Regenerative Architecture: A Pathway Beyond Sustainability

REGENERATIVE ARCHITECTURE: A PATHWAY BEYOND SUSTAINABILITY

A Thesis Presented by

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ABSTRACT

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The current paradigm in the field of architecture today is one of degeneration and obsolete building technologies. Regenerative architecture is the practice of engaging the natural world as the medium for, and generator of the architecture. It responds to and utilizes the living and natural systems that exist on a site that become the "building blocks" of the architecture. Regenerative architecture has two focuses; it is an architecture that focuses on conservation and performance through a focused reduction on the environmental impacts of a building.

This paper introduces regenerative architecture as a means for architectural design. I present the Nine Principles of Regenerative Architecture and Place Analysis Criteria, which I developed in order to provide a logical and succinct means for creating regenerative architecture. These are employed and embedded in the creation of the R_Urban Intervention Dwelling model and tested on the Coop House design project.

The result was an architectural design in which the Nine Principles of Regenerative Architecture are embodied through the application of the Place Analysis Criteria process. Though the process underwent many mutations through its infancy, the final product has proven to work in producing successful and potentially regenerative architecture as described in part 1 of this paper.

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CHAPTER 1

REGENERATIVE ARCHITECTURE

Introduction to Regenerative Architecture

Sustainability in architecture, as understood by modern society today, is an inadequate measure for current and future architectural design, for it aims no higher than trying to make buildings "less bad". The current standard of building requires very little in regard to the environment and the standard that is set for what is considered a "sustainable" building is extremely low. The dynamic in architecture as it pertains to the environment, expects little in order to be deemed a success. When a structure is built, it is celebrated if it employs any level of environmental acknowledgement.

Regenerative architecture is the practice of engaging the natural world as the medium for, and generator of the architecture. It responds to and utilizes the living and natural systems that exist on a site that become the "building blocks" of the architecture. Regenerative architecture has two focuses; it is an architecture that focuses on conservation and performance through a focused reduction on the environmental impacts of a building. It is embodied in the material selection, reduced energy consumption, and intelligent design. The second, more profound piece of regenerative architecture is the treatment of the environment as an equal shareholder in the architecture. It is a practice that employs a full and comprehensive understanding of natural and living systems in the design of a structure.[1] It is an architecture that embraces the environment and uses the millions of years of engineering and evolution as the foundation for a regenerative structure. Regenerative

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[1] Bill Reed, a very prominent and important figure in Regenerative Design as well as in the larger context of architecture, the environment and society, offers a brief definition of Regenerative Architecture. "...a conservation, or high performance, approach focused on reducing our impact AND a living system understanding focused on learning how to engage nature as a co-equal partner." Reed, B. 2007. "A Living Systems Approach to Design, AIA National Convention, May 2007 – Theme Keynote Address". May 22, 2007.

design is based on the premise that everything we build has the potential for the integration of the natural world as an "equal partner" in the architecture.

Redefinition…

Architecture is defined as "the art or practice of designing and constructing buildings."[2] This is a common definition of architecture, though it is incomplete; the breadth of possibilities for regeneration and integration are nonexistent as the definition limits us to architecture being solely a building. Buildings exist as a part of a place/site, which our definition of architecture does not account for. The question is why do we remove the building from the site in our definition of architecture? The building requires the site for its existence, but we view them as separate elements. Perhaps we can expand the definition of architecture to "the art or practice of designing and constructing place, through the integration of site and building." This definition is more complete and comprehensive as including the site in architecture is the only way for a building to be "beyond sustainable" or regenerative.

A building is a static entity devoid of environmental integration, leading to a linear model of consumption and waste as depicted in figure 1. Under our current definition of architecture we remove the place from the architecture, inherently dividing the operation of the structure from the landscape and the biosphere. This requires the synthesis of systems in our buildings, which demands a constant input of energy and resources that are disconnected from the site.

Figure 1 describes our current model of treating resources and materials. The disintegration of site and architecture requires resources to be constantly brought into the

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[2] Merriam-Websters Online Dictionary < http://www.merriam-webster.com>

architecture for operation, all of which eventually end up as waste, a construction of human environments. (It is important to note at this juncture that in the natural world there is no such thing as waste, as everything that is produced naturally gets recycled, an imperative part of the cycle of life.) It is a process of degeneration and with a finite amount of resources in the world, we cannot continue using the linear model that has been the foundation of our consumer society for many years.

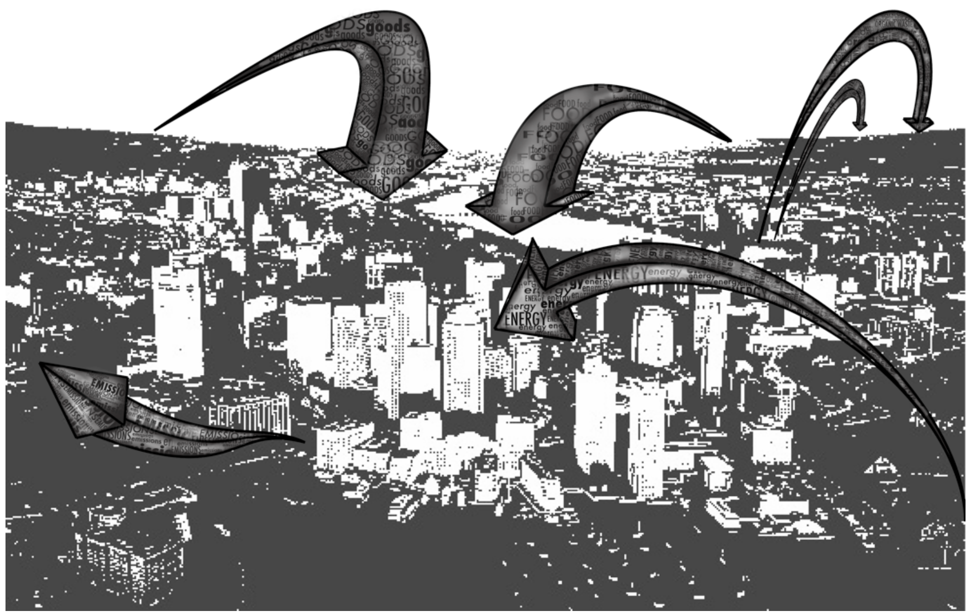

Figure 1 – Current model of resource and material treatment

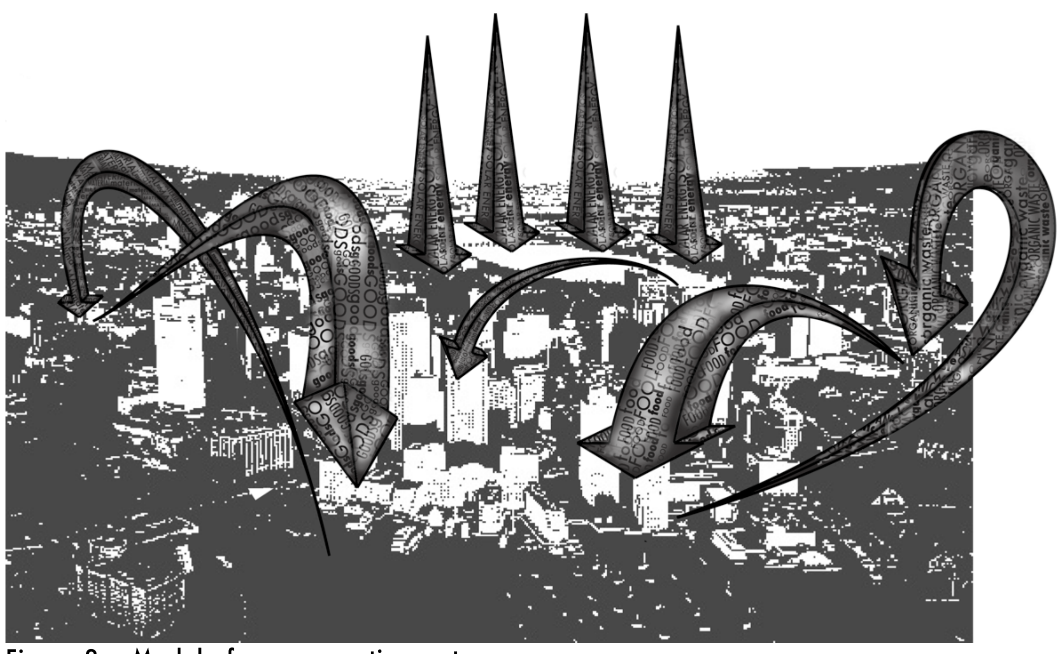

Figure 2 – Model of a regenerative system

Architecture is regenerative when the term architecture incorporates more than just the building. The architecture is the place, the site, the systems, the energy, the building, the fauna and flora, etc. It is an architecture that is purely embedded into the site. It exists as one piece, one system that co-evolves as one complete entity. Once this understanding of architecture is adopted, the opportunities for regenerative architecture become almost limitless. The health of the ecosystem is improved and the architecture is now producing more than it consumes, having a positive existence; this is called regeneration. Figure 2 is a model that graphically depicts a model of regeneration.

The expansion of our built world paradigm allows for humans and the environment to exist in integration. It allows humans to return to a place of equilibrium and regeneration in our life places. The upward spiral of environmental health can begin, which ultimately increases the health of the human species as well as the environment, needless to say it is in our best interest to adopt a process of regeneration and integration.

We can have regenerative architecture when our production output from the system is greater than the net input of resources into the system. The architecture, in its new definition, is producing a surplus of food, more clean water than it consumes, more energy than it consumes, provides richer diversity than was before the structure became part of the system.

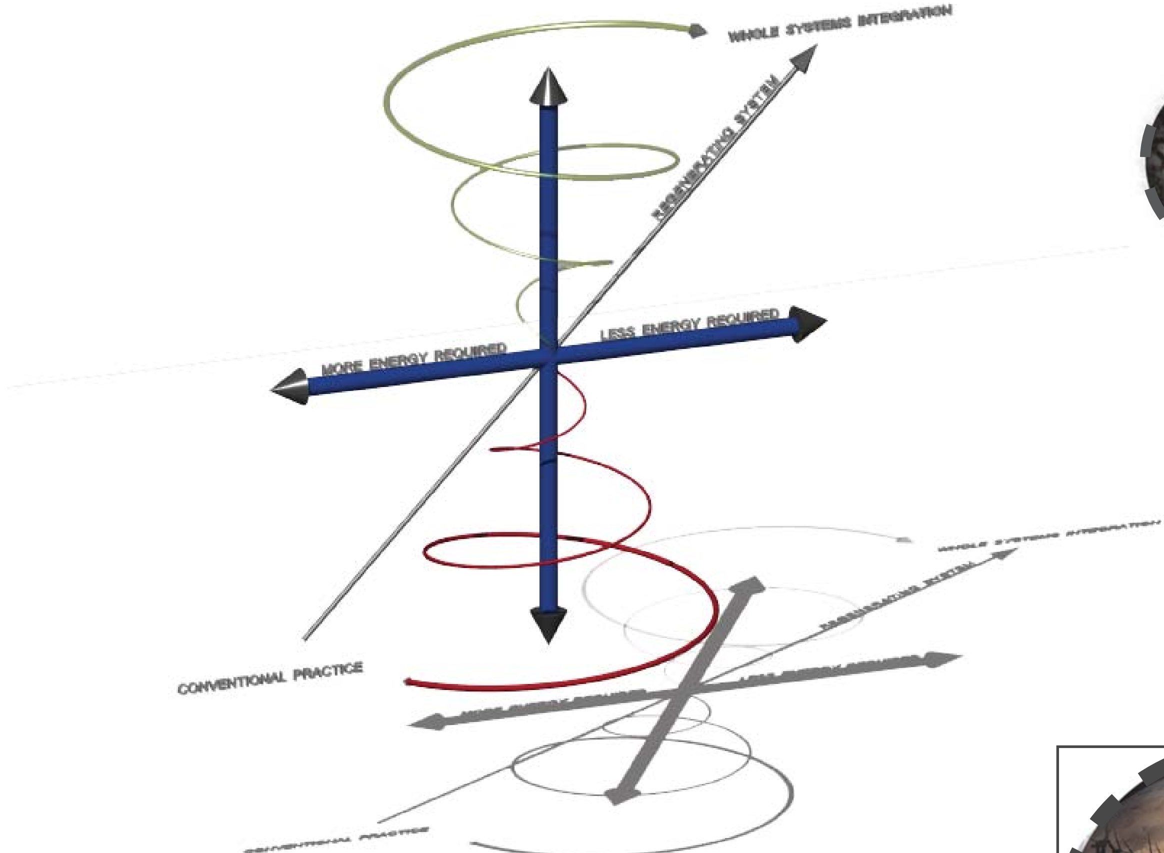

Figure 3 - Trajectory of regeneration

Figure 4 - Paradigm shift

Sustainability – the Less Bad Approach

A "green" building traditionally focuses solely on the first part of regenerative architecture. It employs technology as the means of reduction and conservation. The problem is that the structure is seeking to reduce its contribution to environmental degradation using methodologies and typologies that have been proven they not be the most intelligent and logical solutions for achieving real sustainability. The method of designing and building structures devoid of natural processes and minimal engagement with the environment is still unnatural and illogical.

Consider the booming trend of hybrid vehicles. The hybrid car is the auto industries answer to the polemical argument of how we can help save the environment. The technology, while it is indeed reducing the impact of the car, is still burning fossil fuels in order to operate. We know that using fossil fuels is not the answer to a sustainable mode of personal transport, though as a society, we largely support and encourage the proliferation of this technology.

Architecture is the same as hybrid vehicles. We are trying to solve the dilemma of saving the environment using the wrong solutions. By adopting regenerative architecture we are answering the question of how we can be truly sustainably in our buildings. We are providing solutions using the natural world as the means for doing so.

Architecture has the capability of producing all the requirements that we need for life. A structure can produce energy, food, capture water, purify water, produce oxygen, and capture CO2, among other things. A building has the capability of having a positive existence rather than a negative one. For an architecture that is environmentally "friendly"

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or designed with the environmental impacts in mind we use the term sustainable. We use the term sustainable for any human activity that is performed with the notion that the environmental impacts of that activity are reduced. Mitchell Joachim, a professor of architecture a Columbia University, and ecological designer says about sustainability in a recent interview with Tom Vanderbilt of Wired Magazine, "I don't like the term. It is not evocative enough. You don't want your marriage to be sustainable, you want to be evolving, nurturing, learning. Efficiency doesn't cut it either, it just means "less bad"."[4]

The term has "sustainable" become a catch phrase for anyone who is making an effort lessen the impact of their lives or lessen the impact of the products they produce. But why would we simply want to sustain our environment and ourselves? Why wouldn't we want, let alone feel the need, to do it better and go beyond sustainability and strive for health, equilibrium and wealth? Meeting the needs of a sustainable lifestyle is like meeting the minimum requirements for life in the now and in the future. Our goal should not be a sustainable human dynamic; it should be a regenerative dynamic. It is plain and simple, humans live in a counterproductive manner that is degrading the quality of our world and proliferating the permanence of the damage that is being done.

The current understanding of "sustainable" addresses very little when considering the immense impact that buildings have on the environment. The low standards do not provide solutions for the future. We build for today, but ignore the problem of tomorrow. The paradigm that exists emphasizes building more efficient buildings and reducing the energy consumed by them. In other words, we attempt to reduce the impact of or buildings, mostly through technological means. It separates each system into their own entities and

[4] Wired. Vanderbilt, T. 2008. The Smart List: Mitchell Joachim, Redesign Cities from Scratch. October, 2008, p. 178-179. 16-10.

each system is then independent from the rest of the existing systems that are present within the structure.

Bill Reed describes the unnatural building and design paradigm that we have adopted as our primary means of structure creation in his 2006 article entitled "Shifting our Mental Model – "Sustainability" to Regeneration" as "In the design field" he states, "we primarily see systems, and systems' thinking applied to closed systems such as mechanical systems, envelope systems, and so on. These human designed systems are entropic by nature, requiring a continuous infusion of resources and energy to sustain themselves."[5]

A continuous input of energy and resources into a structure for healthy and complete operation is not sustainable by any means. There is a finite amount of resources in the biosphere and we are exploiting them at a rate faster than they can regenerate or recycle. Closed entropic systems result in the exclusion of the complete, organized and whole systems that are the fabric of the natural world, leading to the degradation of the environment, regardless of how intelligent and efficient the technology employed in a building is or can be.

In the United States we have adopted rating systems such as LEED (Leadership in Energy and Environmental Design) in order to evaluate the "sustainability" of architecture. Rating systems of this nature provide points on a scale, the more points, the higher the rating. This model is a prescription for making building more efficient, more ecologically friendly, and lower impact buildings. It is a recognition that the archetype for building that we use is inadequate, though it is an attempt at fixing a problem using a solution based on

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5 Reed, B. 2006. "Shifting our Mental Model – "Sustainability" to Regeneration". April, 2006. Pg. 5 <http://www.integrativedesign.net/resources>

the archetype that clearly does not work. We cannot fix the problem of unsustainable buildings until we are ready to acknowledge that the way we build is simply incorrect and the standard needs to be shifted away from the "business as usual" and "less bad" approach.

In essence it boils down to decision-making. We can decide how to approach architecture, but it must come as a socio-cultural decision that is delivered in the form of a large-scale adoption of regenerative design principles and the recognition by the consumers and users that our bar is set too low. Technology is not going to save us unless it is technology that is consistent and partnered with the environment. It is the people; the societal body that must recognize our patterning and decision as the root of the problem.[6]

The normative model that we use for designing and building disconnects us from the world in which we inhabit. This paradigm proliferates the mental model that we, as humans, are above the natural world. It, instead of recognizing our connection and dependence on the natural world for existence, propagates the notion that the world is ours to exploit. This is the mental model that has led us to the patterning process and

Figure 5 – Timonium, MD storm water channel - Before

Figure 6 – Timonium, MD storm water channel - After

6 "No amount of regulation, intervention, or standalone brilliance will bring us to a healthier world until we begin to deliberately join and design decisions into coherent patterns that are congruent with nature's own." (Van Der Ryn, S., Cowan, S., 2007, p. 35)

infrastructure that degrades the environment. A clear understanding and perception of the root cause of the environmental crisis is the first step to regeneration. It is then up to each respective individual, group, industry, state and nation to analyze and develop intelligent and practical solutions to the crisis.

The image in figure 5[7] a simple storm water management channel. It is an example of the ubiquitous mental model that humans are above the natural world, proliferating our disintegration with the environment in which we rely for survival. It is displaying a "solution" to a "problem," when in fact the "problem" is purely a construction of human society. Storm water is not a problem at all; it is a part of the natural system of the world. It is a necessary element in which other systems rely for their own proper function, which leads to the unhealthy function of every other natural system. This "solution" to this "problem" is representative of how we, as a species, by and large synthesize the world for our own convenience.

[8] We must adopt an understanding that everything is connected through the web of mutually supportive relationships and reintegrate ourselves with the environment. If we adopt a mental model that we are a part of nature and we have the ability to enhance the health of the environment we can begin to develop solutions to our problems using the problem as the solution. For example, the image above is the same place and view as the previous image after a redesign using regenerative design principles. The difference is the mental model that was used in designing the system. If we redefine our paradigm we can easily shift to a world constructed in accordance with nature as depicted in this image.

[7,8] These images depict a site in Timinonium, MD. The redesign was done by the Regenesis Group, LLC for the town of Timinonium. For more information see http://www.regenesisgroup.com. Images are used with permission from owner.

Guiding Principles for Regeneration

"Tissue builds around the flow of energy and becomes the physical expression or embodiment of that energy–form. The essential nature of the flow and the corresponding nature of the medium through which it is passing determines its expression in form. Energies moving over and around form further shape it.
Form repeats in predictable arrays called patterns. Each part of a system expresses a form of the pattern of the whole. At certain levels of complexity, systems shift to a higher order of organization, and patterns shift to a higher order as well, as demonstrated mathematically by fractals.[9]

–M. Murphy and V. Marvick, 1998

The perception of place as a collection of patterns and interdependent systems provides the designer with the first step in the regenerative design process. Before a structure can be generated, the designer must "know" the place on an intimate and deep level based on the existing patterns, forces and energies of a site. This is done through exploration and analysis using systems of mapping and documentation. The patterns and webs develop a unique portrait of the site. The dynamics of the place begin to reveal themselves as tangible data that is then used as the generative information of the architecture. Tim Murphy and Vicki Marvick have created a set of criteria and questions that act as guidelines for understanding, analyzing and documenting the place.

In coming to know place, we become aware of individual flows and their relationship with each other. We go beyond questions of composition and structure–What does this flow consist of? What are its parts?–to the qualities it exhibits as a result of its essential nature. These qualities correspond to multiple dimensions:

- How quickly does it move? (Velocity, viscosity, resistance encountered.)
- Which direction does it moving? (Spatial dimension: directional orientation.)
- How much is flowing at various points? (Volume-indicates order of flow.)
- How big is it? (Spatial dimensions of height and breadth.)
- How often does it flow? (Dimension of time: cycles/periodicity.)
- How long does it flow? (Duration.)

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9 Murphy, T. and Marvick, V. July,1998 Issue #49. Permaculture Acitivist #39.

• Where does it overlap and interact with other flows? (Social dimensions.)

• What's the significance of this flow for our aspirations for relationship? (The social dimension between our system and the entity of place.)[10]

Murphy and Marvick present us with a model for developing a successful and comprehensive regenerative architecture. William McDonough, a very prominent architect who employs many of these principles in his work has developed a set principles called The Hannover Principles. They are a set of design guidelines that were created for the World Exposition in Hannover, Germany in 2000. They prescribe a method for designing that is based on the elements Earth, Air, Fire, Water and Spirit and that humans must coexist with nature. The Hannover Principles describe the innate interdependence that humans have with the natural world including the effects of our designs on the viability of ecosystems. They consider "all aspects of human settlement", and the interactions of people with their built environment and nature.

The Hannover Principles

1. Insist on rights of humanity and nature to co-exist in a healthy, supportive, diverse and sustainable
condition.
2. Recognize interdependence. The elements of human design interact with and depend upon the natural world, with broad and diverse implications at every scale. Expand design considerations to
recognizing even distant effects.
3. Respect relationships between spirit and matter. Consider all aspects of human settlement including community, dwelling, industry and trade in terms of existing and evolving connections between spiritual and material consciousness.
4. Accept responsibility for the consequences of design decisions upon human well-being, the viability of natural systems and their right to co-exist.
5. Create safe objects of long-term value. Do not burden future generations with requirements for maintenance or vigilant administration of potential danger due to the careless creation of products, processes or standards.
6. Eliminate the concept of waste. Evaluate and optimize the full life-cycle of products and processes, to approach the state of natural systems, in which there is no waste.
7. Rely on natural energy flows. Human designs should, like the living world, derive their creative forces from perpetual solar income. Incorporate this energy efficiently and safely for

[10] Tim Murphy and Vicki Marvicks approach was created as a means for permaculture designers, though the guidelines can be applied to architecture, as architecture is an integral piece of permaculture. The rubric is borrowed from their article "Patterning as Process" (1998).

responsible use.
8. Understand the limitations of design. No human creation lasts forever and design does not solve all problems. Those who create and plan should practice humility in the face of nature. Treat nature as a model and mentor, not as an inconvenience to be evaded or controlled.

Two other sets of design guidelines that are crucial to consider for regenerative architecture have been developed and have been extremely influential in the field of regenerative design. The first is entitled "The Five Principles of Ecological Design." They were developed by Sim Van Der Ryn and Stuart Cowan. They highlight the importance of knowledge of place and the importance of designing structures that compliment the natural world. Cowan and Van Der Ryn emphasize the importance of integrating the natural systems and processes in the most fluid manner possible as they believe that "the more seam-less these factors are integrated into the design, the less our activities will detract from the health of nature."[11]

Cowan and Van Der Ryn describe their intentions clearly by stating, "Ecological design occurs in the context of specific places. It grows out of place the way the oak grows from an acorn. It responds to the particularities of place: the soils, vegetation, animals, climate, topography, water flows, and people lending it coherence."[12]

1. **Solutions Grow From Place.** Ecological design begins with the intimate knowledge if a particular place. Therefore, it is small scale and direct, responsive to both local conditions and local people. If we are sensitive to the nuances of place, we can inhabit without destroying.
2. **Ecological Accounting Informs Design.** Trace the environmental impacts of existing or proposed designs. Use this information to determine the most ecologically sound design possibility.
3. **Design With Nature.** BY working with living processes, we respect the needs of al species while meeting our own. Engaging in processes that regenerate rather than deplete, we become more alive.
4. **Everyone is a Designer.** Listen to every voice in the design process. No one is participant only or designer only. Everyone is a participant-designer. Honor the special

[11] Sim Van Der Ryn and Stuart Cowan are two of the most influential practitioners and researchers in the field of Ecological Design, as they refer to it. Ecological Design is, in a sense, a bible for those interested in regenerative design. Cowan and Van Der Ryn provide a set of 5 principles that encompass all aspects of regenerative design. The book is now being published as a revised and updated 10th anniversary edition.
[12] Van Der Ryn, S., and Cowan, S. 1996. Ecological Design. Washington, DC. Island Press. Pg. 39

knowledge that each person brings. As people wok together to heal their places, hey also heal themselves.

5. **Make Nature Visible.** Denatured environments ignore our need and potential for learning. Making natural cycles and processes visible brings the designed environment back to life. Effective deign helps to inform us of our place within nature.

The second set of guidelines/principles is called The Todds' Principles of Ecological Design, created by John and Nancy Jack Todd. Their intention was to create a set of guidelines that would clearly and definitively place nature "at the center of the design process." Their principles focus on nature being the teacher and generator of design. They incorporate architecture, food production and waste management into the principles so as to acknowledge, what they view as the three most important criteria to address in regenerative and ecological design.

The Todds' Principles of Ecological Design

1. The living world is the matrix for all design.
2. Design should follow, not oppose, the laws of life.
3. Biological equity must determine design.
4. Design must reflect bioregionality.
5. Projects should be based on renewable energy sources.
6. Design should be sustainable through the integration of living systems.
7. Design should be coevolutionary with the natural world.
8. Building design should help heal the planet.
9. Design should follow a sacred ecology.

All three of these design models exhibit many similarities in their prescription. They are all based on the same basic premise, though each has their own fundamental focus, whether it is architecture or design in general. The basic theme that is concurrent throughout all three is the premise that design needs to be in response to the local biosphere and the specific place that the architecture is generated for.

Honeybees and Flowers –mutually beneficial and reciprocal relationships

Architecture rarely engages the natural world in which it is placed. There is a vast rift that exists between the environment and architecture. A paradigm that has the potential to influence and dramatically change the way we build is one of inclusion and understanding. It is a paradigm that prescribes a deep understanding of the natural world and the systems that exist within it. We can build using the environment as our model and guide for the architecture that is generated. It is a process that requires the inclusion of all of the natural processes of the natural world.

The essence of regenerative architecture is based on the conception that there is no disconnect between human and nature. It suggests that humans and nature are one; we are not above nature but an integral part of nature. It is based on *whole systems thinking*, which means that everything is connected as one system and that each piece of the system is equally important to the health of the system as a whole (see diagram 3). The mental model of whole systems thinking in architecture generates an architecture that is wholly comprehensive and inclusive in nature. It incorporates all parts of the ecosystem and biosphere as equally integral participants in the generation of the architecture.[14]

The environment provides many answers to the problems we face. We can choose to acknowledge these answers and employ them in our architecture and start to generate architecture that is created through the inclusion of these processes. This provides us with the potential to build architecture that can regenerate the health of the environment as

13 Image used with permission from Appleseed Permaculture

14 "*Whole systems thinking* recognizes that the entirety of existence is interconnected, and moves us beyond mechanics into a world that is activated by complex inter-relationships—natural systems, human social systems, and the conscious forces behind their actions. Everything is connected—in the act of building design we are inextricably engaged in direct and indirect reciprocal influence in the immediate community (place) and the planetary systems we are a part of." (Reed, B., 2006, p.5)

opposed to simply doing less damage to it. Ethan Roland, a regenerative designer in the New England poses the question to designers, "How can we do the greatest good for the greatest amount of beings for the longest amount of time with the least impact?"[15]

Regenerative architecture, through the whole systems thinking model, reconnects humans to their life-places. A comprehensive architecture is produced from, by, and for the place in which it is built. It becomes an embedded piece of the ecosystem, contributing to the natural balance, which inherently connects the occupiers of the dwelling to the land on a deep and spiritual level. The deep connection returns humans to their role in being equal shareholders in the health and wealth of the place and the biosphere in which we exist.

Through the adoption of whole systems thinking and regenerative architecture, humans develop mutually beneficial relationships with their life places. The land provides a healthy, connected existence and in return the humans exist as positive contributors to the place. Reciprocally maintaining relationships are created, fostered and proliferated.


Figure 7 – Honeybees at work

Consider a honeybee that pollinates a flower. This action increases the health of the flower species through the bee's action of carrying the pollen of one flower to another, maintaining a diverse gene pool necessary for the health of the flower species. In the process of pollinating the flower the bee is provided with sustenance for itself and its hive. The relationship of the bee to the flower and the flower to the bee is one of symbiosis and reciprocal maintenance. The relationship between to two species is one that has been

[15] Roland, E. 9/2008. Sustainability Lecture Series, University of Massachusetts.

developed and engineered through the course of the co-evolution of both species; it is a precise and efficient affair between two drastically different species.

These reciprocally maintaining and mutually beneficial relationships are the foundation for the health of the world. Without the balance and equilibrium that nature has engineered, we would not exist as a species. The balance is what supports us, though the current paradigm that we use for interacting with the world is threatening and degrading the equilibrium that gives us the opportunity to exist in the first place. We as humans have the opportunity to return ourselves to a place of deep connection. We are the most highly evolved species and are the most capable of rapid adaptation and shifting our means of living by taking an active role in the participation of maintaining the equilibrium that we are so deeply indebted to as a species. We can use the flower and bee example as the model for how we should be interacting with the environment because the one sided relationship that we have developed between us and the earth cannot continue indefinitely.

So, Why Do We Poop in Clean Water?

Since the industrial era we have been developing our built world using technologies, patterns and systems that largely contradict how the natural world has engineered itself through the course of the evolution of life. Architecture is one of the worst contributors to this contradiction. Our design principles display a bifurcation between the built world and nature. The natural world is a collection of many natural systems and energy flows that are all integrally connected. Each individual system relies on every other system for healthy operation. The web of the interconnectedness and mutually beneficial relationships that exist in our world is quite literally the foundation by which we, and the rest of the life on earth, exist.

Buildings have an enormous impact on the environment as they consume tremendous amounts of natural resources, water, and energy as well as produce a great deal of pollution. Andres R. Edwards describes the impact that buildings in this country alone have on the environment in quantifiable terms, "In the USA, buildings are responsible for over 65 percent of total electricity consumption, 30 percent of total greenhouse gas emissions, 136 million tons of construction and demolition waste (approximately 2.8 pounds per person per day) and 12 percent of the potable water use. Globally, buildings use 40 percent (3 billion tons annually) of all raw materials." [16] The figures that Edwards presents to us are staggering. They help to put into perspective the shear enormity of the crisis that we are dealing with as a species as well as the immense danger that we are putting the rest of the worlds species in. In fact, 2/3 of all species in the world are facing extinction and we are the solely responsible for it.[17]

Architecture, as we know it today, operates with a divorced relationship from the natural world. We remove our built environments from the natural environment by synthesizing and replacing the natural systems by which all other life on earth exist. For example, the predominant method for cooling a structure is by using artificially produced energy to run a motor that uses mechanized systems and chemicals to cool the air that is then forced through a system of tubes and vents to deliver a precise amount of air at a specified temperature to a room. What this example depicts is one of the many ways in which we artificialize our world through the architecture we build.

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[16] The Sustainability Revolution: portrait of a paradigm shift is one of the leading texts to date that clearly and comprehensively articulates the environmental crisis and what we, as a society, can do to "shift our paradigm". Pg. 97

[17] Roland, E., 2008

To contrast the previous example it seems prudent to provide an example of a system of air treatment in structure that does not require energy input, chemicals, machines, and provides a healthier living environment. Cooling and heating air naturally happens when the structure is designed with the intention of providing itself with it's own integrated method for performing this action.

The first and most natural way of cooling a structure is by using deciduous trees to block the sun from direct contact with the structure in the summer. A deciduous tree will block 60-90% of solar radiation during the summer and only 20-50% during the winter, when solar radiation is desired for solar heat gain.[18]

The design of the structure itself can produce air movement through the use of calculated overhangs on the southern side of a structure. An overhang can be designed to block the direct summer sun from penetrating the structure, but allow direct winter sun for solar heat gain. The overhang also produces a system of high pressure on the south side and a system of low pressure on the north side. The high and low pressure systems are then engaged with each other using cross ventilation through the structure, producing a cooling effect in the summer and a heating effect in winter. This is known as active solar cooling and active solar heating.[19]

The name of this section is entitled "Why do we poop in clean water?" and you may be wondering why. Well, it's a metaphor. It is a metaphor for the nonsensical deviation from logic that we, as a culture, have chosen to adopt and proliferate despite our knowledge of how to live and exist in manner that is consistent with the natural world. We build, design, engineer, manufacture and encourage products of our species that

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[18] Data borrowed from, Melby, P., Cathcart, T. 2002. Regenerative Design Techniques, Practical Applications in Landscape Design. New York: John Wiley & Sons, Inc. Pg. 73

[19] (Same as note #18)

ignore the millions of years of testing, engineering, and designing that evolution has done for us. Pooping in clean water is an example of the paradoxical world we have built for ourselves. It is a process/system that we have engineered for relieving us of our waste (pun intended) despite the knowledge that we have of how to naturally, effectively and efficiently dispose of our waste.

Figure 8 – Compost cycle

Composting is the most basic form of waste processing. It's safe, healthy, efficient, affordable, and natural. We are offered a means of processing our waste without using fresh water, or chemicals to treat the waste, and the guilt of knowing that every time you flush the toilet you are performing one of mans most unnatural and puzzling acts.

Pooping in clean water is symbolic of how far we have strayed from living at peace with the environment. It is shows us that the engineering of our built world is not the most logical and efficient that it can and should be. Architecture is but one part of the obsolete infrastructure in which we still rely. The principles of designing for the future can be readily applied to the ways in which we make the products we use, the energy we consume, the food we eat, etc. All of these systems have alternative methods for production that have been designed by their respective industries. The problem and challenge now is to wholly adopt the "alternative" methods and shift these means into being the way we make things.

The paradox in referring to methodologies that honor, respond to, engage and mimic the natural world as "alternative" is that our "traditional" methodologies are so

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[20] Image found at http://www.reuk.co.uk/Introduction-to-Compost-Toilets.htm. This is an excellent source of information about composting toilets. The authors describe in depth the different available systems and how they work.

drastically unnatural in their implementation. We have adopted methods of development that contradict the rules of nature, such as pooping in clean water. The built environment is unnatural and provides virtually no benefits to the environment. Needless to say it is a one sided, mono-directional relationship.

Architecture is a perfect example of a product that is generated by man that is requiring the adoption of alternative methods as it embodies many systems, products and energies. Architecture is something that is used everyday by most world citizens. It is something we, as humans, rely on for shelter, comfort and health. We rely on architecture to sustain us, as a species. Our entire existence has become dependant on the structures that we construct. Herein lies the most hypocritical dynamic of our existence; we build structures that must sustain us, though these structures are not capable of sustaining themselves, or us as the users and creators of the structures, without the constant input of energy, materials, etc. Why is the norm not to design structures that can do all of the aforementioned things we need them to do?

Every structure created provides opportunities to enhance the natural world. Every wall and roof can provide a medium for life production. Each building is presented with the opportunity to become part of the natural occurrences, structure and flow of the site in which it exists. A structure can become the site and interact with the natural environment. Our current building methods treat the site as the place in which the building exists as opposed to treating the site as an ecosystem that has the potential to accommodate and accept a structure as simply another piece of the dynamics of the site as a whole. Traditionally there is a dichotomy between the site and the structure, but when the site and the structure are integrated, the health of the site can be reinforced by the presence of the architecture.

Humans exist with the notion that we are not connected to nature, but above it. We view the world as a conglomeration of resources available for consumption rather than the place by which we exist. Humans do not live in isolation, we are part of the natural world where "all things exist in a mutually supportive and reciprocal relationship to all other things...One of our obligations, if we choose to think of sustainability at any level, is to understand the pattern of relationships we engage when we make choices in our activities. We then can be prepared to ask how our actions can potentially support an even richer web of relationships."[21]

Conclusion

It is evident in our architecture, engineering, agriculture, economy and manufacturing. The processes that we have chosen to adopt for the construction of modern society have generated a very serious environmental epidemic that is deeply embedded in our culture. It is so deeply embedded, in fact, our society is for the most part blind to causes of the problems we have created. "In Many ways, the environmental crisis is a design crisis. It is a consequence of how things are made, buildings are constructed, and landscapes are used. Design manifests culture, and culture rests firmly on the foundation of what we believe to be true about the world. Our present forms of agriculture, architecture, engineering and industry are derived from design epistemologies incompatible with natures own."[22]

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[21] Reed, B. 2005. "Sustainable Design: Moving towards Integrated Design in a Disintegrated World". National Association of Independent Schools Magazine, Spring, 2005. <<u>http://www.integrativedesign.net/resources</u>>

[22] Van Der Ryn, S., and Cowan, S. 1996. <u>Ecological Design.</u> Washington, DC: Island Press

As a society we are largely disconnected from the world we inhabit. We take for granted the place that provides us with life, food, shelter, water, happiness and love. We pay very little respect to that which sustains us by offering negligible amounts of reciprocal sustenance. The earth provides us with the resources we need to thrive, but virtually none of those resources are returned to the systems from which they derive.

Regenerative design offers people an opportunity to live in a home that is constructed with the future in mind. It means building homes that sustain human life in a time of potentially imminent economic, social and environmental collapse. It is possible to design a structure that can produce its own food, energy, heating, cooling, water capture and purification, using materials that are derived locally and in a truly sustainable manner. Architecture is innately provided with seemingly infinite amount of opportunities to engage the natural world in design and existence.

The future is very unclear, but one thing is very clear, if a collapse of the global economy occurs, the homes we live in now cannot and will not provide us with the essentials required for living. If a collapse of this nature occurs, the public infrastructure in which we rely on for food, energy, transport, etc., will collapse with it. The immanency of this threat should be enough to push, us, as the creators of this problem, to reinvent our methodologies, systems and dynamics. David W. Orr, professor at Oberlin College and author of several important books, states in the foreword of The Sustainability Revolution: portrait of a paradigm shift, "All informed citizens know about the perils ahead, including rapid climate destabilization, species extinction, pollution, terrorism and ecological unraveling in its many forms, and the human political and economic consequences."[23] He

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[23] Edwards, A.R., 2005. The Sustainability Revolution: Portrait of a Paradigm Shift. British Columbia, CA: New Society Publishers.

makes it very clear here that change is coming and action is imminent as people are increasingly becoming aware of the dangers that lie ahead.

CHAPTER 2

THE NINE PRINCIPLES OF REGENERATIVE ARCHITECTURE AND PLACE ANALYSIS CRITERIA

Introduction

In the first section the theory and principles that formulate the practice of regenerative architecture are presented. They contrived and assembled through much research, discussion and thought as an attempt to create a synthesis of the human-centric, built world and the natural world to which we owe our very existence.

In this section the theories and principles that are defined in the first section are analyzed and a new set of design and site analysis criteria are presented. These principles borrow much of the criteria that are used across a diverse range of fields such as permaculture design, regenerative design, architectural design, Cradle-to-Cradle principles, biodynamic design, and biophilic design. The intention of these principles is to offer a design process and criteria for regenerative architecture as it is described in the first section.

It is important to note that I felt the need to develop a set of principles that were specific to regenerative architecture. I have described and mentioned many relevant topics, ideas and principles in the first section and none are designed specifically for the regenerative architecture. I felt as though it was necessary to attempt to generate a synthesis of all of the embodied ideas that I have laid out in section 1. It is my offering to the advancement of our society and our built world. I have made an attempt to create a "recipe" for living in unison and in engagement with the natural world in which we owe our existence.

My set of principles, while universal in nature, is intended to be directed towards residential dwelling specifically. It is my point of view that the most essential, man-made, structures are the ones in which we call home. Our homes are what provide us with shelter, safety, warmth and comfort. It is in our dwellings that the most profound memories occur, and the occupiers typically have a much deeper connection to their dwelling than their place of work, for example.

I believe that if we can reverse the degenerative practices that happen in, on and around the home, we, as a society can begin to implement change on an enormous level. It is for these reasons that my guidelines and principles are geared towards a smaller, more attainable and achievable scale.

In support of the nine principles of regenerative design, I have developed a thorough set of place analysis criteria. The criteria are developed using the scale of permanence method of permaculture. The scale of permanence is a relative scale that determines the "changeability" of a particular site system. For example, the first and most permanent system on the site is Climate. The climate is a system in which we have very little control over, thus we perform the place analysis starting with climate. The last to be processed in the place analysis step is Aesthetics and Experience of Place, because this has been determined to be the most malleable site system in which we are concerned with in regenerative architecture.

The Nine Principles of Regenerative Architecture

The first of the nine principle is "whole systems design integration." This principle embodies and describes what is inarguably the most crucial set of guidelines in the set. The first states, "All systems and entities are accounted for and incorporated into the overall system design." What this means is that in the design process we are viewing the site as a whole system and within that system we cannot begin to pick and choose which elements are important to our needs and us. Our needs are not the only needs that must be accounted for within the system and approaching the design process with the intention of operating within the whole system without segregating, alienating or overlooking any of the members of the whole system community of the given site.

The second guideline of the Whole Systems Design Integration principle states, "all systems are involved in communities of mutually supportive relationships." This is a guideline that, when followed, reinforces the first guideline by requiring each system element be comprehensively treated within the design, allowing for each relationship to strengthen the whole system.

The whole system is constructed with a conglomeration of mutually supportive relationships within the system as described in the section entitled "Honeybees and Flowers –mutually beneficial and reciprocal relationships" in part 1. A system cannot exist without the mutual support of system elements. An example of this can be seen in a well-implemented living roof system. The roof of the structure is planted using local sedum, grasses and vegetation and provides a habitat for these species to thrive. The plantings, in turn, provide the structures with a great deal of thermal insulation, storm water capture and purification and eliminates the heat island effect of a traditional roof, just to list a few.

The third guideline in the Whole Systems Design Integration principle is called the principle of multiplicity. This states that each entity within the system should perform more than one function or satisfy more than one need within the system. This is a principle that is at the core of permaculture design and is traditionally describing one of the methods for designing polycultures within edible forest gardens and permaculture gardens; the theory behind it is universal, though, and can be applied readily to regenerative architecture.

The fourth guideline within the Whole Systems Design Integration principle is the Principle of Redundancy. It states that each need within the system is met with more than one solution. This is also a principle that is at the core of permaculture design. The Principle of Redundancy is based on the recognition that within a natural system there is no one solution for the healthy operation of the system. An implementable and realizable example of this within regenerative architecture is the acquisition of usable energy. We have a few great solutions at our disposal for providing ourselves with energy, namely solar, wind and biomass (burning biomass for energy). In a regenerative design we should consider implementing at least 2 of these options for meeting our demand for energy, thus solving the problem of energy with more than one solution, strengthening our energy system, solidifying our energy input, making it more reliable, efficient and beneficial.

The second principle of regenerative architecture is "integration into the landscape." This principle carries with it three main focus points. The first states that the site analysis of the landscape and its natural elements and systems are the foundation for and generator of the design. It is describing the process as a generative one, transforming data, knowledge, and insight collected from the site into architectural and landscape form. In applying this method, we have the opportunity to create a design that is purely of and for the site.

This leads into the second piece of the second principle. It states that the dwelling and landscape integration create a new unit/whole entity. What this means is that by designing through "whole systems design" and "integration into the landscape" there is no longer a bifurcation between the dwelling and the landscape. We are creating a new entity that transcends site and architecture, as it is now embodying both elements.

The third piece of "integration into the landscape" states that the construction of the dwelling is naturally artificial or artificially natural. This means that we recognize that architecture is an artificial entity, as it is something that we impose upon a landscape. In regenerative architecture, we must try to bridge the gap between the artificial and the natural, thus synthesizing the relationship between the two.

The third principle of regenerative architecture is "intelligent limits." This principle states that every program has a minimum required limit, but has a potentially infinite maxima, the design reflects the equilibrium of the program, and each material and space is potentially maximized and integrated into its fullest potential positive net input into the whole system. Intelligent limits is crucial to the design process because it ensures that an equilibrium can be met within the system, though an equilibrium can occur in many different conditions and can evolve in many different ways based on what is imposed upon the site.

In the design, we want to apply intelligent limits in order to achieve an equilibrium that is regenerative and without limiting the potential for regeneration within the system. We are also making the effort to integrate each element of the system so as to achieve the greatest positive effect on the whole system.

The fourth principle is "concentration," and what this principle is primarily concerned with is space. Each system element has a relative location or locations within the siteand it is often overlooked that the special relationships between system elements can have enormous impacts on the operation of the system. We should design each

I. WHOLE SYSTEMS DESIGN INTEGRATION
- A. ALL SYSTEMS AND ENTITIES ARE ACCOUNTED FOR AND INCORPORATED INTO THE SYSTEM DESIGN
  - 1. SCALE IS IRRELEVANT. EACH ENTITY IS EQUALLY IMPORTANT AS THE WHOLE
- B. ALL SYSTEMS ARE INVOLVED IN COMMUNITIES OF MUTUALLY SUPPORTIVE RELATIONSHIPS
  - 1. EACH RELATIONSHIP STRENGTHENS THE WHOLE SYSTEM
- A. PRINCIPLE OF MULTIPLICITY
  - 1. EACH ENTITY IN THE SYSTEM PROVIDES SUPPORT TO MORE THAN ONE OTHER ENTITY.
  - 2. EACH ENTITY SERVES MORE THAN ONE FUNCTION IN THE SYSTEM
- B. PRINCIPLE OF REDUNDANCY
  - 1. EACH NEED IN THE SYSTEM IS MET WITH MORE THAN ONE SOLUTION.

II. INTEGRATION INTO LANDSCAPE
- A. NALYSIS OF THE LANDSCAPE AND ITS NATURAL ELEMENTS IS THE FOUNDATION AND ORIGIN OF/FOR DESIGN
- B. DWELLING AND LANDSCAPE INTEGRATION CREATES A NEW UNIT/WHOLE ENTITY
- C. THE CONSTRUCTION OF THE DWELLING UNIT IS NATURALLY ARTIFICIAL OR ARTIFICIALLY NATURAL.

III. INTELLIGENT LIMITS
- A. EVERY GIVEN PROGRAM HAS A MINIMUM REQUIRED LIMIT, BUT A POTENTIALLY INFINITE MAXIMA.
- B. THE DESIGN REFLECTS NATURAL EQUILIBRIUM OF PROGRAM
- C. EACH MATERIAL AND SPACE IS POTENTIALLY MAXIMIZED AND INTEGRATED TO ITS FULLEST POTENTIAL POSITIVE NET INPUT INTO THE WHOLE SYSTEM

IV. CONCENTRATION
- A. LESS IS MORE
- B. EACH SPACE IS ACCOUNTED FOR AND IS NECESSARY.
- C. FLEXIBLE SPACES/PROGRAMMATIC DUALITY

V. INTELLIGENT CONSTRUCTION
- A. THE SYSTEM IS CONSTRUCTED USING NATURAL AND ARTIFICIAL PROCESSES
- B. THE CONSTRUCTION IS DESIGNED TO MAXIMIZE MATERIAL EFFICIENCY
- C. EACH MATERIAL IS IMPLEMENTED TO ITS MAXIMUM POTENTIAL
- D. THE ARCHITECTURAL IMAGE IS EMBODIED IN CONSTRUCTION AND MATERIALITY
- E. PREFABRICATION/RAPID PROTOTYPING

VI. BOLD ECOLOGY
- A. ECOLOGICAL SYSTEMS ARE REGENERATIVE
- B. ECOLOGICAL PRODUCTION PROVIDES POSITIVE NET OUTPUT
- C. ECOLOGY EMBODIES ALL NATURAL ELEMENTS AND HARNESSES THE ARTIFICIAL
- D. THE NATURAL IS ALSO ARTIFICIAL
- E. ENERGY IS TRANSCENDENT
  - 1. ENERGY IS INFORMATION
  - 2. ENERGY IS PRODUCTION
- F. ECOLOGY IS IMAGE

VII. COMMUNITY
- A. SCALE IS IRRELEVANT TO THE IMPORTANCE OF AN ENTITY/GROUP
- B. SUPPORT FOR THE EXCHANGE OF EXPERIENCE AND SOCIAL PRACTICE IS EMBODIED
- C. ALL MEMBERS OF THE COMMUNITY ARE PARTICIPANTS IN AND INFLUENCERS OF THE DESIGN

VIII. EXPERIENCE OF PLACE
- A. THE IMAGE OF THE PLACE FORMULATES POSITIVE EXPERIENCE
- B. THE EXPERIENCE IS DRIVEN BY CLEAR SYSTEMIC FORM
- C. THE PLACE IS EXPERIENCEABLE BY THE INDIVIDUAL AND BY THE COMMUNITIES ALIKE.
- D. THE EXPERIENCE OF THE PLACE IS POSITIVE
- E. THE PLACE DESCRIBES STORY

IX. CULTURE
- A. THE SOCIAL HISTORY OF THE PLACE IS PRESENT IN THE DESIGN
- B. THE GEOLOGICAL HISTORY IS COMPLIMENTED AND PRESERVED
- C. ALL PRESENT CULTURES ARE CONSTITUENTS OF THE PLACE
- D. CULTURAL PERMANENCE IS ACCOMMODATED
- E. THE QUALITY OF LIFE FOR ALL CULTURES IS ENHANCED BY THE DESIGN AND INTERVENTION
- F. THE COLLECTIVE CONSCIOUS OF CULTURE IS HARNESSED

Figure 9 - The Nine Principles of Regenerative Architecture

elements relative location with the intention of maximizing the capability of that system and what it can provide to its counterpart systems.

In the principle of concentration, we are also largely concerned with maximizing the space that we use. In analyzing our site and systems we can understand what the potential is for a given space. Also, on the other hand, we should take care not to over-program a space, as well as omitting spaces from "design," as our intervention is not always the best solution for a given site, system or space. It is important to remember that less can be more.

"The principle of intelligent construction" is the fifth principle. It refers to the construction of the architecture, as well as to the construction of systems, and the site. Intelligent construction regards efficiency of materials, maximizing the potential of materials, and constructability as the core of the principle. One other crucial piece is the embodiment of the "image" of the design in the materials. What this means is, the expression of the design can be made through material selection. Materials tell a story about the place, the design, the systems and the users.

The sixth principle of regenerative architecture is "bold ecology." Bold ecology is a term that insinuates the implementation and proliferation of ecological systems that perform multiple functions, are regenerative and provide a positive net output. The bold ecological system transcends our current perceptions of ecology, as it embraces and embodies everything that ecological systems have to offer us as well as to the whole system. We engage with the ecology, it provides us with our shelter, sustenance and place. It becomes more than simply ecology, as our lives are embedded within it.

The seventh principle of regenerative architecture is "community." Communities can be composed of homogenous elements as well as collections of diverse entities. They can occur and exist at extreme minima and maxima, and are always defined by their connectedness to all other communities, and without the existence of all other communities the distinction of one singular community would not be possible. Communities evolve on every level of scale, and through the self-organizing nature of communities, systems are born.

All communities in a system are composed of a sub-set of communities that exist on a smaller scale and coalesce to form the system. Each system and community can be subsequently disassembled to reveal the components that constitute their existence.

Layers of scale are the almost infinite calculable scales of organized communities and systems that exist in the universe. For example, a community of bacteria exists on a different level of scale than a community of human beings. Layers of scale reveal to us the pattern of relationships that occur between the different communities and systems across the horizon of scale.

The complexity of the community or system is increased exponentially as the scale increases, because the amount of communities of smaller scales is increased. It is important to understand that not all communities are calculable, and may not be comprehendible, though their existence is imperative to all subsequent communities.

The eighth principle of regenerative architecture is the "experience of place." The experience of the place principle embodies a set of qualities and phenomenological characteristics that are identifiable in and specific to any place. The experience is one that should be positive and driven by clear systemic form. The place should experienceable by communities and individuals, and should tell a story about the place. The experience of place reflects the intentions of the design and describes the regenerative nature of the system.

The ninth principle of is "culture." Culture is an absolutely essential principle, which manifests itself on all layers of scale and is present in every species, polyculture, structure and system. Each cultural entity is a constituent of the place and should be harnessed and celebrated through the design process. Each place tells a story and has a history embedded within it and it is through cultural expression that these stories are told. The cultural expression is identified through pattern recognition during the place analysis process.

Place Analysis Criteria

The place analysis criteria were created as a guide for the place analysis step in the design process of the R_Urban Intervention Dwelling. The criteria are set up in order based on their place in the scale of permanence. The order in which they reside is the order in which the place analysis process must occur. The set of criteria is comprehensive and it is intended to incorporate each site system.

The place analysis step is the phase of the design process in which the designer becomes engaged with the site. It is in this step that the designer extracts all of the necessary data required for a regenerative architectural design to be developed.
The process begins with the creation of a detailed site plan. The site plan is used as a base map for the subsequent mapping of the site systems. Each criterion is mapped using a system of transparent or translucent overlays, i.e. tracing paper, digital, vellum, etc. It is important that a mapping language is developed and employed by the designer and kept concurrent throughout the whole process. The idea is to map each system as deemed appropriate by the designer, though each overlay is done in the order prescribed by the Place Analysis Criteria and is done thoroughly so as to generate a set of data maps that

accurately and clearly represent the site systems as they exist. (See figures 20-23 on pages 51 and 52 for examples of overlays.)

After the completion of the overlays, the designer then begins to translate the data into a formal and architectural language as three-dimensional forms take shape. The translation process is an intuitive process that requires the designer to intellectually interpret the data and visualize what effect the data may have on three-dimensional forms. As the process of translation develops, many design iterations are created and a linear design process develops as the design evolves with the data translation and form making.

LANDFORM
SLOPE
TOPOGRAPHIC POSITION
GEOLOGY
ELEVATION

BUILDINGS & INFRASTRUCTURE
EXISTING STRUCTURE
NEW CONSTRUCTION NEEDS
FOOTPRINT
LOCATION
ORIENTATION
PASSIVE SOLAR HEAT/COOL
ACTIVE SOLAR HEAT AND ENERGY
PROGRAMMING
MATERIALS
USE GROUP
ZONING BY-LAWS
BUILDING CODES
CONSTRUCTABILITY
EFFICIENCY

ZONES OF USE
EXISTING ZONES
NEW ZONES
REPROGRAMMING
USE IMPACTS
NEW PROGRAM
HUMANNESS
SCALE

MICROCLIMATE
DEFINE VARIOUS MICROCLIMATE SPACES
SLOPE ASPECTS
SUN/SHADE PATTERNS
COLD AIR DRAINAGE
SOIL MOISTURE PATTERNS
HUMANNESS
WIND (EFFECTS OF AND EFFECTS ON)

WATER
EXISTING SOURCES OF WATER SUPPLY
FLOW PATTERNS
FLOODING AND PONDING AREAS
POSSIBLE LOCATIONS FOR FUTURE WATER SOURCE
GREYWATER PURIFICATION, USE AND CAPTURE
WATER CONSERVATION
WATER HARVESTING
IRRIGATION
POTABILITY

ACCESS & CIRCULATION
ACTIVITY NODES
PEDESTRIAN ACCESS
PEDESTRIAN CIRCULATION
EGRESS
STORAGE
MATERIAL FLOWS

VEGETATION & WILDLIFE
EXISTING VEGETATION
AREAS OF CHANGEABILITY
FOOD PRODUCTION
DIVERSITY
HABITAT
SITE INSULATION
ABUNDANCE
ECOSYSTEM ARCHITECTURE

AESTHETICS & EXPERIENCE OF PLACE
ARRIVAL & ENTRY EXPERIENCE
VIEWS AND VIEW LINES
INTERIOR VIEWS
EXTERIOR VIES
MATERIALITY
TEXTURES
COLORS
PUBLIC
PRIVATE
FORMAL AND INFORMAL SPACES

Figure 10 - Place Analysis Criteria

Whole Systems Neuron Mapping

The whole systems neuron map is an attempt to three-dimensionally map the place analysis criteria. The intention was to generate a set of three-dimensional data that is used as a means of analyzing the relationships that the place systems have with each other. The understanding of the relationships that the systems have is key in developing a design that is comprehensive and based on mutually supportive relationships.

The neuron map borrows the structure of the neurons in the brain of mammals. A neuron consists of 3 parts: the neuron body, the axon, and the dendrite. The neuron body is responsible for receiving and sending data through electrical impulses to other neurons. The axon is responsible for the sending of data and signals and the dendrite is responsible for the reception of data and signals. Each neuron has many axons and dendrites and is connected to thousands of other neurons.

The whole systems neuron functions very similarly to the cellular neuron. Each system is broken down into its constituent parts, and each part is represented with its own neuron. Each system is represented through clusters of neurons. The structure of each cluster is determined by the relationships that exist between each respective system part. The same is true for the overall structure of the whole system; the relative location in space of each system is determined by the strength and number of relationships that exist between the different systems. (See figure 11 on page 40)

The relationship between each system and each system part is analyzed and a determination of the nature of the relationships is made. The different types of relationships are mono-directional supportive relationship, mutually supportive reciprocating relationship, or no relationship. In the instance that there is a mono-directional relationship the system part and/or system that has the influence has an axon that represents that relationship.

The influenced system or system part has a corresponding dendrite that received the influence from the influencing system/system part. In the instance that there is a mutually supportive relationship, or in other words a reciprocally influencing relationship, there is a corresponding axon and dendrite on each system/system part.

An example of one system having an influence on another is solar energy and its influence it has on the water system on the site. Each identified part of the water system is directly influenced by the solar energy in which it is engaged with. In this instance each water system neuron have dendrites that received the influence directly from the corresponding axon on the solar energy neuron. (See figures 12-15 on page 40)

An example of 2 sets of systems that have mutually supportive relationships are the vegetation system and the water system. In this case, each part of each system has reciprocal relationships with each part of the other system. There are dendrites on each vegetation system neuron that correspond to each system part in the water system. In the water system there are corresponding axons that connect to the dendrites of the vegetation system parts. The same is true in the direction of the vegetation system influencing the water system. (See figures 12-15 on page 40)

The end result is a model that describes the complexity that exists within the whole system. The map can be constructed and used for all place criteria analysis operations under the criteria set forth in the previous section. The benefit of using this model is the deep understanding that the user gets of the whole system of a site. It provides an intimate glance into the connections and relationships that construct the site. Each site in which this model is employed will yield a different neuron map as each site is different and the exact relationships that exist within each site are different. (See figures 12-15 on page 40)

NEURON SYSTEMS MAPPING

ANATOMY OF A SYSTEMS NEURON

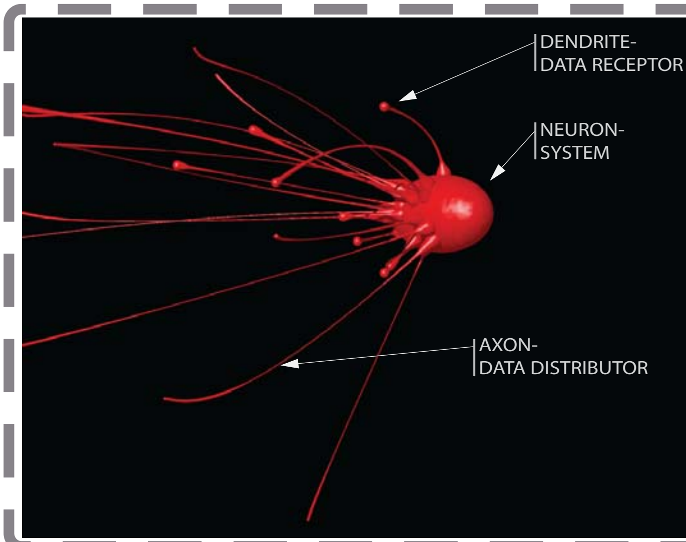


Figure 11 - Anatomy of a systems neuron

POLYCULTURE COMPLEXITY AND RELATIONSHIP DEVELOPMENT

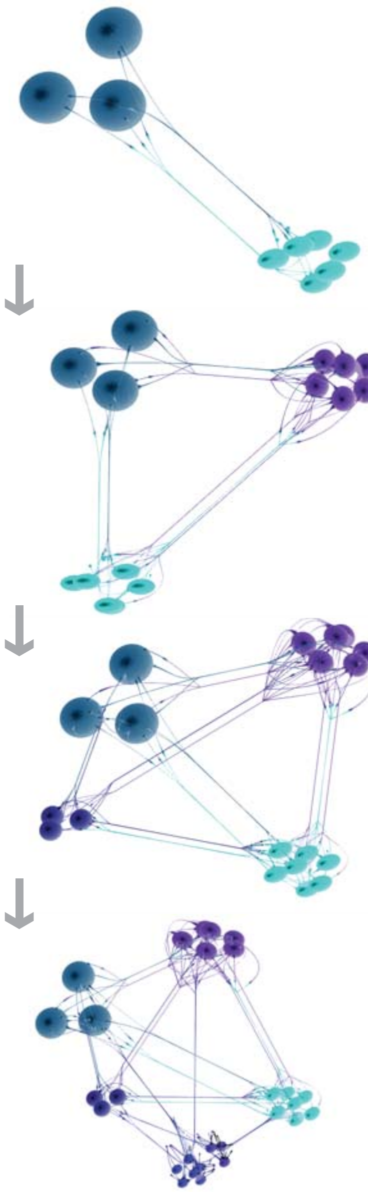


Figure 12 - Polyculture complexity/ relationship development

THE WHOLE SYSTEMS NEURON MAP

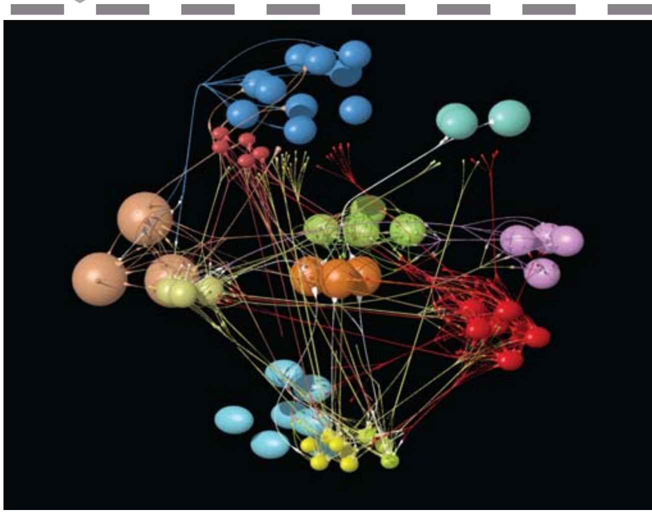


Figure 13 - The whole systems neuron map

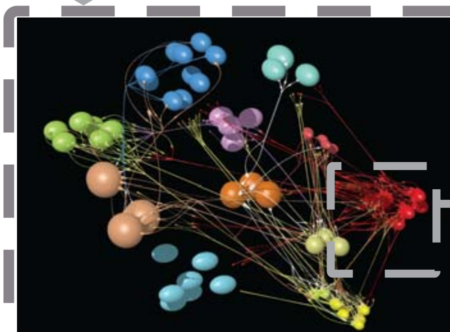


Figure 14 - The whole systems neuron map

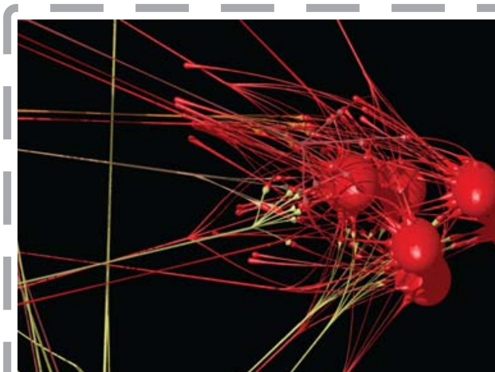


Figure 15 - Detail of w.s.n.m.

CHAPTER 3

THE R_URBAN INTERVENTION DWELLING

Introduction

The R_urban Intervention Dwelling is a model and a method for small-scale architectural interventions employing a human-centric site and program analysis and assessment system based on the criteria laid out in the nine principles of regenerative architecture. It is an attempt to un-standardize our dwelling paradigm, through the development of a method that allows for rapid, efficient and economical construction that performs under the principles of regenerative architecture. It is a model for an alternative choice to the "McMansion" that has disintegrated the residential life of those communities, families and individuals who have chosen to purchase them.

The name "R_Urban Intervention Dwelling" means Rural and/or Urban Intervention Dwelling. The intention behind developing the model for the R_Urban Intervention Dwelling stems from an understanding that our current method for developing residential architecture is wholly unsustainable and an intervention in this methodology is necessary. The unit can be developed and designed for any site, rural, suburban or urban, using the nine principles of regenerative architecture and the place analysis criteria.

The term "intervention" was chosen because it is evident that in most areas, the practices are by and large degenerative and a shift must be made within these practices. The R_Urban Intervention Dwelling is implemented as a model for the form regenerative practices can take. It intervenes in the existing paradigm and offers an alternative. The "intervention" is two-fold. The first side of it is the environmental intervention that occurs within the unit, as it operates within the regenerative systems of the place. The second side of it is very much less tangible, as it is an educational intervention. The structure provides an example to people that depicts a "sustainable" lifestyle as being more bountiful, healthier and happier. It is common for people to believe that living "sustainably" means making serious sacrifices to their way of life. The R_Urban Intervention Dwelling shows people that transitioning to a regenerative lifestyle does mean change, but not at the expense of luxury, comfort and well-being.

The R_urban Intervention Dwelling employs a method of construction called CNC or computer numerical control. CNC is a technology that has been around since the 1940's and is very common in the manufacturing industry today. It is a technology that relies on computers to send information to a milling machine that cuts, assembles and/or creates objects, parts and products. The technology produces extremely accurate and precise products with a seemingly infinite amount of customizability and options. Many industries today use this technology to rapidly produce and rapidly prototype their products, though in architecture it is not commonly used.

The R_urban Intervention Dwelling is designed to be assembled in sections that are pre-manufactured and sandwiched together on-site to create one solid, fluid structure. The structure, the utilities, amenities, etc., are designed concurrently as the CNC manufactured sections are created, embodying all building elements. The process virtually eliminates construction waste and the building materials can be very diverse, though the primary material of the R_urban Intervention Dwelling sectional pieces is recycled high-density plastic. Also, this method of construction greatly reduces the impact that the structure has on the site during construction, as the construction happens largely off-site.

It became clear that during the design process that the method of construction for the R_Urban Intervention Dwelling would not utilize standard construction methods. The universal design solutions that make our built world today do not suffice in creating place-based architecture, as their applications and customizability are not adequate or diverse enough. The new solution for residential architecture simply could not be justified in using methods and materials that have led to the degeneration of our world, as we know it. Rethinking what it meant to design and construct a structure became the challenge and it was no easy task. The R_Urban Intervention Dwelling was tested in design phase using structural insulated panels, GlueLam, steel frame, stick frame, rammed earth, cob and straw bale. None of these options sufficed in generating a final product that embodied all of the characteristic that the unit was specified to have. The design options were very limited in all of the options and it was clear that a flexible, easily customizable and easily "idealizable" method was necessary.

CNC was the strongest option as it offered all of the characteristics that were necessary in the unit. It borrows many design aspects from industrial design as the architecture was now being machined from singular elements to create a whole structure. The result proves to be very strong structurally, versatile in its application, recyclable, and potentially universal. It is easy to implement options such as living roofs, rainwater capture, passive and active solar energy, wind power, etc., as there are few limits to the customizability of the R_Urban Intervention Dwelling.

R_Urban Intervention Dwelling 1 – The Coop House

The Coop House is an architectural design that was developed using the R_Urban Intervention Dwelling model. It is a 750 square foot unit designed for 1 or 2 residents. The unit contains 2 parts, the main living area and the greenhouse, all in one structural unit. The Coop house is designed to be a zero non-renewable energy structure, as it is passively

Figure 16 - The site and surrounding landscape

Figure 17 - The site and immediate neighborhood

Figure 18 - The site

Figure 19 - Existing conditions

heated and cooled as well as naturally ventilated. The greenhouse provides heat storage during the winter months and adds supplemental heating to the main living area of the structure.

It is located in Hingham, Massachusetts, on the South Shore of the state. The site is located on the Wier River, a tidal inlet with a well-preserved ecosystem and abundant health within the biome system. The southeastern edge of the site overlooks the Wier River and one of the Hull Wind turbines. The site is located in a neighborhood that is dominated with small post-war cape style homes. The demographic is lower-middle class to middle class in median annual per household income. There has been and continues to be an influx of small parcels of property being redeveloped with oversized "McMansion" style homes.

The slow-but-sure transformation of the neighborhood was a major contributor to the decision to utilize this place for the first R_Urban Intervention Dwelling. It is an opportunity to intervene in the trend that is developing and educate and engage the residents in avoiding the take over of the obsolete technology of poorly constructed "McNansions."

The Coop House utilizes an existing 16′ x 16′ concrete slab-on-grade foundation and extends to the garage structure to the west of the new structure. The foundation was the site of a chicken coop that was used for approximately 45 years before the previous owner stopped raising chickens and sold the property. The site of the coop was chosen because it met many of the criteria that were necessary for the successful implementation of the R_Urban Intervention Dwelling Model.

The first and most pronounced reason for the selection of the coop site was the existing infrastructure that exists on the site. There is a single-family 1000 square foot home and a 600 square foot detached garage structure as well as the 256 square foot chicken coop. The site is 5,625 square feet with approximately 2,700 square feet of productive, plantable and buildable space, including the 256 square feet of the existing coop footprint. There is a grade change of approximately 10 feet on the southern side of the site and a grade change of approximately 3 feet on the northern side of the site.

The three structures that exist on the site create a predominantly closed pocket in the "backyard" of the existing house. The pocket is a relatively flat area that is approximately 1000 square feet of green yard space. This space is the focal point of the Coop House design as the southern façade is open to the yard space, using large glazing panels and an operable sliding door on the southeast corner.

The architectural form was developed using the place analysis criteria. The analysis revealed all of the necessary information for the structure to take shape. The north side of the structure starts at grade and slopes steeply upward towards the south, creating fluid surfaces on the north and blending the boundary of wall and roof. The fluid shape was formed in particular by two of the site systems in particular. The wind system had the most prominent influence as the cold northwesterly winter wind attacks the structure and flow aerodynamically up and over the surface northern surface of the structure. The water system was the second most influential system on depicting the fluid shape of the structure. There was a need to capture and purify the precipitation that acted on the structure and the final form allows for the water to flow evenly and smoothly down the northern façade, and ending up captured on grade level as the structure curves to become parallel to the ground plane.

The northern façade is treated with a living roof system that is designed to offset the ground surface that is consumed by the structure. The living roof is also intended to diffuse the winter wind, reducing the thermal impact that it has. It is also the precipitation treatment system, as it allows the water to penetrate the soil surface, reducing the intensity of the water flow downwards, but also purifying the water and watering the living roof simultaneously. The living roof is an excellent insulator for all months of the year. It can provide up to an additional R50 insulation value to the northern façade and roof structure, an extremely significant amount of insulation, appropriate for the extremes of New England Weather.

The southern façade required a large amount of glazing in order to achieve the goal of passive solar heating. The façade has 278 square feet of glazed surface, and an additional 35 square feet on the east façade and 17 square feet on the west façade. This amount of glazing provides the appropriate amount of solar gain needed for the greenhouse to function well as well as for the living space to be passively heated.

The southern façade has a roof overhang that extends beyond the glazing, designed to shade the interior during the summer to prevent overheating and allow for the southern winter sun to penetrate deep into the structure, taking advantage of the mass of the structure in storing the energy. The overhang is far more prominent on the eastern end of the structure as more precise protection from the summer sun is needed for the living space. The overhang diminishes slightly as it sweeps across the southern façade to its most shallow point on the western edge of the structure.

The overhang received its curvature and projection distance from the place analysis done for the solar energy system of the site. The sun paths were modeled three dimensionally for the 20th of each month from December to June. The path created a direct path arch that was applied to the structure and analyzed in order to extract the overhang form. The sun path model for the month of April was used as the guide for the form. The southern façade also received a curvature in both the x and y axis directions, performing a compound curvature within the surface. This curvature was formed by the projection of the sun path arch for the month of December, the month in which the sun is the lowest in the sky.

The southern façade has an entry into the greenhouse, as well as an entry into the living space on the southeastern corner of the structure. Across the living area section of the southern façade is an integrated deck space with an integrated bench seat that sweeps up from the eastern side of deck, across the façade at 2′ 6″ in height and ends with a symmetrical sweep down to the western edge of the deck. The overhang above, curves down at the edge, providing an outdoor "room" for the occupants of the structure to enjoy in the recreational weather months. A screen mesh can be applied to the edge of the overhang and draped down to the edge of the deck on the 3 exposed sides, protecting the space from mosquitoes and other pests. Above the deck, embedded in the interior surface of the overhang are downlights to provide the outdoor space with light for night-time activities.

On the interior of the southern façade is an integrated all-season planter for food production, interior air quality enhancement, humidity control and temperature regulation. The planter is designed to maximize the entering solar radiation, receiving the maximum yield for the given solar energy input. The vegetation on the interior of the glazing also performs an insulative function as it diminishes laminar airflow up the interior surface of the glass due to convective radiation. There is also a buffer created between the occupants and the intense heat of direct southern light.

The Eastern façade has an incorporated cord wood storage unit for zone zero access to heating fuel. Integrating the wood storage into the façade maximizes the function of the wall, while providing the occupants with protected cordwood and painless access to it. The top half of the interior surface of the wood storage space is a translucent fiberglass panel. The panel is intended to allow diffused eastern morning sun to penetrate through the cordwood and into the space through the panel. The lighting effect that is produced is a treat for the occupants in the morning, without sacrificing the performance of the wall. The cordwood provides insulation from the outdoor climate, as well.

The interior of the living space is composed of 1 fluid surface that flows, mutates, and changes in order to form all of the amenities, which are integrated into the structure. The planter wall accommodates a bench seat on the interior, employing the vertical wall space as the seat back for the bench. The table surface and second bench seat are incorporated into the same formal gesture, creating a fluid surface that forms a functional element. The same principle is applied to whole of the interior surface, incorporating kitchen counter surfaces, bench seating for lounge seating, and an interior thermal mass wall, as well as the bathroom amenities.

The thermal mass wall has a wood-burning stove integrated into the living space side of the wall. The stove is used as supplemental heating in the winter months and the wall, being over 1 foot thick provides thermal storage for the heat produced by the stove. This wall also incorporates a ladder stair on its southern end. The ladder stair leads to the sleeping loft that is integrated into the upper level of the structure.

The sleeping loft is an additional 100 square feet approximately and is integrated into the structure above the mass wall, the bathroom, and out into the greenhouse space. The loft is open and at its widest point on the living area end. It tapers down to a narrower diameter on the greenhouse end. This is intended to create a cocoon effect for the occupants, making it feel protected and secure for a comfortable space for sleeping. The fluid form of the interior of the sleeping loft provides enhanced airflow within the space, also providing more sleeping comfort.

The bathroom is located between the greenhouse/living area partition wall and the thermal mass wall. They space is long and narrow with a composting toilet on the innermost wall. The bathroom is designed to be a wet bath, meaning it does not have a separate shower or bath stall, but a showerhead in the ceiling above, utilizing the whole bathroom space as the shower space. There is also a sink integrated in the thermal mass wall on the entrance end of the space. The hot water plumbing is integrated into the thermal mass wall, insulating the pipes and helping to reduce heat loss and also potentially helping to heat the water when the wood stove is in operation.

There is a glazed sliding pocket door that provides entry from the greenhouse into the living area. The landing on the greenhouse side of the door also services a doorway that accesses the garden space in the yard area, as well as a ramp that descends down two feet in elevation to the floor of the greenhouse. The top of the greenhouse floor is two feet below the top of the existing slab of the coop, and one foot above street level.

The main entry into the structure is on the northern façade. The entry faces east and is protected from being inset 3 feet from the roof edge. The surface of the northern façade splits and peels outward to accommodate and protect the entrance. The entry faces east for protection from the cold northwesterly winds of the winter. From the street, a lightly sloped ramp guides the occupant up and into the large, welcoming opening that forms the entry way.

On the southern side of the structure is a series of fabricated and integrated zone 1 annual and perennial food production planters that are attached to the eastern and southern edges of the deck. Beyond the planters is the yard space, which is designed to be a grilling area, raised keyhole planters and circulation pathways. On the edge of the yard space the grade begins to slope downward and descends to approximately 9 feet below the grade of the yard. Along the contour of the hill are on-contour planting beds that alternate between planting beds and swales down to the bottom of the hill, as it levels out and the property line ends.

The design process was extremely rigorous as it started with the existing structure of the coop and as the place analysis was performed and the results were translated into form, the form began to take shape. The design was done in iterations, as it took many formal changes and mutations before the final form was achieved. The process required an iterative process due to the application of the place analysis data throughout the whole iterations, forcing mutations as the place analysis was applied to the form. The form was essentially "grown" from the place analysis, following an evolutionary path that yielded what could be considered one of many possible "ideal" solutions for and by the site.

The iterative process was also necessary because the relationships, as described previously in the section entitled "Whole Systems "Neuron" Mapping", that each building and site element have with each other must be understood and developed. It is important that as many reciprocal and supportive relationships are developed as possible. This was also the case for all of the Nine Principles of Regenerative Architecture.

The R_Urban Intervention Dwelling design process that was employed in the design of the Coop House has proven to be a viable process for achieving the goals set for by the Nine Principles of Regenerative Architecture. The Coop House is integrated into the landscape, works in conjunction with the place and has a great deal of potential to be considered regenerative. The final design has not been detailed down to every detail, though at was not necessary in generating and testing the design process proposed. The process, while not perfect from the outset has undergone it's own changes throughout.

Many intangibles became revealed and flaws in the process were amended. The resultant process has a clear linear path and is theoretically implementable anywhere.

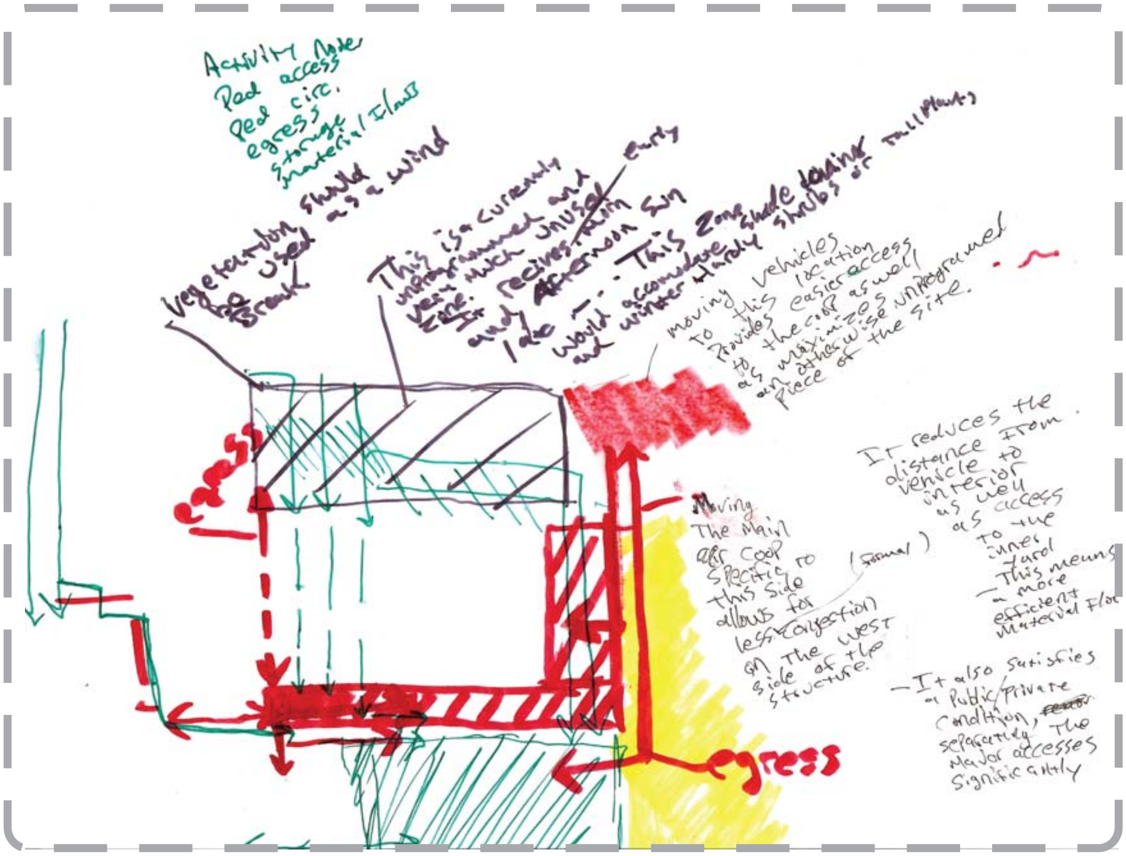


Figure 20 - Overlay example 1, zones of use

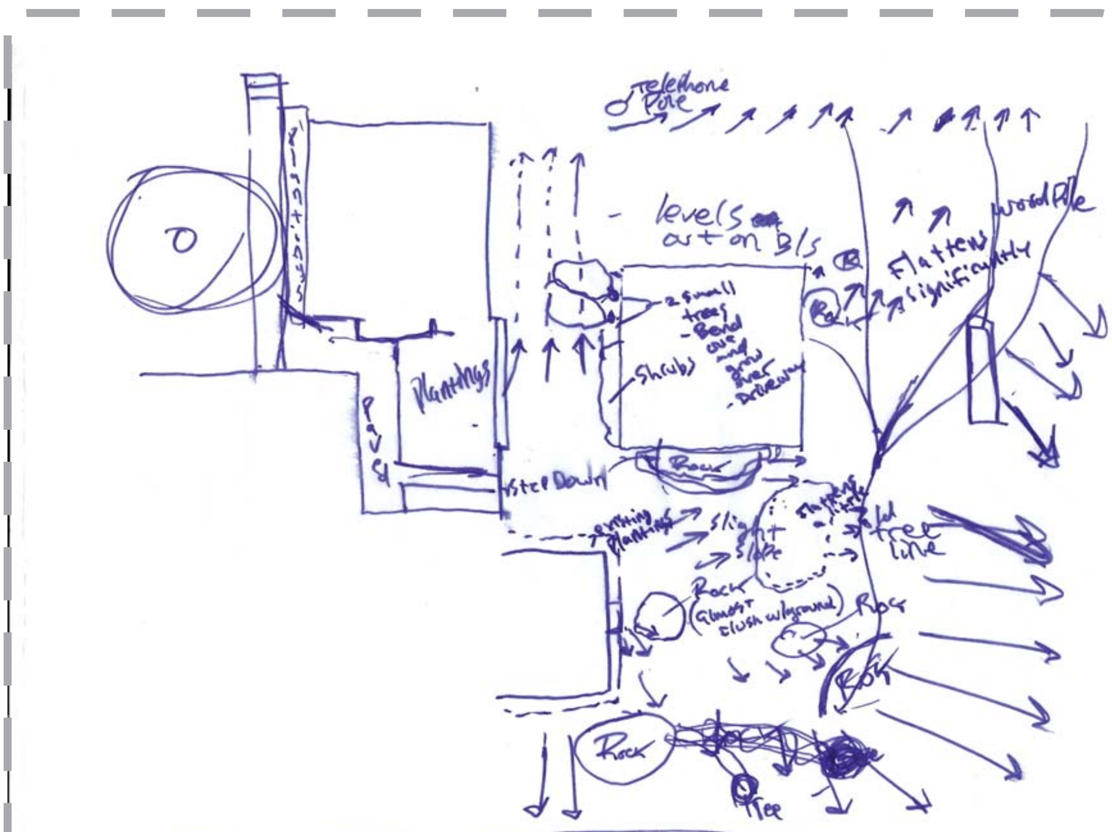


Figure 21 - Overlay example 2, slope

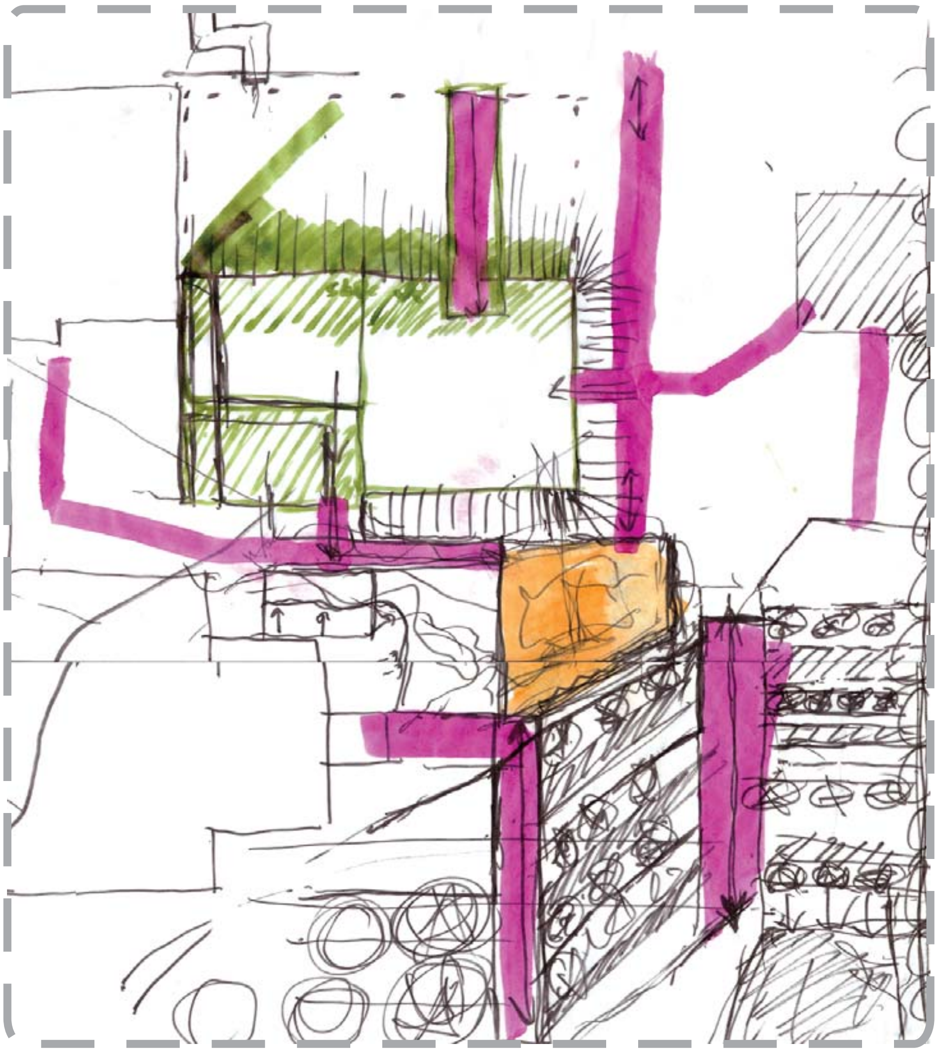


Figure 22 - Overlay example 3, design development

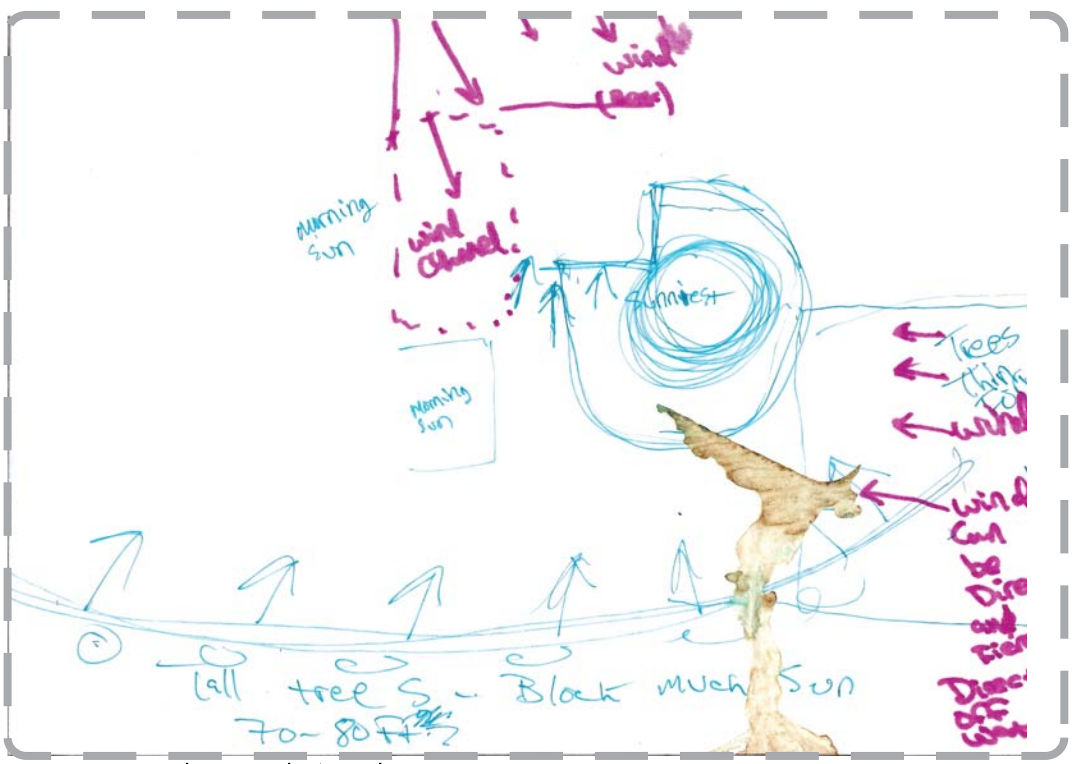


Figure 23 - Overlay example 4, wind pattern

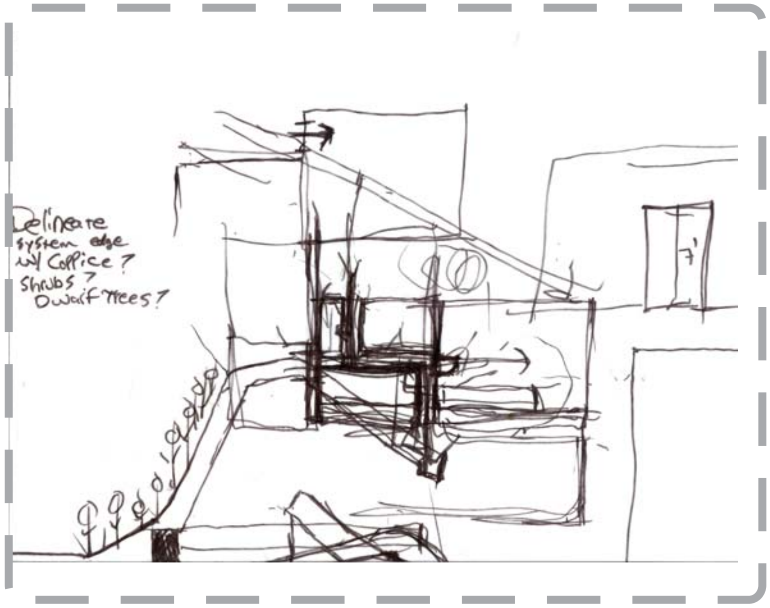


Figure 24 - Design development sketch example 1

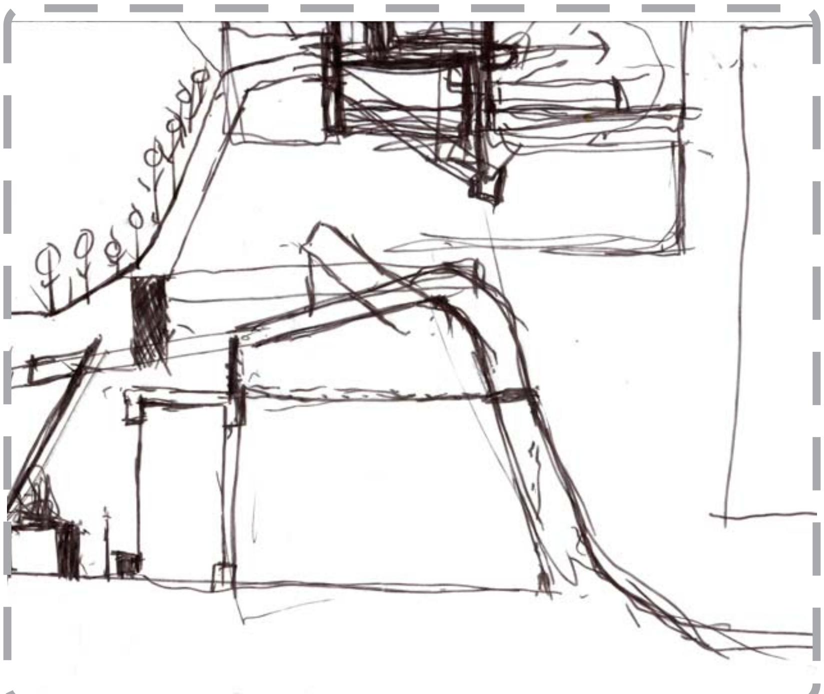


Figure 25 - Design development sketch example 2

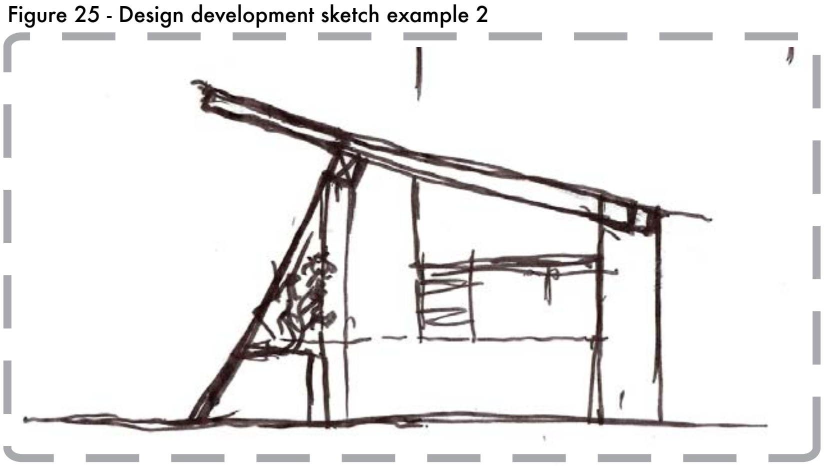


Figure 26 - Design development sketch example 3

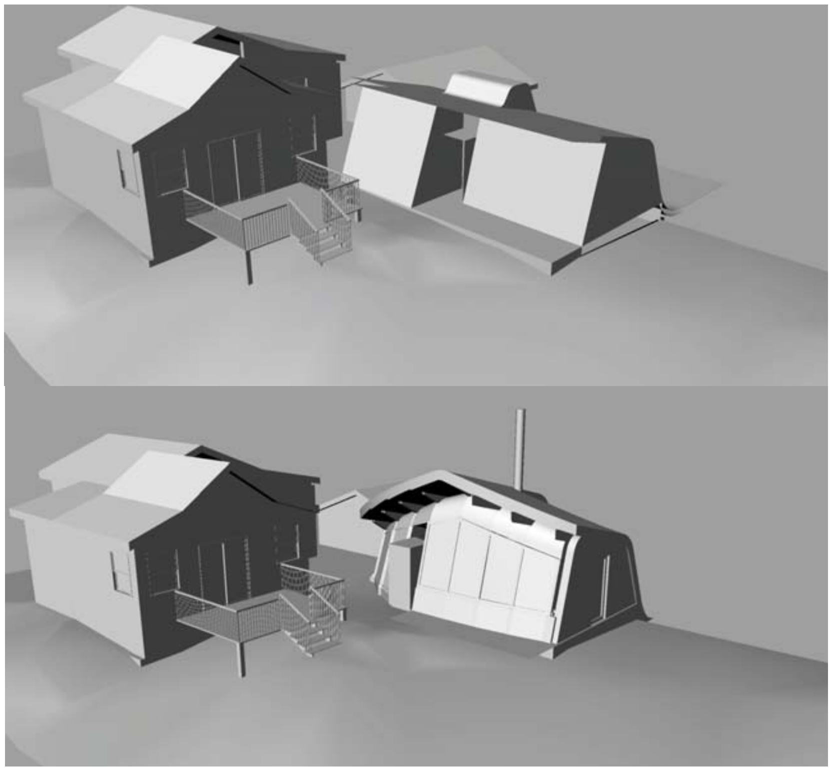


Figure 27 - Design development models

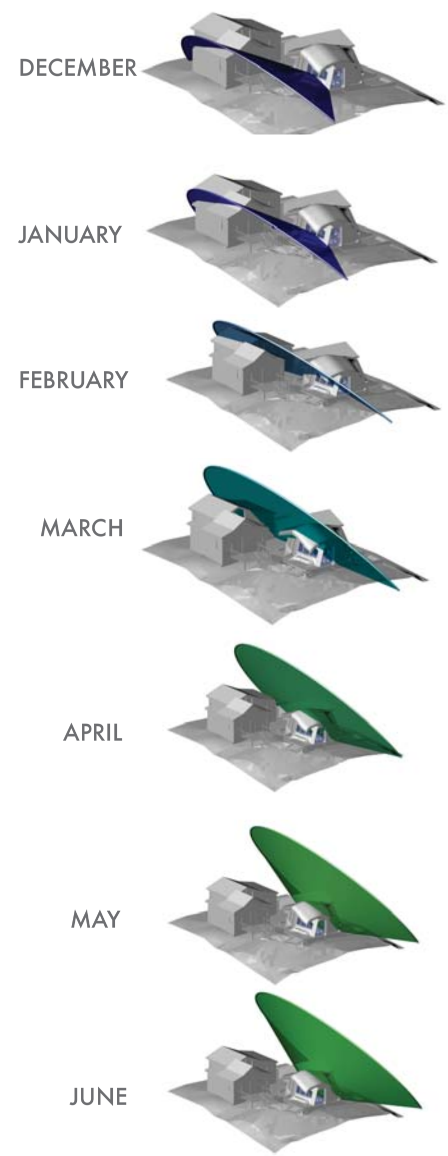


Figure 28 - Solar path analysis model

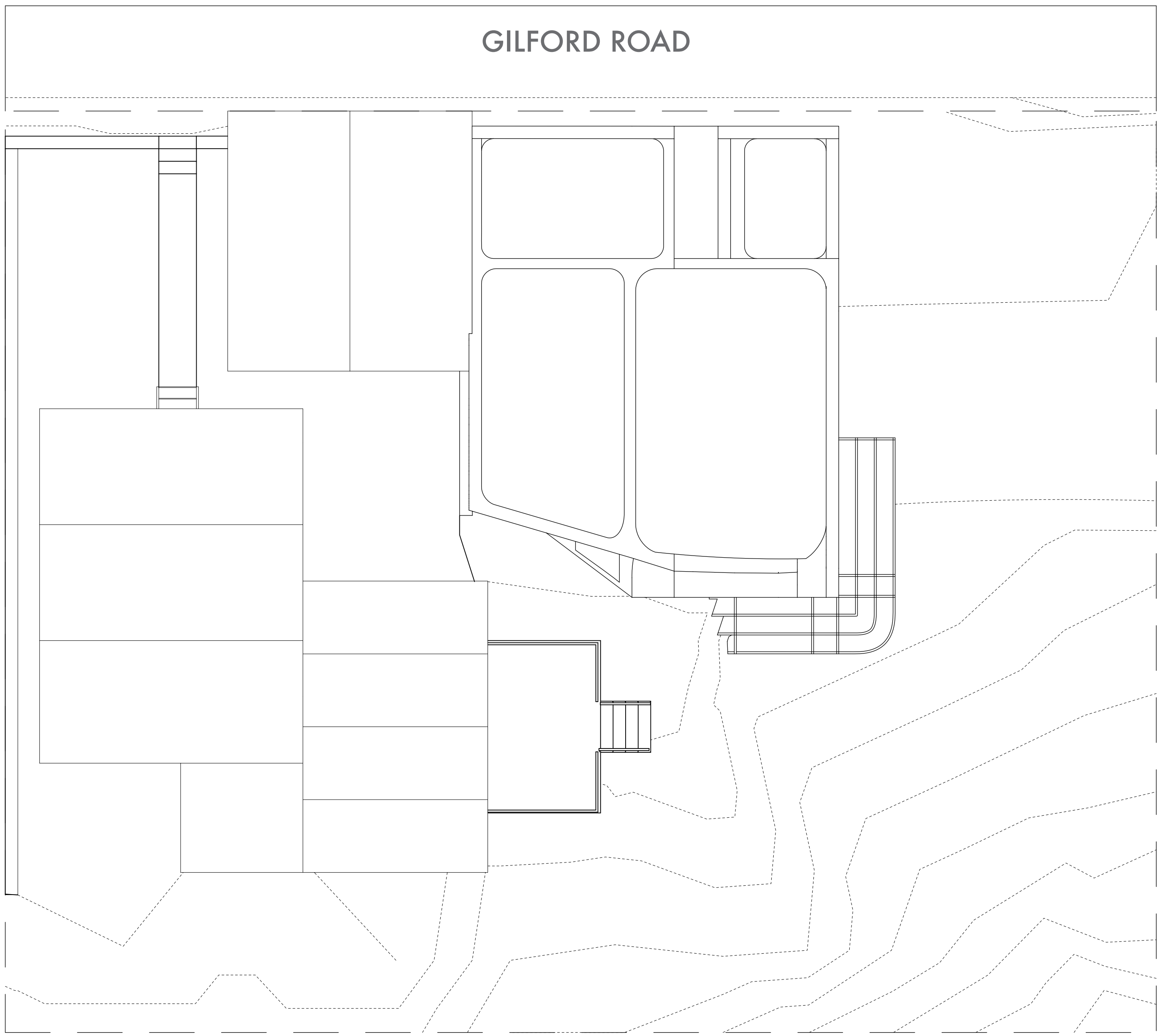


Figure 29 - Site plan

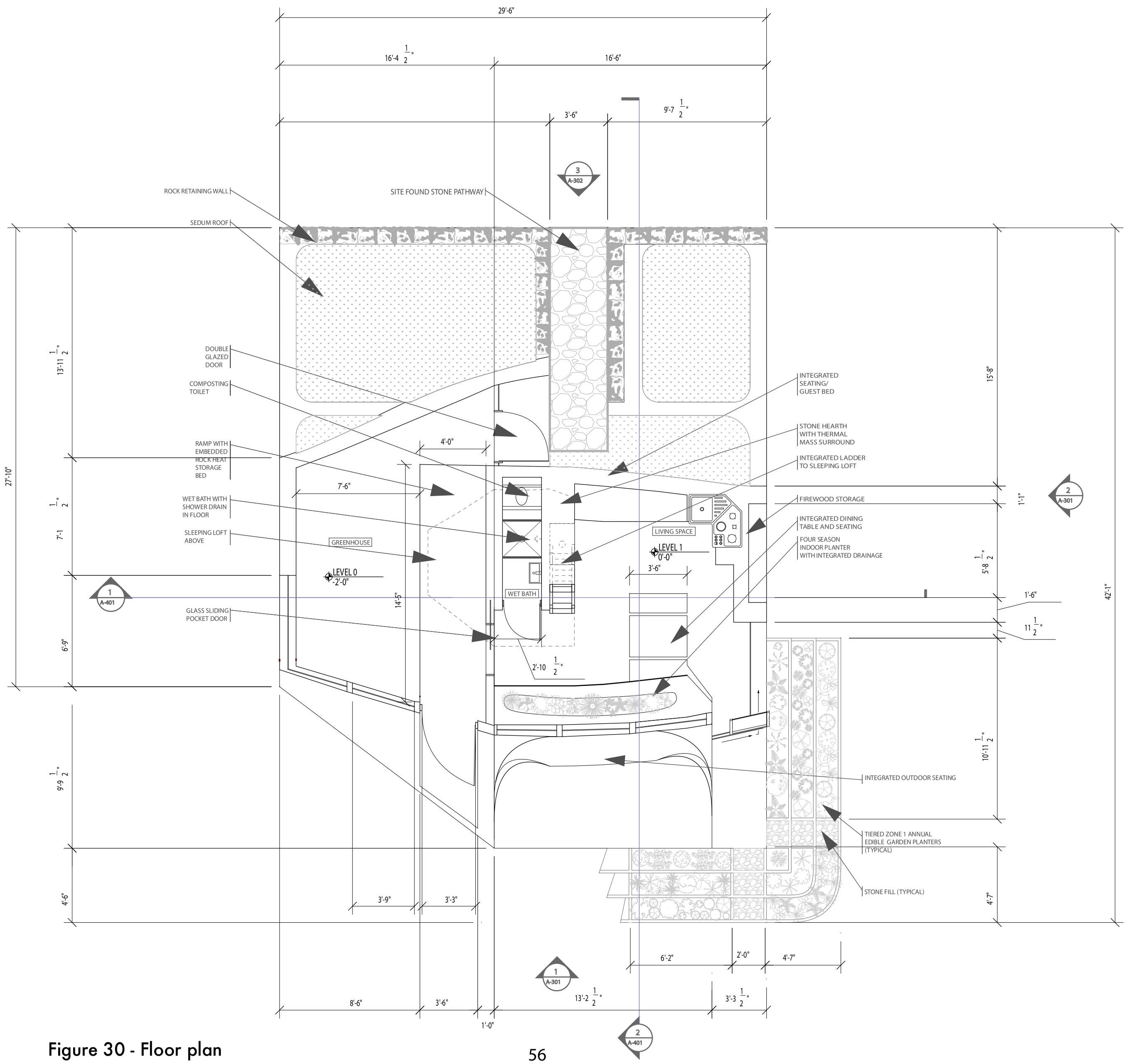


Figure 30 - Floor plan

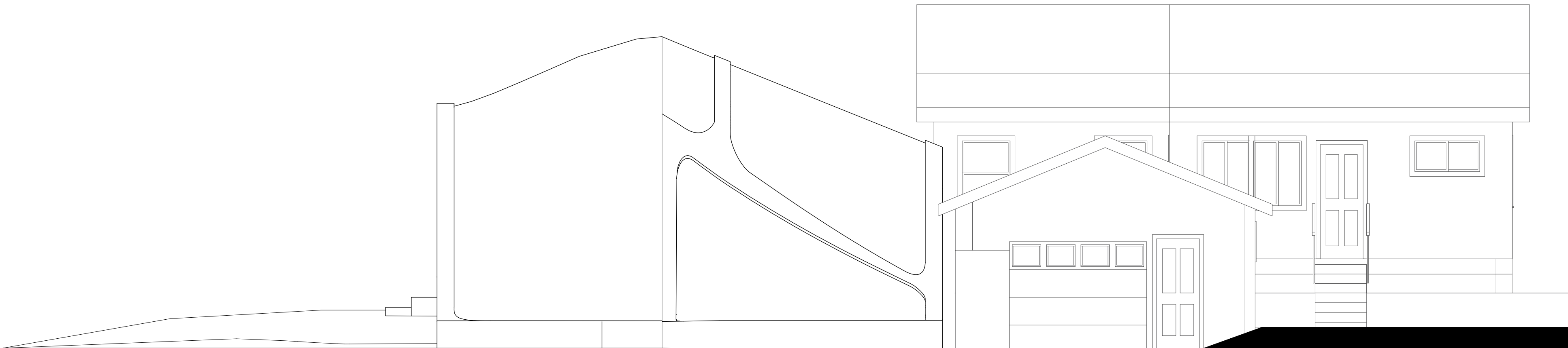


Figure 31 - North elevation

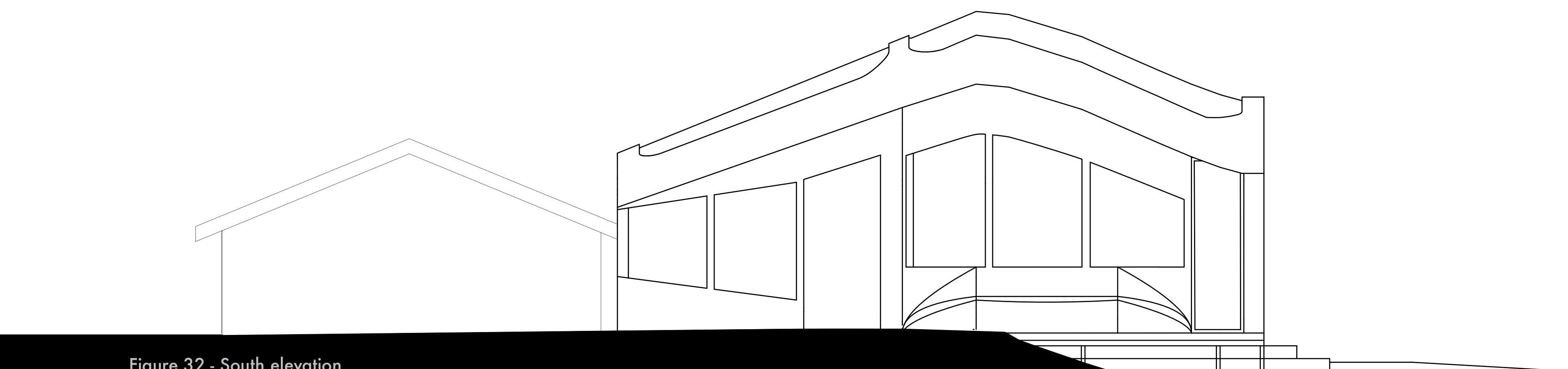


Figure 32 - South elevation

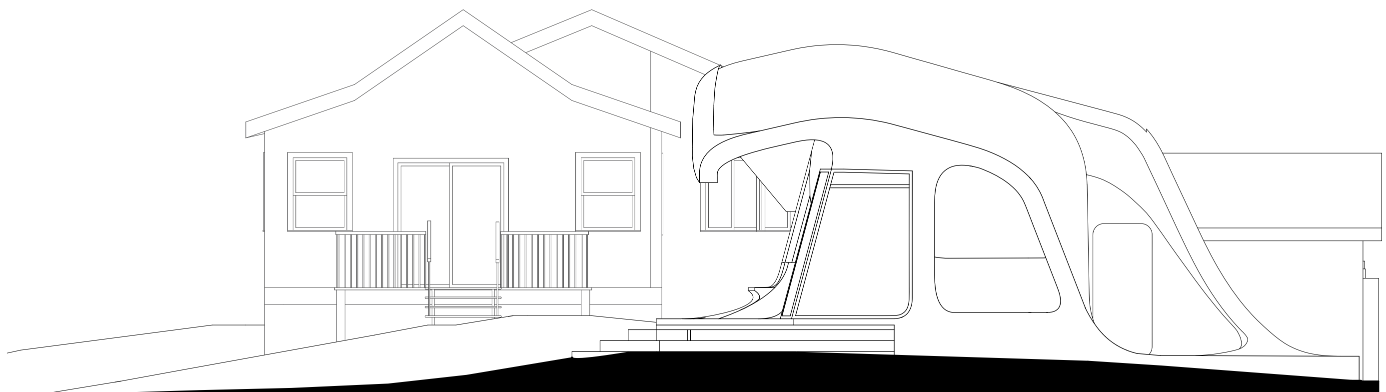


Figure 33 - East elevation

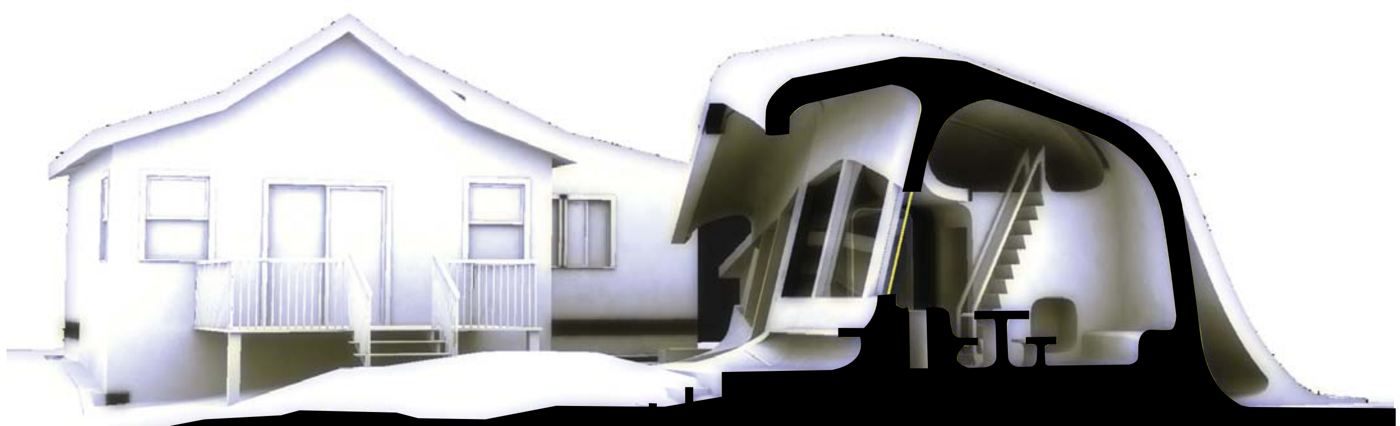


Figure 34 - Perspective section

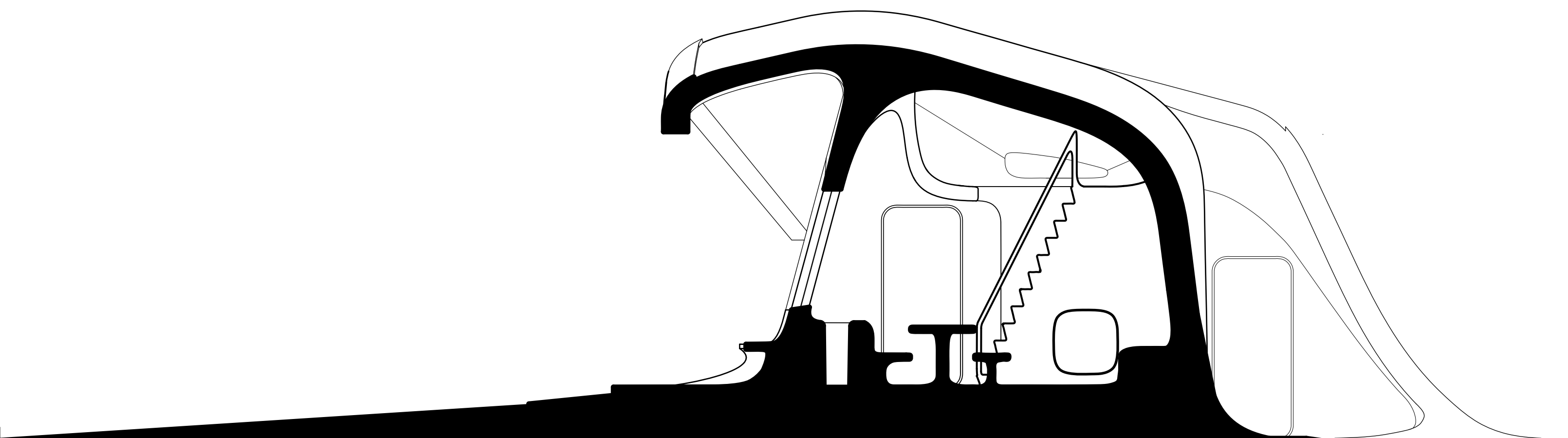


Figure 35 - Building section

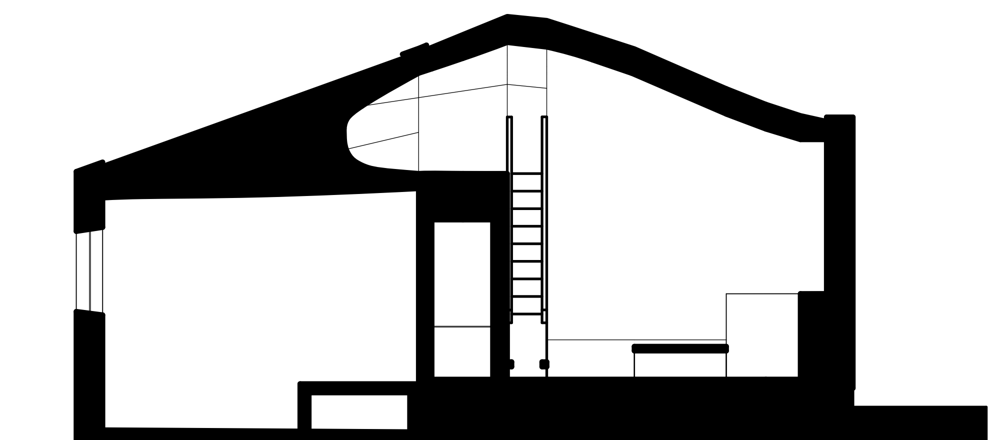


Figure 36 - Building section

Figure 37 - Rendered exterior view

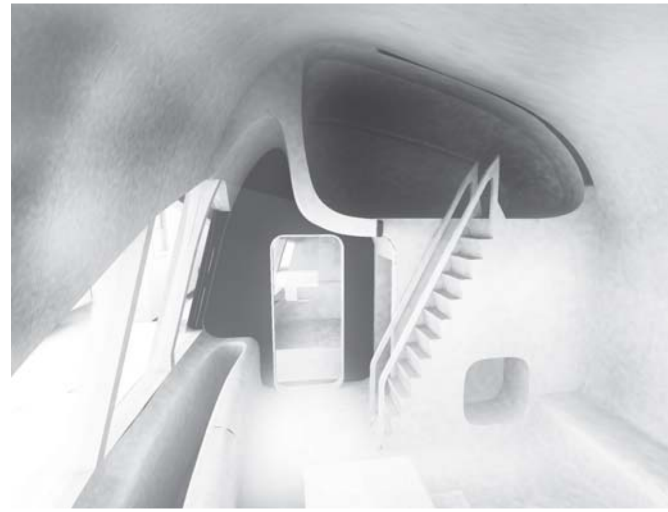


Figure 38 - Rendered interior view

Figure 39 - Rendered exterior view

Figure 40 - Rendered exterior view

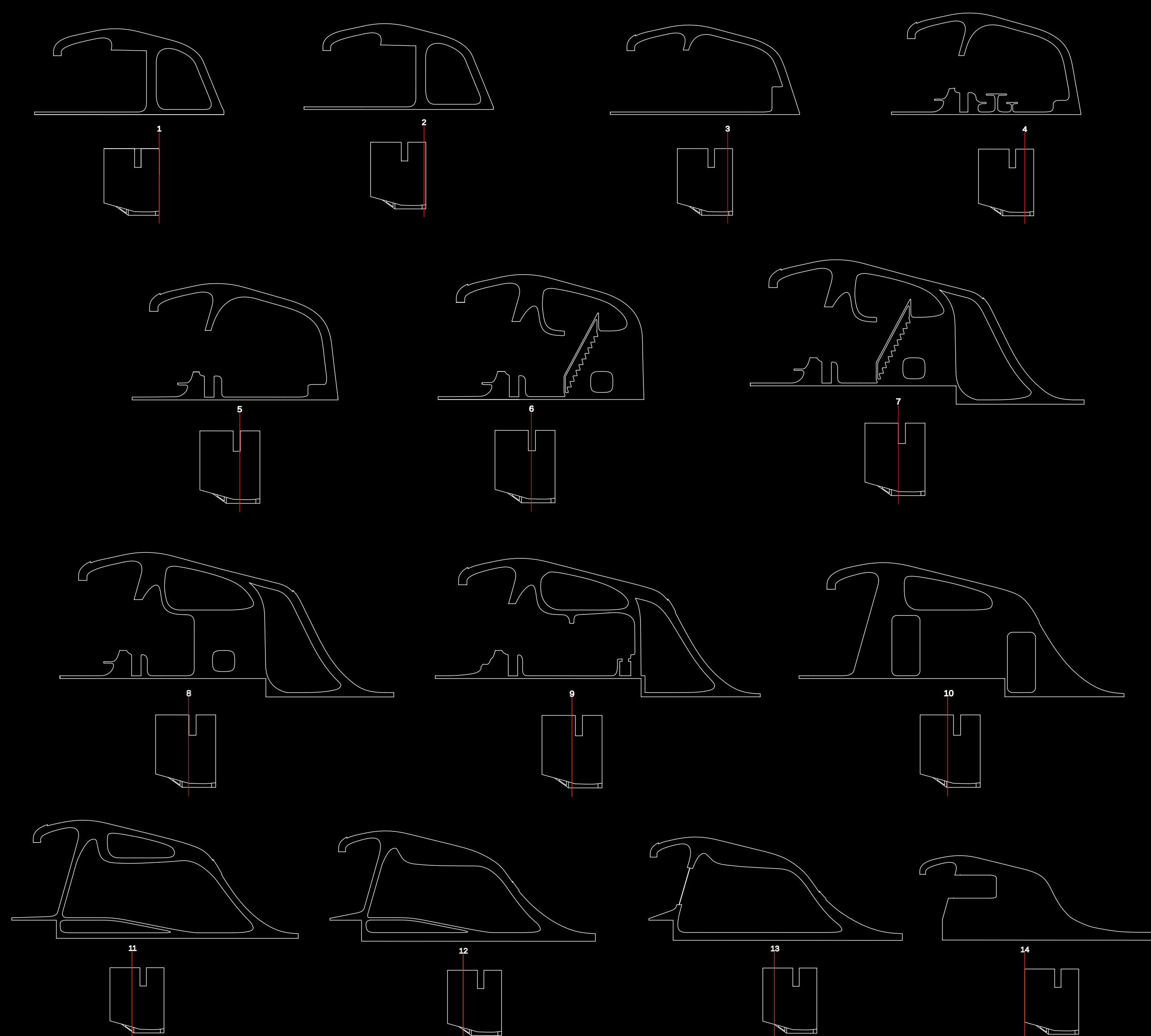


Figure 41 - Section diagrams

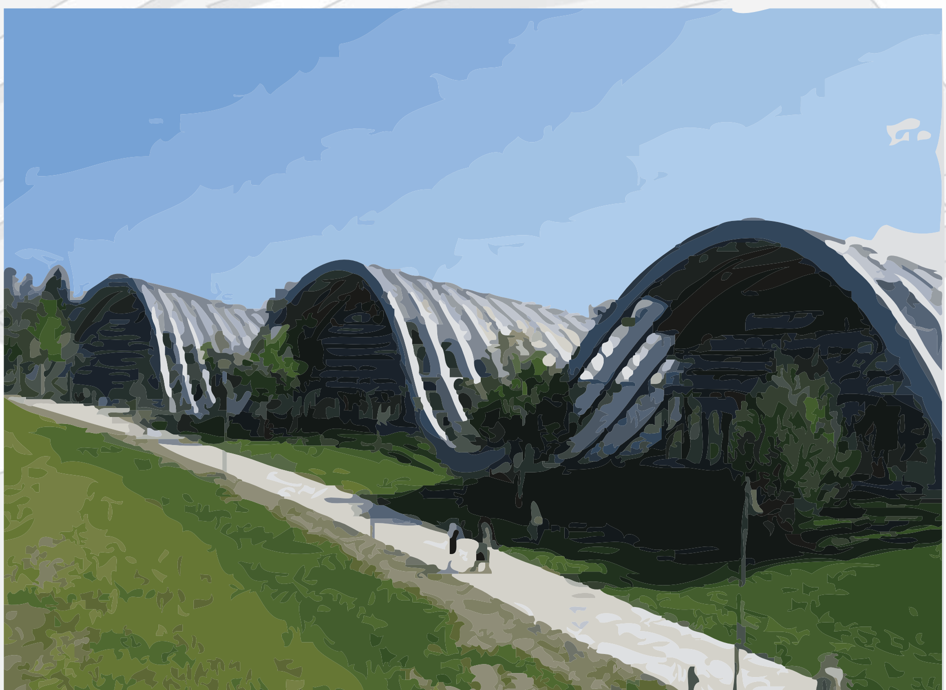
APPENDIX

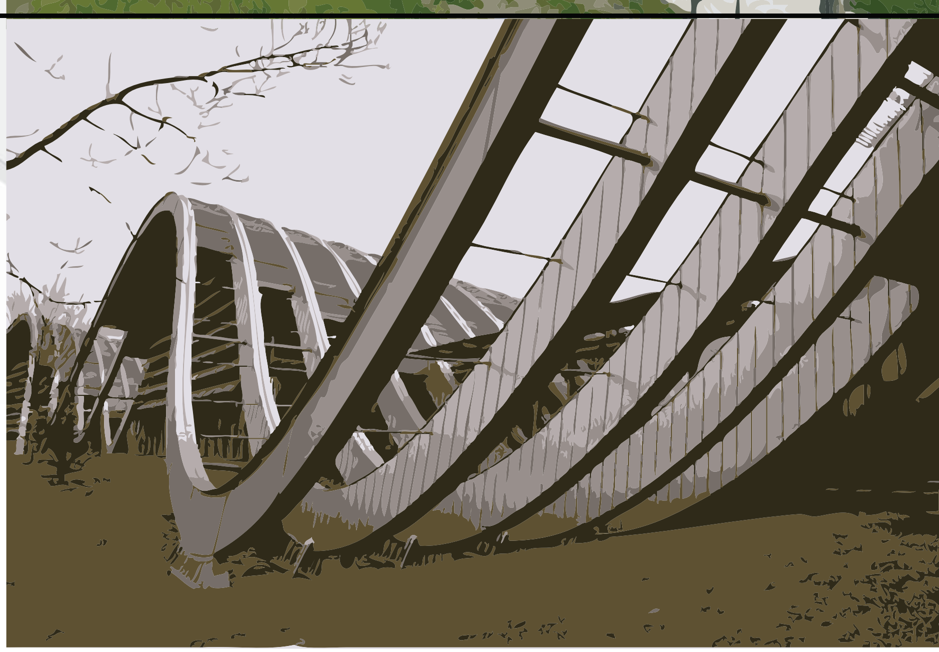
ZENTRUM PAUL KLEE MUSEUM
ARCHITECT : RENZO PIANO
LOCATION : BERN, GERMANY

Louvers controlling light penetration

Vegetation integrated with architecture

Form responsive to landscape





rotor house

architect . luigi colani

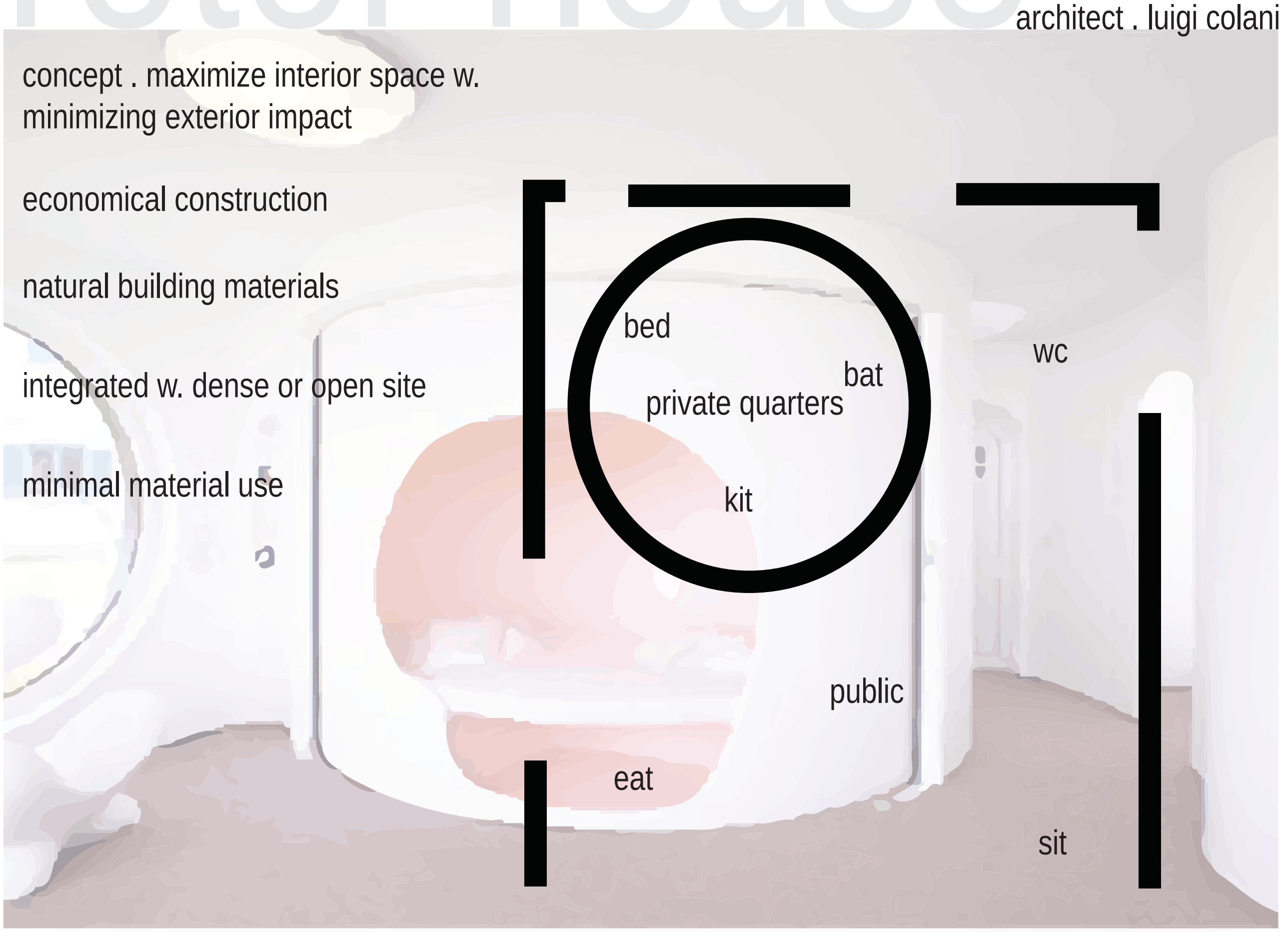
concept . maximize interior space w. minimizing exterior impact

economical construction

natural building materials

integrated w. dense or open site

minimal material use



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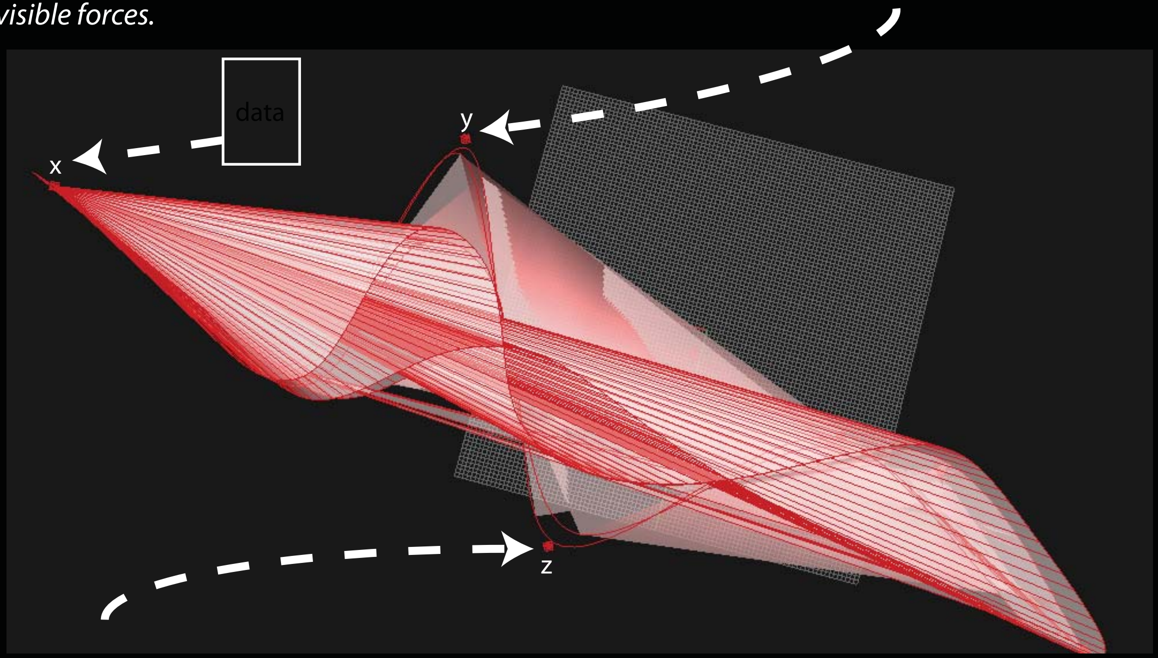
to challenge traditional ideas about architectural design methods in search of simulations which can simulate the appearance of life, the spacial effects and a combination of deformable surfaces and physical forces. Rather then being designed as stationary inert forms, space is highly plastic, flexible and mutable in its dynamic evolution through motion and transformation.
Form is not only defined by its internal parameters, but also by a mosaic of other fluctuating external, invisible forces.



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