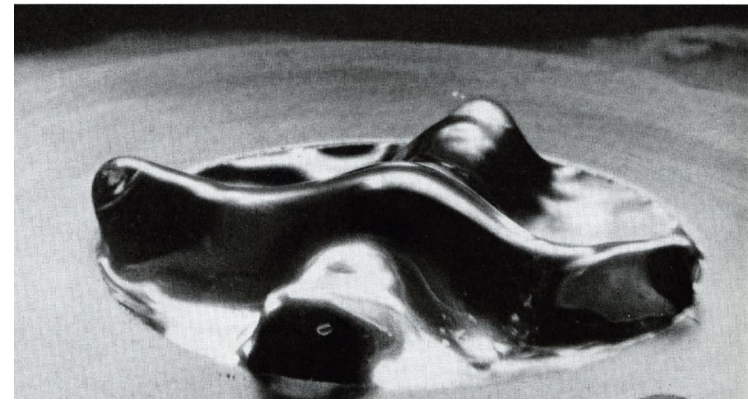
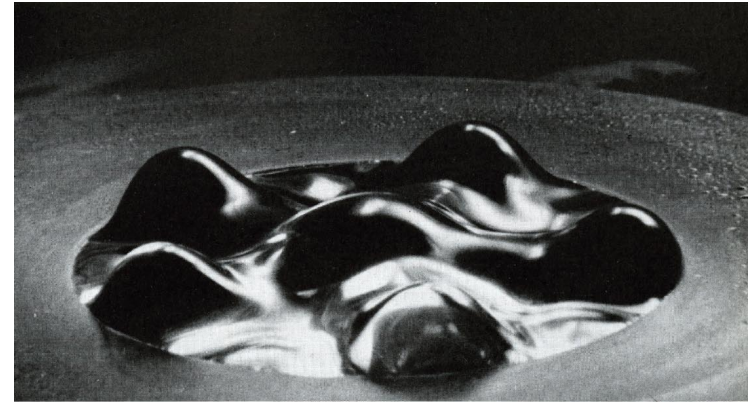


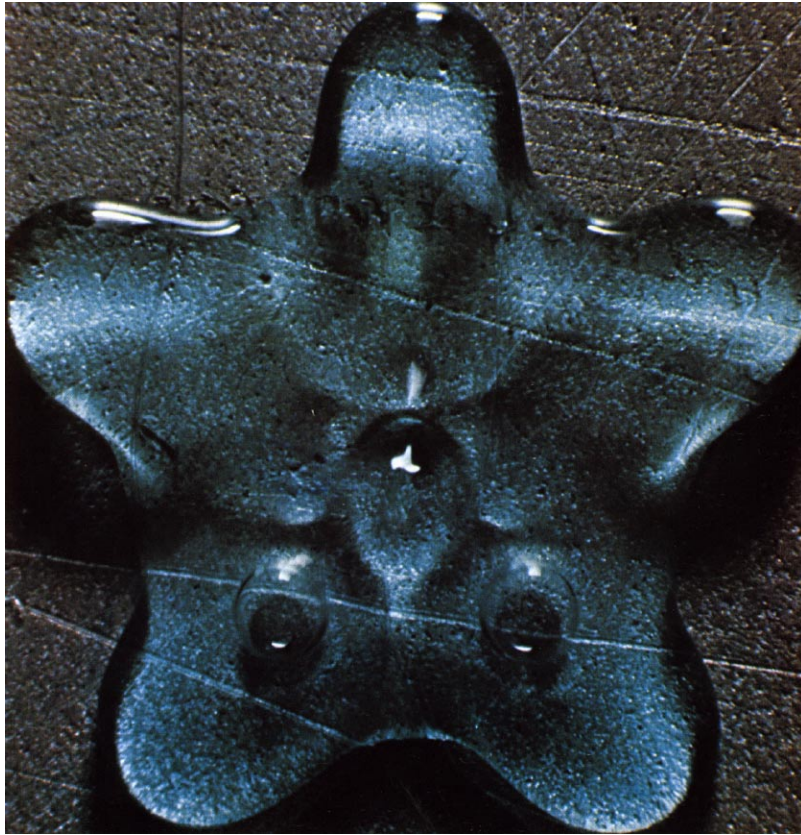
3.31 | Formation of the Human Eye

"The hollowing out of inner spaces is a fundamental process—an archetypal form-gesture in all organic creation, human and animal, where in the wrinkling, folding, invagination processes of gastrulation, organs for the development of consciousness are prepared. Forms arising out of this archetypal creative movement can be found everywhere in nature."⁸

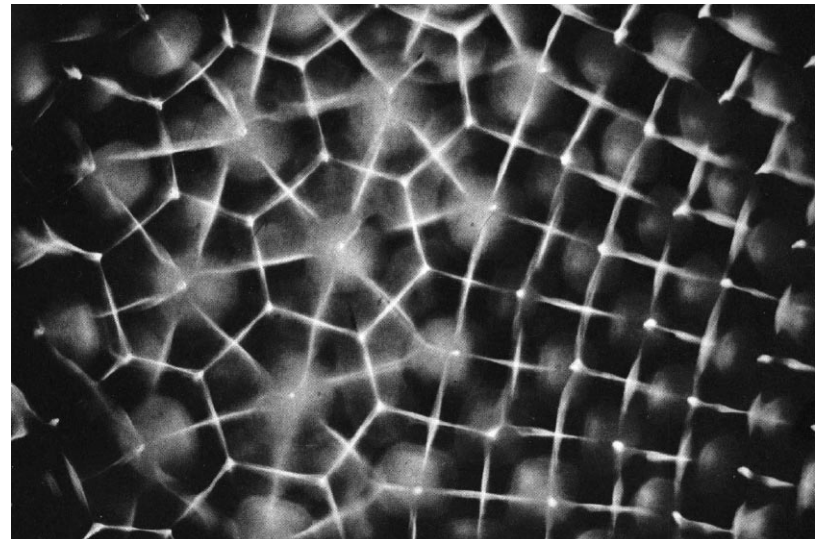
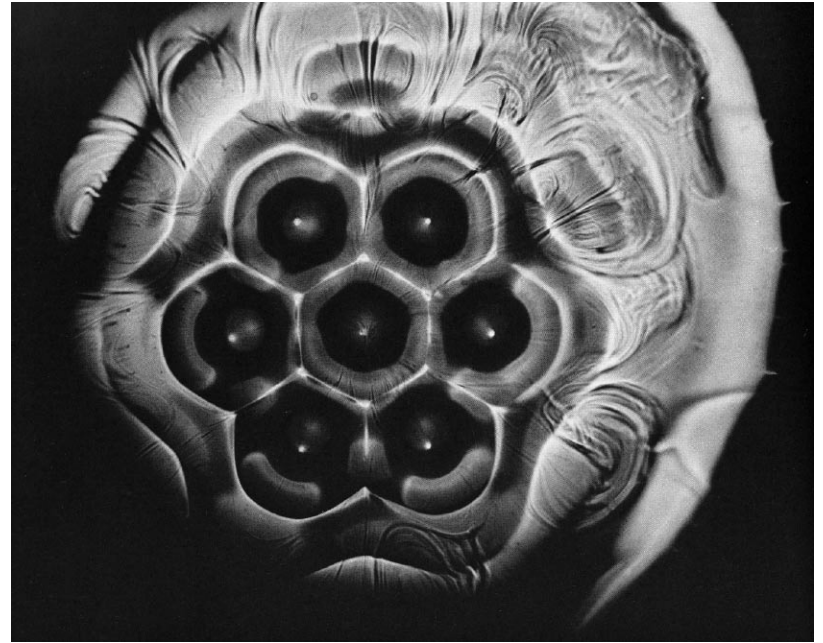
"Every water basin, whether ocean, lake or pond, has its own natural period of vibration. This varies according to the shape, size and depth of the basin. The whole morphological character of a lake finds expression in this natural period of vibration; it is like a "note" to which the lake is "tuned". This "note" has "overtones" in its vibration, like a flute or the string of a musical instrument."⁹

"The formative boundary surfaces in flowing movement prove to be areas of sensitivity. They respond to the slightest changes in their surroundings by expanding, contracting or making rhythmical waves. Water creates an infinite variety of these surfaces and is therefore not merely an inert mass, as we usually think. It is interwoven with countless sensitive membranes, which are prepared to perceive everything taking place in the surroundings. Water is not enclosed within its inner surfaces but open to its surroundings and to all the stimuli and formative impulses from without. It is the impressionable medium par excellence. Indeed it is so sensitive that not only does it react to changes in its immediate surroundings, but also to the delicate, imponderable influences of the planetary universe."¹⁰

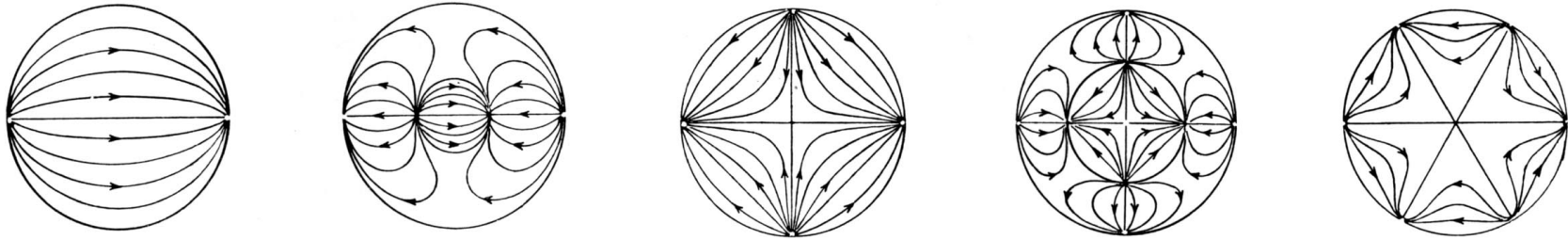




3.32 - 3.33 | Cymatic Shapes (Opposite and Above)
Drops of water pulsate as polygonal and overlapping figures when excited by vibration, as shown by Hans Jenny's research into cymatics.

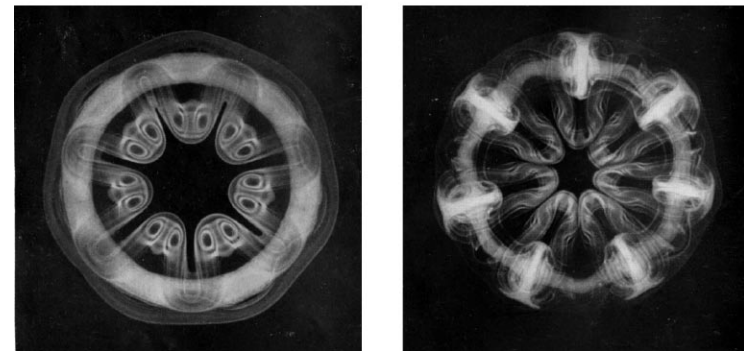
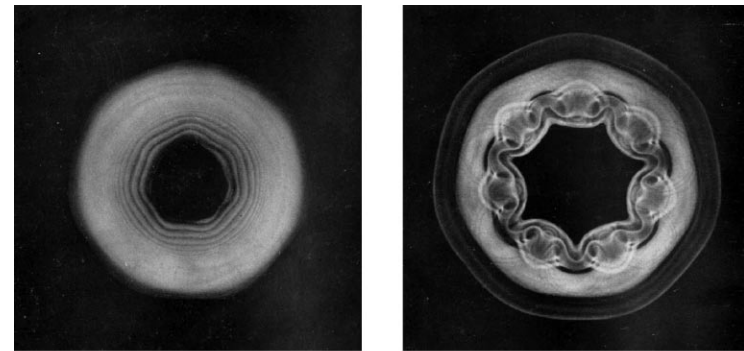


3.34 - 3.35 | Liquid Lattices (Right)
Films of liquid display complicated lattice patterns when irradiated by sound, allowing various and changing types of symmetries to form.



3.36 | Oscillations

Regular geometric patterns of flow occur in oscillating containers filled with water. These patterns vary with the shape of the container.

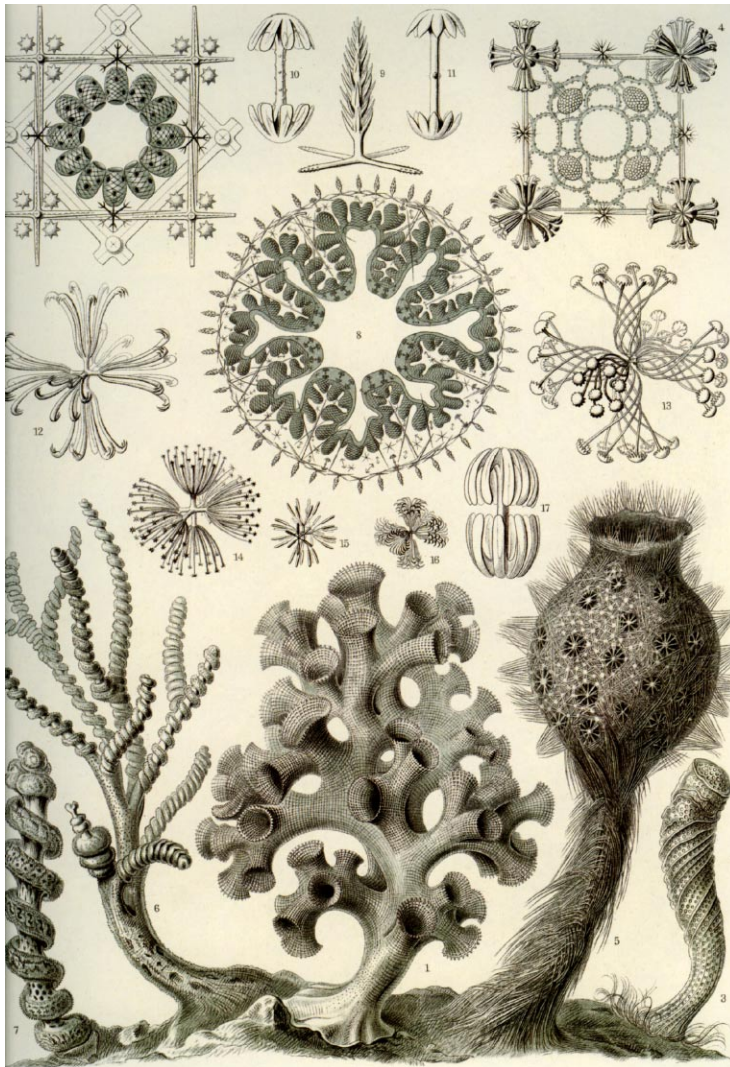


3.37 | Vortex

A rising vortex ring takes on various star-like forms, the structures of which become visible as it makes contact with the surface.

“There is such unlimited movement in this sheath of water encompassing the earth that it can on a global scale even be regarded as an organ mediating between earth and cosmos, integrating the earth into the course of cosmic events and enabling it to take part in these events.”

“Thus water becomes an image of the stream of time itself, permeated with the rhythms of the starry world. All the creatures of the earth live in this stream of time, it flows within them, and, as long as it flows, sustains them in the stream of life.”¹¹



3.38 | Hexactinellae

Deep sea biota as drawn by Ernst Haeckel, from his central work *Art Forms in Nature*. The exactness and complex symmetries of his drawings demonstrate the relationship of life-forms to fluid phenomena.

*"Boundary surfaces, with their rhythmical processes, are birthplaces of living things. It is as though the creative, formative impulses needed the boundary surfaces in order to be able to act in the material world."*¹²

1. Marshall McLuhan and Quenti Fiore, *The Medium is the Massage* (New York: Bantam Books, 1967), 68.
2. Theodor Schwenk, *Sensitive Chaos: The Creation of Flowing Forms in Water and Air* (London: R. Steiner, 1965), 10.
3. *Ibid.*, 13.
4. *Ibid.*, 20.
5. *Ibid.*, 28.
6. *Ibid.*, 19.
7. *Ibid.*, 15.
8. *Ibid.*, 41.
9. *Ibid.*, 30.
10. *Ibid.*, 65.
11. *Ibid.*, 68.
12. *Ibid.*, 42.



Living Landscapes: Machinic Gardens

“There seems to be reason to believe that the original forms of life were anaerobic, existing without oxygen. There is indeed speculation that bioluminescence—which is most familiar today in the firefly—is a residue of this period when it was necessary for organisms to expel an oxygen that was toxic. There is a further and more entertaining speculation to the effect that this same primitive bioluminescence was a precursor of the evolution towards the nervous systems of animals and thus of the human brain, the great oxygen consumer. This suggests that the brain is the descendent of an early waste-disposal system.”¹

—Ian McHarg, *Design With Nature*

4.0 | Woodward Avenue Wastewater Treatment Plant, Hamilton

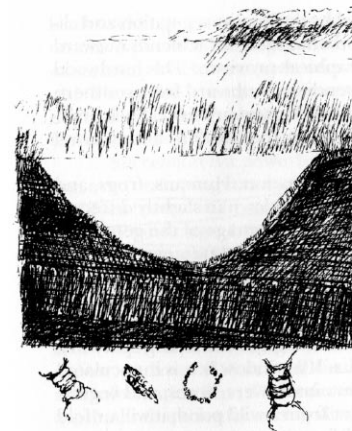
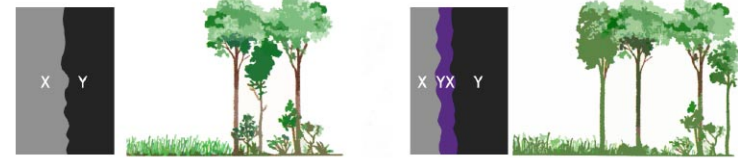
Water is the great system of material transportation around the earth. To this end, living creatures, communities and environments depend on water to exist, as they exchange material between life forms in supporting biological functions. The significance of water, then, is its ability to cross ecological boundaries. A study of water’s role in our living environment then begins with relating the temporal and spatial transformations in boundary regions of ecosystems. These areas become separate ecological niches unto themselves, often extremely productive due to the diverse nature of species and microenvironments within, as well as the constant transfer of biomass and energy assisted by water. No where are these transfers more visible and of such importance than in wetlands; liminal regions connecting water to land, often acting as filters between stream, rivers, ponds and lakes. From this, we can diverge to a study of established methods of wastewater treatment, commonly found in municipal wastewater treatment plants. Constructed wetlands offer an interesting model for wastewater treatment, being either attached to existing treatment facilities, or entirely new systems unto themselves, as they utilize wetland plants to filter potential pollutants from rural, urban and even some industrial sources. John and Nancy Todd of Ocean Arks International take such systems further in their *Living Machines*, as the processes found in wetlands are separated, contained in tanks and often housed in greenhouse structures to accelerate their processing abilities. From this extend further iterations of hybrid natural and technological cleansing systems, such as floating bioremediative living piers, to algae photo bioreactors. It is the combination of such systems that we then find in industrial ecosystems, which seek to close the loop between the refinement of materials, the assembly of products, and the resulting production of waste, thereby mimicking nature’s own closed life-cycles, owing much of their function to the connectivity of environments linked to water.

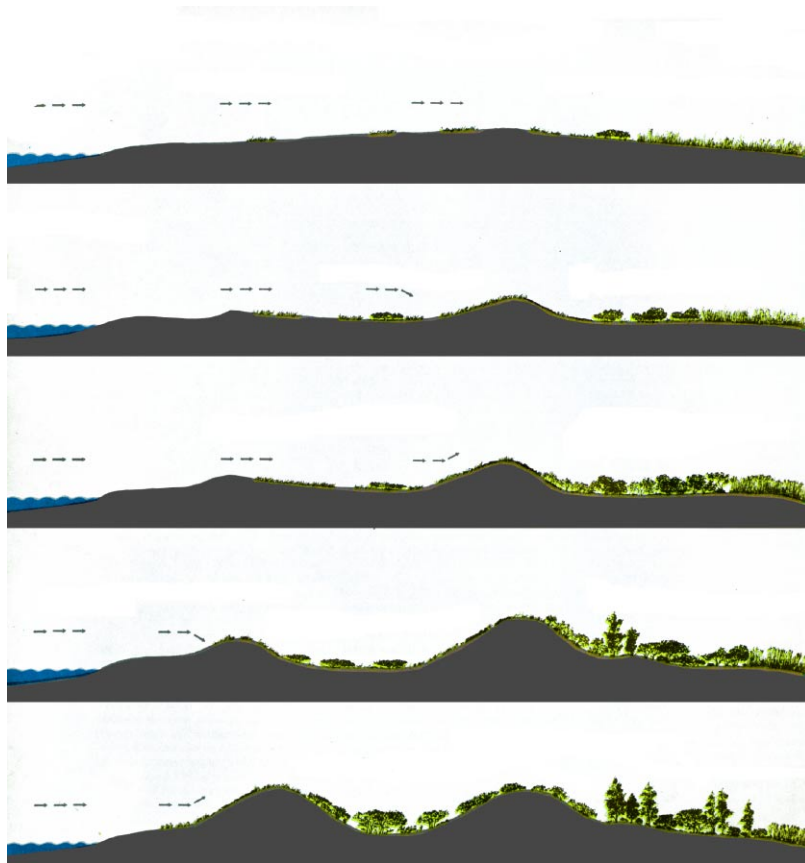
Liminality of Nature

Boundary regions in nature are often some of the most valuable and productive areas of ecosystems, themselves being specialized but diverse communities. The ecotone describes one such condition of two ecological communities meeting, in which different permutations are possible of the third boundary environment that forms between. These range from a distinct partition to a new hybridized intersection where completely different species of plants and animals might live than those of the adjacent communities. Succession might be viewed as a temporal equivalent of an ecotone, wherein the transformation of the makeup of an ecologically community takes place, as various species compete with one another while simultaneously altering the local environment, making it possible for new species to live. John Todd describes this process as being creative, potentially parallel to the design and construction of environments:

“Succession is a powerful conceptual tool for thinking about, designing, even reshaping communities. It allows us to cope creatively with change and even to steer it. In nature change is a creative force.

Diversity leads to increased stability, protection from external change, variety, and overall system efficiency, which in turn results in greater order and information flow. The ordered complexity that is created embodies two attributes that scientists rarely discuss in their analyses, harmony and beauty. These are not ephemeral qualities. They have meaning that speaks directly to us.”²





4.3 | Dune Formation

4.1 | Ecotone (Left, Above)

The principle of the ecotone, or region between two adjacent communities, demonstrates how critical the principle of the 'boundary' is, as a region of varying integration and hybridization of the systems of life, or two responsive fields. In some cases, an entirely new form of community develops in the boundary zone, becoming a habitat for creatures specific to this connected field. (Smith 2000, 283)

4.2 | Succession (Left, Below)

Succession in a small pond, shown in increments of decades, where the overall structure, and its constituents of flora and fauna change over time.

The sand dune might further be seen as a combination of these two forms of boundary regions in nature. As Ian McHarg explains, the people of the Netherlands learned to replicate the dune's function in their construction of dikes, as these provide, like their natural counterpart, a boundary layer capable of defending the land against the violent sea.³ Further, Theodor Schwenk intimates the deeper dependence and interconnection between such regions, its inhabitants, and the understanding of this significant bond:

*"Just as in a living organism cause and effect intermingle in a simultaneous correlation, so do they also in water. For instance, the waves flowing over the beach arrange the sand in ridges, but at the same time these formations affect the waves and influence their forms. An interplay like this resembles an intimate co-operation which results in the creation of a third factor, which, however, can only be seen from a higher level, when the human mind apprehends the prevailing whole."*⁴

Wetlands

“Wetlands are not isolated entities. They are linked to their surrounding landscape in terms of sensitivity to terrestrial disturbance, and they are dependent on the presence and proximity of surrounding water bodies. There is a functional interdependency of wetlands, and since from a watershed perspective they operate together as complexes, their losses are also felt collectively.”⁵

Wetlands are effectively ecotones, ‘edge’ habitats, acting as transitional ecological communities between dry land and deep water.⁶ They are border environments of the in-between that is not entirely terrestrial or clearly aquatic. Not only do these regions occupy a physical state as an edge, but are equally temporally liminal.

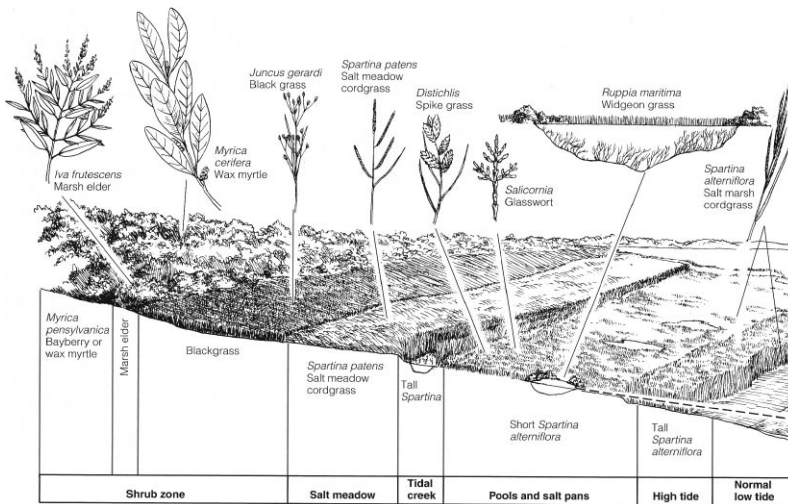
“In a geological sense, natural wetlands are an ephemeral component of the landscape, highly dependent upon disturbance whether as long-term, large-scale tectonic forces or localized phenomena such as annual or daily flooding and drying, fire, or storm events. Without tectonic or hydrologic disturbance, wetlands gradually progress through a succession of stages to relatively dry upland-type ecosystems.”⁷

Further, these regions fluctuate seasonally and annually, dynamically responding to climate and varying hydrology.⁸ Nutrients entering wetlands are received, held and recycled as they are continually washed up from upland regions, and through this, support a great variety of macro- and microscopic vegetation. These in turn convert inorganic chemicals and organic materials, whether directly or indirectly, into food for animals, including human beings.⁹



4.4 - 4.5 | Bog

Two photographs depicting a bog environment, including a coniferous moss-covered swamp environment (above) that surrounds a floating bog (below).



4.6 | New England Salt Marsh

Patterns of zonation in a New England salt marsh reveal some natural principles of how living responsive fields generate specific zones of growth, as an expanded 'edge' condition, showing the complexities of boundaries in ecological systems.



4.7 | Riparian Wetland

A wetland adjacent to a stream, containing cattails shooting up from the murky water.

*"Microbes—bacteria, fungi, algae, and protozoa—alter contaminant substances to obtain nutrients or energy to carry out their life cycles. The effectiveness of wetlands managed for wastewater treatment is dependent on developing and maintaining optimal environments for desirable microbial populations. Fortunately, these microbes are ubiquitous, naturally occurring in most waters and likely to have large populations in wetlands and contaminated waters with nutrient or energy sources."*¹⁰

With this capacity, wetlands act as immense and complex biological filters that can remove and convert large quantities of pollutants from point sources, including municipal and certain industrial waste water effluents, as well as non-point sources such as from mines, and agricultural and urban runoffs, which might contain organic matter, suspended solids, metals and excess nutrients.¹¹ The 8 million square kilometers of wetlands worldwide have historically been viewed as evil dens harboring pests and criminals¹², operating under a fearful interpretation of 'wilderness'. Only more recently has the term 'wetland' come into use, with approximately the last 35 years, and our understanding of their great value and function within larger ecosystems has come to light.

Wetland classification, especially of its constituents plants and associated capacities for nutrient or pollutant removal, continues today as scientists begin to reconsider the ways they are interconnected and support our biosphere. Generally, they are seen as regions that adapt to varying amounts of contaminants, water flows, and water levels. They are classified hierarchically within 5 large systems, divided progressively into 10 subsystems, 55 classes and 121 subclasses.¹³ More generally, shallow-water or water saturated areas dominated by water-tolerant woody plants and trees are known as swamps; areas dominated by soft-stemmed plants are considered marshes, which are generally the type most adaptive to fluctuating water levels¹⁴; and areas containing mosses are bogs, known for their ability to accumulate limonite and other metals.¹⁵ In a typical marsh wetland, there are six major planting zones, or subdivided 'edge' habitats, being open water, deep marsh, shallow marsh, wet meadow, shrub wetland and forested wetland.¹⁶ Within these regions are five major growth forms of vegetation, being free floating, floating anchored, submerged, emergent, and woody.

These precious resources we know are being lost, most commonly as they are used inappropriately for drainage and clearing for agriculture, along with the alteration of their chemistry, as well as their being over used for recreation or physically modified for development.¹⁷ These regions have been traditionally converted to farmland, though we are finding now that they are some of the most productive regions of the world, far exceeding farm production of biomass. Seemingly, these areas now need to be protected, and though naturally forming, we now need to integrate wetlands within our synthetic developments to insure both their and our own survival.



4.8 | Riparian Marsh

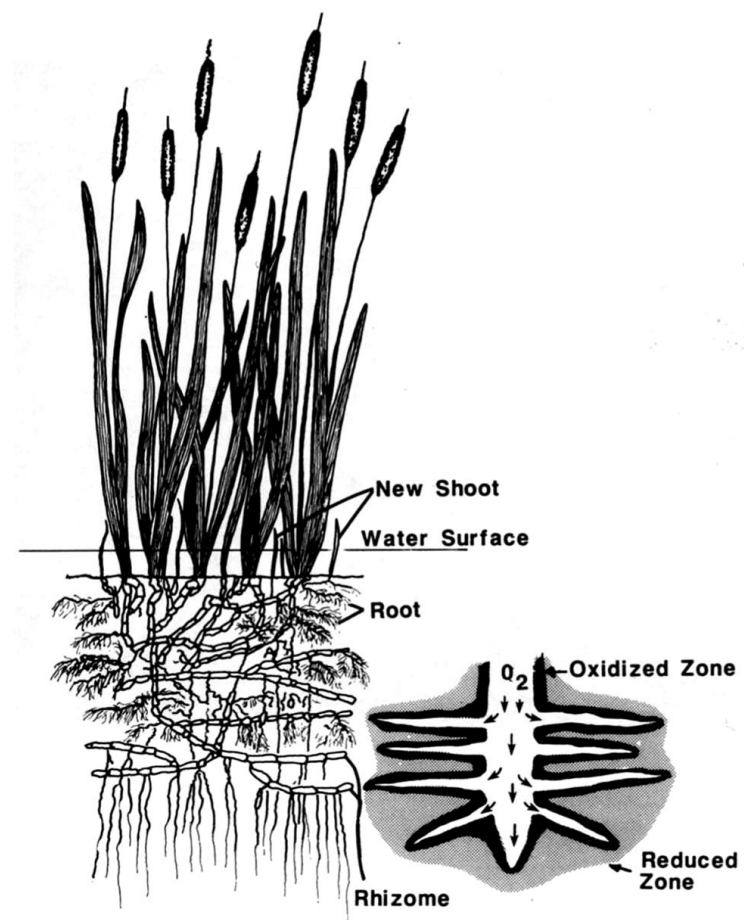


4.9 | Deciduous Swamp

The Rhizosphere

The fantastic ability of wetland ecosystems to filter and break down various materials, including detritus and other potentially toxic substances is owed to the specialized plants that occupy these regions. Such plants create a thin boundary layer of air around their roots known as the rhizosphere, in which microorganisms may live, feeding on the materials water carries to them. The Rhizosphere then acts as the most significant transitional zone of material transfer and transformation, as this thin layer of air on wetland plant root systems is expanded exponentially by the microscopic tendrils, folds and twists in the roots themselves, thereby creating a dense network of filtration below the water.

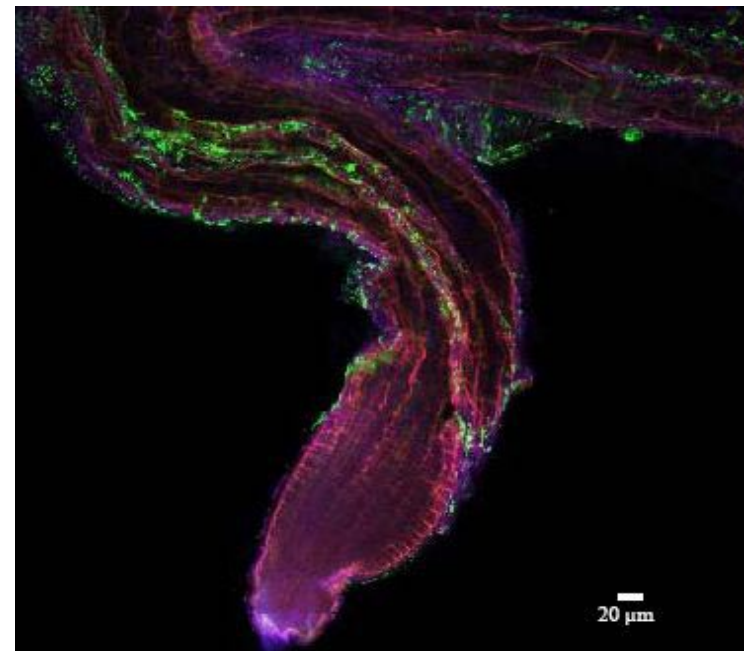
“The juxtaposition on a microscopic scale of an aerobic region surrounded by an anaerobic region multiplied by the almost astronomical area of rhizosphere boundary is crucial to nitrification-denitrification and numerous other desirable pollutant transformations. Nutrient or other substance uptake by plants is generally insignificant except for a few systems that incorporate periodic plant harvesting to physically remove plant biomass. However, these systems tend to have high operating costs.”¹⁸



4.10 | Cattail Rhizosphere

4.11 | Micro Living Layer

A microscopic image showing microorganisms (green) collecting about the rhizosphere of a plants root system.

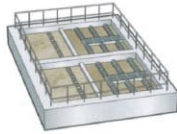




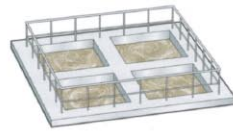
1. Upon entering the plant, wastewater is pumped through bars or screens to remove large debris such as newspapers, sticks, rags, and cans.



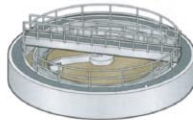
2. Sewage pumps lift the wastewater to primary settling tanks at surface level.



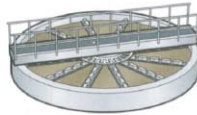
3. Heavier materials settle to the bottom of the tank, while lighter materials—as well as oil and grease—float. Collection devices skim oil and floatables from the top and remove the primary sludge that has settled at the bottom.



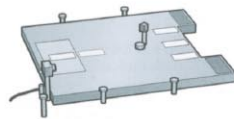
4. The partially treated wastewater flows to a secondary treatment system (known as the "activated sludge process"), where air and "seed sludge" from the plant are added to the wastewater to break it down further. Air pumped into the aeration tanks stimulates the growth of bacteria and other organisms that consume much of the remaining organic materials that pollute the water.



5. The aerated water moves to final settling tanks, where additional settlement occurs. These solids are removed and join the primary sludge for further processing. The water, after being treated with chlorine, is released as effluent into a nearby waterway.



6. Thickeners are added to the sludge, while additional water is removed from it and treated. The material sits for a day to allow the solids to become more concentrated.



7. The solids are sent to a final set of oxygen-free tanks, called digesters, which are heated to 95 degrees Fahrenheit to stimulate the growth of anaerobic bacteria, which will consume the organic material in the sludge over a period of 15 to 20 days.

Wastewater Treatment

Typical municipal wastewater treatment uses a combination of synthetic physical processes along with chemical and biological processes to remove contaminants from sewage. The process is usually broken down into 3 parts, Primary, Secondary, and Tertiary Treatment. The first stage consists of removing solids from the waste stream. Following this, dissolved biological matter is converted into a solid mass, using bacteria found inherently in water. Lastly, these solids are neutralized then disposed of or reused, and the treated water is to be disinfected by chemical or biological means. The effluent from the wastewater treatment plant (WWTP) is then discharged into a body of water, which may include a phase of further natural biological filtration such as that found in a lagoon or wetland.

4.12 | Wastewater Treatment

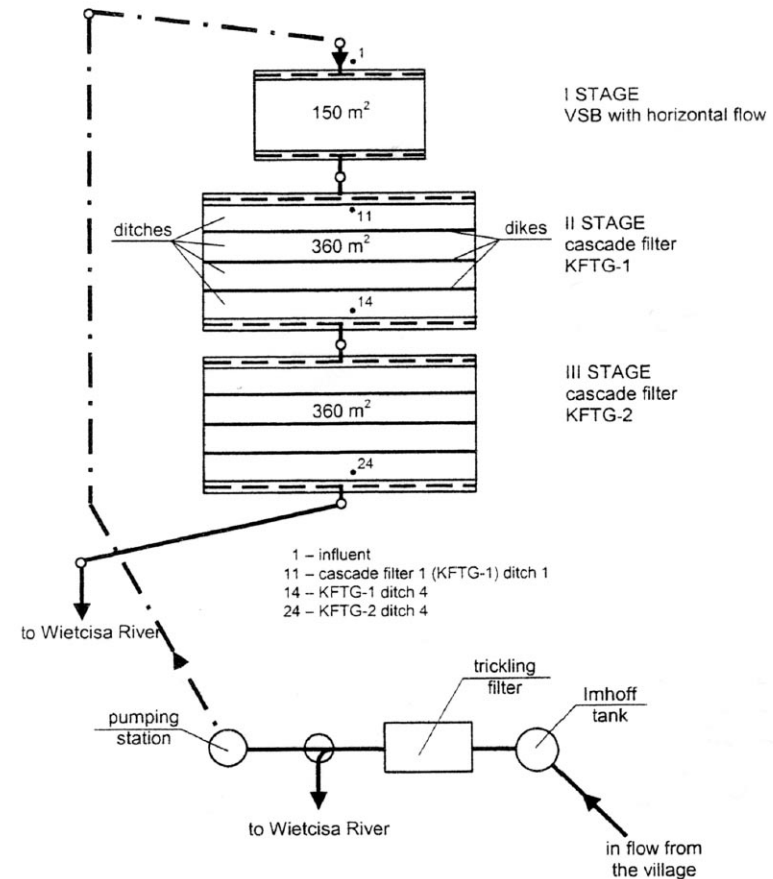
Typical components of a municipal waste water treatment system.

Constructed Wetlands

“The modern process of formally creating wetlands to function as centers for wastewater or contaminant treatment is only several decades old. Surprisingly, it took engineers and scientists quite some time to realize that many of the biological breakdown processes that they were endeavoring to construct within the controlled environments of sewage treatment plants mimicked processes that already existed naturally in many wetlands.”¹⁹

Having observed the capabilities of natural wetlands to absorb and transform potential contaminants in our water-based connected systems, it is only logical to introduce this property into our synthetic and cultural infrastructures. Constructed wetlands exhibit a capacity to dramatically alter an organic material, from pesticides to cellulose, using microorganisms that employ an enzymatic or biological chemical process to ‘bioconvert’ a particular substrate.²⁰ This goal of bioconversion is central to the function of constructed wetlands as they yield through this process carbon dioxide, biomass and detoxified water. The microorganisms responsible for this bioconversion are inherently adaptive and therefore suited to such adverse environmental conditions, as through genetic modification, they are capable of producing new strains to survive varying hostile conditions which in some cases, allows them to detoxify their own surrounding environment.²¹, which collectively allows overall detoxification of water. This process can assist in the elimination or alteration of toxic metals, producing nontoxic forms. In pursuing the applicability of constructed wetlands, we can come across overarching precepts of their positive and negative aspects:

“Constructed wetland systems (1) are relatively inexpensive to construct and operate; (2) are easy to maintain; (3) provide effective and reliable wastewater treatment; (4) are relatively tolerant of fluctuating hydrologic and contaminant loading rates; and (5) may provide indirect benefits such as green space, wildlife habitats, and recreational and educational areas.



4.13 | Przywidz Wetland System

A schematic of the wetland system a Przywidz, Poland, designed as a hybrid system for the removal and retention of selected heavy metals. Sewage is treated in a conventional wastewater treatment plant, consisting of an Imhoff tank and trickling biofilter, followed by a reed inhabited wetland system used typically for treating domestic sewage.



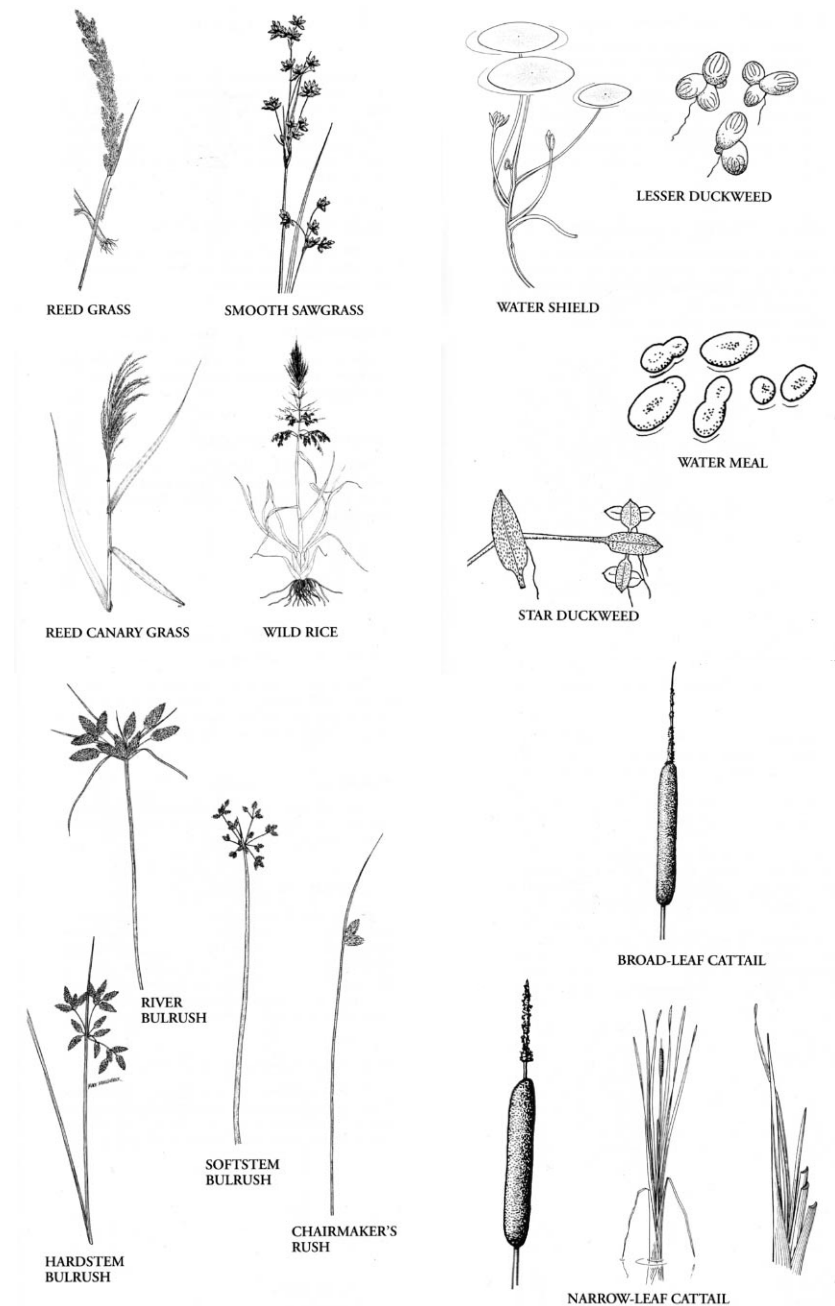
4.14 | Devil's Leg Waste Water Treatment Plant
 A 20 hectare waste treatment plant situated at Devil's Lake, North Dakota, USA, in a former wetland environment. Now, this system treats waste water using biological processes associated with a proprietary system utilizing floating aquatic plants that survive in all climates. Duckweed plants absorb and neutralize pollutants in the water, as well as stabilize biological processes in the pond, as was designed and intended by Viet Ngo/Lemna International.

*Disadvantages of constructed wetlands for wastewater treatment relative to conventional systems include: (1) relatively large land area requirements for advanced treatment; (2) current imprecise design and operating criteria; (3) biological and hydrological complexity and our lack of understanding of important process dynamics; and (4) possible problems with pests.*²²

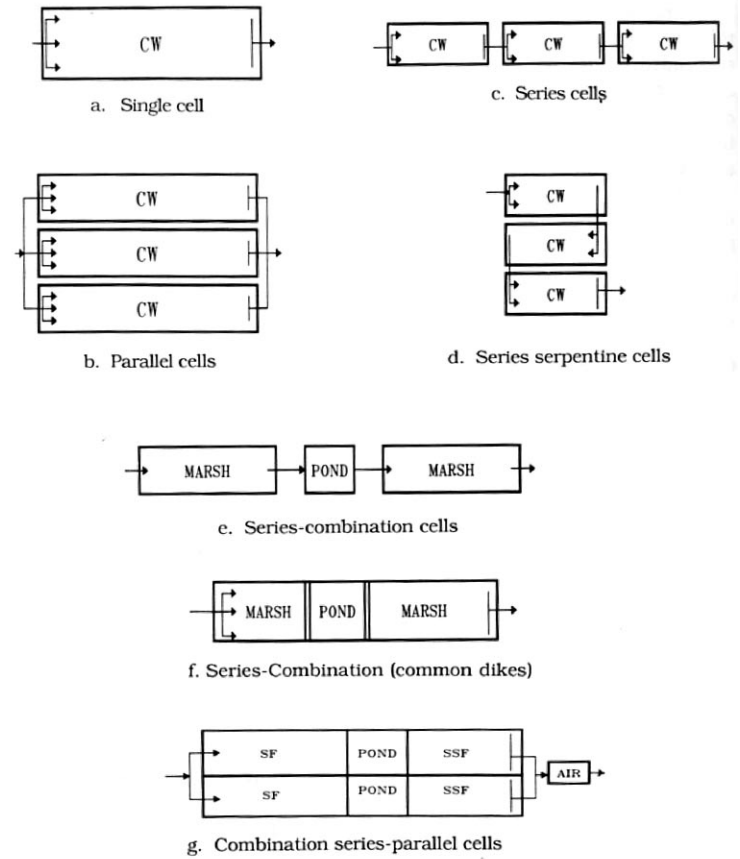
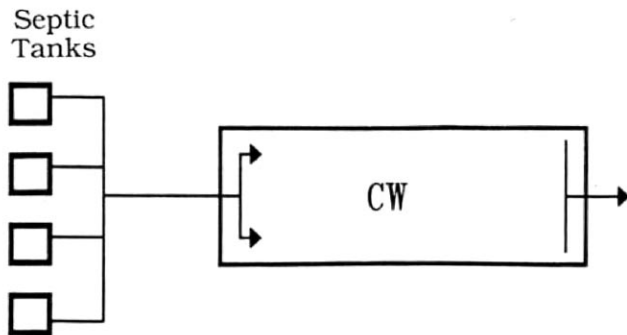
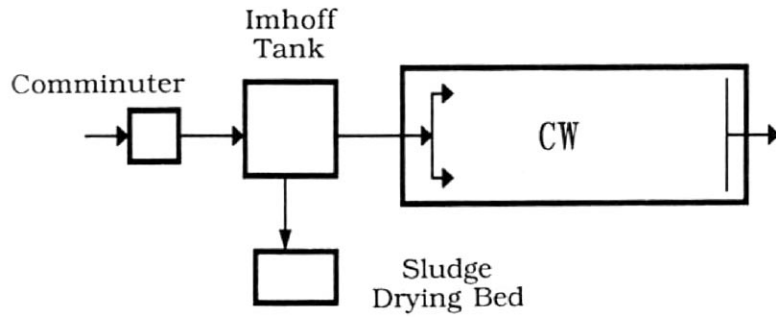
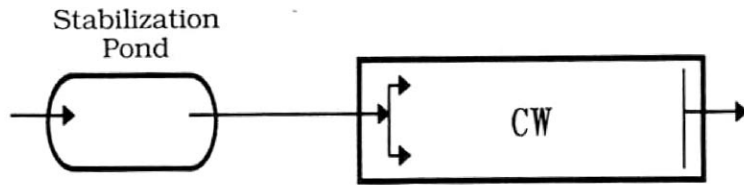
The apparent disadvantages of constructed wetlands are, however, primary reasons for further research and testing of such systems as we can yield potentially more beautiful and enjoyable environments, understand how to better integrate urban system with natural processes, and further catalogue or uncover these complex natural process themselves to achieve a greater body of environmental knowledge. Due to the limited information we currently have on wetlands, we are only beginning to understand plant adaptations to their environment and their subsequent effect on the environment itself.²³ While research continues into the effectiveness of constructed wetlands, certain figures relating to their implementation arise, specifically concerning the physical areas required for their construction, relating to their ability to remove or neutralize toxic substances. For instance, a typical three bedroom household would require approximately 100 m² of treatment wetland, roughly the size of a garage.²⁴ Meanwhile, the Prywidz wetland system in Poland corresponds to a 150 person equivalent at a flow rate of 22.5 m³/day, utilizing a total area of 870 m² for wetlands proper²⁵, suggesting an average area of 5.8 m²/person, suggesting a reasonable and efficient use of space. Applying this to a city is generally less determinable, as this would suggest a population of 500,000 would utilize an area of 2.9 km², yet the area would expand further if applied to the flow rate of typical WWTPs to figures upwards of 5 times this value. Yet, these figures become significantly misleading, as constructed wetland projects of this scale have yet to be accomplished, but are worth investigation through research and testing as we may increasingly integrate our infrastructures with natural systems.

Constructed Wetland Design | Connection and Configuration

Common practice in designing and building constructed wetlands involves separations of plant types and processes into varying and multiple cells, assisting with maintenance and operation as some cells may be temporarily shut down, cleaned out, harvested or replanted when required without disrupting the operation of the overall treatment system.²⁶ Further, a flexible system of outlets and connections between cells aids in regulating water level to promote their proper functioning.²⁷ As in a wastewater treatment plant, preliminary treatment, consisting of screening or comminution is done to remove coarse solids, is performed before wastewater enter the constructed wetland cells. This is done in conjunction with primary treatment to remove heavier solids and reduce organic load, accomplished with Imhoff tanks, septic tanks, stabilization ponds or a primary sedimentation tank.²⁸ Next, two primary types of wetland cells are used, being Surface Flow (SF), where water's movement is controlled by shallow depth, low flow velocity, plant stems and litter, and Subsurface Flow (SSF), wherein wastewater is routed through and below the surface of a permeable substrate supporting emergent vegetation.²⁹ Within the cells, various plants are placed in appropriate substrates depending on the flow desired, and depth of the roots. Common cells are based on marsh and meadow wetland types, with sand-gravel substrates, cattail (*Typha*) in marsh cells, and reed canary grass (*Phalaris*) in meadow cells. Additionally, pond cells assist with ammonia reduction and nutrient removal through algal uptake, as well as increased pH and nitrification. Additionally, pond cells can prevent short-circuiting and reestablish uniform flow distribution in a downstream cell, while also being ideal homes to fish such as *Gambusia* that can be stocked for mosquito control. The sequencing and arrangement of wetland cells should enhance wastewater distribution, thereby maximizing contact between wastewater, substrate and vegetation in minimizing short-circuiting.³⁰ By varying the sequencing and connections between cells, greater variation of processing waste can occur while inherently adding control to the system.



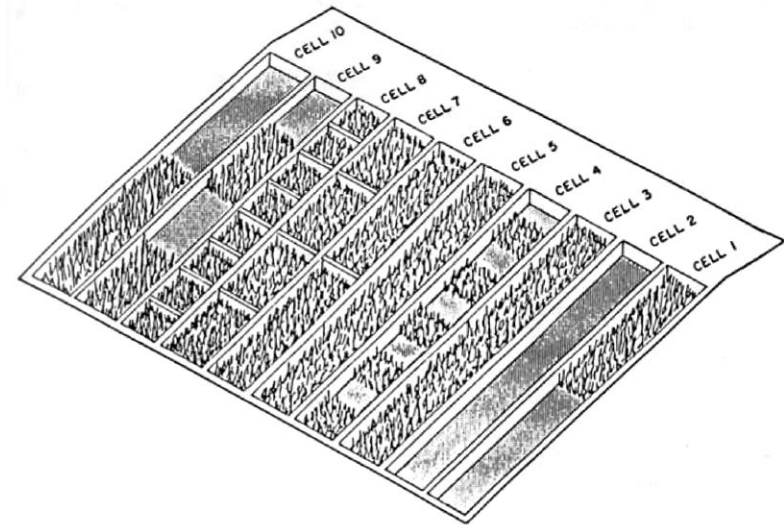
4.15 - 4.18 | Examples of Typical Wetland Plants



4.19 - 4.20 | Wetland Cell Configuration and Flow Patterns
 Varying flow schemes for preliminary and primary treatment and constructed wetlands (left). Different configurations for constructed wetlands, incorporating Surface Flow (SF) cells, Subsurface Flow (SSF) cells, and Ponds (above).

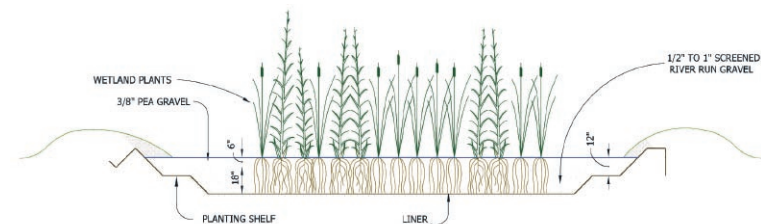
Constructed Wetland Cell Development

While many guidelines have been established for the design and implementation of constructed wetlands, ongoing testing and monitoring is key to developing and evolving the function of such systems. Many studies point to variety of cell types and altering the sequence of open pond cells and planted cells improve the overall ability to process wastewater. It would seem mimicking the variety and complexity of natural wetlands aids the construction of these synthetic ecosystems. However, the particular types of waste and plantings need to be considered together, as well as the compounded transformations that will occur within the living network as influents are changed in composition or quality, and the plant and microbial communities adapt to establish their own equilibrium with their dynamic environment over time.



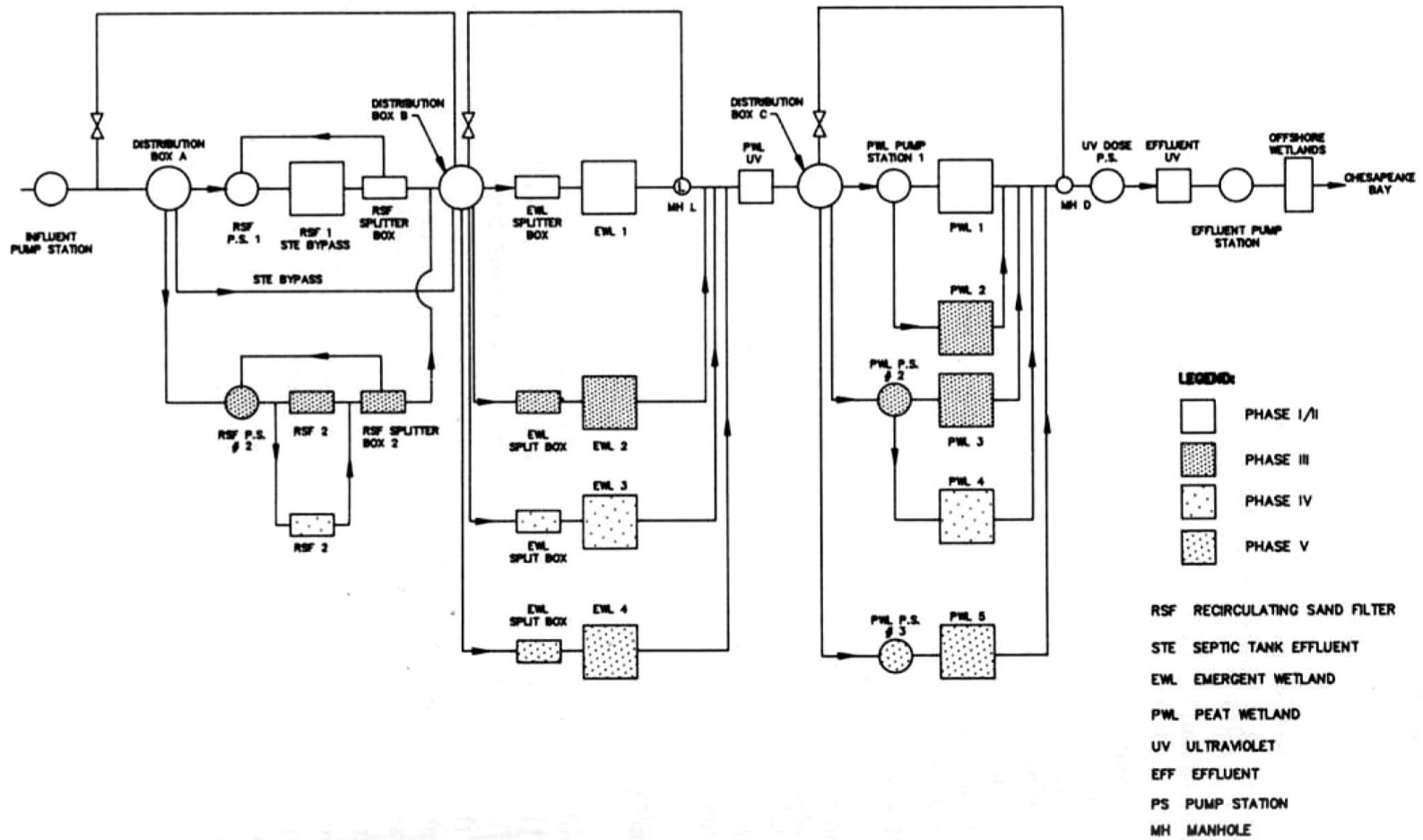
4.21 | Wetland Pilot Project

This constructed free surface wetland pilot project was conducted as a study in Arcata, California, USA. Various vegetation harvesting patterns along with cell configurations were tested, revealing the greatest suspended solids removal, and lowering of biological oxygen demand occurred in those plots that exhibited the most variation, through harvesting and compartmentalization, as in cells 4 and 8.



4.22 | Wetland Cell Section

Typical components of a constructed wetland, as demonstrated by John Todd's Ocean Arks International.



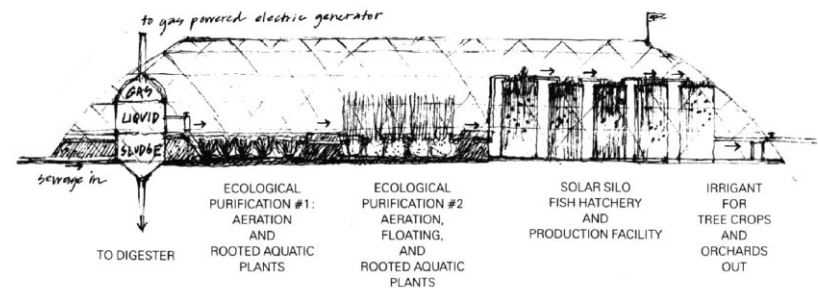
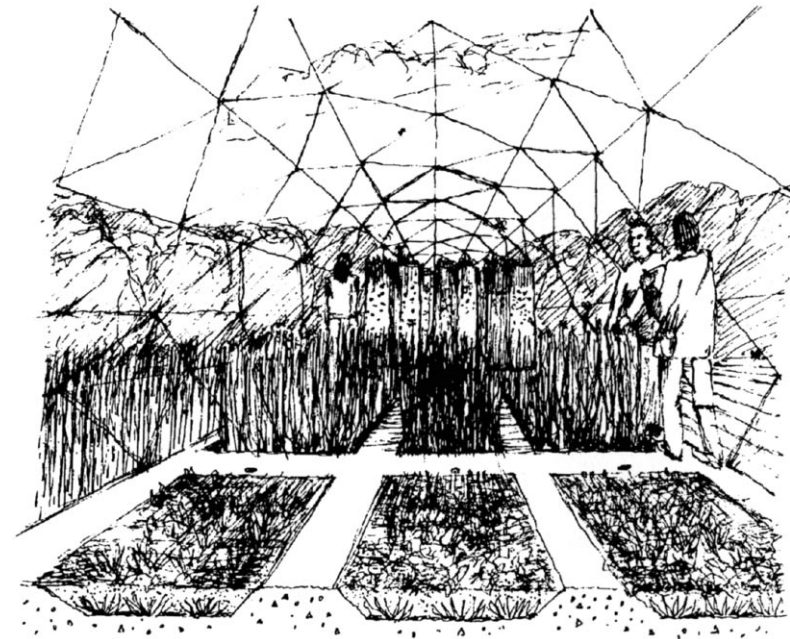
4.23 | Phased Wetland Design

The process flow design of a constructed wetland system for the Mayo Water Reclamation Subdistrict Large Communal Water Reclamation Facility (LCWRF). This system demonstrates a constant function, with the subsequent addition of new components and wetland cells, along with the manipulation of the flow through the overall system.

Living Machines

John and Nancy Jack Todd, founders of Ocean Arks International, have developed systems and technologies incorporating specialized intricate biological processes to purify water while producing material for potential use as food or even electricity, using only light from the sun as an energy source. Known as Living Machines, these self-contained networks of ecological systems are developed for their specific need.³¹ They are often built within greenhouse structures to add to their management, but also to drastically improve their productivity due to the warm interior environment. Within these systems, waste acts as a resource for aquatic ecosystems composed of bacteria, algae, microscopic animals, snails, fish, flowers and trees.³² Such constructions generally cleanse water as effectively, if not more so, than most treatment plants, while costing less than typical secondary treatment methods. Within such systems, further productivity gains may be achieved through biogas and electricity generated from the plants and sediments, while these hybrid mechanisms may also act as fish hatcheries, utilizing the heated and sterilized water reservoirs. John Todd views current wastewater treatment processes as not only inadequate, but also of great economic and environmental expense:

“Currently, the wastewater treatment industry is itself a major polluter. It can be faulted on at least three fronts. Technically, it produces byproducts in the form of sludges that are difficult to dispose of and often toxic. Chemically, it uses hazardous compounds in the treatment process, all of which end up in the environment. Chlorine, for example, is widely used and can combine with organic matter to produce chloramines, which are known carcinogens. Aluminum salts, also frequently used to precipitate out sludge and phosphorus, have been implicated in problems ranging from the weakening of the forests to Alzheimer’s disease. Further, the treatment industry is simply not cost effective economically.”



4.24 | Bioshelter

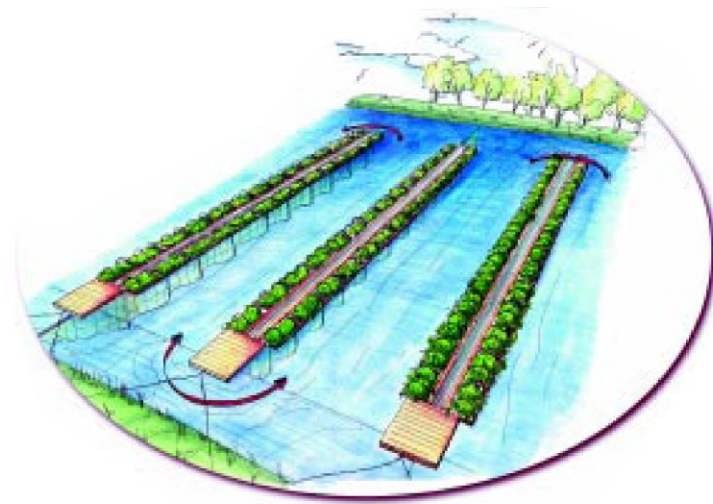
A Perspective and section through the combined system for sewage purification, aquaculture, and a gas/electricity facility. This system presents an early model for the living technologies later utilized in Todd’s Living Machines.



*Advanced wastewater facilities cannot be built and operated without massive federal subsidies. Nor do conventional waste treatment technologies produce anything in the way of economic by-products to offset their operating costs.*³³

However, Todd does not dismiss current technologies outright, but points to their usefulness and prospective incorporation into living systems. Todd cites Lewis Mumford's words on the subject from his book *The Pentagon of Power*, suggesting a need to better understand natural processes in order to further implement and advance our own technologies:

*Teamed with intelligent and sensitive monitoring and information technologies the horizon expands. Toward the end of The Pentagon of Power Dr. Mumford summarizes, "If we are to prevent megatechnics from further controlling and deforming every aspect of human culture, we shall be able to do so only with the aid of a radically different model derived directly, not from machines, but from living organisms and organic complexes (ecosystems). What can be known about life only through the process of living—and so is part of even the humblest of organisms—must be added to all the other aspects that can be observed, abstracted, measured."*³⁴



4.25 | Restorer

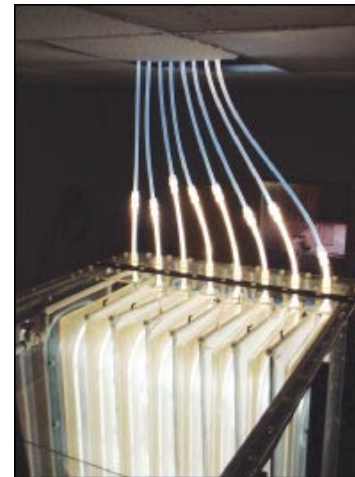
Ocean Arks International's Restorer technology, incorporating floating piers of Living Machine type cells, treating water as it is guided through the system.

Algae Photo Bioreactor

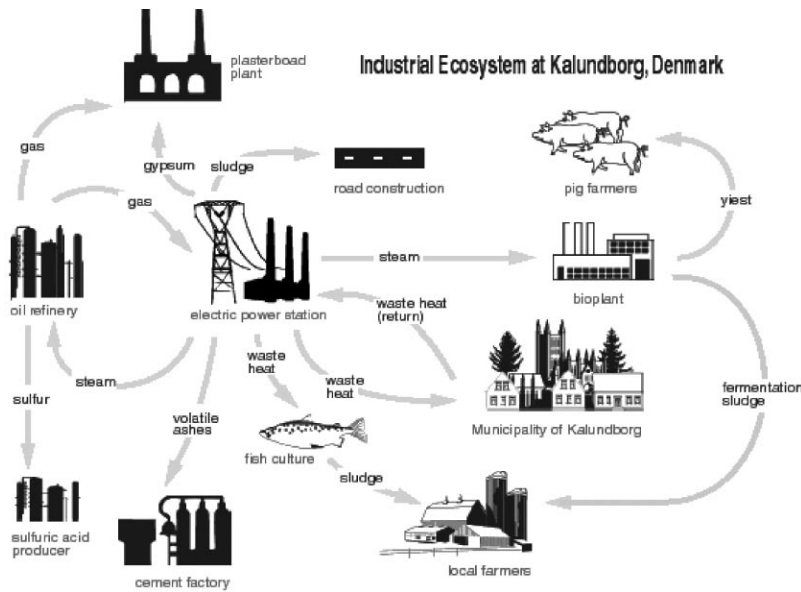
These prototype systems exhibit the potential conversion of CO₂ from industrial plant flue gases to biomass, and absorption of other industrial air-bound pollutants by pumping algae through translucent tubes. Further, Algae itself can be used as biomass for fish feed, or has the potential as a crop fertilizer. As well, recent developments suggest fuels including biodiesel, ethanol, methane might be extracted from algae, being a rich source of natural oils³⁵. These in turn could be converted to bioplastics or assist in making hydrogen for evolving fuel-cell technologies. Algae, composed of simple single-cell organisms, also needs approximately 10% of full-strength sunlight for growth³⁶, and thus can be grown in stacked translucent tubes, or be supplied light from fibre optic solar collectors, allowing such technologies to be used in interior or even subterranean locations. The effort to combine these related Algae-based technologies promises to yield many alternative systems to counteract rising energy costs and concerns of pollution and CO₂ related climate change.



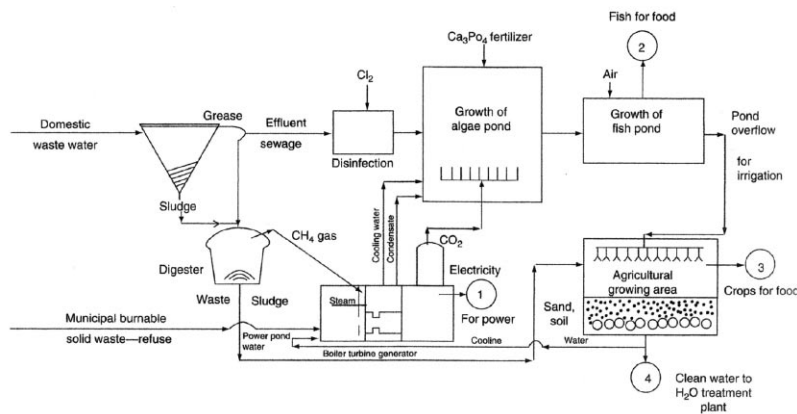
4.26 | Algae Fuel Field
A conceptual rendering of a field containing the Solix Algae Photo Bioreactor system, which may be used to produce biodiesel fuel, extracted from the algae grown in translucent tubes.



4.27 | Glow and Grow
Fibre optics channel light screens placed between glowing plates where algae can grow.



4.28 | Kalundborg Industrial Ecosystem



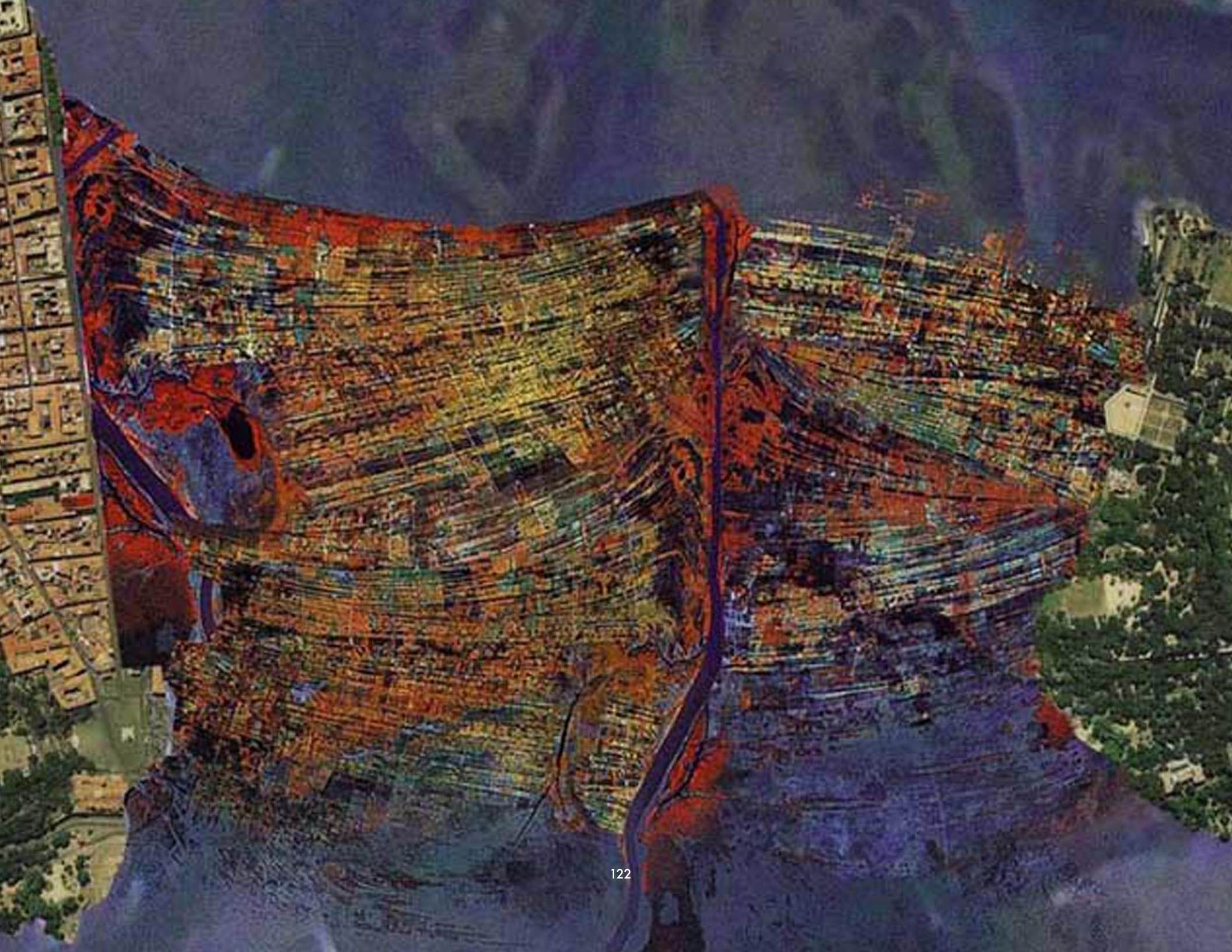
4.29 | Food, electricity and water production plant

Industrial Ecosystems

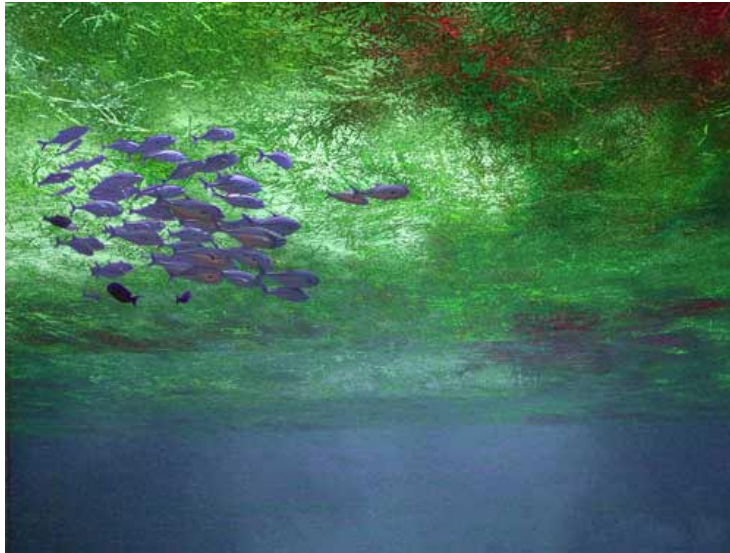
Increasing issues arise in developing appropriate and sustainable means of treating industrial wastewater and other production and manufacturing wastes. Certain types of such wastes may be introduced into municipal wastewater treatment plants, but the chemistry of such water must be controlled and specified. The issues of developing processes of industrial waste treatment are becoming an ever widening polemic, as more complex synthetic compounds are created and larger amounts of toxic effluents are formed from a broadening range of industries. However, many industrial sources, such as steel mills, have invested interest in minimizing the release of certain materials into the environment, as often these can be recycled and reused within their own plants. Although, a growing urgency for finding interconnected methods of production and processing continues to rise. Industrial ecosystems seek to close the loop within industrial processes, as we are finding wastes from some industries can become the raw material for others. Such systems are illustrative of our contemporary need for the combination and crossing of processes, even if isolated within procedures of manufacturing, as we begin to look to ecological models to operate. To this, Leland Dadson writes about one of the most advanced industrial ecologies established to date; that of Kalundborg, Denmark:

“At Kalundborg, steam and various raw materials such as sulfur, fly ash and sludge are exchanged in what is the world’s most elaborate industrial ecosystem. Participating firms each benefit economically from reduce costs for waste disposal, improved efficiencies of resource use and improved environmental performance. For example, gas captured from the oil refinery which had previously been flared off is now sent to the electrical power station which expects to save the equivalent of 30,000 tonnes of coal a year. By the year 2000, Denmark, a clear international leader in promoting sustainable development, will establish regulations that require that virtually all discharges by industries be in the form of products that can serve other useful purposes.”³⁷

1. Ian L. McHarg, *Design with Nature* (Garden City, N.Y.: Doubleday, 1971), 50-51.
2. John Todd and Nancy Todd, *From Eco-Cities to Living Machines: Principles of Ecological Design* (Berkeley, Calif.: North Atlantic Books, 1994), 29.
3. McHarg, *Design with Nature*, 7.
4. Theodor Schwenk, *Sensitive Chaos: The Creation of Flowing Forms in Water and Air* (London: R. Steiner, 1965), 78-79.
5. R. L. France, *Wetland Design: Principles and Practices for Landscape Architects and Land-use Planners*, (New York: Norton, 2003), 15.
6. Donald A. Hammer, ed., *Constructed Wetlands for Wastewater Treatment: Municipal, Industrial, and Agricultural* (Chelsea, MI: Lewis Publishers, 1989), 5.
7. *Ibid.*, 8.
8. France, *Wetland Design*, 28.
9. Hammer, *Constructed Wetlands for Wastewater Treatment*, 10.
10. *Ibid.*, 14.
11. *Ibid.*, 12.
12. France, *Wetland Design*, 14.
13. Hammer, *Constructed Wetlands for Wastewater Treatment*, 6.
14. *Ibid.*, 13.
15. *Ibid.*, 12.
16. France, *Wetland Design*, 61.
17. *Ibid.*
18. Hammer, *Constructed Wetlands for Wastewater Treatment*, 15.
19. France, *Wetland Design*, 16.
20. Hammer, *Constructed Wetlands for Wastewater Treatment*, 90.
21. *Ibid.*, 99.
22. *Ibid.*, 16.
23. *Ibid.*, 73.
24. France, *Wetland Design*, 51.
25. Û Mander and P. D. Jenssen, eds., *Constructed Wetlands for Wastewater Treatment in Cold Climates* (Southampton, UK: Boston : WIT Press, 2003), 301.
26. France, *Wetland Design*, 57.
27. *Ibid.*, 68.
28. Hammer, *Constructed Wetlands for Wastewater Treatment*, 364.
29. *Ibid.*, 363.
30. *Ibid.*, 364.
31. Todd, *From Eco-Cities to Living Machines*, xvii.
32. *Ibid.*
33. *Ibid.*, xvi.
34. Lewis Mumford, "The Pentagon of Power," quoted in John Todd and Nancy Todd, *From Eco-Cities to Living Machines: Principles of Ecological Design* (Berkeley, Calif.: North Atlantic Books, 1994), 74.
35. The Warren Centre for Advanced Engineering. "Algae Bioreactor to Generate Biofuels from Smokestack CO₂," <http://www.warren.usyd.edu.au/bulletin/NO47/ed47art4.htm> (accessed November 21, 2007).
36. Patrick DiJusto, "Blue-Green Acres," Scientific American Inc., <http://www.sciam.com/article.cfm?id=blue-green-acres> (accessed November 21, 2007).
37. Dadson, Leland Thomas, "Instrumental Matrix: Regenerative Systems in Hamilton, Ontario," (master's thesis, University of Waterloo, 2005), 205.

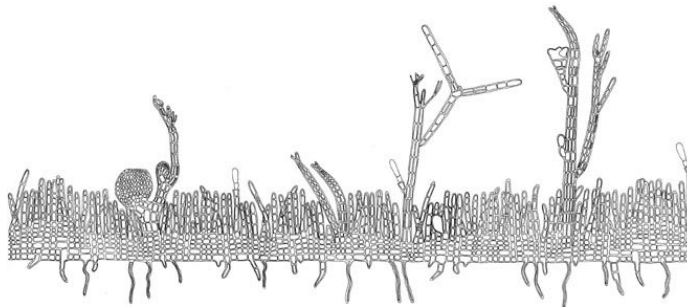


Fields of Visions



Also stemming from the origins of Fuller's Geoscope as a tool of environmental observation and manipulation, these fluid projects materialize various emerging realms of design associated with hybridized technological and biological functions. These precedents for the design of interconnected cultural and natural systems imply a mode in which the condition of fields, landscapes, and immersive complex structures might support an integration of social and cultural dynamics, such that one might inform the other. These systemic landscapes offer novel and creative views of the world, as they present us with natural systems and processes, modify the environment in their interconnection to it, and project future transformations that might become of the earth's surface. These works of designed space present architecture in terms of ubiquitous, responsive composite environments, as they are now ambient architectures, and immersive icons.

One such project is Aniko Meszaros' 'Plant Anima' project; a genetically engineered landscape of microscopic plant species floating to form a thin film on the surface of water, becoming a living bridge of connective tissue between adjacent areas of land. Though the project is a great biotechnological endeavor, it is rooted in aesthetic craft, tying natural process to creative manipulation.



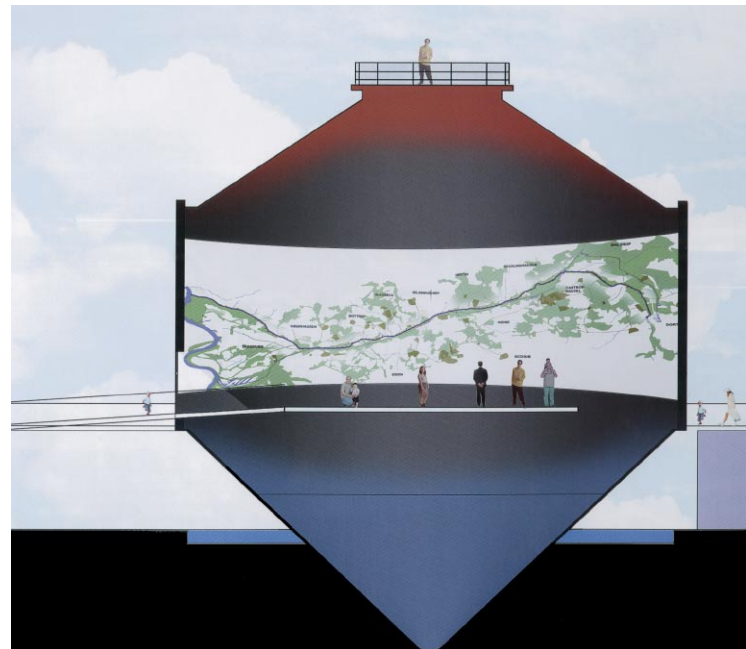
5.0 - 5.2 | Plant Anima
The genetically designed wilderness environments of Aniko Meszaros' plant anima project.

"Biotechnology proposes new possibilities of aesthetic invention and the exploration of ideas of beauty. The possibility indeed exists to begin literally to conceive and design the world of nature and its elements. Individual plants, groupings of species, and even entire ecosystems, can be crafted biologically with the precision and control of production methods within creative traditions. The design of a new nature can extend beyond its historical position within the practices of topiary and agriculture into the creation of entirely new vegetal territories of habitation."¹

Fluid Perception | An Aesthetic Quagmire

Through systems and structures of observation, we arrive to the creation of a new aesthetic derived from processes involved in wastewater treatment, and industrial processes in general, as they relate to the creation and maintenance of the health of the environment, and the aesthetic experience and understanding of our place within the world. This new aesthetic moves toward a conscious manipulation of our environment as part of the evolution and response the planet. Through this, it is appropriate to question the presence of the subconscious of the environment; the other side of the noösphere. Interestingly, we might conclude that wetlands traditionally have fulfilled this position, perceived as places of darkness, chaos and evil. This is pursued by Richard C. Smardon who has studied the perception of wetlands as it relates to their creation, design, and cultural success or complete aversion within his discussion *Human Perception of Utilization of Wetlands for Waste Assimilation, or How Do You Make a Silk Purse Out of a Sow's Ear?*:

"A negative attitude toward wetlands can be traced, in many cases, to our European ancestors. The "bog-swamp" mythology developed in Europe, where people thought pixies, heathens, and strange mythical creatures lived in wetlands, was brought across the Atlantic and intensified with more stories of wolves, wild dogs, crop-destroying hordes of crows, and quicksand. Attitudes toward wetlands changed from fear to indifference after the industrial revolution. Wetlands were commonly believed to be wastelands good for nothing except causing disease and producing mosquitoes. In fact, and English scholar has noted that "wetlands have been significant mainly at half-conscious or subconscious levels of culture," and that "the psychology of wetland experiences has been such as to render them rather easily repressible."²





Even with a changing image and revaluation of the role of wetlands in a larger ecological context, our traditional sentiments and reactions to them are still present. Yet, could this not enter a new mode of aesthetic; a new way of receiving these environments into our consciousness by virtue of their apparent anti-aesthetic, or alternative mood, which could in turn produce a deeper, more comprehensive understanding? Leo Marx discuss the effective allegiance we have intrinsically to certain, typically rural, landscapes. His 'Pastoralism of the Mind' is an interesting case of the limitations to our aesthetic experience of the world, to which he sends a warning of the dangers our environmental preference could yield:

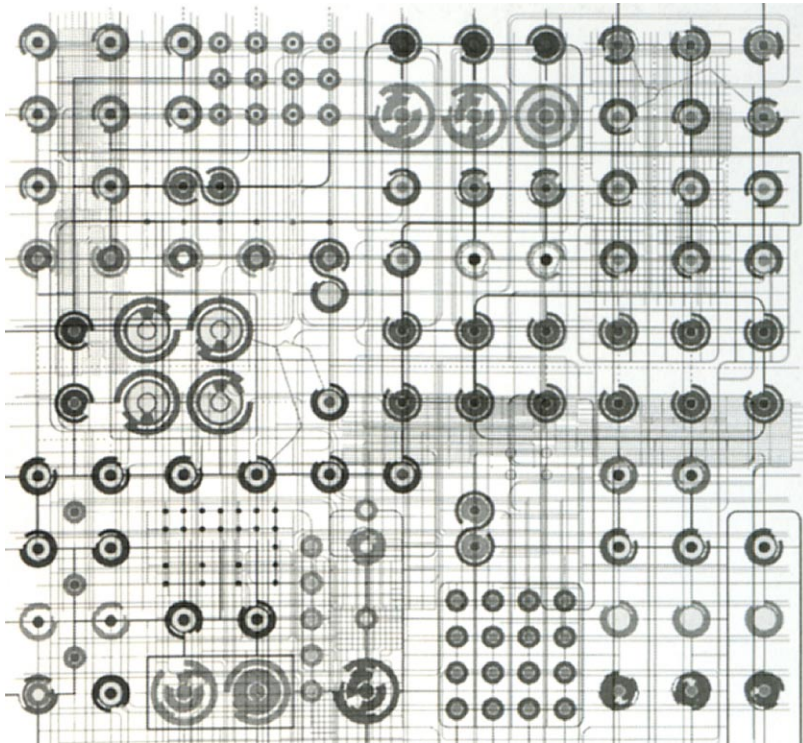
"Aided by the insights of Freud, Ortega, and the historians, we may begin to characterize the dominant motive back of this curious state of mind. Evidently it is generated by an urge to withdraw from civilization's growing power and complexity. What is attractive in pastoralism is the felicity represented by an image of a natural landscape, a terrain either unspoiled or, if cultivated, rural. Movement toward such a symbolic landscape also may be understood as movement away from an "artificial world, a world identified with "art," using this word in its broadest sense to mean the disciplined habits of mind or arts developed by organized communities. In other words, this impulse give rise to a symbolic motion away from centers of civilization toward their opposite, nature, away from sophistication toward simplicity, or, to introduce the cardinal metaphor of the literary mode, away from the city toward the country. When this impulse is unchecked, the result is a simple-minded wishfulness, a romantic perversion of thought and feeling."³

5.3 - 5.5 | Restoration of Emscher River (Opposite Page)

Located in the Ruhr Valley, Germany, this interpretive landscape by Atelier Dreiseitl modifies a former water treatment plant into an industrial park and information centre.

5.6 - 5.7 | Nantes Water Treatment Plant

Edouard François drawings emphasize a synthetic rapport between the facilities function and nature, where both the operation of the plant and symbolic and aesthetic qualities of this amalgamated environment play off one another.



5.8 | Urban Waterways

A conceptual diagram of a field of cartridge filtration columns, proposed for the 2004 Burnham Prize Competition by WilliamsonWilliamson, a Toronto, Ontario based architecture and design firm. Part of a larger vision for the Chicago River, this presents an articulated system of water filtration wherein the purifying mechanisms are exposed, in a complex manifold array.



5.9 - 5.10 | Glowing Rivers

Conceptual renderings of a prototype for a public indicator of water quality, deployed in the East River of New York City. Colour here indicates whether the water is safe (above) or unsafe (below).

“Under every city there is a dark and hidden Venice, but we no longer celebrate our waterways out in the open. In its myriad cycles water is the source of all life, but when we, in industrial societies, harness it for our use in plumbing and sewage we keep it underground, in pipes as part of a system that is efficient for the user but displaces the problem to a distant site. Here it becomes either a source of pollution or demands costly and energy intensive purification.”⁴

—John Todd, *From Ecocities to Living Machines*

Perhaps this limited aesthetic can be turned around and an embracing of the complex could emerge. The aesthetic of the complex is represented in the fluid projects shown here, demonstrating transformation and infinite interactions yield not only an immersion of activity, but also an atmosphere of surreality ranging from euphoria to complete discomfort, but strangely becoming a more accurate representation of reality, though being a complete synthetic creation. This created complexity may reveal the very multiplicity of interactions our environment exhibits, but could also create its own set of artificial connections, thereby risking a new blind allegiance to complexity itself.

Our models and visions of our environs are legitimized through their complexity, or rather, their interconnection to others models of our environment, as they forming meta-worlds, and sub-realities. But through this, complexity itself comes into question. Complexity, the engine of life, of consciousness, of creation is still an approximation of our world. Returning to our perception of reality, an aesthetic allegiance may be developing for that which is difficult to comprehend or observe as a whole, as though this quality in itself is not only true to the world, but also beautiful. Yet, we must not undermine our own aesthetic judgment, as it carries with it great capacities for comprehension, and affects decisions on a daily basis. This aesthetic of complexity generates a capacity for creativity, in as much as it may hinder our perceptions of reality. While moving toward a new aesthetic of the complex we inadvertently create a cultural complex of the aesthetic. It is within this dilemma that design takes place.

Pleasant Response

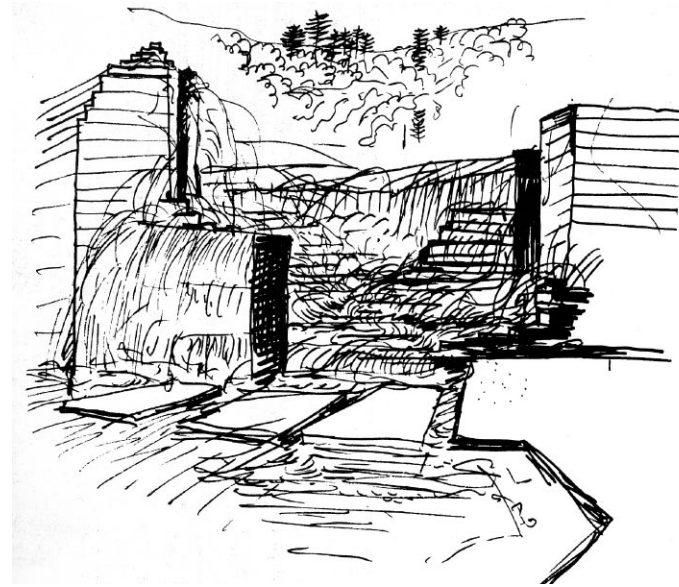
In confronting the limitations of typically static design tools and our own incapacity to completely foresee the impacts of our structure on people and the environment, Lawrence Halprin developed a new means to free the creative process by making the process, itself, visible.⁵ Termed as ‘Scoring’, this new dynamic model of design emulates a way making place by integrating its inhabitants in its creation, to the same effect as a musical score sets out the notes to be played, later to be interpreted by the musician. Put another way, Halprin devised a conceptual and graphical method for encouraging temporality and therefore responsiveness in the built environment that encourages visitors to engages spaces by bringing to them both creativity and life. Halprin’s literary opus, *The RSVP Cycles*, outlines the notion of a creative feedback loop as a new method of design. The acronym, RSVP, of course initially invokes the idea of response, but the meaning expands as Halprin unveils the operations of this new design process:

- “R *Resources which are what you have to work with. These include human and physical resource and their motivation and aims*

- S *Scores which describe the process leading to the performance*

- V *Valuation which analyzes the results of action and possible selectivity and decisions. The term “valuation” is one coined to suggest the action-oriented as well as the decision-oriented aspects of V in the cycle.*

- P *Performance which is the resultant of scores and is the “style” of the process.”⁶*



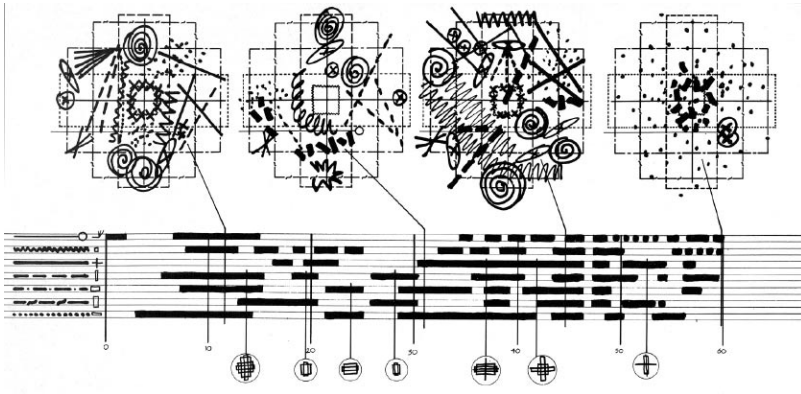
5.11 - 5.12 | Lovejoy Plaza, Portland, Oregon



A redefinition of role is then central to Halprin's design method, altering visitors or inhabitants of such projects into central actors in these works. This brings about a further reevaluation of the designer's imposition, as they are now a contributor to a collective environment.

"We are searching for ways to break down this dichotomy—for ways to allow people to enter into the act of making art as part of the art process—of open-ended scoring devices which will act as guides not dictators. These kinds of scores have the built-in possibilities for interaction between what is perceived beforehand and what emerges during the act. They allow the activity itself to generate its own results in process. They communicate but do not control. They energize and guide, they encourage, they evoke responses, they do not impose.

This redefines the role of the artist. It is no longer adequate for him to be a solitary "hero." He is repositioning himself in society and relating once again to the whole community."



5.13 - 5.14 | Overhoff-Halprin Fountain

A time-based sculpture and its associated 'score' diagram come together to make the work a dynamic interactive performance.

Atmospheres

Two models of demonstrating cloud phenomena as an immersive experience. The first example in some way still objectifies the dynamic display, while the second allows it to expand seemingly infinitely. Both models are well suited to being interpretive material, but offer diametrically opposed involvement with the material and its perception. What is further evident from these projects, however, is their approach to exposing phenomena through an association to ambient qualities of mood, though the emotion itself is ambiguous. The ambivalence of experience in such environments encourages deeper speculation and perhaps introspection into one's aesthetic experience. By contemplating the emotive and sensorial effects in addition to the observed phenomena itself, a new relationship comes forth between experience and place; one of continual response and environmental empathy.

5.15 | Gelsenkirchen Cooling Tower

Converted from a cooling tower in the Ruhr city of Gelsenkirchen, Germany, Herbert Dreiseitl has created an immersive centre to display some of the phenomenological aspects of water. Encompassed by swirling clouds, visitors stand on a glass mezzanine floor, viewing the ephemeral fluid movements of the display against the rigid latticework supporting the structure.

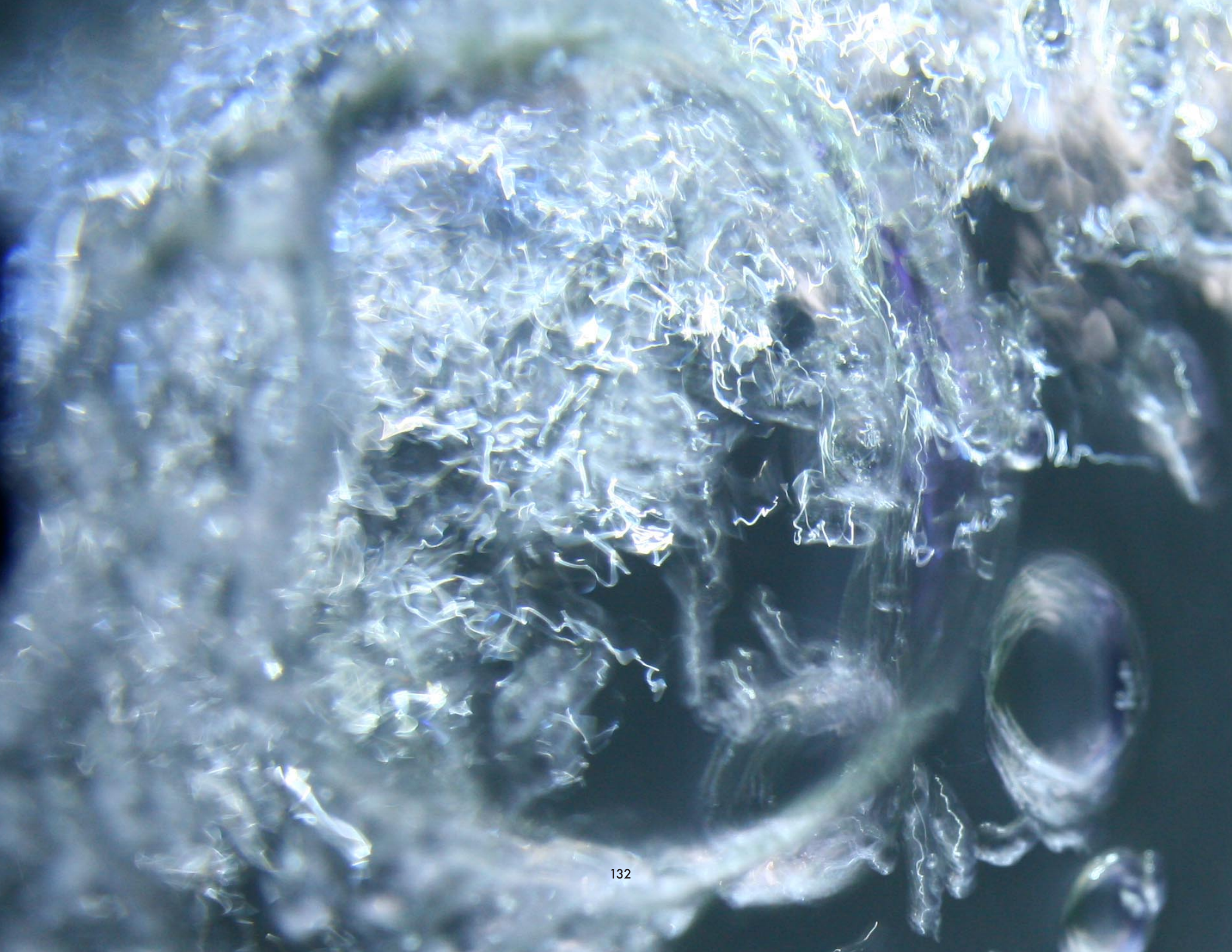




1. Aniko Meszaros, "Plant Anima Project," <http://www.anikoland.com/instruments.html> (accessed April 4, 2008).
2. Richard C. Smardon, "Human Perception of Utilization of Wetlands for Waste Assimilation, or How Do You Make a Silk Purse Out of a Sow's Ear?" in *Constructed Wetlands for Wastewater Treatment: Municipal, Industrial, and Agricultural*, ed. Donald A. Hammer (Chelsea, MI: Lewis Publishers, 1989), 287.
3. Leo Marx, *Machine in the Garden: Technology and the Pastoral Ideal in America* (New York: Oxford University Press, 19uu), 9-10.
4. John Todd and Nancy Todd, *From Eco-Cities to Living Machines: Principles of Ecological Design* (Berkeley, Calif.: North Atlantic Books, 1994), 98.
5. Lawrence Halprin, *RSVP Cycles: Creative Processes in the Human Environment* (New York: G. Braziller, 1969), 3.
6. *Ibid.*, 2.
7. *Ibid.*, 19.
8. *Cyber_Reader: Critical Writings for the Digital Era*, ed. Neil Spiller (London: Phaidon, 2002), 153.
9. Gyorgy Kepes, *Arts of the Environment* (New York: G. Braziller, 1972), 3.
10. *Ibid.*, 5.
11. *Ibid.*, 6.
12. *Ibid.*, 11.

5.16 - 5.17 | Blur Building

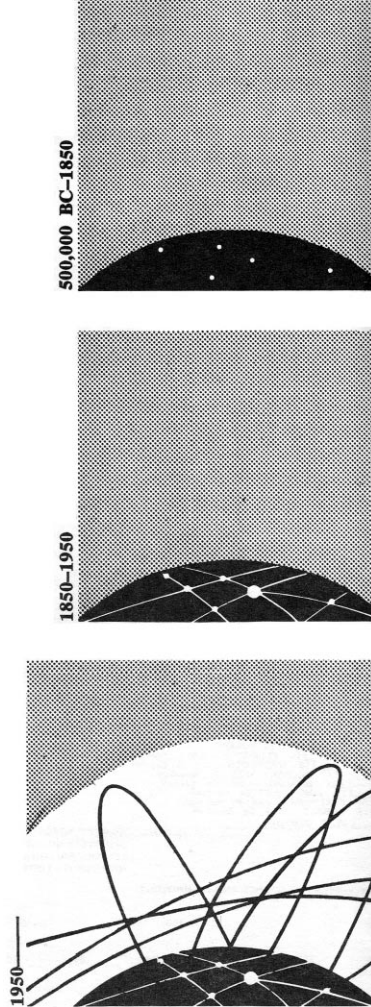
Diller + Scofidio's Blur Building for Expo. 02, Arteplage, Yverdon-les-Bains, Switzerland. This temporary pavilion set out to challenge notions of material qualities in architecture, while creating distinct ambience for visitors absorbed within this synthetic cloud engulfing the delicate structure of this raised island, itself surrounded by water.



Connected Fields

Emanating from the Landscape and its primary precedent, the Geoscope, a collection of theories and discussions form an interconnected array of connected fields of research that describe our evolving relationship with the earth. This discourse begins with an overview of spheres; models of the living earth best represented in the Biosphere, Gaia, and the Noösphere. To comprehend these models, an evolution of perception has equally occurred, as described in Gestalt psychology and the subsequent development of technologies of observation and communication described by Marshall McLuhan. Conveying the complexities of the environment, as it is now observed, is then first reviewed within the theories of Ian McHarg who utilizes mapping as a primary tool to uncover and comprehend the elaborate connections of ecosystems. A further conceptual model derived from such natural systems is elaborated upon in the essay on the 'rhizome' by Gilles Deleuze and Felix Guattari. Proposing such an amalgamation of conceptual and physical models of dynamic interconnected space are then reconceived in Jean Baudrillard's work *Simulacra and Simulation*, wherein a hyperreal environment is created in these connections of such models of our world. Such levels of interrelations give rise to a discourse on cybernetics, describing control, self-regulation and communication in natural systems and machines, whether considered separately or together. The amalgamative power of this realm of thought leads to Donna Haraway's reinvention of the human beings as a hybrid entity, or cyborg. As such, ontological questions arise as pursued by Brian Massumi in *Parables for the Virtual*, wherein the boundaries between human and computer become as ambiguous as notions of 'being' and 'becoming'. Lastly then, the Hybrid Condition returns us to question the development of consciousness as part of biological evolution and synthetic creation, which, through our own integration with the environment, will propagate in the proliferation of a conscious environment.





6.2 | Fuller's World

A diagram depicting the initial isolation of man, moving to the interconnection of systems on earth, to the total global connection achieved with air travel and radio communication. The image somehow foresees the evolution of conscious networks and media.

6.1 | The Geoscope, N.Y. (Opposite)

A vision of the Geoscope situated in contemporary New York city as Fuller had originally planned.

6.0 | Connected Fields (Previous Two Pages)

Geoscope

Buckminster Fuller's Geoscope stands as a primary source for the development of world design endeavors to create responsiveness, connectivity and complexity in the environment. Though Fuller's view tends to be politically charged (ironically inherent to his anti-political stance), and grounded more heavily in the technological aspects of global connectivity, his vision remains as one of tremendous optimism and potential for a dynamic relationship between all human beings and the processes of the earth.

Fuller's Vision

In his Keynote address for the Vision 65, World Congress on New Challenges to Human Communications, Buckminster Fuller exclaimed that 99% of the important work done by mankind goes unseen, as many of the great advances in technology and communication have been made in disciplines utilizing regions of the electromagnetic spectrum that are undetectable to man.¹ Fuller then suggests that key technological advancements act as catalysts for the progression of humankind. The technologies of detection, mapping, communications, and those of production represent the areas that will propel humanity forward. This thinking would directly oppose the political agendas and ideologies that are generally thought to run the world, as for Fuller the world's problems cannot be solved by politics and can only be solved by a physical invention-and-design revolution.² Fuller's devotion to physical designs coupled with his worldly thinking pushed him to generate some of the most compelling and captivating designs of the time—works that would take on relevance of a cosmic scale, while attempting to address the very needs of the individual. It was fitting, then, that individual human beings are located very much at the centre of the earth's processes, capable of controlling these dynamics through perceptual augmentation brought by

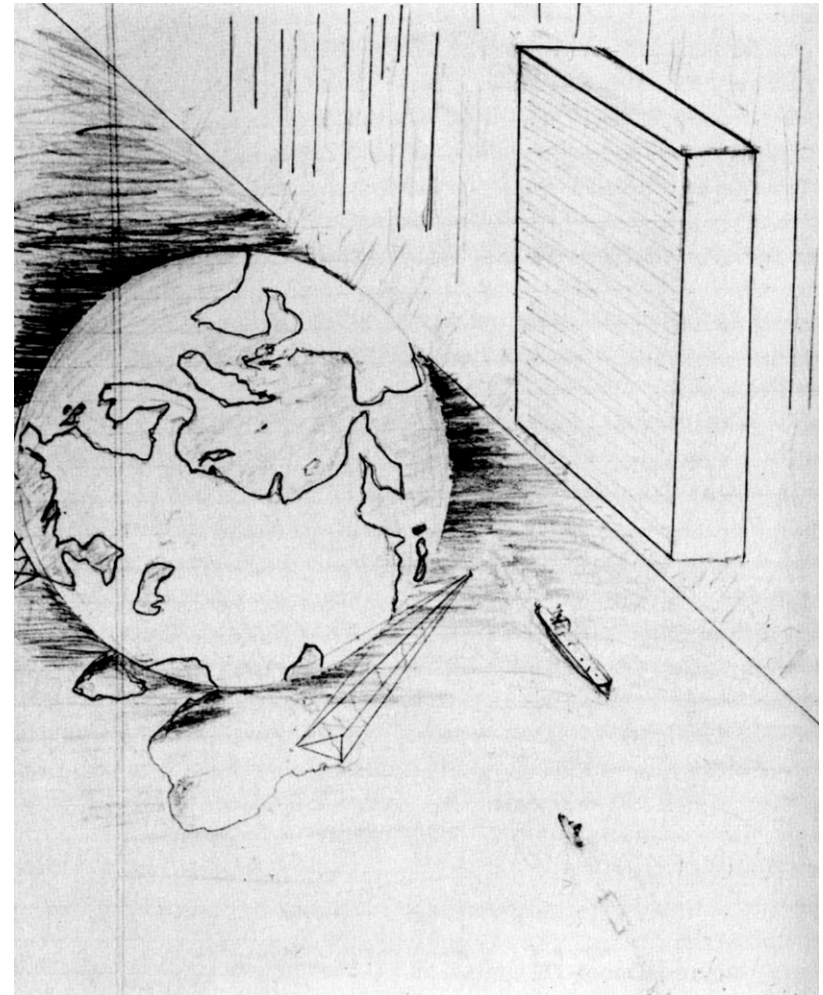
new and evolving technologies, allowing a greater connectivity between people and the world.

It is human will, especially that of the individual, that is fundamental to Fuller's beliefs, indicative of the American Capitalistic movements that are inherent to the 1960s, and the following decades of the Cold War and post-Second World War development of American culture. Simultaneously, however, Fuller envisioned a connected global unity that was present (and goes on to be sensed today), wherein the economic and ecological flows of the earth as a whole can be measured and made visible. These, for Fuller, were to be ultimately controlled in a global social movement, following the predictions and monitoring of these flows, observed and acted upon within his Geoscope.

Centre of the Sphere

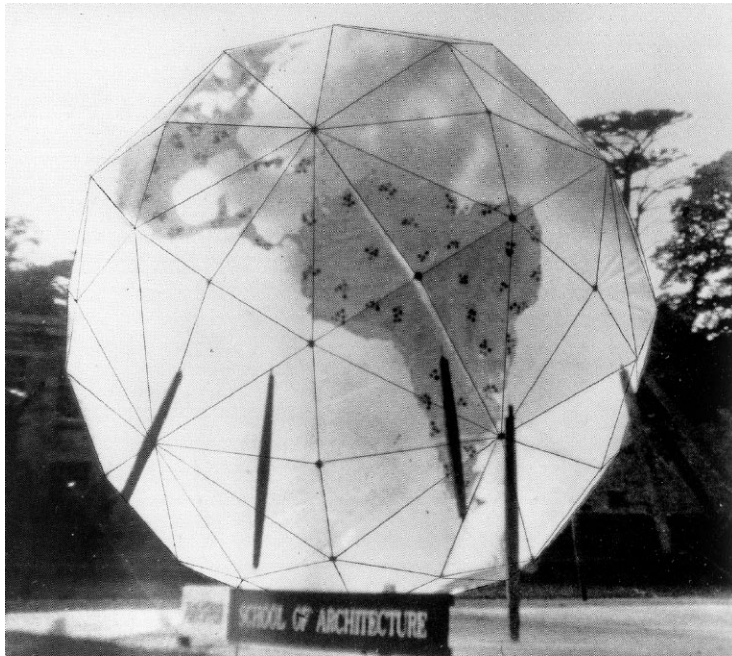
"The particular Geoscope that we think about a great deal is 200 feet in diameter. The reason that we have chosen that 200-foot size—which is about twice the diameter and eightfold the volume of the world globe at the New York World's Fair—is that if we use the aerial mosaic contact photographs taken by the Air Force at the lowest standard flight level, and put the whole world inventory of contact-size photographs together as a continuous spherical surface mosaic picture, they will make a 200-foot diameter globe. In the 200-foot-diameter spherical aerial mosaic we can see men's houses—but we can't see men. In a sense we can recognize man because we recognize his farm and his house. On a 200-foot globe, pasted up with an aerial photo mosaic, you could see all of humanity's highways, railways, towns, and houses. Any human could identify his home on such a sphere."³

Buckminster Fuller's dream of a perfectly calibrated machine for global control was that which ultimately led to his development of the Geoscope. He described the Geoscope as a 200-foot diameter globe, complete with an image of the entire earth visible inside and out, constructed from satellite photographs. This image



6.3 | Geoscope Sketch

A drawing by Fuller depicting a bird's-eye view of the Geoscope beside the UN building in New York City.



6.4 | The Geoscope, Nottingham

Though a fully operational geoscope was never built, many versions, at different scales were created. Here is a Geoscope model built at the school of Architecture in Nottingham, England.

would be of high enough resolution that individual houses could be seen, making the designed and built environment paramount to the overall system, as though the physical constructions of humankind become the necessary representation of their inhabitants. Architecture is now dynamic information.

The Geoscope is a system for global unity; unity created, however, through the sphere's operating as a central mechanism of control. Fuller professed his project was to be scientifically based and apolitical, yet there also seems to be a direct correlation to the global democracy that the United States attempts to create as a unifying agent in the world even today. Originally, this control centre for spaceship earth was to be built in New York City over the water near the United Nations building.⁴ The symbolism of this location, now officially marked as the centre of world, continues to resonate.

Lining this sphere were to be some 10 million electric light bulbs, all connected to a main computer, where one would in effect, have an omnidirectional "spherical" television tube which, seen from the United Nations Building, would have as good resolution as a fine-mesh halftone print.⁵ This screen would then be used to display collected information from around the globe, ranging from population data, to weather patterns, to economic flow, all updated in real time. The Geoscope, however, relies on our ability to understand the entire system of the earth's operations through images displaying the collected data of the earth's resources—surely a level of comprehension that would be difficult even to the greatest thinkers, and the most observant. What Fuller does address here, though, is a need for global understanding in an age where the world is shrinking rapidly.

Fuller's belief in the computer was so assured while visionary, that he felt computers could be used to gather data on language, to assist in finding their roots. He proposed using the computer to phonetically develop a world language, again with the concern in mind of establishing global connections and communication. As such, language would become a global equalizer through homogeneity.

Buckminster Fuller posited that ancient world maps were conceived as flat spaces, extending to infinity, but the contemporary conception of the earth places limits on its size and its resources. He also seems to point to a new thinking that eliminates the idea of boundary (at least on a nation's scale), where inside and outside are negligible, and the central point is the unity that exist in the world. Both of these ideas are embodied in the sphere of the Geoscope, as a sphere "is a mathematically finite or closed system. It is an omnisymmetrical closed system. A sphere is finite unity".⁶

World Games

Fuller proposed that his Geoscope would house the "World Games Series", used in the computer program "How to Make the World Work". The World Game itself is based on general systems theory, combined with von Neumann's game theory as "played" by the national defense and joint chiefs of staff in the development of computerized world-war games and the theory of world economic warfaring.⁷ The game then, relies heavily on Fuller's vision of an interconnected world, where energy itself (or electricity) would cross all nations in a large network. He held an extreme optimism, believing we could create an availability of resources in connecting them to all people, hoping this would eliminate all class struggles. Of course, this proposition relies on an assumption that we will surpass our traditions of constructing limits and borders within and between our societies.

"The general-systems-theory controls of the game will be predicated upon employing within a closed system the world's continually updated total resource information in closely specified network complexes designed to facilitate attainment, at the earliest possible date, by every human being of complete enjoyment of the total planet earth, through the individual's optional traveling, tarrying, or dwelling here and there. This world-around freedom of living, work, study, and enjoyment must be accomplished without any one individual interfering with another and

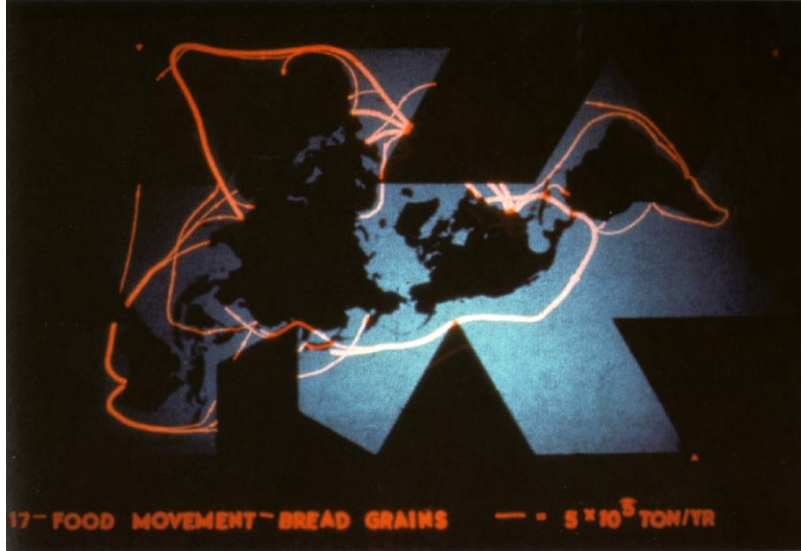
*without any individual being physically or economically advantaged at the cost of another."*⁸

As much as Fuller's goals of freedom and individuality are, today, primary constituents of human values and human rights, his particular vision of unity is strangely at odds with contemporary values of diversity, noted as important in both cultural and biological terms, for the Geoscope is predicated on a notion of singularity and centrality of control. Further, though Fuller's system and game was to support the rights of the individual, professed to be on a worldly scale, it has a particularly capitalist, if not American locality, and sensibility. But with the Geoscope's game in mind, Fuller really believed in a Utopia by augmented connection to the earth as a whole to bring about a single, peaceful unity.

With as much faith Fuller had in the development of technologies for connectivity and unity, the Geoscope is not self-regulating, but relies on human input—it is a human-played game for testing the world. Why would he not seek optimization through a particular algorithm, and allow the computer to find the solution to global resource dilemmas? Perhaps Fuller understands our own capacity to deal with some of the complexities of our environment, or the infinite variables at hand. This reveals Fuller's own faith in human consciousness and reason.

"There will be competitive teams from all around earth to test their theories on how to make the world work. If a team resorts to political pressures to accelerate their advantages and is not able to wait for the going gestation rates to validate their theory they are apt to be in trouble. When you get into politics you are very liable to get into war. War is the ultimate tool of politics. If war develops the side inducing it loses the game.

*...This world-around freedom of living, work, study, and enjoyment must be accomplished without any one individual interfering with another and without any individual being physically or economically advantaged at the cost of another."*⁹



6.5 | Geoscope Display

An image depicting food resource flow paths on Fuller's dymaxion air-ocean map, effectively representing an unfolded geoscopic display system.



6.6 | Playing the World Games

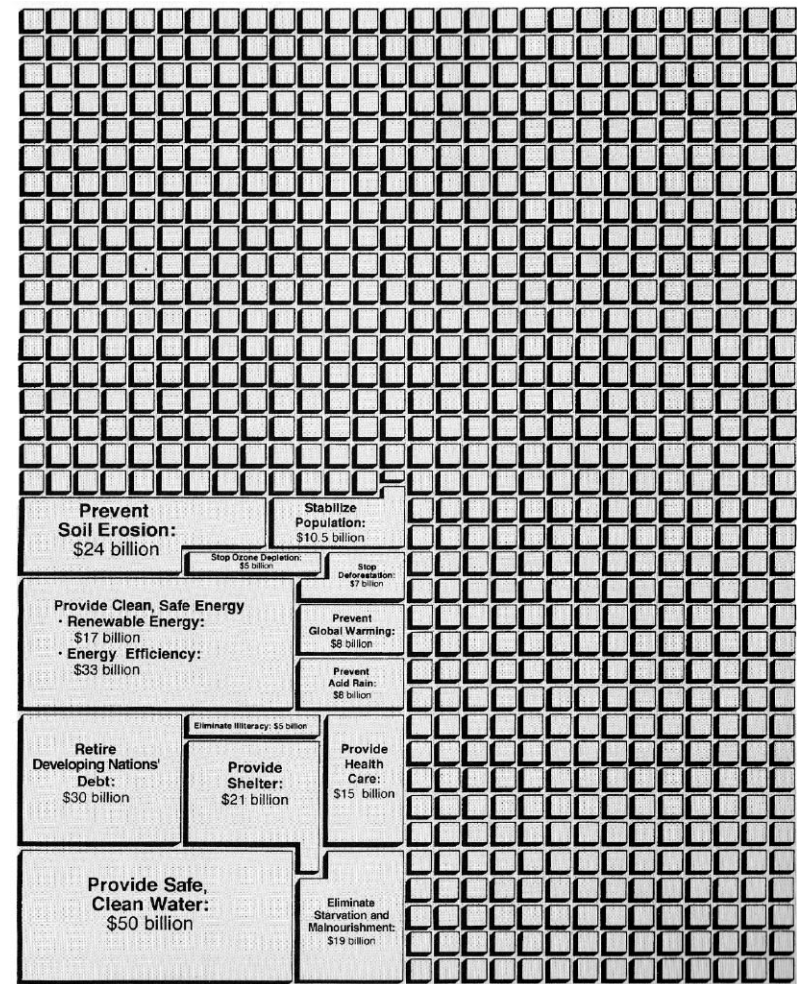
An image of the World Games being played on Fuller's Dymaxion Map, not yet in the three-dimensional form Geoscope.

The Geoscope was to be a computerized and connective system that would make the worldly scale both visible and controllable at the human scale—an overarching super-architecture of amalgamated processes and realms, placing humanity at its centre. We then might ask in what ways would our own health be weighted against the environment's state? Of course, both the health of our selves and that of our environment are mutually dependent and interconnected, and this is probably what Fuller would remark. However, the point of balance and optimization between these scales is debatable. Observed outside of Fuller's technocratic humanist lens, the Geoscope surely values human life as greater than that of the environment, for in Fuller's anthropocentric view, we are placed in a hierarchical advantage over natural resources. Nature becomes our possession, even if its constituents are distributed evenly, thereby contradicting the mutual interconnectedness the project initially implies. Ironically, Fuller outright rejects all other forms of ethics, or politics in his description of the Geoscope's machinic function, yet somehow implies a reliance on the internal and inherent good in humanity. In some ways, he seems to point to all violent acts, especially war, as being the result of political agendas, which surely play a large role, but how is a human tendency or instinct of violence accounted for? These questions of rhetoric perhaps fall outside the scope of this discussion, but do point to some of the fundamental difficulties we all encounter in amalgamating our technologies with ourselves, and our environment.

"The players will be forced to improve the program—failure to improve also results in retrogression of conditions. Conditions cannot be pegged to accomplishment. They must also grow either worse or better. This puts time at a premium in playing the game."¹⁰

Stasis is not possible in this model world, accounting for precepts of chaos and dynamics in the environment. Though there is an implication of an ideal and optimization of progress within the proposed framework for the project, the fundamental system is one of global responsiveness. In addressing the earth as a limited system of resources, bound together in a continuous mutual flux, Buckminster Fuller's vision of a control centre for the earth has become an idyllic, but evermore realistic, proposition for environmental and sustainable design, with an ultimate goal of harmony through dynamic feedback and the simultaneous freedom of humanity through a more intimate understanding and connection with the planet earth.

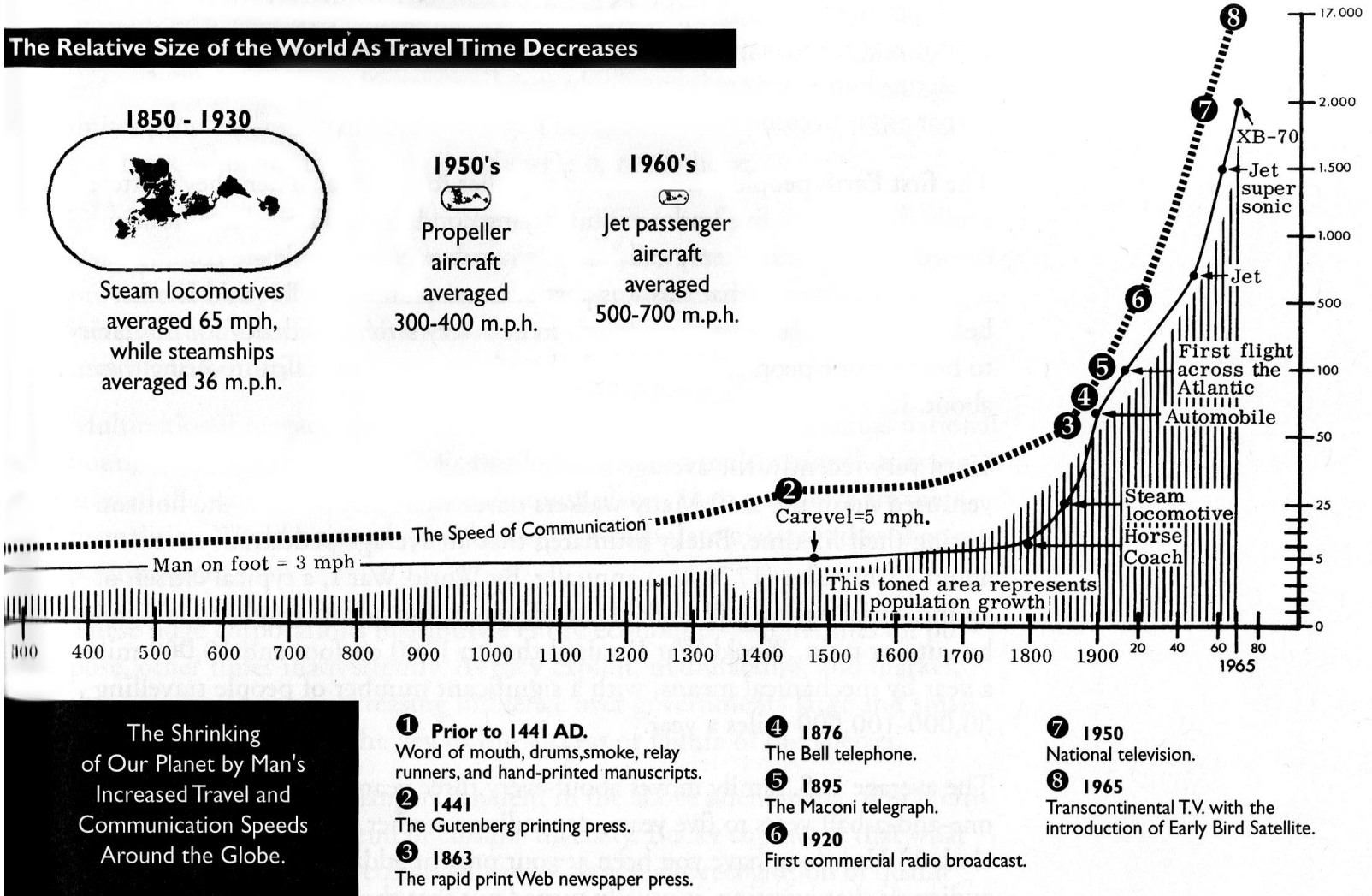
"Humanity will become emancipated from its mental fixation on the seven-day-week frame of reference. I myself now have many winters and summers per year as I cross the equator from northern to southern hemisphere and back several times annually. I have now circled the earth so many times that I think of it and literally sense it in my sight as a sphere."¹¹



6.7 | World Resource Management

Fuller illustrates that to solve much of the world's principle economic, environmental and social problems would use approximately 25% of global military spending (\$1 Trillion at the time). Not only does this show Fuller's quantification of the components of life, but more important, it envisions the world as a single conglomerate of resources. This ironically simplifies the situation by making the earth's processes a singular whole, in a case of economic dynamics that are far more complex. Fuller does make it clear, however, that the single largest area for spending is in providing safe, clean water.

The Relative Size of the World As Travel Time Decreases



The Shrinking of Our Planet by Man's Increased Travel and Communication Speeds Around the Globe.

6.8 | Shrinking World

The fulfillment of the dream of the 'world-man' becomes a reality, and is demonstrated in the relative scale of the earth that has become ever smaller with our increased capabilities of transportation. Fuller describes the sense of the scale of the earth that shrinks exponentially with time. Today, this sense appears to continue along the same curve.

Development and Construction

Buckminster Fuller’s primary model for the construction Geoscope was his own invention, the geodesic dome. Prior to this, his structures such as the Dymaxion House utilized a central mast supporting horizontal planes. His method of developing his structures, however, originated with the study of the geometry of the world itself.

Fuller traced circular routes around the globe that effectively formed a Union Jack. These were marked at a 45-degree latitude, and four more circles were traced to connect these points. The triangles that were formed were subdivided into smaller triangles allowing him to read positions and geographical features from the globe and transfer them to a flat square and triangle of equal side-length.¹² The solid formed out of Fuller’s tracing of the globe, consisted of six square faces and eight equilateral triangular faces, he named the Dymaxion. It is also an Archimedean solid known as a cuboctahedron. Though there is still distortion in Fuller’s mapping techniques, this has been reduced from other earth maps, especially near the boundaries of cells. Later, he made a revised icosahedron version of the map, the Dymaxion Air-Ocean Map, with a volume closer to that of a sphere.

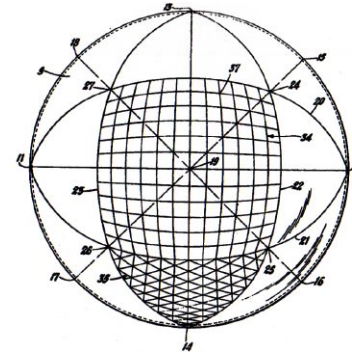
Fundamental to Fuller’s experiments was his ‘hands-on’, empirically centered approach, where many of his descriptions of the geometries he created related to how he made them, such as “poles of spinnability”. This tactile and empirical method of creation speaks volumes of his approach to understanding,¹³ as it seems to be at the root of the understanding that is to come from the observation and use of the Geoscope.

The Geodesic form is fundamentally based on a group of solids, consisting of the icosahedron, pentagonal dodecahedron and the rhombic triacontahedron, all from the family of solids containing five-fold symmetry. Almost all of Fuller’s domes consist of a mixture of hexagons and pentagons, from the inherent symmetries of the solids used as a base. This geometry leads to a method



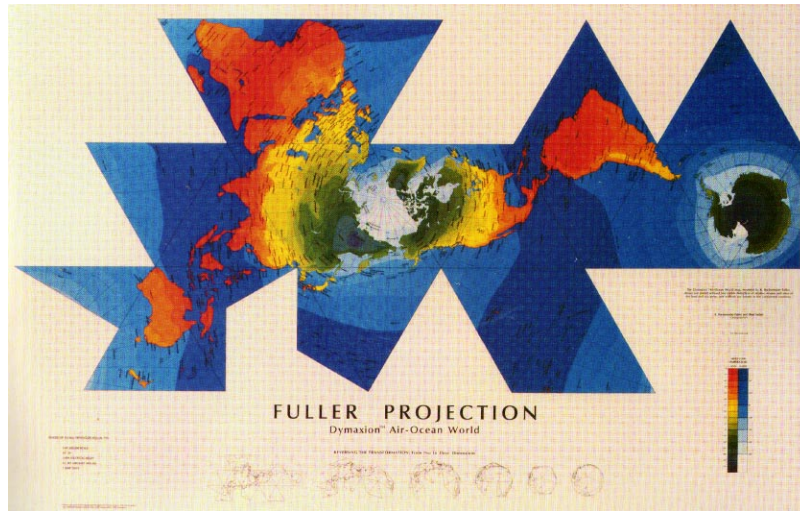
6.9 | Earth Connected

A sketch by Fuller describing his idea for a “One Town” Air Ocean Map. The world for him was indeed shrinking to a scale that could now be grasped.



6.10 | Geometry of the Earth

Earlier tracings of great circles around the earth that revealed the Dymaxion form to Fuller.

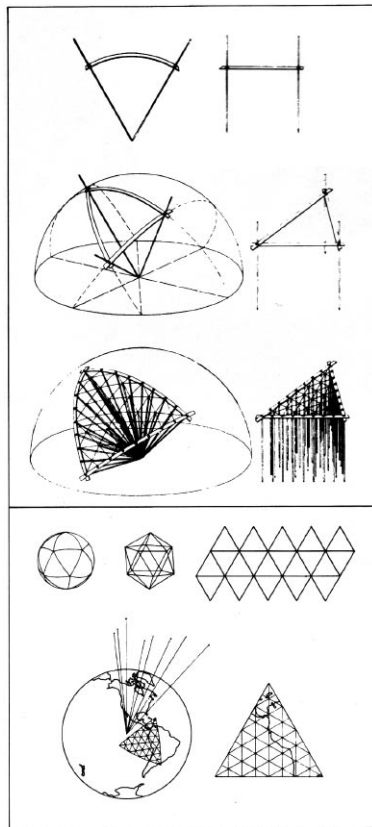


6.11 | One-World Map

This Dymaxion map shows the early stages of the geodesic development, wherein an attempt was made to find geometries that could be unfolded to give a better two-dimensional representation of the earth than the projection methods of the day. Note that this particular view point places the north pole at centre, and give the impression of a single continent surrounded by a single ocean, ever reinforcing Fuller's sense of a connected globe.

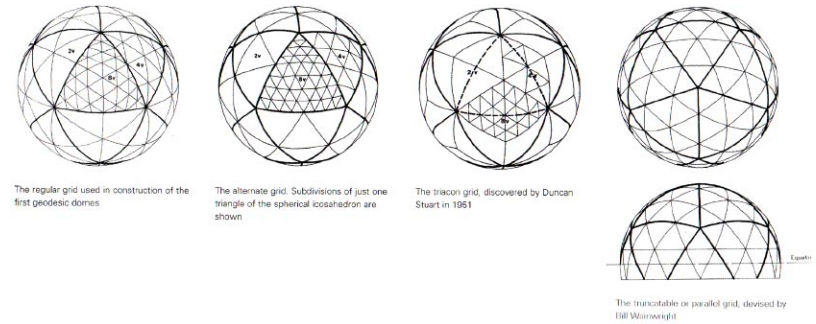
of assembling the domes. Further, by virtue of these patterned geometries, Fuller's constructions became known as some of the most efficient structures built by humankind, due to their great carrying capacity and light weight.

The Dome's overall construction then emerged initially as a problem of mapping the earth that evolved into a structural problem. As such, what is fundamental to geodesic domes, is their exoskeletal structure, as opposed to the endoskeleton of the Dymaxion House and like projects. It is quite fitting that Fuller's goal of the Geoscope, embodied in the geodesic form, is to return to its roots of global mapping. Having based the dome on the symmetries and geometries of a sphere, Fuller received the gold-medal from the American Institute of Architects in 1970, for his geodesic dome was considered as "the strongest, lightest and most efficient means of enclosing space yet known to man."¹⁴ Due to the visibility of the construction through its exposed structure, a visibility of technique and geometry become emergent effects of these structures, such that the ideas of mapping or observing, the earth, and the model sphere become unified.



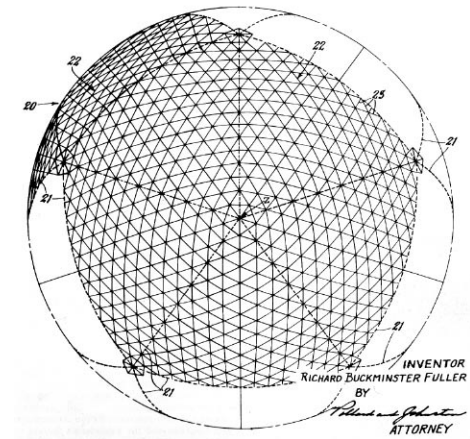
6.12 | Drawing Globes

Several drawings showing Fuller's geometric tracing around the earth, the forms of which lead to an icosahedron, the base for the geodesic form



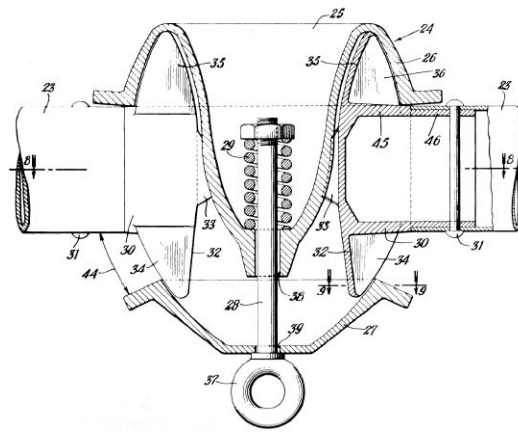
6.13 | Geodesic Tracing

Later iterations of the subdivision of the triangles of the inscribed icosahedron gave the geometry necessary for the stable form of the geodesic sphere.

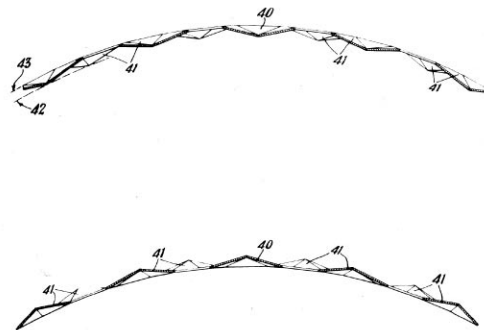


6.14 | Geodesic Geometry

The icosahedral and subsequent triangular division is clear in this drawing made for the patent of Fuller's geodesic structures



6.15 | Geodesic Connections
A sectional view of the connections between the struts of the dome



6.16 | Geodesic Structure
The structure of the dome is clearly three-dimensional, as the geometries of pyramids of hexagonal bases play a role in the frame's rigidity. This further alludes to a need for topography as means of creating a system for stability.

Criticism

Though the dome aspired to the integrity of the earth's own structure, it did have its failings. Lewis Mumford attacked Fuller for creating a product of "autocratic technocracy", a throwback to the Pharaonic and a reflection of the "impulse to suppress human variety and autonomy, and to make every need and impulse conform to the system of collective control imposed by the autocratic designer."¹⁵ Stewart Brand also accounted for many of the shortcomings of the domes in his study *How Buildings Learn* saying they were a massive, total failure, as they leaked, the angles between facets could never be sealed successfully. The structures are impossible to shingle, and the inside is one big room that is impossible to subdivide. Sound would be sent to everywhere in the dome. It was also very difficult to construct, and would leave enormous waste from the rectangular pieces of material that were used to provide triangular forms.¹⁶

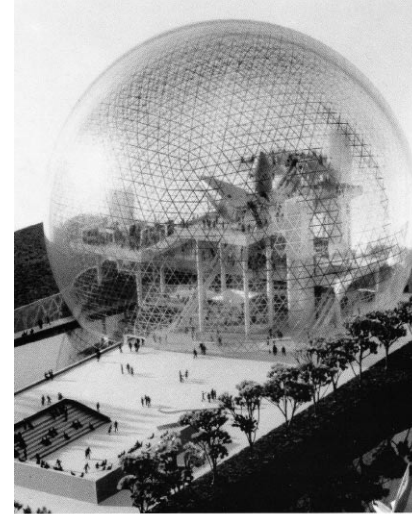
Though it is undeniable that Fuller does express a particularly mechanistic view, he also suggests the system, and communications based ideas are founded in the human body itself, representing another shift between scale Fuller so commonly makes — between the individual and the world. In keeping with this, Fuller responded in the following manner when asked by his daughter to define Man:

“... a self-balancing, 28-jointed adapter-base biped, an electro-chemical reduction plant, integral with the segregated stowages of special energy extracts in storage batteries, for subsequent actuation of thousands of hydraulic and pneumatic pumps, with motors attached; 62,000 mile of capillaries, millions of warning-signal, railroad, and conveyer systems; crushers and cranes [...] and a universally distributed telephone system needing no service for 70 years if well managed; the whole, extraordinarily complex mechanism guided with exquisite precision from a turret in which are located telescopic and microscopic self-registering and recording range finders.”¹⁷

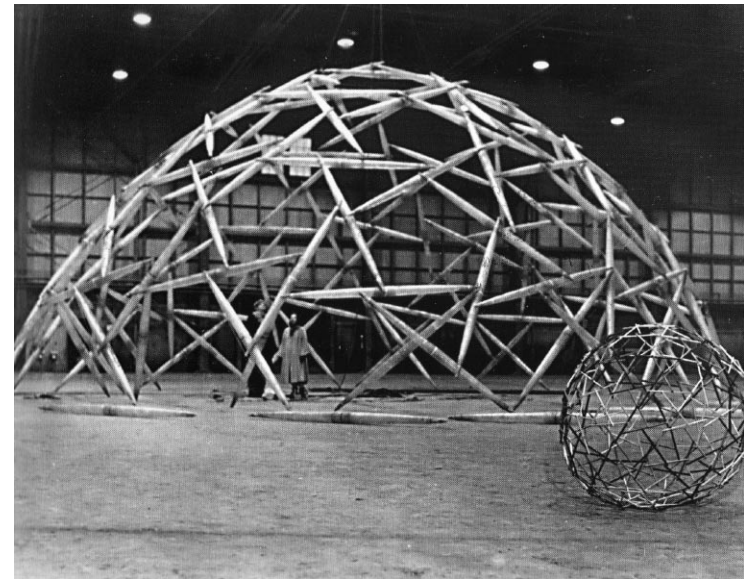
Controls

Principal to the Geoscope and geodesic domes in general, is the function of controlling the environment, whether it was that which was enclosed by the domes, or in the case of the Geoscope in particular, all of “Spaceship Earth”. This attempt to create environmental control originates from Fuller’s experiments with the Butler Dymaxion Dwelling Unit, wherein inhabitable microclimates could be created in these domes while exposed to nearly all exterior climatic conditions.¹⁸

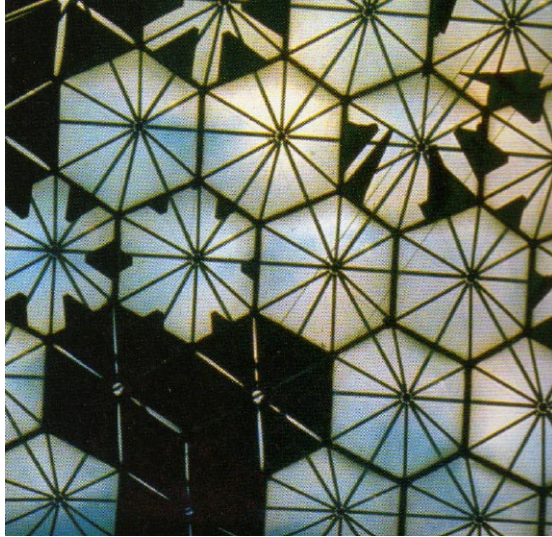
The issue of controls becomes fundamental again. Control as a means of engagement and a simultaneous disengagement from the environment contributes to the geodesic dome’s particular and peculiar relationship to the earth. One of the foremost examples of geodesic structure is the dome that was created



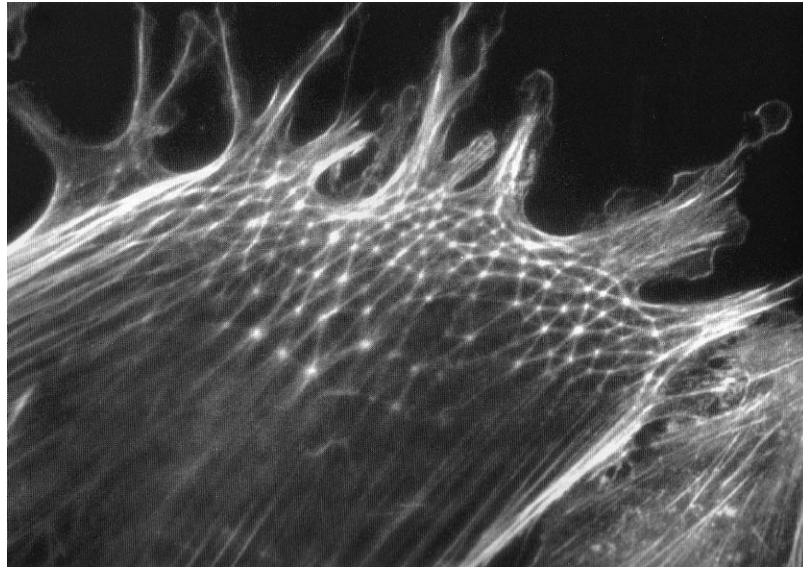
6.17 | Geodesic Model
A model of the dome for Expo '67.



6.18 | Tensegrity
A sphere and dome constructed as tensegrity structures.



6.19 | Dynamic Structural Membrane
A view of the shutters on the skin of the dome that were frozen in place when the guiding cables were twisted. A system meant to activate the structure as though it were a living, breathing, sensitive organism.



6.20 | Cellular Tensegrity
Donald Ingber's study of biological responsiveness found at the cellular level. Geodesic structures surrounding a cell act reflexively, like microscopic living tensegrity structures, embodying the basic elements of responsive architectures, being fundamental components of life.

for the 1967 World Expo U.S. Pavilion in Montreal, as “this structure incorporated a computer program [that] was supposed to guide the shading system, but unfortunately on the first day the operating cables twisted, leaving all the shades jammed in a random position.”¹⁹ The intent, however, to control light the environment, inside and out, became paramount to the generation of his later structures.

Geodesic Variations

Fuller felt he both invented and revealed structures, as they were common to his own designs and nature. This fundamental link was, in practical terms, a source of difficulty in generating patents, yet fundamental to his career, and the very basis of the Geoscope. As mentioned, an exemplary version of Fuller's geodesic structures was the dome for Expo '67. This, in fact, was originally to house the World Games, however this idea was short lived, as the organizers opted for a theme of “Creative America” instead, exhibiting painting by Andy Warhol, Roy Lichtenstein as well as an icosahedral Dymaxion Air-Ocean Map by Jasper Johns. It was clear that Fuller's vision of a totally unified globe could not overpower the patriotic trend of 1960s America.

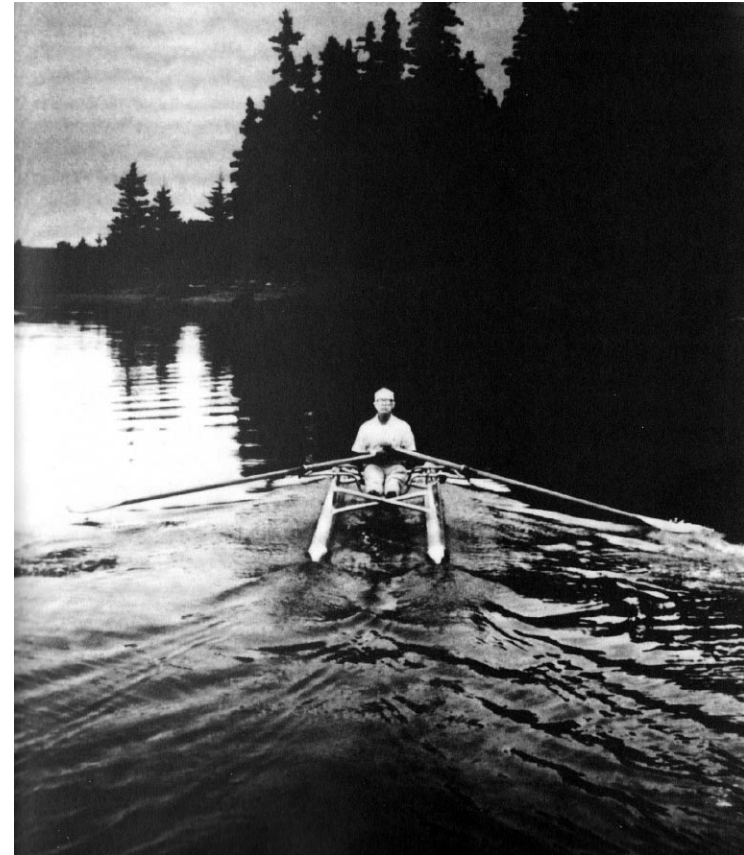
Other inventions developed from geometric explorations include the “Octet Truss” developed for extremely strong floor structures in his project for an automated cotton mill. An example of which is 65-pound aluminum strut truss that could support six tons.²⁰ With further experiments and the aid of one of his students, Kenneth Snelson, Fuller created the category of forms known as tensegrity structures, as Snelson demonstrated that tension structures could be extended in all directions to create networks of forces that counterbalanced each other.²¹ This very idea of a “network of forces” balancing each other, is also at the heart of the purpose of the Geoscope, being an attempt to find a dynamic equilibrium on a global scale. The principles of tensegrity structures also helped Donald Ingber develop a model for the distribution of forces in cell structures, as well as providing Harold W. Kroto with the

necessary idea to develop a model of the Carbon 60 molecule, later to be termed Buckminsterfullerene, known more commonly as the “Buckyball”.²² The insight we have gained from Fuller’s work extends far beyond the single use of his ideal Geoscope, and reaches to the fundamental building blocks and forces of nature.

Connection Re-Imagined

Though a functioning Geoscope was never constructed, we have become an even more interconnected global society, using more developed means of electronic communication every day. Though a project such as the Geoscope would still likely not be constructed, due to its overarching ideologies of a potential autocracy as well as the countless variables that cannot be accounted for within the dynamics of the globe, it is now somehow a more appropriate time for such a structure and system to exist, given the availability of information that is being collected every second the globe around, and the noticeable increase in climatic, economic and social change.

The Geoscope provides a compelling means of connecting to our environment and nature itself. Expanding our sensory horizons with the latest in communications and sensing equipment has long been a means of an attempt to form, or perhaps discover, our own identity through understanding our place in the world. Of course, this is not the only means of creating such a connection, as a much more direct, human-scaled, and perhaps visceral approach can be taken. Fuller appreciated this form of connection, evident in his rowing excursions in a boat he himself designed. The role of the technology here may be lessened, but the goal is much the same—of connection to the earth. Fuller’s Geoscope, like his rowing needles, propose a new interconnected composition of space and time, where, perhaps, a technological movement forward toward a harmony of social and physical optimization, in turn allows for a return to an earlier state of being within our constantly dynamic, liquid primordial home.



6.21 | Rowing
Fuller rowing in his own design of “Rowing Needles”.

1. R. Buckminster Fuller, *Utopia Or Oblivion: The Prospects for Humanity* (New York: Overlook Press, 1969), 114.
2. Ibid, 125
3. Ibid, 116.
4. Ibid.
5. Ibid.
6. Ibid, 119.
7. Ibid, 125.
8. Ibid, 159.
9. Ibid, 157.
10. Ibid, 159.
11. Ibid, 160.
12. Michael John Gorman, *Buckminster Fuller: Designing for Mobility*, (Milano: Skira, 2005), 86.
13. Ibid, 101.
14. Ibid, 115.
15. Ibid, 189.
16. Ibid, 191.
17. Ibid, 189.
18. Ibid, 125.
19. Ibid, 134.
20. Ibid, 122.
21. Ibid, 177.
22. Ibid, 180.



Spheres

“Greatest of the secrets hidden in flowing liquids is that the harmony of the spheres resounds and vibrates within them. In the ear they have become sense organ! The phenomena in flowing liquids provide a key for man; he may see reflected in them the splendour of the harmonies of the spheres.”¹

—Theodor Schwenk, *Sensitive Chaos*

Expanding from the centre of the theory and conceptual structure of Buckminster Fuller’s Geoscope, we find connected fields of research, inherently beginning with cosmological models of the earth. These describe our place within our overlapping constructed and natural environs. As such, it is a discussion of ‘spheres’ that arises, denoting both spheres of thought pertaining to the sciences and philosophy of the perception of our earth, as well as the spatial understandings of the globe, stemming from notions of nested astronomical orbs. The Biosphere, Gaia, and the Noösphere, all speak of interrelated systems that connect living and non-living dynamics, and point to a unity or organism-like holism of the earth, as these theories themselves evolved in synchronous.

The Biosphere

“More than half a century ago the great geologist Suess took a bold and lucky step when, in addition to describing our planet by the classical sequence of concentric, spherical shells (barysphere, lithosphere, atmosphere, etc.), he decided to add the biosphere, in order to affirm, in a concise and vivid way, that the frail but super-active film of highly complex, self-reproducing matter spread around the world was of decidedly geological significance and value.”²

The Biosphere was named by the Austrian scientist Eduard Suess, in his work *The Origins of the Alps* from 1875. This layer of life on the earth has become a primary model for our viewing and understanding the earth as a whole. This conceptual realm of inhabitation merges several other layers of which the earth is composed, intimating the interdependency of living systems with various material realms of resources, as well as their widespread interconnection to living entities. These areas are unified in this

7.0 | Liquid Spheres

Surface tension maintains a layer between spherical air bubbles and the water line.

single biological skin of our globe. But this zone of life goes far beyond the material, as we can first observe in the descriptions of Vladimir L. Vernadsky. The Russian (later Soviet) mineralogist, geochemist and natural philosopher was first to fully develop the concept of the biosphere³:

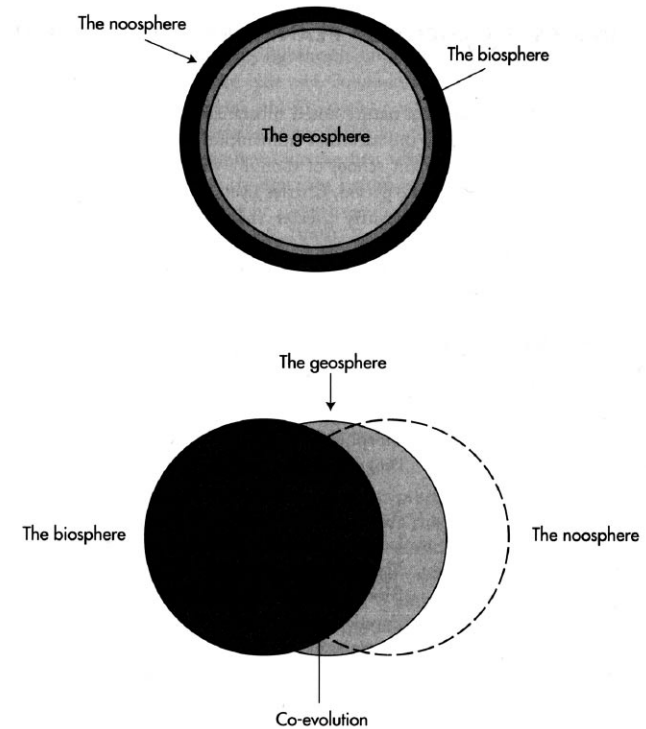
“The substance of this boundary region, the biosphere, becomes active under the influence of the stream of energy. It accumulates and distributes the energy received and finally transforms it into free energy in the biosphere. Hence, this exterior crust must not be considered as the domain of matter alone, but as a region of energy also, a place of transformation of the planet by external cosmic forces.”⁴

To Vernadsky, the biosphere acts as a lens through which light diverges, converges, and is converted to other forms of energy, thereby giving life to the world. Such acute observations made by Vernadsky suggest an understanding of nature and life being driven especially by the elemental forces of sound and light; these elements so often crucial to our perception of the world, but now equally being acknowledged as formative of the environs themselves.

“Two concepts have been inadequately stressed in the past: (1) Pasteur was correct in regarding the preponderance of optically active compounds as the most characteristic general property of living matter and its products; this idea is of immense importance; (2) the functions of living organisms in the energetics of the biosphere have been seriously neglected. Biogeochemical energy may be colonized by a given species. For certain bacteria, the limiting velocity of extension of a dividing chain of cells tending to embrace the whole circumference of the Earth would tend to approach the velocity of sound.”⁵

The Earth's spheres

Atmosphere: the gaseous sphere.
 Hydrosphere: the watery sphere.
 Lithosphere: the solid sphere.
 Geosphere: the combination of the three above.



7.1 | The Earth's Spheres
 Two diagrams depicting the Earth as a series of integral layers of matter, life, and consciousness.

In as much as life-forms define the environment of the biosphere, this same environment defines the very living matter of which it is composed. We find then a greater truth, that through biological life being so connected to its milieu, the two become themselves inseparable, defined as being one and the same.

*"...It is usually forgotten that living organisms are a regular function of the biosphere. The living organism, chiefly in philosophical speculation, but also in biology, is erroneously contrasted with its medium, as if the two were independent objects."*⁶

What begins to emerge, through the fundamental unifying definition of the biosphere, is an understanding and even a sense of the living earth being a single entity. Ironically, this unified image of a singular living orb only arises from a model wherein smaller organisms cannot be considered in isolation from their own larger context.

Gaia

*"Science is not obsessively concerned with whether facts are right or wrong. The practice of science is that of testing guesses; forever iterating around and towards the unattainable absolute of truth. To scientists, Gaia is a new guess that is up for trial or a novel "bioscope" through which to look at life on Earth. In some sciences, Gaian ideas are appropriate, even if not welcomed, because the vision of the world through older theories is no longer sharp and clear. This is particularly true of theoretical ecology, evolutionary biology, and the Earth sciences generally."*⁷

James Lovelock's Gaia theory essentially provides the basis to understand the Earth as a singular living being, of which we human beings are as equally a part as all other life forms. Our role is neither as owner or steward of the planet.⁸ Looking at ourselves, however, we can equally see that we are composed of billions of individual cells, as well as communities of microorganisms that

once lived freely as individuals themselves. This can be observed, for instance, in the energy transforming living components of cells, being the mitochondria and chloroplasts of animal and plant cells respectively, both having been independent bacteria in the past.⁹ In this manner of description we can break down the perception of the individual into groupings of smaller individuals. However, we still maintain the notion of the individual, the singular entity, or human being. This precept is, to Lovelock, an essential function of life:

*"Living things such as trees and horses and even bacteria can easily be perceived and recognized because they are bounded by walls, membranes, skin, or waxy coverings. Using energy directly from the sun and indirectly from food, living systems incessantly act to maintain their identity, their integrity. Even as they grow and change, grow and reproduce, we do not lose track of them as visible, recognizable entities."*¹⁰

With self-definition of the individual life-form as the modus operandi of life itself, Lovelock goes further to identify Gaia as being distinct from the biosphere (even though it is founded in its origins of a holistic planetary definition). Gaia is defined as a singular living being, in such a way that resonates as an essential comprehension of our environment as an interconnected living whole:

*"The name of the living planet, Gaia, is not a synonym for the biosphere. The biosphere is defined as that part of the Earth where living things normally exist. Still less is Gaia the same as the biota, which is simply the collection of all individual living organisms. The biota and the biosphere taken together form part but not all of Gaia. Just as the shell is part of a snail, so the rocks, the air, and the oceans are part of Gaia. Gaia, as we shall see, has continuity with the past back to the origins of life, and extends into the future as long as life persists. Gaia, as a total planetary being, has properties that are not necessarily discernible by just knowing individual species or populations of organisms living together."*¹¹

The Gaia hypothesis, introduced in the 1970s, was found on the decree of the earth achieving an automatically regulated homeostasis, produced by feedback processes performed unconsciously by its constituent biota. Factors such as temperature, oxidation state, acidity and aspects of rocks and waters are kept constant through this communication between environment and its inhabitants.¹² Reflexivity and responsiveness are then crucial to maintaining life, and thereby give life form as well. This higher level of organization within life is crucial to the Gaia hypothesis, as it suggests a mechanism for self-maintenance found within all levels of complex organisms, especially those that become more complex in structure and function. This model of identity maintenance extends through scalar boundaries, from the small single celled organisms, to the planet, therein merging creatures and the environments in which they live through this multi-scalar relationship.

To explain Gaia theory, Lovelock devised a simpler model of the earth entitled “Daisyworld”.¹³ In this representation, a planet, not unlike our own, grows two colours of daisies, one light in colour, and the other dark. The two populations of flowers grow so as to maintain an ideal temperature on the planet for their propagation, by utilizing their differing capacities for heat absorption and reflection. In much the same way, Gaia operates as a coupled system of life and its environment. Lovelock outlines four principles relating to this act of mutual dependency found within Gaia:

- “1. Living organisms that grow vigorously, exploiting any environmental opportunities that open.*
- 2. Organisms that are subject to the rules of Darwinian natural selection: the species of organisms that leave the most progeny survive.*

3. Organisms that affect their physical and chemical environment. Thus animals change the atmosphere by breathing: taking in oxygen and letting out carbon dioxide. Plants and algae do the reverse. In numerous other ways, all forms of life incessantly modify the physical and chemical environment.

4. The existence of constraints or bounds that establish the limits of life. It can be too hot or too cold; there is a comfortable warmth in between, the preferred state. It can be too acid or too alkaline; neutrality is preferred. Almost all chemicals have a range of concentrations tolerated or needed by life. For many elements, such as iodine, selenium, and iron, too much is a poison, too little causes starvation. Pure uncontaminated water will support little; but neither will the saturated brine of the Dead Sea.”¹⁴

To Lovelock, such a description of our earth as an organism can be understood as both a complete and unified system, but also as a collection of parts.¹⁵ Indeed, it would seem both modes of perceiving Gaia are needed to understand such a description of life. Further, Lovelock does not ignore any spiritual means of connecting to the earth. Perhaps in this way, one can activate a scientific understanding, through a deeper philosophical or contemplative relationship with the world.

“There are many ways to keep in touch with Gaia. Individual humans are densely populated cellular and endosymbiont collectives, but clearly also identities. Individuals interact with Gaia in the cycling of the elements and in the control of the climate, just like a cell does in the body. You also interact individually in a spiritual manner through a sense of wonder about the natural world and from feeling a part of it.”¹⁶

Having defined Gaia as an automatically regulated living system, guided by unconscious links between living individual and their environments, we may begin to ask questions about how a conscious manipulation of the environment, or consciousness itself is part of Gaia, in as much as we are part of the whole of the earth. Returning to Vernadsky, his development of the Biosphere directs us to such questions of humanity’s relationship with the earth:

“But in our geological epoch – the psychozoic era, the era of reason – a new geochemical fact of capital importance is manifest. In the course of the last few thousand years, the geochemical action of humanity has, by means of agriculture seizing the living green matter, become intensive and excessively multiplied.”¹⁷

It is clear that our own consciousness of our connection to the earth and our attempts to control or manipulate natural processes are intertwined with the study of the earth itself. In much the same way, the relationship between the evolution of the earth and that of consciousness was further pursued by another individual, Pierre Teilhard de Chardin, who, like Lovelock, equally sought to answer questions of our relationship and place on the earth in balancing the scientific and the spiritual in this exploration.

Thinking Together | The Noösphere

Pierre Teilhard de Chardin was a Jesuit priest, trained as a paleontologist and a philosopher. In contrast to Fuller, de Chardin was most interested in pursuing ideas of global connectivity from a spiritual point of view. In *Activation of Energy*, a compendium of writings by de Chardin, first published in 1963 (eight years after his death) he outlines an effort to cover many areas of man’s relation to the world, both natural and technological, and the potentials of such relationships in terms of our responsibilities, and the direction human evolution is taking. Most importantly here, Teilhard de Chardin outlines his development of the Noösphere; the thinking skin of the earth.

It is interesting that Teilhard de Chardin first notes a primary and global cause of distress is a rising sense of connection. This is recognizable as the main side effect within and between cultures after the atrocities witnessed in the Second World War, but further reemphasizes how close humans really are in social and spatial terms:

“Mankind, in coming of age, has begun to be subject to the necessity and to feel the urgency of forming one single body coextensive with itself. There we have the underlying cause of our distress.”¹⁸

This global tension is heightened in considering the ecological and biological connections we all have, and, to Teilhard de Chardin, are increasing in number and strength. In fact, de Chardin points to the earth as a single, unified organism, wherein our own biologies are becoming linked by nature and necessity.

“It is no longer possible for us to live and develop without an increasing supply of rubber, of metals, oil, electricity and energy of all sorts. No individual could henceforth manage to produce his daily bread on his own. Mankind is more and more taking the form of an organism that possesses a physiology and, in the current phrase, a common ‘metabolism’.”¹⁹

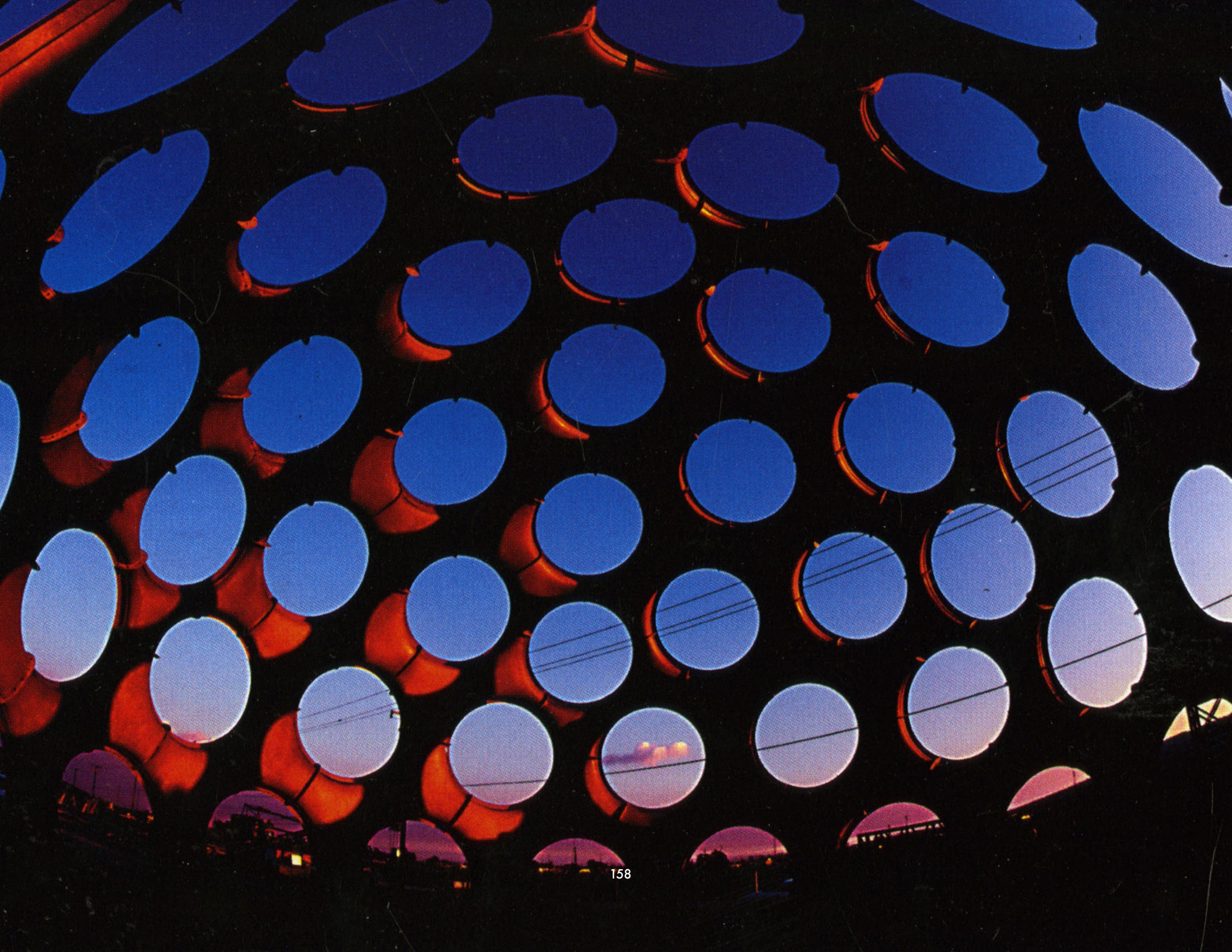
Central to the development of a global unity, and de Chardin’s conception of the Nöosphere is the principle of complexity as a development in the process of evolution, playing a central role in the development of consciousness. Teilhard de Chardin argues that it is a critical formation of complexity that creates consciousness in the human brain, and under further evolutionary development, a complex global network of thought will develop.

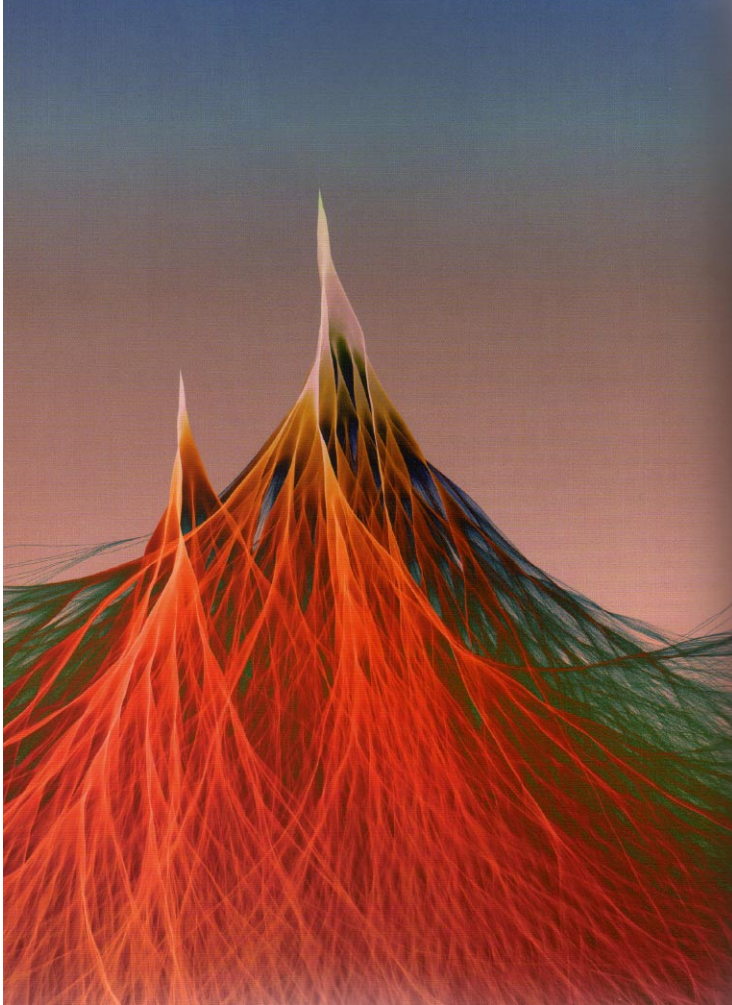
“Moving towards the infinitesimal, we meet dispersion; towards the immense, agglomeration; towards the complex, centration and consciousness – in other words, vitalization.”²⁰

Pierre Teilhard de Chardin’s development of the Nöosphere, and evolving super-consciousness has an inherent link to spiritualism, by pointing to a human transcendence to arrive with the coming of a higher level of being. What is still speculated upon after de Chardin’s writing, is the linking and balancing today of technological systems of thought, founded in the development of the World Wide Web, and natural or ecologically connected processes of evolution, and how these ingredients evoked in de Chardin’s writing might emerge or converge together.

“The recognition and isolation of a new era in evolution, the era of noogenesis, obliges us to distinguish correlatively a support proportionate to the operation – that is to say, yet another membrane in the majestic assembly of telluric layers. A glow ripples outwards from the first spark of conscious reflection. The point of ignition grows larger. The fire spreads in ever-widening circles till finally the whole planet is covered with incandescence. Only one interpretation, only one name can be found worthy of this grand phenomenon. Much more coherent and just as extensive as any preceding, it is really a new layer, the ‘thinking layer’, which, since its germination at the end of the Tertiary era, has spread over and above the world of plants and animals. In other words, outside and above the biosphere there is the noosphere.”²¹

1. Theodor Schwenk, *Sensitive Chaos: The Creation of Flowing Forms in Water and Air* (London: R. Steiner, 1965), 88.
2. Paul R. Samson and David Pitt, *The Biosphere and Noosphere Reader: Global Environment, Society, and Change* (London; New York: Routledge, 1999), 73.
3. *Ibid.*, 26.
4. Vladimir L. Vernadsky, "The Biosphere," in *The Biosphere and Noosphere Reader: Global Environment, Society, and Change*, eds. Paul R. Samson and David Pitt (London: Routledge, 1999), 35.
5. *Ibid.*, 36.
6. *Ibid.*, 38.
7. James Lovelock, *The Ages of Gaia: A Biography of our Living Earth*, 1st ed. (New York: W.W. Norton, 1988), 12.
8. *Ibid.*, 14.
9. *Ibid.*, 18.
10. *Ibid.*, 17.
11. *Ibid.*, 19.
12. *Ibid.*
13. *Ibid.*, 35.
14. *Ibid.*, 39.
15. *Ibid.*, 215.
16. *Ibid.*, 211.
17. Vladimir L. Vernadsky, "Geochemistry," (1924), quoted in *The Biosphere and Noosphere Reader: Global Environment, Society, and Change*, eds. Paul R. Samson and David Pitt (London ; New York: Routledge, 1999), 27.
18. Pierre Teilhard de Chardin, *Activation of Energy*, trans. René Hague (London: Collins, 1970), p15.
19. *Ibid.*, 36.
20. *Ibid.*, 31.
21. Pierre Teilhard de Chardin, "The Phenomenon of Man," (1959), quoted in *The Biosphere and Noosphere Reader: Global Environment, Society, and Change*, eds. Paul R. Samson and David Pitt (London; New York: Routledge, 1999), 71-72.





8.1 | Electronic Vision

A landscape created by electron flows in two dimension forming branching patterns known as 'cusps'.

8.0 | Flies' Eyes Pavilion (Opposite)

Buckminster Fuller's dome reminiscent of the compound eye structure found in various insects.

Observing the Immersive

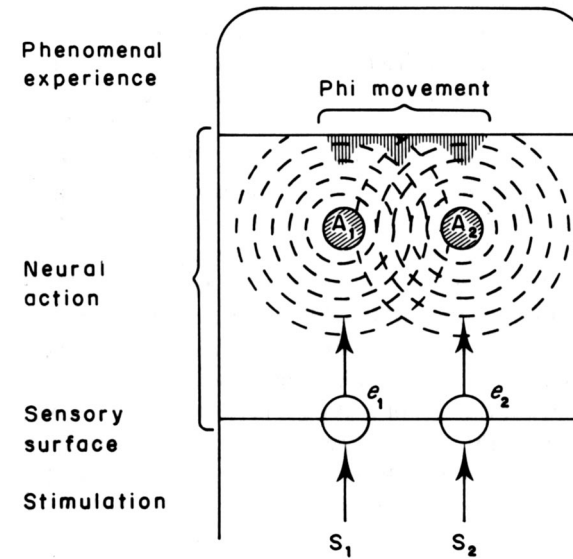
In attempting to grasp the emerging complex of models of the earth, media of representation become paramount in their communication and comprehension, while theories of perception of the environment themselves are formed. In discussing 'sensing the environment', there is an immediate correlation with the study of perception. An account of perceptual psychology, rooted in the development of Gestalt theory, discusses the senses as they pertain to the relationship between the world and our everyday experiences. Though much newer, and more specially focused theories of perception exist today, Gestalt theory points to some common interests of responsiveness, connectedness, and holism that are latent in the areas of research emergent from the Geoscope. The relevance of Fuller's project comes to light, as it evocates a merging of our own perceptual capacities with technological modes of observation. The ubiquity of such systems of communication and our dependence on such media is precisely what Marshall McLuhan understood of the coming era. His words, however, ironically inspire a great technocracy, yet much of his writing offers a direct warning of the limitations to this perceived progress and the popular modes of perception encouraged by new media themselves. In attempting to observe the immersive complexities of our world, new fears and anxieties arise, as observation itself becomes another step toward control, especially as we begin to describe merging these perceptual technologies with our own senses, bodies, and environment.

Gestalt

Gestalt psychology began with an interest in uncovering some of the phenomena of perception that allow us to engage the world on a daily basis. Beginning with one of Gestalt psychology's central tenets of the whole being greater than the sum of its parts, as was outlined by Christian von Ehrenfels, we turn to the development of this dynamic theory of perception that speaks to our holistic understanding of the earth.

"Ehrenfels (1890) had drawn attention to the fact that many groups of stimuli acquire a pattern quality which is over and above the sum of their parts: a tune is more than the sum of its notes; a square is more than a simple assembly of lines—it has 'squareness'. Ehrenfels named this emergent property Gestaltqualität (form quality), a name which was adopted by the Gestalt movement. Later, Rubin (1915) had published his important paper on the distinction between Figure and Ground in perception, a distinction which later found an important place in Gestalt thinking."¹

It was Max Wertheimer who established research into the phenomena of Gestalt psychology. In 1910, Wertheimer observed the illusory movement produced by a toy stroboscope in which two lights flashing alternately at a particular rate produce an experience of pure movement, known as 'Phi-Movement'.² Following this, Wertheimer expanded his research with the work of Kurt Koffka and Wolfgang Köhler, two of Wertheimer's assistants, to develop the laws of grouping through a common development of a theory of figure and ground, representing object and environment. This set of laws includes:
The spontaneous tendency to organize stimuli into wholes, or Gestalten, the Adjacency, or Proximity Principle, Good Continuation, Similarity, Closure and Common Fate. All of these principles of Gestalt tend toward simplicity, symmetry, and wholeness³, though they arrive to us by complex mental processes, and allow us to sort through a richly interconnected



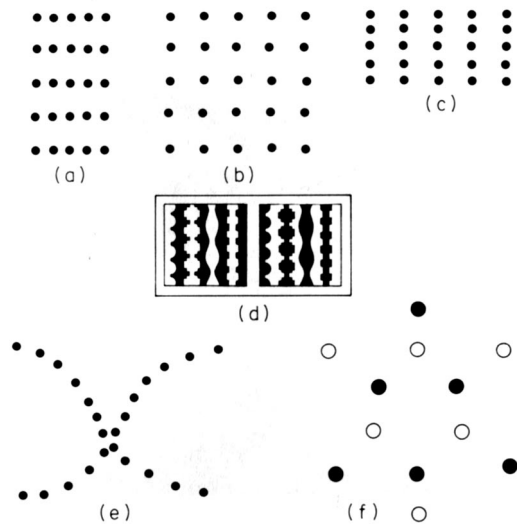
8.2 | Phi Movement

A diagram of Phi Phenomenon with Köhler's field forces. S_1 and S_2 are alternately flashing lights. e_1 and e_2 are events at the two retinae. A_1 and A_2 are points on the visual cortex from which the induced electrical fields spread. The overlap of the two fields yields a unitary percept: phi movement.



8.3 | Figure-Ground

The face-vase illusion, a figure-ground reversal.



8.4 | Laws of Grouping

Some of Wertheimer's Laws of Grouping. a. Proximity induces grouping by rows, b. Proximity is equal and there is no dominant direction of grouping, c. Proximity induces grouping by columns. d. Grouping by symmetry, e. Grouping by continuation, f. Grouping by similarity.

world. As such, perception itself becomes a dynamic, organized process, under Gestalt theory. Returning to the roots of Gestalt, or the idea of the figure and the ground, is the realization of a mutual dependency of the overall field of sensory stimuli, against the discernable objects, or rather, structures that are perceived. Again, an integration of environment and object is observed, or at least one is defined by the other. It is no wonder how principles of Gestalt have entered the world of design concerned with the relationship between objects and space or environment, as Gestalt terminology, both in visual and written terms pertains to the emergence of 'meaningful objects' and events, within this dynamic relationship of subject and field.

The fundamental element in Gestalt psychology is the creation or perception of the boundary. In perceiving the 'line', or the definition of form between figure and ground, it might be assumed that Gestalt is a binary method of understanding. But, taking in the temporal dynamics of Gestalt, as was initially begun with research in illusory movement, the notion of boundary slips into liminality, where we can see and inhabit a larger region of definition, of grey, of merging field and figure. However, the importance of the distinct perceived boundary is upheld by its rendering complex structures visible and understandable. In fact, these structures may extend beyond the realm of cognition, back to that of the physical. Köhler, trained as a physicist, considered the possibility that perceptual Gestalten were manifestations of a more global set of phenomena, including what may be actual physical Gestalten.⁴ This theory, though unproven, does point to an interconnectedness between mental and physical space. This was pondered further by Köhler, as he suggested a symmetry and balance of fields occurred within the brain itself, mirroring the phenomena the brain allows us to apprehend. This isomorphism, though a recipient of great criticism, denotes once again the desire to find a holism not only between elements of the material world, but also connected to mental processes. Such a connection is immediately recognized in the ongoing development of communication technologies.

Global Villa

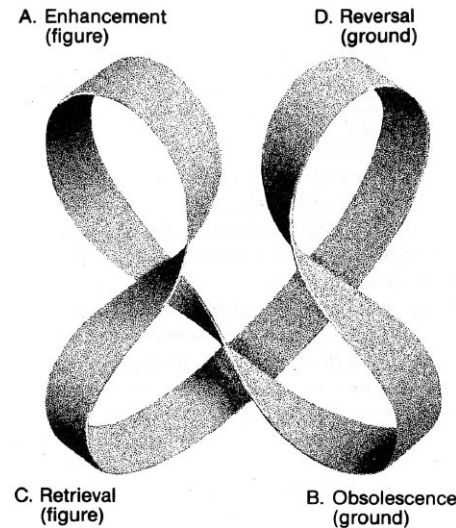
Marshall McLuhan's *The Global Village* was first published in 1986, six years after his death, by the book's co-author Bruce R. Powers, after collecting the thoughts and writings the authors shared. McLuhan, being a communications theorist, posited the importance of communications media in the 20th and 21st centuries. Coining the phrase "the medium is the message", McLuhan became famed as Guru of information technology, having witnessed only the early formation of these electronic modes of communication during his life. This understanding of media dominating one's experience of the world, while simultaneously linking global social structures, became central to our understanding of our place and relationship with the world as a whole.

Principle to this global unification through communications technology, is the actual sense of the world as a complete and unified environment. McLuhan argued that much of education stresses left-brained thinking that generally is associated with isolated and serial modes of thought. But, he expressed his concern that in a newly interconnected sphere of technology, a right-brain model of communication becomes the primary means of understanding. Though this depiction of the brain itself is perhaps limited, McLuhan's use of this model points to the way in which emerging media become sensed simultaneously:

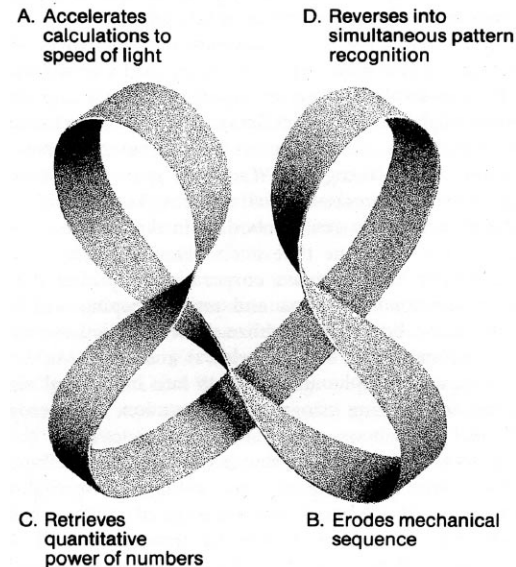
*"For use in the electric age, a right-brain model of communication is necessary to demonstrate the "all-at-onceness" character of information moving at the speed of light. As voice, print, image, and sensory data proceed simultaneously, figure and ground are often in opposition rather than in a sequential relationship. For example, the consciousness of the data-base user is in two places at once: at the terminal and in the center of the system."*⁵

McLuhan goes further into this theory, where he expresses a need for a dual understanding of the world, as expressed in his tetradic method, wherein both the figure and ground of a

Tetrad Structure

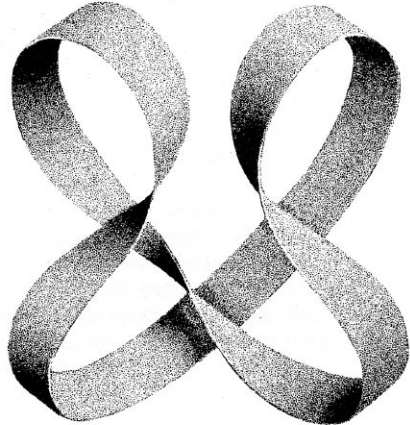


Computer



Satellite

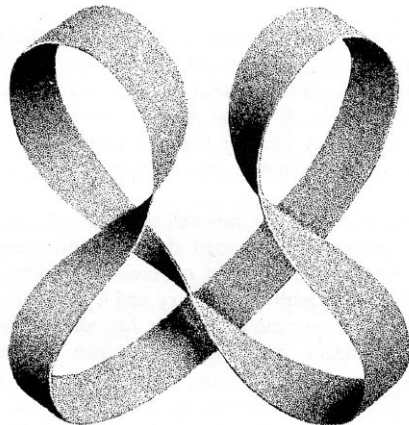
- A. Enlarges global information exchange
- D. Reverses into iconic fantasies



- C. Retrieves world-view, like early compass
- B. Obsolesces language for images

Global Media Networking

- A. Instantaneous diverse media transmission on global basis
- D. Reverses into loss of specialism; world-wide synesthesia



- C. Brings back Tower of Babel: Group voice in ether
- B. Erodes human ability to decode in real-time

situation are experienced simultaneously as they are projected through emerging the media. This produces a convergence and combination of perception in which the sense of being in two places in time and space is experienced simultaneously, as exemplified in the 1968 television broadcast of astronauts landing on the moon:

“The book of nature contains innumerable borderlines and interfaces. The resonant interval may be considered an invisible borderline between visual and acoustic space. We all know that a frontier, or borderline, is a space between two worlds, making a kind of double plot or parallelism, which evokes a sense of the crowd, or universality.”⁶

McLuhan’s writing evokes a sense of ‘wholes’ in the world arriving through technology itself. Yet, for all the relations drawn between our nature and our technology, it has become difficult to say which, of our technology or perception to understand the world as a complete entity, precedes the other. McLuhan, however, is not expressing an optimism in his understanding of this new world dynamic. He shows great concern, and his methods for understanding this new realm are also the means of dealing with the inherent loss of current social structures that will ensue with the continued linking of communications media.

8.5 - 8.8 | McLuhan’s Tetrad Structures

"In an electrically configured society all the critical information necessary to manufacture and distribution, from automobiles to computers, would be available to everyone at the same time. Espionage becomes an art form. Culture becomes organized like an electric circuit: each point in the net is as central as the next.

*...
Electronic man loses touch with the concept of a ruling center as well as the restraints of social rules based on interconnection. Hierarchies constantly dissolve and reform."⁷*

With global society now effectively living under a single megastructure of communication technology, the roles of individuals are seen to change, when a new relationship with the earth, its resources and space have shifted dramatically. The process of this technological link-up seems to be in great harmony with de Chardin's vision of the evolution of consciousness, but arrives with much less promise of enlightenment, as further responsibility is placed on human kind:

"Ecology shifts the "White Man's Burden" onto the shoulders of the "Man-in-the-Street." The meaning of the atomic bomb is that we can no longer fight territorial wars as a sort of solo game-playing, so beloved of the left-hemisphere. The age of information remakes the world in our image. The media extensions of man are the hominization of the planet; it is the second phase of the original creation."⁸

The "hominization of the planet", as McLuhan puts it, begins to point to his understanding of 'nature' being something created by humans. This perspective, he points out to Bruce Powers, is contrary to much of the historical understanding of nature, but has become a dominant stance, and a compelling vision of our own role on the earth:

"Well, let's first deal with the word "nature." It is itself an abstraction. We know that literate Greeks had to find a word for their ability to abstract visual order out of the environment which surrounded them. So, having identified a number of balances or cause and effect equilibriums, they called them nature (physis) and everything else was chaos. And you find this idea being adopted right down the time tunnel from Parmenides to Descartes, Galileo, Hobbes, and Locke."⁹

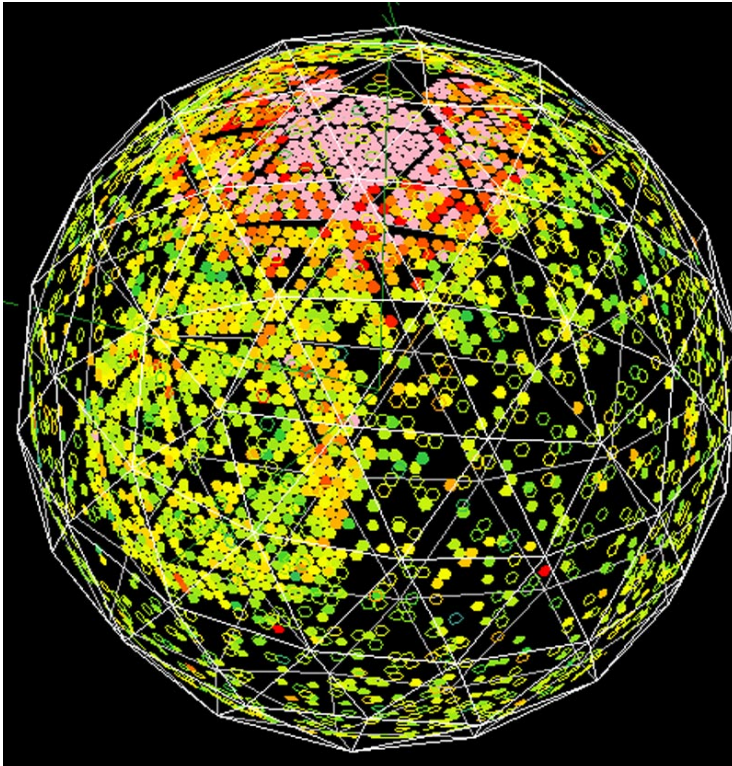
McLuhan recognizes one of the potential issues of media of communication encompassing the environment involves a need to escape a possible realm of over-stimulation. He then asserts that Canada could be exactly the environment, or anti-environment for this escape, or separation:

"Since the United States has become a world environment, Canada has become the anti environment that renders the United States more acceptable and intelligible to many small countries of the world; anti-environments are indispensable for making an environment understandable."¹⁰

Even since McLuhan's time, Canada has entered, with great force and speed, the spheres of global communication technologies, and in turn, global socio-political discourse. The image of the Canadian wilderness to which McLuhan alludes may no longer be linked to the country's reality, however, a new hybrid wilderness could form in this vast landscape.



1. Ian E. Gordon, *Theories of Visual Perception* (Chichester: John Wiley & Sons, 1989), 49.
2. *Ibid.*, 50.
3. *Ibid.*, 54.
4. *Ibid.*, 58.
5. Marshall McLuhan and Bruce R. Powers, *The Global Village: Transformations in World Life and Media in the 21st Century* (New York: Oxford University Press, 1989), 3.
6. *Ibid.*, 4.
7. *Ibid.*, 92.
8. *Ibid.*, 93.
9. *Ibid.*, 131.
10. *Ibid.*, 149.



8.9 | Sudury Neutrino Observatory (Top)

8.10 | Neutrino Imaging (Bottom)

The Canadian "anti-environment" allows for a greater capacity to perceive the cosmos, but perhaps only when situated deep below the surface of the earth.



Defining the Boundless

“The rhizome is altogether different, a map and not a tracing. Make a map, not a tracing. The orchid does not reproduce the tracing of the wasp; it forms a map with the wasp, in a rhizome. What distinguishes the map from the tracing is that it is entirely oriented toward an experimentation in contact with the real. The map does not reproduce an unconscious closed in upon itself; it constructs the unconscious. It fosters connections between fields, the removal of blockages on bodies without organs, the maximum opening of bodies without organs onto a plane of consistency. It is itself a part of the rhizome. The map is open and connectable in all of its dimensions; it is detachable, reversible, susceptible to constant modification. It can be torn, reversed, adapted to any kind of mounting, reworked by an individual, group, or social formation. It can be drawn on a wall, conceived of as a work of art, constructed as a political action or as a meditation.”¹

—Gilles Deleuze and Felix Guattari, *A Thousand Plateaus*

9.0 | Rhizosphere Space

The Rhizosphere, a thin layer of air around root structures in wetland plants allows communities of micro-organisms to grow in what is otherwise a completely anaerobic environment.

We continually face problems developing in contemporary issues of defining, mapping or representing global regions, places, or concepts when it is through the very perceptual definition of these realms, that they become essentially limitless in the layered complexity of which they are composed. A necessity for a simulated reality becomes apparent from this, as we are only capable of constructing models to describe the complexities and interrelations of a world that can never be completely understood. Ian McHarg, who was concerned with mapping the dynamics of ecologies, their own internal transformations, and their fragility, becomes a valuable resource in the pursuit of communicating complexity. Through this, McHarg acknowledges the apparent global formation of a super-organism that can only arise through the interaction of complex natural processes.² One such derived or synthesized model for the understanding of this continuous, uncentred space is found in discussions by Gilles Deleuze and Felix Guattari, especially concerning the ‘rhizome’, acting as a model for networks of systems, real, imaginary, or virtual alike, themselves all now becoming part and parcel. Mapping has become a dynamic act. A constant interchange exists between observing and creating place. These constructed images of reality become the reality itself, as discussed by Jean Baudrillard in his work *Simulacra and Simulation*. Herein, Baudrillard describes a hyperreal environment that is created through the interweaving of the cosmic models we create of our earth.³

Natural Design

To understand and contend with the complexity of the natural environment, Ian McHarg, a landscape architect wrote extensively on regional planning using natural systems. His words urge for simplicity to take hold of our actions in grappling with complex natural environments, such as to use the inherent natural properties found within ecological systems to fulfill our cultural needs.⁴ Such complexities seem to manifest from the environment when we consider the interchange that takes place at boundaries, themselves being expanded regions of infiltrating environments on either side of these supposed delineations. As such, McHarg reveals an understanding of boundaries within ecology extending in temporal, spatial and scalar dimensions, and therein, inform us of how to create our own synthetic boundaries in physical and social milieus:

“Ecologists describe the thin film of life covering the earth as the biosphere, the sum of all organisms and communities, acting as a single superorganism. Persuasive evidence for this derives from the oceans themselves –Henderson observed a marked correspondence between the regulatory mechanisms of the ocean and organisms, accomplished by temperature regulation through evaporation and regulation of alkalinity.”⁵

Reiterating the stance of Lawrence Henderson, author of *The Fitness of the Environment*, McHarg not only demonstrates the condition of the Earth as organism, but further intimates the nested scalar model that relates organisms and natural processes themselves, as though living fundamentals exist equally at all scales, and operate in much the same way at these differing orders, offering something of a dynamic-fractal vision of the earth. This inter-scalar system of connective living beings again suggests a relationship of adaptation that flips itself back into an ontological question of the relationship that exists between environment and one’s own self.

“I can think of no better way of looking at the world and its processes than as if these were a timeless yearning, occurring in a milieu with a proclivity for evolution and for life, in which the environment is fit and may be made more fitting—in which the test is the capacity to adapt the environment and one’s self.”⁶

Rhizome

Interwoven in a complex state, our culture immediately can be modeled on natural systems or networks, as is suggested by the philosopher pair, Gilles Deleuze and Felix Guattari, in their discussion of art work (in this case, their own book, *A Thousand Plateaus* as rhizome. They describe a condition of being uncentered, uncontrollable, re-forming where broken and therefore interconnected but unpredictable:

“3. Principle of multiplicity: it is only when the multiple is effectively reated as a substantive, “multiplicity,” that it ceases to have any relation to the One as subject or object, natural or spiritual reality, image and world. Multiplicities are rhizomatic, and expose arborescent pseudomultiplicities for what they are. There is no unity to serve as a pivot in the object, or to divide in the subject. A multiplicity has neither subject nor object, only determinations, magnitudes, and dimensions that cannot increase in number without the multiplicity changing in nature (the laws of combination therefore increase in number as the multiplicity grows).”⁷

Such a model describes a condition beyond the ideal of the perfect orbs as suggested by nested ‘spheres’, and enters a realm of a pure, heterogeneous network, allowing artificial cultures and natural systems to merge. Within this, a further discussion arises about a difficulty of using units of measurement, in a condition of pure multiplicity, as there is no singular unity. Measurement, or mapping space, is dependent on the multiple structure, which perhaps reveals a problem with the model, requiring self-reference

to exist. But perhaps in this way, it is somehow truer to the creative world which we observe and form, and thus truer to the overlapping of reality, projected or imagined space, and future transformations as these exist co-dependently and simultaneously.

Through McHarg, Deleuze and Guattari, we see a common ecological mapping of the environment onto humanity, thereby collapsing one into the other, as a synthesis of perception and creation. Yet, in having established the interconnections of ecology and technology, thought and spirit, and culture and communication, questions of reality itself emerge. In a hybridized environment, standard hierarchies and definitions are blurred or forgotten entirely. The boundary between real and imaginary, or 'true' and 'false' fade away, while we both deconstruct prior definitions and create a haze of connectors.

Critical-Mass-Media

The French postmodernist philosopher and cultural theorist Jean Baudrillard deals precisely with the media-based world McLuhan has observed, taking the theory further into the realm of epistemology in questioning the nature of reality. In *Simulacra and Simulation*, Baudrillard's central argument is that all our creations and perceptions of the world are in fact simulations of the ideas of what anything is or should be, and thus become simulacra, never attaining a true 'reality', but not being a pure simulation of the real either. This complex, self-referential postmodernist view is best exemplified in the Borges fable Baudrillard suggests, in which the Empire's cartographers drew a map so detailed it covered the territory exactly, and with the decline of the Empire, it is the map itself that frays:

"Today abstraction is no longer that of the map, the double, the mirror, or the concept. Simulation is no longer that of a territory, a referential being, or a substance. It is the generation by models of a real without origin

or reality: a hyperreal. The territory no longer precedes the map, nor does it survive it. It is nevertheless the map that precedes the territory—precession of simulacra—that engenders the territory, and if one must return to the fable, today it is the territory whose shreds slowly rot across the extent of the map."⁸

This model of the world (or model of the model of the world, in Baudrillard's terms) actually disables our perception for we cannot identify reality or illusion unto themselves. It seems both reality and simulation are fused in what is a schizophrenic hypersimulation, making the roles of perception and imagination ever more crucial in the process of world making. The problem he goes on to address, however, is that much of our world has been founded upon myths imbued in material, and with only the media of simulation remaining, meaning has been lost:

"... just as consensus would have it that material production, despite its dysfunctions and irrationalities, opens onto an excess of wealth and social purpose. We are all complicitous in this myth. It is the alpha and omega of our modernity, without which the credibility of our social organization would collapse. Well, the fact is that it is collapsing, and for this very reason: because where we think that information produces meaning, the opposite occurs."⁹

"Thus information dissolves meaning and dissolves the social, in a sort of nebulous state dedicated not to a surplus of innovation, but, on the contrary, to total entropy. Thus the media are producers not of socialization, but of exactly the opposite, of the implosion of the social in the masses. And this is only the macroscopic extension of the implosion of meaning at the microscopic level of the sign. This implosion should be analyzed according to McLuhan's formula, the medium is the message, the consequences of which have yet to be exhausted."¹⁰

Baudrillard goes on to criticize the position of media dominance, for in this theory, the human body itself is nothing but a medium. This contested stance, however, is still debated, and often gives leverage to the ideas behind cybernetic and cyber-organic systems. In speaking about J.G. Ballard's novel *Crash*, a work that explores the sensuality and sexuality that arises in the hybridization and destruction of both humans and machines in their interface, as depicted in the sexual interactions taking place after severe car crashes, Jean Baudrillard loops the thinking back to the early pioneers of connective political and social theories in a criticism of the world the group observes:

"From a classical (even cybernetic) perspective, technology is an extension of the body. It is the functional sophistication of a human organism that permits it to be equal to nature and to invest triumphally in nature. From Marx to McLuhan, the same functionalist vision of machines and language: they are relays, extensions, media mediators of nature ideally destined to become the organic body of man. In this "rational" perspective the body itself is nothing but a medium."¹¹

The potentials of an interface of technology, nature and human-being go far beyond any form of rational thinking. However, the meaning of this hybridization comes into question. This new 'sense' of life, between 'medium' and 'being' is further pursued by contemporary writers addressing these transitional conditions producing new realms of cyber culture and virtual space.

1. Gilles Deleuze and Felix Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia*, trans. Brian Massumi (Minneapolis: University of Minnesota Press, 2005), 12.
2. Ian L. McHarg, *Design with Nature* (Garden City, N.Y.: Doubleday, 1971), 47.
3. Jean Baudrillard, *Simulacra and Simulation* (Ann Arbor: University of Michigan Press, 1994), 2.
4. McHarg, *Design with Nature*, 7.
5. *Ibid.*, 44.
6. *Ibid.*, 52.
7. Deleuze and Guattari, *A Thousand Plateaus*, 8.
8. Baudrillard, *Simulacra and Simulation*, 1.
9. *Ibid.*, 80.
10. *Ibid.*, 81.
11. *Ibid.*, 111.



Creating Natures: Merging Technology and the Organic

In as much as the image or map joins with reality, the more ephemeral notions of 'being' and 'place' merge with their technological and systemic counterparts. The history and discourse of cybernetic systems utilizing feedback loops within organisms and machines lead us to a theory underpinning the construction of entirely new living systems and environments. In this light, cybernetics points to an fusion of the natural and the artificial, as it becomes a model for dynamic interaction that does not differentiate between the two. Donna Haraway pioneered this very precept in her development of the cybernetic organism, or 'cyborg', as such entities challenge not only precepts of ontology, but bring into question social constructs of gender, race, and cultural hierarchies. Yet, with as much hope for new generations of rights and equality to be brought about by merging technology with the organic, there are equally fears of such new life-forms and systems being uncontrolled composite creatures. However, it is precisely through their ontological anarchy that these beings create freedom. Following this, we observe that 'being' and 'becoming' are indistinguishable, as outlined in Brian Massumi's *Parables for the Virtual*. An ambiguity arises between human and computer, and being and process, as the mind merges with the machine. Networked, it follows that collective minds form environments unto themselves, such as to create the contemporary ambiguity between the individual and the system. The amalgamation of complex thinking systems is not, however, completely artificial, but part of the natural process of the evolution of Teilhard De Chardin's Noösphere. Within this model, the principle of complexity as a system of creating higher order and relationships, is the generator for a collective global consciousness. We indeed are living in a Noöspace; an environment of in-betweens, but collectively a whole.

10.0 | Cybersense

Motion of the human body itself is now mapped spatially, displaying time in a frozen image.

Cyber

Neil Spiller gives us an overview of the development of cyber-theory and systems in his book *Cyber_Reader*. Tracing the roots of early computation, we begin with Charles Babbage, inventor of the ‘Analytical Engine’, from 1864.¹ This precursor to the computer was a mathematical machine that could quickly calculate logarithms and cartographical charts, thereby continuing through the roots of technologies of mapping, an ancestor to the Geoscope, in its attempt to aid us to understand and grasp the world spatially and numerically. Descending from this came a rapid development of computers, ever changing our interaction with the world:

“Now the mathematical exactitude of computers and their programs can even create imaginary worlds that still have empirical qualities, and it is this phenomenon that gives the virtual world its awesome power. This power is seen by some to be immensely liberating, and by others to be stripping us of our liberty.”²

It was Alan Turing who then devised a thought experiment known as the ‘Universal Turing Machine’ from 1950, in which he conceived of a computer that could interact with its users by responding to questions with such convincing communication that it would be impossible to determine if it is actually a human or machine offering response. Such a device ushers in the era of ‘Artificial Intelligence’, ever narrowing the distance between ourselves and our tools of interaction. Continuing from this strain of research, Gordon Pask, author of *The Architectural Relevance of Cybernetics* from 1969, developed ‘Conversation Theory’, supporting further evolution of the interface between human beings and computers.

“Pask’s learning environments, whether for entertainment or touch-typing or statistics, viewed the human as part of a resonance that looped from the human, through the environment or apparatus, back through the human and around again. For Pask, that is the interaction by which we understand each other when we speak or dance together.”³

Parallel to this, runs Cybernetics Theory, as developed by Norbert Wiener. Cybernetics, a theory for the control, self-regulation and communication between systems, applies equally to living systems as it does to machines, but further suggests an integration of these spheres of thought. From this precept, entire new fields of research, in combining natural, social, and artificial systems arise, from general systems theory, toward industrial ecologies, and artificial intelligence. Because of the power of cybernetics to apply itself to nearly all systems, we find an evolution of cyber-environments, being realms between the physical, imagined and computed, or, as coined by William Gibson, ‘Cyberspace’.⁴ Further still, the ‘Cyber’ designation may apply to an individual, a cybernetic organism, a ‘Cyborg’.

Egosystem

Donna Haraway’s *Simians, Cyborgs, and Women* focuses on the reinterpretation of what human beings are, and our relationship with one another, other creatures, and the world we create. All of these elements are fused together in Haraway’s definition of the cyborg, which itself seeks a lack of concrete definition in exchange for a more dynamic hybridized existence in its multiplicity. Through this, Haraway seeks a reinvention of nature, offering hope from the oppression typical and limited definitions uphold.⁵

*"A cyborg is a hybrid creature, composed of organism and machine. But, cyborgs are compounded of special kinds of machines and special kinds of organisms appropriate to the late twentieth century. Cyborgs are post-Second World War hybrid entities made of, first, ourselves and other organic creatures in our unchosen 'high-technological' guise as information systems, texts, and ergonomically controlled labouring, desiring, and reproducing systems. The second essential ingredient in cyborgs is machines in their guise, also, as communications system, texts, and self-acting, ergonomically designed apparatuses."*⁶

Haraway's cyborg is a socialist-feminist model of a new form of humanity, that attempts to defy common boundaries and hierarchies of power structures founded in defining race, class and sex. The cyborg is the essence of going beyond definition. Envisioning such an indeterminate identity, we might ask how what are the scalar limits of these constructs? Seemingly, Haraway's cyborg model could become a community, field or an array of systems, approaching something closer to the interconnected spheres of McLuhan or Teilhard de Chardin, yet not heading toward some ultimate singular form, but rather, remaining in shifting ambiguity.

"A cyborg is a cybernetic organism, a hybrid of machine and organism, a creature of social reality as well as a creature of fiction. Social reality is lived social relations, our most important political construction, a world-changing fiction.

...

*Liberation rests on the construction of the consciousness, the imaginative apprehension, of oppression, and so of possibility. The cyborg is a matter of fiction and lived experience that changes what counts as women's experience in the late twentieth century. This is a struggle over life and death, but the boundary between science fiction and social reality is an optical illusion."*⁷

The ambiguity of roles or identity of a cyborg may point to an anarchistic tendency, in an effort to subvert existing systems of

power and control. But, this new model of humanity also goes much further, and deeper into our own nature. As we combine our understanding of reality and fiction, we are formed by our imagination:

*"Our bodies, ourselves; bodies are maps of power and identity. Cyborgs are no exception. A cyborg body is not innocent; it was not born in a garden; it does not seek unitary identity and so generate antagonistic dualisms without end (or until the world ends); it takes irony for granted. One is too few, and two is only one possibility... The machine is us, our processes, an aspect of our embodiment. We can be responsible for machines; they do not dominate or threaten us. We are responsible for boundaries; we are they."*⁸

Donna Haraway attempts to come to terms with the difficult result of the hybridized realm we have created, for in creating a responsive sphere of pure interconnectivity, the role of the individual, or the identity of the self continuously comes into question. The cyborg seems to not only accept this hybrid I/We or Inner/Outer reality, but embraces it as a means of generating a way of life.

Liminal Ontology

Brian Massumi, a Professor of Communications at the Université de Montréal, explores the development of the self, in a complex world of multiple levels of sensory interactivity. His work, *Parables for the Virtual: Movement, Affect, Sensation* describes the primary shift in ontological study, as one that looks less into the notion of 'being', and much more into the perception of 'becoming'. In allying himself with the German polymath Gottfried Leibniz, he pursues the idea of self as a process of development, in as much as the idea of nature undergoes constant change:

*"Shouldn't we assert, with Leibniz, that all the predicates that can be stated of a thing— all the "accidents" that might befall it (even those remaining in potential)—are of its nature? If so, "nature" changes at the slightest move. The concept of nature concerns modification not essence."*⁹

Massumi goes on to assert that the very concept of change or changes of state are unto themselves ontological studies. This points to Massumi's argument, that in pursuing our understanding of the world around us, as it shifts, we ourselves shift in identity.

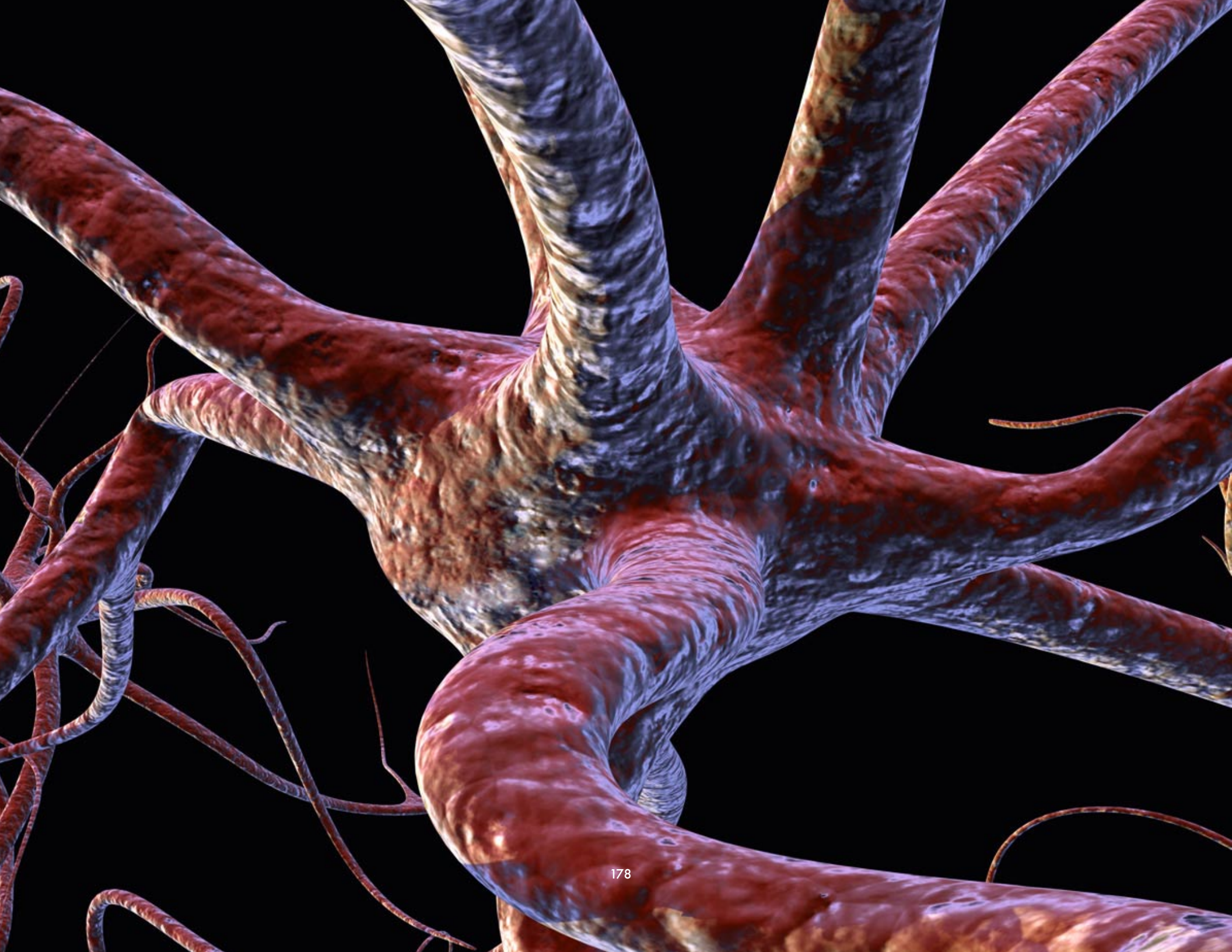
*"Indeterminacy and determination, change and freeze-framing, go together. They are inseparable and always actually coincide while remaining disjunctive in their modes of reality. To say that passage and indeterminacy "come first" or "are primary" is more a statement of ontological priority than the assertion of a time sequence."*¹⁰

By looking at the crossover of nature and culture that has been in constant flux over time, we become aware of our very means of gauging this dynamic relationship, and in this, achieve what Leibniz refers to as the 'perception of perception'. Massumi goes on to show that we have an effective doubling of sensation and action within the environment, as we engage the environment and become aware of this engagement simultaneously. It is this

awareness, then, that contributes to the development of self, in relation to our sensations and movements with the varied environs. The link, he goes on, between movement and sensation in the environment is merely a virtual, or abstract unity.

An establishment of self through the virtually connected movement and sensation in the environment might extend further into general movement and sensation in responsive systems and technologies that constitute interconnected landscapes and reflexive architectures. In this sense, connectivity is itself an abstraction, but perhaps one that addresses 'real' issues we face today of ecological and social importance in a global society. As we experience a shift from 'being' to 'creating beings', the construction of synthetic responsive worlds then suggest a deeper questioning of the 'identity' of the environment.

1. *Cyber_Reader: Critical Writings for the Digital Era*, ed. Neil Spiller (London: Phaidon, 2002), 8.
2. Ibid.
3. Ibid., 77.
4. William Gibson, *Neuromancer* (New York: Ace Books, 1984).
5. Donna Haraway, *A Cyborg Manifesto: Science, Technology and Socialist-Feminism in the Late Twentieth Century* (Routledge, 1991), 1.
6. Ibid.
7. Ibid., 149.
8. Ibid., 180.
9. Brian Massumi, *Parables for the Virtual: Movement, Affect, Sensation* (Durham: Duke University Press, 2002), 7.
10. Ibid., 8.



“In this context it is salutary to suggest that the path and direction of evolution may not be identical to human ideas of destiny... The that brain may or may not be the culmination of biological evolution or it might in contrast be an aberration, a spinal tumor, and finally, although no man will hear it, the algae may laugh last. The burden of proof, then, lies with man and brain. He is required to demonstrate that he is capable of understanding and managing the world of life to ensure survival.

We can conclude that there are two extreme viewpoints of man-nature. In the first, anthropocentric man-ignorant of evolutionary history, innocent of man’s dependence, his allies and cohorts, low-browed and brutish—destroys as he goes, while adulating man and his works. (Can we suggest that his aggression is only a cultural inferiority complex?) The opposing view is less certain of man’s place. It reserves the right to justify man as not only a unique species, but one with the unequalled gift of consciousness. This man, aware of his past, his unity with all things and all life, proceeds with a deference born of understanding, seeking his creative role.”¹

—Ian McHarg, *Design with Nature*

11.0 | Neuron Network

A microscopic image of a neuron in the human brain. These nerve cells are interconnected, allowing them to transmit electrical impulses, or information to other cells.

The Hybrid Condition: A Conscious Complex

Stemming from the vision of a connected world, composed of hybridized beings, and the merging ontological dilemmas Brian Massumi raises, we ultimately arrive at questioning our role and position in this global system. As human beings, are we part of the system or are we the system itself through our very perception and subsequent creation of our environment? Are we natural? Are we inherently cybernetic, or is this a synthetic creation? Further, is our artificial creation in fact natural? These questions all relate to our own development of consciousness, self-consciousness and environmental consciousness. We then can posit our special-ness or rarity in this evolving interconnected world of thought.

“Perhaps the greatest conceptual contribution of the ecological view is the perception of the world and evolution as a creative process.

...

In this energy is employed with matter through living processes. The energy is temporarily entrapped; it will inevitably be lost to entropy but it will also be replaced. Meanwhile the living creatures persist, evolve and in their beings and their modifications to the earth, act to raise matter to higher orders. This tendency, which is the sum of all life and all time, and the orderings which these have accomplished, is described as negentropy. Perhaps it can be given the more affirmative and colloquial title of creation—the world’s creativity.”²

As Ian McHarg suggests, our consciousness and system of consciousness, or brain, is that which both separates us from other species, but also inherently binds us deeply with nature, through the very process of the development of life. Termed as ‘negentropy’, the development of complexity seems to be linked not only to the evolution of living system and beings, but is further responsible for the propagation of human consciousness.

Negentropy, is again pursued by James Lovelock³ through the objective of actually defining life, as he summarizes Austrian physicist Erwin Schrödinger's findings on the subject:

*"Schrödinger concluded that, metaphorically, the most amazing property and characteristic of life is its ability to move upstream against the flow of time. Life is the paradoxical contradiction to the second law, which states that everything is, always has been, and always will be running down to equilibrium and death. Yet life evolves to ever-greater complexity and is characterized by an omnipresence of improbability that would make winning a sweepstake every day for a year seem trivial by comparison."*⁴

Negentropy, or complexity is a force of life, a strange opposing harmony of the physics of the universe, which tends toward entropy or disorder. Life itself seems to have developed out of an antithetic relationship with the cosmos, producing the physical synthetic systems we observe on our earth. Yet, within this context, human beings are perhaps rarer still; highly concentrated organizations of complexity, order, or negative chaos. We have achieved a special and important place within our environment through our understanding of it, as described by John and Nancy Todd, designers of 'Living Machines', complex amalgamations of natural and artificial systems for waste treatment, in the opening of their seminal book, *From Eco-Cities to Living Machines*:

*"In terms of biochemical make-up and genetic structures, the similarities between the human being and the bacteria, for example are greater than the differences. The illusive and pervasive issues of how human beings, as the only self-conscious species, are to live in the world is a logical outgrowth of our new biological knowledge."*⁵

Our developed consciousness, being self-referential, as well as environmentally, naturally and self-generated, again places us in a special and specific position. We are somehow aware of our intimate connection to the world, but through this, both distanced

and objective. How might we reaffirm and reposition ourselves in our environment?

Edouard LeRoy, French mathematician turned natural philosopher, and a critical thinker in the development of the Noösphere, attempts to tackle the central issue of the double relationship of human beings and their environment and the duality of our synthetic and natural engagement of the world around us, in his work *The Origins of Humanity and the Evolution of Mind*:

"Thus, at the heart of the human phenomenon there is a latent paradox. It would seem that humanity is systematically much more biologically potent than it should be.

...

*This is without a doubt a new form, but one that will only fool the superficial or partial observation or narrow inattention to what, in reality, is natural in the artificial. If we want to capture the full biological reality, we should not separate mankind from his tools, his real organs or his technology: his real functions."*⁶

Strangely through our self-consciousness, we achieve a separation from our environment and our own creations, but these are both part of us and natural. Surely LeRoy along with Teilhard de Chardin understood the importance of including our own creative force with our natural evolution, as our evolution of complexity is intertwined with our conscious development in a cosmic process of physico-psychic concentration.

*"Everything, rather, goes to show that, in and through mankind, the cosmos is still continuing its arduous drift towards increasing states of complexity: of centration in consequence, and, as a further consequence, of consciousness."*⁷

Yet, our separation persists. The dualism of the natural and synthetic, the technological and biological remains a fundamental rift in the understanding of our selves. Arthur Koestler wrote

extensively on this subject in his critical work *The Ghost in the Machine* describing the primitive brain and hence mind being nested within, and allowing the emergence from without, of our contemporary human mind. His description of our dualistic condition is found in an anecdotal story about two watchmakers, Bios and Mekhos.⁸ Mekhos, the technological, synthetic man, constructs his watches by adding a single part at a time, such that when disturbed, he must rebuild the watch from the beginning. Bios, the biological, natural man, builds his watches with the same number of components, but assembles them in hierarchical groupings, such that when his work is disturbed, he must only restart the last hierarchical assemblage. This model of being and creating, is fundamental to Koestler's precept of the Holon; a means of perceiving a cell, an individual, a city, or a world, as being a 'part' and a 'whole' simultaneously.

"The first universal characteristic of hierarchies is the relativity, and indeed ambiguity, of the terms 'part' and 'whole' when applied to any of the sub-assemblies. Again it is the very obviousness of this feature which makes us overlook its implications. A 'part', as we generally use the word, means something fragmentary and incomplete, which by itself would have no legitimate existence. On the other hand, a 'whole' is considered as something complete in itself which needs no further explanation. But 'wholes' and 'parts' in this absolute sense just do not exist anywhere, either in the domain of living organisms or of social organizations. What we find are intermediary structures on a series of levels in an ascending order of complexity: sub-wholes which display, according to the way you look at them, some of the characteristics commonly attributed to wholes and some of the characteristics commonly attributed to parts."⁹

Koestler presents us with a way of creating complexity, toward which we might consider the development and construction of our own consciousness. The Noösphere is a creative, generative complex, but it is not without its problems. We have created a complex of the conscious; we have a difficulty with acting

responsibly, and responsively within our environment, as our awareness, and conscious construction of the world objectively separates us from it. From this, we turn back to some of the early theories that gave rise to noöspheric thought, through which our modern and post-modern self-referential thinking has developed. French Philosopher Henri Bergson's *Creative Evolution* describes again, this complex development of life as a creative force.

"The life that evolves on the surface of our planet is indeed attached to matter. If it were pure consciousness, a fortiori if it were supra-consciousness, it would be pure creative activity. In fact, it is riveted to an organism that subjects it to the general laws of inert matter. But everything happens as if it were doing its utmost to set itself free from these laws."

...
With man, consciousness breaks the chain. In man, and in man alone, it sets itself free. The whole history of life until man has been that of the effort of consciousness to raise matter, and of the more or less complete overwhelming of consciousness by the matter which has fallen back on it. The enterprise was paradoxical, if, indeed we may speak here otherwise than by metaphor of enterprise and effort. It was to create with matter, which is necessity itself, an instrument of freedom, to make a machine which should triumph over mechanism, and to use the determinism of nature to pass through the meshes of the net which this very determinism had spread. But, everywhere except in man, consciousness has let itself be caught in the net whose meshes it tried to pass through: it has remained the captive of the mechanism it has set up."¹⁰

Bergson suggests, in this birth of this post-modern dilemma, that through self-reference and self-reflection of consciousness, we achieve a strange separation from consciousness itself, therein developing the artificial in consciousness ironically through the natural introspection of humanity.

The authors, thinkers and visionaries reviewed have described the development of both individual and environmental identity. This has been generated in the context of the uncertainty outlined by the postmodern movement in seeking ecological and technological connectivity. Though this study is ontological, it has roots in structures and systems of a physical, social and virtual nature that extend far beyond any one individual. The link between the ‘environment’, consisting of these varied ‘real’ and ‘imaginary’ realms, and the development of the individual, or, the perception of one’s own identity presents further interesting questions of the relationship of the individual to their environment. Further, we observe the creation of environment and individual to be derived from one another, if not completely synonymous. Thus, we can apply these ontological dilemmas to the interconnected, holonic view of the world that we have established. How, then, does this conscious complex apply to our environment—the thinking layer of the earth—from the Noösphere to the World Wide Web? If we have combined our own synthetic and natural development of complexity with that of our environment, what is its form, and what will it become? Following this development of theories of global perception and manipulation yields a far larger, cosmic creation in which we must now live. The Geoscope presented us with a centrifuged model of control, for a unified world. However, the theories emergent from Fuller’s system suggest a heterogeneous, interconnected, dynamic and uncontrollable field. The stream of thought emanating from the Geoscope yields an interconnected manifold, a super holon, in which the whole is in the part, as much as the part is in the whole. It is a liminal realm of oscillating gestalts, where figure and ground fuse. As such, the complexity of our environment compounds, and through the pursuit and creation of our environmental consciousness, we construct a conscious environment.

1. Ian L. McHarg, *Design with Nature* (Garden City, N.Y.: Doubleday, 1971), 44.
2. *Ibid.*, 53.
3. James Lovelock, *The Ages of Gaia: A Biography of our Living Earth*, 1st ed. (New York: W.W. Norton, 1988), 25.
4. *Ibid.*, 23.
5. John Todd and Nancy Todd, *From Eco-Cities to Living Machines: Principles of Ecological Design* (Berkeley, Calif.: North Atlantic Books, 1994), 1.
6. Edouard LeRoy, “The Origins of Humanity and the Evolution of Mind,” quoted in *The Biosphere and Noosphere Reader: Global Environment, Society, and Change*, eds. Paul R. Samson and David Pitt (London: Routledge, 1999), 61.
7. Pierre Teilhard de Chardin, *Activation of Energy*, trans. René Hague (London: Collins, 1970), 35.
8. Arthur Koestler, *Ghost in the Machine*, 1st American ed. (New York: Macmillan, 1968), 46.
9. *Ibid.*, 47-48.
10. Henri Bergson, “Creative Evolution,” quoted in *The Biosphere and Noosphere Reader: Global Environment, Society, and Change*, eds. Paul R. Samson and David Pitt (London: Routledge, 1999), 58.

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