

Human-Driven Extensive Greenroof Design

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Extensive Green Roof Technology – Human-Driven Design – Sensation – Design as Inquiry

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Human-Driven Extensive Greenroof Design*Beau T. Henderson****Abstract***

Throughout history, utopian ideals have existed promoting nature as a necessary affect for better aesthetic and psychological being. Yet, as human populations climb so do stresses upon the natural environment – therefore, bringing “the city in harmony with nature” becomes more challenging. Fortunately, hope exists through the use of greenroof technology.

Greenroofs are a green space created by continuous layers of drainage, protection, growing medium, and plants either onto or integral to a roofing system. This paper explores extensive greenroofs, characterized by low-maintenance and shallow growing medium.

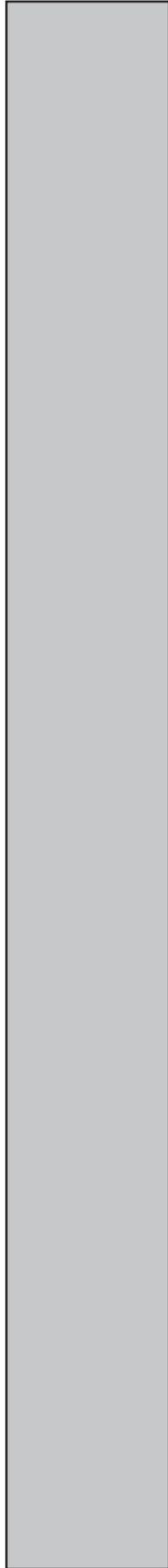
Greenroof benefits (ecological, economical, aesthetic, psychological) are classified as: *Market* and *Human*. Further exploration of *human*-driven benefits result in the definitions of active and passive sensation (the division of sensation): *Active sensation* is the immediate, present, unimagined engagement of a specific sense. *Passive sensation* is the imagined perception (sensing) of an object or element. As defined, Active Sensations are *real* and, therefore, have limits/defects/boundaries; yet, Passive Sensations are *imagined*, and therefore, *limitless*. As alluded by William James, “The philosophy which is so important in each of us is not a technical matter; it is our more or less dumb sense of what life honestly and deeply means. It is only partly got from books; it is our individual way of just seeing and feeling the total push and pressure of the cosmos.”

The remainder of the document explores *human*-driven greenroof design; emphasizing *design as a form of inquiry*.

Acknowledgements

Let me begin by thanking the members of my thesis committee – Ben, Erik, and Patrick – Ben for design development and defense suggestions; Erik for being the first onboard, for being so interested, and for the many suggestions and comments; and, especially, thank you Patrick to whom I owe a great deal for diligently working to keep me on track, and allowing this project to be not-so-typical, as well as, the countless comments and encouragement. Further, I would like to thank the entire landscape architecture department faculty and staff; in particular, Teresa, for tolerating my complete disregard of all things due, and without whom I might be spending another nine years in school. Specifically contributing to this document, I say thank you to Linda Velasquez for a very accessible and deep forum of knowledge; to Ed Snodgrass for discussion, materials and a tour; to Dr. Cavoti for his advice and knowledge; to Robin and Mouse Grass and the Foundry Art Studio for inspiration, discussion and a workspace; to Andy B. for a pre-reading and scannings; and, to Li'l Buddy for technical assistance and personal stylings. Also, let me mention some others who in some way impacted the production of this project: ma, rich, bean, combs, dorms, sarah b, shawn, bess, amol, rob, jake, dave, david, kathy, anyone feeling slighted, and of course, the family.

18.0 The Charette	39
18.1 Roof 3	39
18.2 Roof 1	41
19.0 Conclusions	42
Epilogue	43
Appendices	45-60
Appendix A. Endnotes	46-51
Appendix B. Layers/Components	52
Appendix C. Plant Lists	53
Appendix D. Thesis Guidelines	54
Appendix E. Scholarship	55-59



List of Objects

The objects appearing in this document are of several types: *images*, *figures*, and *sidebars*. Those categorized as *images* are photographs or other representations credited to outside sources (sources other than this author - *image* sources appear below in parantheses), while *figures* are drawings, diagrams, or photos credited to the author of this thesis document. *Sidebars* contain information which expand or support elements of the text – for a further explanation on sidebars refer to *How to Read*.

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Images:

Image 2.1 Le Corbusier (photo credit: Le Corbusier Center Foundation)	14
Image 2.2 Frank Lloyd Wright (http://www.franklloydwright.org/) (Image 2.2 not labeled in text)	14
Image 2.3 Extensive Greenroof (ZinCo GmbH)	14
Image 2.4 Rouge River Rendering (Richard Rochon of Rochon Associates, Inc.)	15
Image 3.1 Intensive Greenroof System (ZinCo GmbH)	16
Image 3.2 Extensive Greenroof System (Roofscapes, Inc. - www.roofmeadow.com)	16
Image 4.1 Hanging Gardens (The Bettman Archive)	19
Image 4.2 Frederick Law Olmsted (http://www.fredericklawolmsted.com/)	19
Image 6.1 William James (The Pragmatism Cybrary- http://www.pragmatism.org/default.htm)	21
Image 7.1 John Locke (http://www.trincoll.edu/depts/phil/phil/locke.html)	22
Image 7.2 Dr. Cavoti (Washington & Jefferson College)	22
Image 9.1 VA State Map and Routes (VPI&SU - www.vt.edu)	26
Image 9.2 Virginia Tech Campus Map (VPI&SU - www.vt.edu)	26
Image 12.1 Extensive Greenroof (ZinCo GmbH)	28
Image 13.1 Japanese Garden Influence (Sunset Books)	30
Image 13.2 Black Cobblestones (Ortho Books)	31

Figures and Table:

Figure 3.1 Squares are Rectangles, Rectangles are not necessarily Squares (Fig 3.1 not labeled in text)	16
Table 3.1 Comparison of Extensive and Intensive Greenroof Systems	16
Figure 7.1 Active and Passive Sensation (division of sensation)	23
Figure 7.2 Differences in Perception	23
Figure 9.0 View North over Site	26

Figure 9.1 Site Diagrams (Roof 1, 2, & 3 Highlighted)	26
Figure 9.2 Site Photo (view north towards site along steamtunnel walkway)	26
Figure 11.1 Photo (<i>out-of-place</i> units)	27
Figure 11.2 Photo (<i>infrastructure</i> type elements)	27
Figure 11.3 Site Analysis	27
Figure 12.1 Photo (elevated Roof 2)	28
Figure 12.2 Concept and Design Development	28
Figure 13.1 Roof 1 rendered	30
Figure 13.2 Roof 2 rendered	30
Figure 13.3 Japanese Garden inspired perspective	30
Figure 13.4 Roof 3 rendered	31
Figure 13.5 Pumice elevation	31
Figure 13.6 Section/Elevation of marker area (section A-A)	31
Figure 13.7 Photo (view of site from Fralin Biotechnology Center)	31
Figure 13.8 Roof 3 Section Lines	32
Figure 13.9 Section A-A	32
Figure 13.10 Section B-B	32
Figure 13.11 Section C-C	32
Figure 13.12 Section D-D	32
Figure 13.13 Section E-E	33
Figure 13.14 Section F-F	33
Figure 13.15 Layers Section	33

Sidebars:

Sidebar 2.1 Le Corbusier	14
Sidebar 2.2 Frank Lloyd Wright	14
Sidebar 2.3 Greening Gotham’s Rooftops	15
Sidebar 2.4 Greening Rooftops for Sustainable Cities	15
Sidebar 2.5 Ford Motor Company’s Rouge River Plant	15
Sidebar 4.1 Evapotranspiration – so what?	17
Sidebar 4.2 ASHRAE	17
Sidebar 4.3 Storage Space	18
Sidebar 4.4 The Hanging Gardens of Babylon	19
Sidebar 4.5 Frederick Law Olmsted	19
Sidebar 5.1 Barriers to Green Roof Technology Diffusion	20
Sidebar 5.2 Niche Opportunity	20
Sidebar 6.1 The BASF Connection	21
Sidebar 6.2 Starting to Change...	21
Sidebar 6.3 Market Disregard?	21
Sidebar 6.4 William James	21
Sidebar 7.1 John Locke	22
Sidebar 7.2 Dr. Cavoti explains...	22
Sidebar 7.3 Barbeque Analogy	23
Sidebar 7.4 Dr. Cavoti explains...(2)	23

How to Read this Document

Each page of the body of this document is broken into three columns of text, in addition to this text, extraneous information is provided through the incorporation of sidebars. These sidebars relay information that support, clarify, or highlight elements of the text. Each type of sidebar is represented by the color scheme explained below.

Also, further information is provided through endnotes. These endnotes (found in **Appendix A**) help demonstrate the evolution of this document by referring to abandoned or random thoughts, additional information, further inquiry, or pre-revised text, among other things. Essentially these endnotes deliver elements which would otherwise not have appeared within this document.

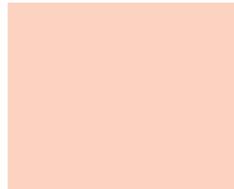
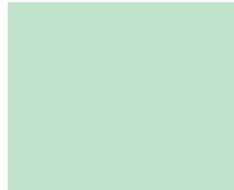
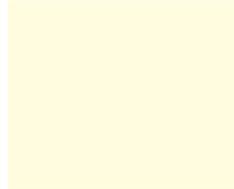
Direct quotations and paraphrases are oft cited throughout the text as follows: (Author’s Last Name, Year, Page #) - in all cases, the sources can be indexed to the **References** section by Author’s Last Name.

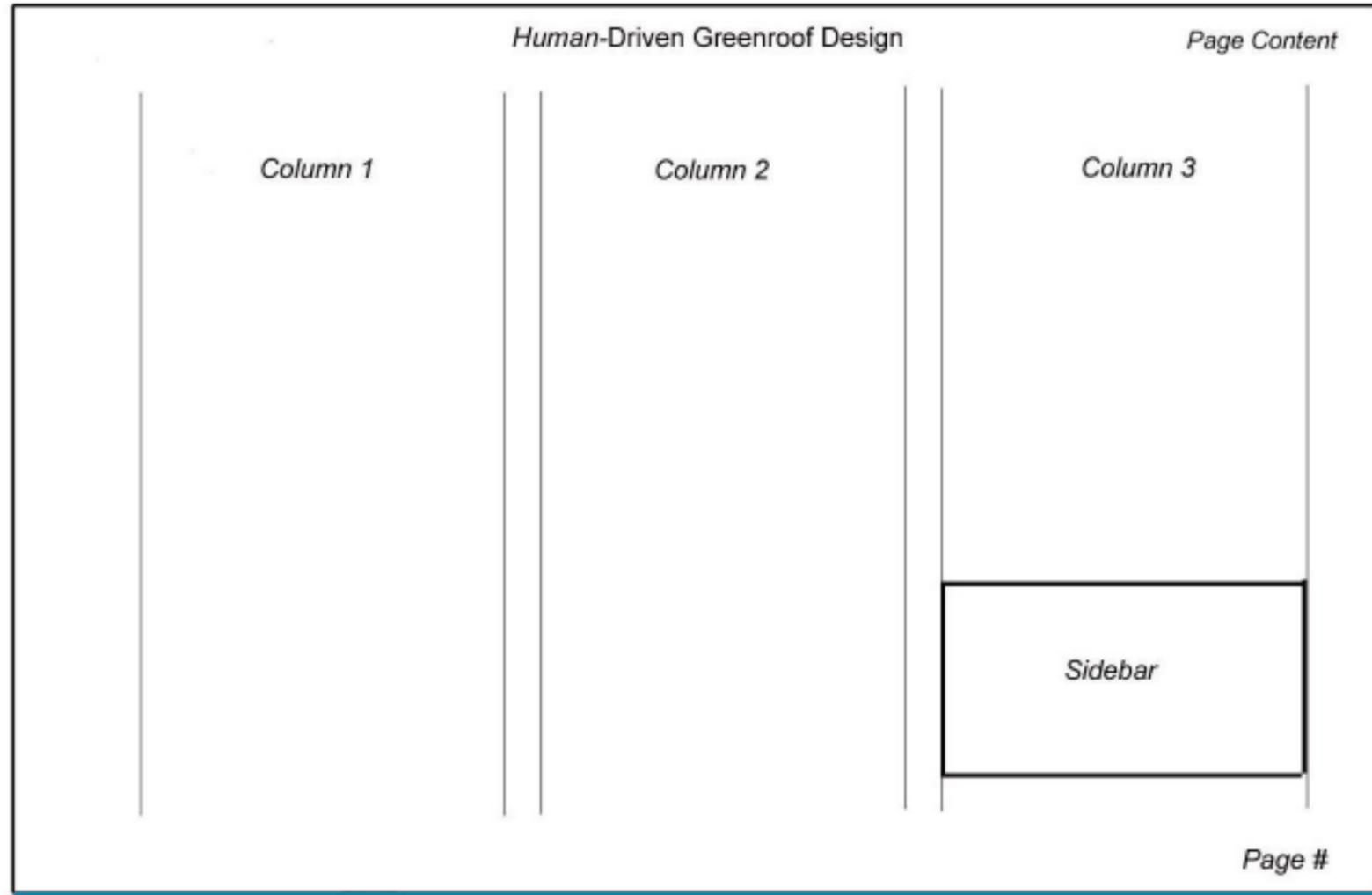
A list of objects appear in the preceding section, these objects (*images*, *figures*, and *sidebars*) have previously been explained (see page vii).

It should also be noted that the *figures* appearing in **Part II (b). Post-Defense Processes** intentionally do not show up on the **List of Objects**, nor are they labeled.

Sidebar information is cited within the sidebar as necessary, instances in which a source is not provided refer to **List of Objects**.

Sidebar Types and description

-  Biographical - provide biographical information on individuals influencing or mentioned in the document.
-  Typical - as described, these snippets of information some way support or clarify portions of the document.
-  Typical - separate colors are used as a way for discriminating between two sidebars of this type on a single page.
-  Highlighted Project - describe or demonstrate greenroof projects.
-  Author’s Commentary - commentary from the author presented as conversation or story.
-  Outside Commentary - commentary offered from outside source.



Prologue

I have always enjoyed trying to understand where ideas and thoughts not only came from but also how they evolved. The extraneous or “discarded” information within this document (in the form of sidebars, quotation, and endnotes) attempts to relay that evolution. I have many times been quite intrigued when going back to reread material which I had composed at an earlier date – often wondering if indeed I was the author as I could recall little to nothing of what was written – and so throughout this document I’ve tried to capture as much of the work or “mood” involved in its creation.

W.H. Gilman describes these “shifts in the power of knowing things in some moods which we do not know in others” in relation to Ralph Waldo Emerson [with Emerson’s words in brackets]. “He wrote the poem *Days* in 1851; a year later he could not remember composing or correcting it, knew he could not write its like again, concluded again that [one state of mind does not remember or conceive of another state]. We are like [mesmerized patients who are clairvoyant at night & in the day know nothing of that which they told]” (Gilman, 1965, p. x).

Because of my shifting moods this project has taken the shape now before you, and, despite those shifting moods it has become a somewhat consistent, linear, and controlled document.

For those about to read this document, know three things:

- 1) A conscious effort has been made to keep the text as succinct as possible. Much of the length or bulk of this document can be attributed to extraneous and/or supporting information, which has been (in most instances) formatted for readability.
- 2) This is a completely academic undertaking; although any conjectures to “real world” plausibility or application would be flattering, such connections are not the requisite ends.
- 3) At some point this project became about more than just the subject at hand (*human-driven extensive greenroof design*). It became an attempt to relay the methods of the mind and the processes of thought – to contribute beyond the scope of *product*, to examine the methods and reasoning of *design as inquiry* – as Emerson might explain: “the ways and effects of thought rather than the thought itself” ...”But this function of opening and feeding the human mind is not to be fulfilled by any mechanical or military method; is not to be trusted to any skill less large than Nature itself” (Emerson, *Lectures and Biographical Sketches*, Education – p. xi and 442 in Gilman). Therefore, if, to be fulfilled we must trust Nature; then, quite appropriately we explore extensive greenroofs – an inherently ecological tool.

*It is a secret which every intellectual man quickly learns, that, beyond the energy of his possessed and conscious intellect, he is capable of a new energy (as of an intellect doubled on itself), by abandonment to the nature of things; that, beside his privacy of power as an individual man, there is a great public power, on which he can draw, by unlocking at all risks, his human doors, and suffering the ethereal tides to roll and circulate through him: then he is caught up into the life of the Universe, his speech is thunder, his thought is law, and his words are universally intelligible as the plants and animals. The poet knows that he speaks adequately, then, only when he speaks somewhat wildly, or, “with the flower of the mind”; not with the intellect, used as an organ, but with the intellect released from all service, and suffered to take its direction from its celestial life; or, as the ancients were wont to express themselves, not with intellect alone, but with the intellect inebriated by nectar. As the traveler who has lost his way throws his reins on his horse’s neck, and trusts to the instinct of the animal to find his road, so must we do with the divine animal who carries us through this world. For if in any manner we can stimulate this instinct, new passages are opened for us into nature, the mind flows into and through things hardest and highest, and the metamorphosis is possible. (Emerson, *Essays, Second Series, The Poet*; p.325 in Gilman, 1965)*

Part I

Theory Process

Nature says to the American, I understand mensuration & numbers. I have measured out to you by weight & tally the powers you need. I give you the land & the sea, the forest & the mine; the elemental forces; nervous energy, & a good brain. See to it that you hold & administer the continent for Mankind.

– Ralph Waldo Emerson, *journal entry*, 1863.

Let it be felt that the mind is all, & then it will follow in irresistible logic as it does in actual truth that the only reasonable efforts to increase human happiness must be aimed at the mind & not the body.

– Ralph Waldo Emerson, *journal entry*, September 11, 1828

Empirical science is apt to cloud the sight, and, by the very knowledge of functions and processes, to bereave the student of the manly contemplation of the whole. The savant becomes unpoetic. But the best read naturalist who leads an entire and devout attention to truth, will see that there remains much to learn of his relation to the world, and that it is not to be learned by any addition or subtraction or other comparison of known quantities, but is arrived at by untaught sallies of the spirit, by a continual self-recovery, and by entire humility. He will perceive that there are far more excellent qualities in the student than preciseness and infallibility; that a guess is often more fruitful than an indisputable affirmation, and that a dream may let us deeper into the secret of nature than a hundred concerted experiments.

Ralph Waldo Emerson

1.0 Position

Extensive greenroof design should more appropriately affect human-scale interaction.

“[M]ost of the world today lives in a linear state of compulsive profit motive and consumer-based technocracy”¹ (Wines, 2000, p36). Although the very essence of extensive greenroof systems run counter to this “motive,” the systems, themselves, are engineered with just such compulsion in mind. As a result many systems are *installed* rather than *expressed*; *engineered* rather than *designed*.² An old adage states that if you get an engineer to build a library, he’ll ask “how many books?”...but if you hire an architect, he’ll ask “what is a book?” (Miller, 2002) Therefore, we ask “what is a greenroof?”³

The essence of extensive greenroofs, as alluded, lies in ecological values, the desire of a better built world, the hope for environmental consciousness – an understanding of American Indian Chief Seattle: “All things are connected. Whatever befalls the Earth, befalls the children of the Earth”⁴ – a plea for sustainability. Ironically, despite these philosophical proposals we overlook the *human*-scale advantages of greenroof design.⁵ “Designers will recognize that gradually but surely they must underbuild their proposals and compositions with more solid physiological foundations⁶ rather than with mere speculative conversation or sales talk” (Neutra, 1969, p4).⁷

If asked two years, one year, even five months ago I would have argued that the most important aspects concerning greenroof technology were an expounding of their *market* benefits (primarily the economic) and general dissemination of their availability. In other words, I would have argued that greenroofs need to be used.⁸ Now, the more appropriate position assumes use

(see *Greening Gotham’s Rooftops*), thus, the design of such needs to reflect a better understanding of “human”- driven forces.⁹

This is potentially one of the most challenging periods of architectural innovation in history. While many of the established architects today are intimidated by the accelerating momentum of change – fearing their stylistic commitments may be under attack – there is no reason why this revolution cannot be optimistically approached as the threshold of a great creative era. Here, for the first time in seven decades, is an opportunity to invent the future on terms that are sociologically and ecologically responsible. The industrial and technological influences that launched [the 20th] century were rooted in cultural and economic change; as a result, rarely did the architects of early Modernism ever consider such issues as environmental impact, or the related psychological effects of their work on city dwellers as a consequence of this loss of contact with nature. They were committed to formalist and functionalist invention and new technologies, pure and simple. If people didn’t appreciate the result, their negative reaction was dismissed as evidence of the public’s philistine ignorance or conservative values. It is this profound misjudgment on the part of the architecture profession that is at the root of the environmental problems we face today. By insisting on a set of design standards divorced from ecological responsibility, architecture has forfeited its richest source of ideas, caused incalculable environmental damage, and failed to communicate with the very constituency it is obligated to serve (Wines, 2000, p19).¹⁰

“With knowledge of the soil and subsoil of human nature and its potentials, we shall raise our heads over the turmoil of daily production and command views over an earth which we shall have to keep green with life if we mean to survive – not cramped full with all the doubtful doings of a too thoroughly commercialized technology. Tangible observation rather than abstract speculation will have to be the proper guide. And drifting will no longer do” (Neutra, 1969, p7). Understanding the “more appropriate” position requires: first, an understanding of greenroofs; then, an explanation of the theoretical underpinnings; and, finally, design as a form of inquiry properly guiding us.

2.0 Greenroof history

Throughout history, utopian ideals have existed promoting nature as a necessary affect for better aesthetic and psychological being.¹¹ As civilization advanced we began understanding the effects of nature in promoting better ecologic and economic being.¹² Despite this increased understanding, as human populations climb so do stresses upon the natural environment. Therefore, finding a way to bring “the city in harmony with the workings of nature” becomes more challenging.

Over millions of years, nature has been able to regulate toward the creation of stable ecosystems, natural changes tend to be gradual. Yet man, through technological advances, has been able to introduce change much more rapidly and with potentially devastating repercussions.¹³

We face a sharp bend in the road. Behind us lies the landscape we inherit, before us the landscape that, in due time, we will bequeath. Looking back, we see important flaws in the relationship between the human-dominated landscape and the natural world. Looking ahead, we see a need to reform that relationship but find it hard to know just how we might alter our direction, shift our momentum, adjust our speed. We seek a more careful “harmony” of social and natural systems, but we have no sure map to guide us (Meine, 1997, p47).

Two modern advocates of green roof technology were the architects Le Corbusier and Frank Lloyd Wright. Although Le Corbusier encouraged rooftops as another location for urban green space, and Wright used green roofs as a tool to integrate his buildings more closely with the landscape, neither was aware of the profound environmental and economic impact that this technology could have on the urban landscape (Peck and Kuhn, 2000,p2).

A House Is A Machine For Living In...

Born in Switzerland in 1887, Charles Edouard Jeanneret adopted his professional name Le Corbusier in 1922. Jeanneret had been a small-town architect working in Josef Hoffman's Vienna Studio; Le Corbusier was a visionary. An example is his recipe for the International Style: raise the building on stilts, mix in a free-flowing floor plan, make the walls independent of the structure, add horizontal strip windows and top it off with a roof garden.



Image 2.1 Le Corbusier

“Things are not revolutionised by making revolutions. The real revolution lies in the solution of existing problems” – Le Corbusier

...Just Like The Human Heart Is A Suction Pump



Frank Lloyd Wright was born either in Richland Center, or in nearby Bear Valley, Wisconsin, and grew up largely under the tutelage of his mother, Anna, and his aunts and uncles on farmland near Spring Green, Wisconsin. Wright's innovative designs and use of materials often drew controversy. Wright avoided anything that might be called a personal style. Through all his designs, he was guided by principles that he termed organic architecture. By this he meant that every building should relate harmoniously to its natural surroundings.

“No house should ever be on any hill or on anything. It should be of the hill, belonging to it, so hill and house could live together each the happier for the other.” – FLW

“Wright, Frank Lloyd,” Microsoft® Encarta® Online Encyclopedia 2003 <http://encarta.msn.com> © 1997-2003 Microsoft Corporation. All Rights Reserved.

“Le Corbusier,” by WITOLD RYBCZYNSKI; Time 100, Most Influential People of the Century. Available at Time.com: <http://www.time.com/time/time100/artists/profile/lecorbusier.html>

The history of greenroofs can be traced as far back as the history of buildings. The first constructed homes used earthen materials such as wood, stone, dirt, mud and sod. It only makes sense that within and among these natural materials vegetative life would take root. Although these conjectures to rudimentary greenroof systems are plausible, the strongest evolutionary connection to present day greenroofs comes from Iceland. The Icelandic architectural style is typified by a lack of natural resources, meaning the best building materials were those readily at hand: stone and sod. Roofs were completely turfed providing protection against the rain, wind and snow of the region, as well as serving as an excellent means of insulation. With these noticeable benefits and a certain natural aesthetic, greenroofs¹⁴ found use for hundreds of years and spread throughout Scandinavia.



Image 2.3 Extensive Greenroof (ZinCo GmbH)

Eventually, the concept sprang up in Europe, primarily in Germany, and there it has taken on the greatest prominence as an effective tool. Indeed, since the 1960's the primary evolution of greenroofs occurred in Germany. Many German provinces and cities now require greenroofs in building codes or provide stipends to encourage usage. “In 1996 a survey done by Zentralverband Gartenbau e.V.(ZVG), The Gardening Central Association, revealed that approximately 50%, or over 80 cities in Germany offered incentives to building owners utilizing greenroofs.”¹⁵ Furthermore, “twenty-nine German cities in the ZVG survey provide a direct monetary subsidy to developers who use greenroofs. The amount of the subsidy varies widely, ranging between \$0.51 to \$6.20 per square foot (\$5.5 to \$67/m²)” (Velasquez, *Greenroof Industry Support*).

“In Germany, the green roof market expanded quickly in an annual growth rate of 15-20%, ballooning from one to ten million square metres. This growth was stimulated largely by state legislation, municipal grants and incentives of 35-40 Deutsch Marks/m² of roof greened. Other European states have adopted similar types of support. Several cities now incorporate roof greening into regulations. Stuttgart, for example, requires green roofs on all new flat-roofed industrial buildings. Vienna also provides subsidies and grants for new green roofs at the stages of planning, installation and 3 years post construction to ensure ongoing maintenance. Over 75 European municipalities currently provide incentives or requirements for green roof installation... As a result, green roofs have become a common feature in the urban landscape” (Peck and Kuhn, 2000, p3).

Undoubtedly, the question arises, “Why don't we see greenroofs in the U.S. if they have been so effective and popular in Europe?” Perhaps, best addressing this question avoids the politics and economics of modern day

America, instead, referring to an opinion poll of Europeans which found they ranked the environment with more priority than even unemployment, poverty, and insecurity (Velasquez, *History*). Needless to say, most Americans do not give the environment such importance, but hope exists for greenroofs in North America.

Greening Gotham's Rooftops

November 22-23, 2002

Earth Pledge Convenes Public Officials to Discuss Rationale and Options for Government Support of Green Roof Development in New York City.

Officials from twenty-two New York City, New York State, District of Columbia, and Federal agencies gathered to learn about the public value of green roof infrastructure for New York City, and to discuss ways government can support green roof development as a solution to serious environmental and human health challenges.

New York City, November 22, 2002 - Thirty public officials from twenty-two New York City, New York State, District of Columbia, and Federal agencies gathered at the Carriage House Center in New York to learn how green roofs can help solve some of New York City's most pressing environmental and human health challenges. Green, or vegetated, roofs have the potential to combat urban heat island effect, alleviate stormwater pressure on the combined sewage system, reduce energy consumption, and purify the air.

Earth Pledge, a New York-based environmental nonprofit group, brought the officials together as part of its Green Roofs Initiative, a program that is committed to developing citywide green roof infrastructure in New York City...

The forum for public officials was part of Greening Gotham's Rooftops, a two-day event that also featured a symposium, attended by 130 people, that profiled green roof projects from across North America.

Agencies represented at the government forum included the New York City Departments of Buildings, City Planning, Citywide Administrative Services, Design and Construction, Environmental Protection, Housing Preservation and Development, and Parks; the Mayor's Office of Environmental Coordination, the Housing Authority, and the School Construction Authority. Representatives from the Bronx Borough President's Office, Manhattan Community Board 1, Battery Park City, and the Lower Manhattan Development Agency also attended. State and Federal Agencies represented included the New York State Energy Research and Development Authority (NYSERDA), the USDA Forest Service, and the Environmental Protection Agency. Representatives from the city of Washington, D.C.'s Executive Office of the Mayor, Mayor's Council, Departments of Health and Parks and Recreation, and the District of Columbia Public Schools also attended.

The officials heard presentations detailing the rationale for city support of green roof development and outlining the current state of New York City's environment and human health. They discussed ways government could support green roof development, including tax credits, building incentives, regulation, and direct grants, and formed a Green Roofs Task Force to further explore policy incentives for green development.

The forum also featured the announcement of the study Green Roofs for New York City, which Earth Pledge is undertaking in partnership with the NASA/Goddard Institute for Space Studies, Montclair State University, the Mailman School of Public Health at Columbia University, the Columbia Earth Institute, and HydroQual, Inc. The study will determine the feasibility, costs and benefits of large-scale green roof development in New York City, and will quantify the impact of different greening scenarios on human health and the urban environment (<http://www.earthpledge.org/eventsGreener.html>).

Greening Rooftops for Sustainable Cities:

The First North American Green Roof Conference, Awards and Trade Show was held in Chicago, IL on May 29 and 30, 2003.

Presented by Green Roofs for Healthy Cities and co-hosted by the City of Chicago, the two-day event was held at The Congress Plaza Hotel and Convention Center in downtown Chicago right beside Grant Park on Michigan Avenue. The Conference was an exciting opportunity to introduce, explore and present greenroof technologies, research studies and project profiles to government officials, architects, landscape architects, designers, planners, engineers, the business community, and the public at large. Guided tours of the Chicago City Hall and The Chicago Center for Green Technology were sold out and enjoyed by all. (www.greenroofs.com)

The Ford Motor Company's Rouge River Plant, Dearborn Michigan

"According to the Ford Motor Company's press release dated November 3, 2000, the 600-acre, \$2 billion Ford Rouge Center near Dearborn, Michigan, will undergo major redevelopment, laying the

groundwork for sustainable manufacturing at one of the world's largest and oldest industrial icons. This rendering by McDonough + Partners, rendered by Richard Rochon, includes numerous pilots of advanced environmental concepts and a new assembly plant with the nation's largest ecologically inspired living roof on an industrial building. About 454,000 square feet of assembly plant roofing will be covered with sedum, a succulent groundcover, and other plants. The roof will reduce stormwater runoff by holding an inch of rainfall. Also the living plants absorb carbon dioxide as part of photosynthesis, so oxygen is emitted and greenhouse gases are reduced.



Redevelopment of the 1917 complex will form the foundation for the company's vision of balancing lean manufacturing with environmental sensitivity. "This is not environmental philanthropy; it is sound business, which for the first time, balances the business needs of auto manufacturing with ecological and social concerns in the redesign of a

brownfield site," said Ford Chairman Bill Ford, whose great-grandfather Henry Ford constructed the complex. "This is what I think sustainability is about, and this new facility lays the groundwork for a model of 21st century sustainable manufacturing at the Rouge. "While most companies would rather move than invest in an 83-year-old site, we view this as an important reinvestment in our employees, our hometown and an American icon of the 20th century," Ford added." (Velasquez, *North American Case Studies*).

Image 2.4 Rouge River Rendering

Definition

3.0 Definition

There are several ways for defining greenroofs and different greenroofing systems, whether it be growing medium, plantings, cost, or maintenance. This chapter provides several explanations of greenroofs, the definitions to be used throughout this document, and a brief discussion.

“Greenroofs are the result of a complete underlying roof build-up system, providing continuous, uninterrupted layers of protection and drainage” (Velasquez, *Greenroof Concept*).

“A green roof is a green space created by adding layers of growing medium and plants on top of a traditional roofing system” (Peck and Kuhn, 2000, p4).

Greenroofs consist of “a thin veneer of living vegetation installed on top of a conventional roof.” (Charlie Miller, 2001).

In essence, greenroofs are a greenspace created by continuous layers of drainage, protection, growing medium, and plants either onto or integral to a traditional roofing system. (For a more thorough examination of greenroofing components refer to Appendix B.)



Image 3.1 Intensive Greenroof System

The industry classification of greenroof systems is three-fold: intensive, semi-intensive, and extensive. The intensive are designed to be physically-accessible for use as parks, or other higher intensity treatments. Therefore, they are higher maintenance and require a minimum of one-foot (1’) soil-medium to be planted with large trees and shrubs (see Image 3.1). Although technically classified as greenroofs, these are more akin to traditional rooftop gardens.

Image 3.2 Extensive Greenroof System



On the other hand, the extensive greenroofing systems are primarily used for environmental benefits and perhaps a more pure instance of greenroofs, at least in line with the benefits discussed later in

this paper. Extensive greenroofs are typically not physically-accessible except for maintenance, sometimes occurring as infrequently as once a year. They require only one to four inches of soil depth and are planted with a thin vegetation layer, often native grasses and sedum varieties (see Image 3.2).

The semi-intensive system obviously falls between the previous two and affords a bit more planting opportunities than the extensive system, yet not quite as much as the intensive greenroofing systems (see Table 3.1). Quite often a greenroof system may not fall solely under any one of these categories but will contain elements of another or all. In such cases, the system which makes the majority of the roofscape will be the defining system.

Table 3.1: Comparison of Extensive and Intensive Green Roof Systems

	Extensive Green Roof	Intensive Green Roof
Brief Description	thin soil, little or no irrigation, stressful conditions for plants	deep soil, irrigation system, more favorable conditions for plants
Advantages	lightweight	greater diversity of plants and habitats
	suitable for large areas	good insulation properties
	suitable for roofs with 0-30° slope	can simulate a wildlife garden on the ground
	low maintenance	can be made very attractive
	often no need for irrigation and drainage systems	often visually accessible
	relatively little technical expertise needed	diverse utilization of roof (i.e., for recreation, growing food, as open space.)
	often suitable for retrofit projects	
	can leave vegetation to develop spontaneously	
	relatively inexpensive	
looks more natural		
easier for planning authority to dem and green roofs be a condition of planning approvals		
Disadvantages	more limited choice of plants	greater weight loading on roof
	usually no access for recreation or other uses	need for irrigation and drainage systems hence, greater need for energy, water, materials, etc.
	unattractive to some, especially in winter	higher cost
		more complex systems and expertise required

Table Source: (adapted from Peck, Callaghan, et al, 1999, p14).

3.1 Greenroofs vs. Roof Gardens and Eco-roofs

As stated by Theodore Osmundson, a “roof garden is any planted space, intended to provide human enjoyment or environmental enhancement, that is separated from the earth by a building or other structure.” Therefore, by definition, greenroofs are roof gardens. Nonetheless, roof gardens are not necessarily greenroofs.



Roof gardens are similar to intensive greenroofs, yet the usual roof garden is simply the incorporation of containers or similar systems to allow for deep-rooted plants. Rooftop gardens do share most of the benefits associated with greenroofs but since the gardens do not exhibit the uninterrupted layers (but rather free-standing containers or planters) they should not be classified as greenroofs. “Greenroofs are the result of a complete underlying roof build-up system, providing continuous, uninterrupted layers of protection and drainage” (Velasquez, *Greenroof Concept*).

Beyond this, the term eco-roof is sometimes used interchangeably with greenroof. Eco-roofs, however, are much more broadly defined as roof treatments involving natural, renewable materials and could include anything from greenroofs to simple wood shingles.

For the purposes of this paper, *greenroofs* will herein refer primarily to extensive greenroofing systems.

It should be noted that the advantages and disadvantages described in Table 1 provide generic information only. Each individual green roof system will likely be a combination of intensive and extensive, depending on factors such as:

- location;
- structural capacity of the building;
- budget;
- material availability; and,
- client and/or tenant needs. (Peck, Callaghan, et al, 1999, p14).

4.0 Benefits/Advantages/Goals

The benefits of greenroofs are fourfold: ecologic, economic, aesthetic, and psychologic. Extensive greenroofing systems are engineered primarily for ecologic and economic goals, while aesthetics and psychological advantages are secondary and tertiary purposes, respectively. Intensive greenroofs function for primarily ecologic and aesthetic goals with psychology and economics in the backseat. In comparison, typical roof gardens exploit aesthetic and psychologic advantages with economic and ecologic concerns secondary.

These benefits (ecology, economy, aesthetic, psychology) can be classified as: Market and Human. The ecologic and economic are *market* benefits, the aesthetic and psychologic are *human* benefits.

The classification of ecologic and economic advantages as *market* is a result of these benefits being quantifiable. The economics of energy savings, extension of roof life, increase in property values, etc. are obviously quantifiable through dollar amounts. The ecologic benefits are less obvious but also quantifiable, whether it be percentage of stormwater retention, change in ambient air temperature, decibel reduction, etc.

On the other hand, to quantify aesthetics or psychological effects requires human interpretation; an explanation of emotions, feelings, or sensation. Therefore, these advantages fall under *human* benefits

4.1 Market

4.1.1 Ecological Benefits

4.1.1.1 Stormwater management

Maybe the greatest of ecological benefits is the stormwater management capacity of greenroofs. Obviously, as urbanization increases so does the amount of impervious surface cover. As a result, cities develop overstressed sewer systems with very urgent stormwater management problems. Nonetheless, depending on rain intensity, soil depth, and plant types, runoff can be absorbed as much as 15% to 90% with an average of 50% to 60% runoff (Velasquez, *Ecological Advantages & roofmeadow.com, Benefits*).

In a September 2000 article appearing in LA magazine, J. William Thompson explains,

Two years ago...about the only functioning green roof we could find in this country was on top of Tom Liptan's garage...Liptan, ASLA, a stormwater-management professional in Portland, Oregon, believed that putting absorbent plants and soil on top of buildings could keep a percentage of

urban rainfall from gushing into storm sewers and causing rivers and streams to flood. Because there was no such roof to study in Portland, he rigged up an experiment on his garage using a thin layer of soil from his backyard carpeted with sedums and other plants and monitored it to see how much water the roof actually retained.

The roof functions remarkably well by retaining stormwater anywhere from 10-90% depending on the intensity of the storm event (Velasquez, *North American Case Studies*).

“A storm-water retention study for the City of Portland, Oregon found that if half of the buildings in the downtown area had green roofs, (219 acres), an estimated 66 million gallons of water would be retained annually. This would eliminate combined sewage overflows by 17 million gallons” (Beckman, Jones, Liburdy, and Peters, 1997, p26).

4.1.1.2 Reduction of the Urban Heat Island Effect

Pavement, rooftops, and other dark surfaces absorb solar radiation only to reradiate the heat. When these surfaces dominate an urban environment they can raise summer temperatures 6 to 10 degrees. As these increased temperatures meet air pollutants the result is an accumulation of smog – damaging both the environment and human health. NASA has conducted studies of the Urban Heat Island Effect in the metro-Atlanta region and found that in downtown the temperature is on average ten degrees warmer than in outlying regions.

Many factors contribute to the urban heat island effect. The typical materials used for development – asphalt, concrete and brick – absorb heat quicker and store it in greater quantity than natural elements. Therefore, the use of plants and vegetative cover can help reduce ambient air temperature through less absorption of solar radiation, as well as, through evapotranspiration.

Evapotranspiration – so what?

“Water vapor is continuously evaporated from the earth's land and water surfaces. Water present in soils is extracted by plants through transpiration and results in the release of water vapor into the atmosphere. The combined process is called evapotranspiration. Regional and global variation in evapotranspiration have an affect on the environment that directly impacts people, e.g. climate change, agricultural productivity, the water budget of semi-arid regions, and the rate of increase in pathogens and insect populations” (<http://asterweb.jpl.nasa.gov/application/evapotranspiration/>).

ASHRAE

A simulation conducted by the City of Chicago of their City Hall green roof showed that every one degree Fahrenheit decrease in ambient air temperature results in a 1.2% drop in cooling energy use. The study suggests that if, over a period of ten years or more, all of the buildings in Chicago were retrofitted with green roofs, (30% of the total land area), this would yield savings of \$100,000,000 annually from reduced cooling load requirements in all of the buildings in Chicago. The cooling would also slow the chemical processes that produce ground level ozone, nitrous oxides and smog, and help offset the production of sulphur dioxides from coal fired utilities (Peck, Callaghan, et al, 1999, p30).

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

4.1.1.3 Pollutant Absorption and Filtering

The verticality, narrowness, and harshness of the urban landscape create an environment characterized by wind inversions and air pockets full of the pollution made by urban inhabitants. These pollutants can remain suspended in the air for days waiting to be washed away or absorbed. Studies show that treed urban streets have 10-15% fewer dust particles than found in similar streets without trees (Johnston and Newton, 1996, p10). In Frankfurt Germany, for example, a street without trees had an air pollution count of 10-20,000 dirt particles per litre of air and a treed street in the same neighborhood had an air pollution count of less than a third of that amount (Minke and Witter, 1982, p11). Based on data from trees, one estimate suggests that a grass roof with 2,000 m² of unmown grass (100 m² of leaf surface per m² of roof) could cleanse 4,000 kg of dirt from the air per year (2 kg per m² of roof). This estimate is probably high since the lower portion of the grass layer is too dense to be in direct contact with the air. However, even if the amount were 1/10th of what trees could remove, 10 m² of grass roof could still take out the significant amount of 2 kg of dirt every year (Minke and Witter, 1982, p11). Furthermore, “vegetation can remove 95% of cadmium, copper, and lead and 16% of zinc out of rainfall, as well as substantial amounts of nitrogen” (Velasquez, *Ecological Advantages*).

4.1.1.4 Noise Reduction

The soft plant levels of greenroofs can reduce noise pollution anywhere from 8 dB to 50 dB (Velasquez, *Economic Advantages*), with the growing medium blocking lower frequencies of sound, and the plants blocking the higher frequencies. “Tests show that 12 cm (5”) of growing medium alone can reduce sound by 40 dB” (Peck and Kuhn, 2000, p7). This reduction not only effectively insulates the greened building but also has ancillary benefits for surrounding environments.

4.1.1.5 Use of Recycled Materials

Most companies involved with greenroofs use at least some recycled material in their product components thereby saving disposal or landfill sites from unneeded burden. For example, Roofscapes, Inc. offer products made from recycled polyethylene (*roofmeadow.com, Products*), which is a resin used in the production of plastics, films, etc.

4.1.1.6 Creation of Wildlife Habitat

Although the habitat lost from building construction can never be regained or replaced – through the use of greenroofs, habitat substitutes can be found. Greenroofs create an artificial or manmade edge serving as a vegetative habitat patch. Beyond vegetation, these edges serve as wildlife habitats. Studies in the U.S. have shown that butterflies will visit rooftop gardens as high as 20 stories and birds go as high as 19 stories (Velasquez, *Ecological Advantages*).

“In Europe, two types of green roof habitats have been defined and implemented, as part of a larger system of wildlife corridors in urban areas. The first is a “stepping stone” habitat that connects natural isolated habitat pockets with each other. It is important to remember that this connection can be by air only (nesting and migrating birds, insects, airborne seeds). The second is an “island” habitat that remains isolated from habitat at grade. This type of habitat would be home to selected plant varieties whose seeds are not spread by air or over short distances” (Peck and Kuhn, 2000, p9).

“Green roofs can also be specifically designed to mimic endangered ecosystems/habitats, including the prairie grasslands of the midwest United States or the rocky alvars of Manitoulin Island and the Great Lakes Region in Canada” (North American Wetland Engineering, 1998; and Reid, 1996; as in Peck and Kuhn, 2000, p10). “Extensive green roofs, with their lack of human intervention, are more protected and can become home to sensitive plants that are easily damaged by walking, and to birds species that only nest on the ground. Since the soil on an inaccessible green roof is also less likely to be disturbed, it becomes a safer habitat for insects as well. The deeper the soil the more insect diversity the green roof will support” (Peck and Kuhn, 2000, p10).

4.1.2 Economic Benefits

4.1.2.1 Extend the Life of Underlying Roof Structure

The typical roof takes a lot of wear from sun, rain, wind, snow, and ice; all exacting quite a toll. Whereas, a properly laid greenroof, despite higher initial costs, can dramatically improve the life of roofs. Most estimates state that greenroof installation can double the life of underlying roof structures, in practical terms this equates to 20 additional years. Less conservative estimates expound the tripling of roof life (Velasquez, *Economic Advantages*). In a February 2002 lecture by Clayton Rugh, he states that “1/3 of all industrial costs are spent on roof maintenance.”

“European evidence indicates that green roofs will easily double the life span of a conventional roof, and thus decrease the need for re-roofing and the amount of waste material bound for landfill. These are direct operational cost savings for the building owner. Life cycle costing data which includes the cost of deferred maintenance and replacement suggests that green roofs cost the same or less than conventional roof systems” (Peck and Kuhn, 2000, p6).

4.1.2.2 Reduction of Building Energy Costs

“Approximately 1/6 of the electricity consumed in the United States is used to cool buildings” (*City of Chicago, Environment*). As mentioned earlier, greenroofs provide excellent thermal insulation, as a result, buildings are cooler in the summer and warmer in the winter. Studies suggest for a one-story structure with a greenroof, cooling costs could be cut between 20-30%. Likewise, a study done by the Weston Design Consultants for the City of Chicago (see Sidebar p.17 – ASHRAE) estimated that if all of downtown Chicago’s roofs were greened, the result would be an estimated savings of \$100,000,000 annually (*greenroofs.com, Economic Advantages*).

The City of Chicago Department of Environment (DOE) is using a rooftop garden as part of its Urban Heat Island Initiative [UHII]. The 20,300 square foot area being tested for benefits sits atop the Chicago City Hall building and contains over 20,000 plants of more than 150 varieties (City of Chicago, Environment).

Although the Chicago City Hall demonstration roof would fall more in the realm of an intensive greenroof, or, as named, a rooftop garden, the fact that it is being used as a means for testing environmental and economic benefits speaks mightily about its functioning. Chicago is, in fact, the only of several cities participating in the UHII to be using greenroofs as a means to reduce energy demand and lower area temperatures.

The City projects that the rooftop garden would save City Hall roughly \$3600 in avoided energy costs. “The total direct savings are estimated to be 9,272 kWhr per year and the corresponding savings in natural gas for heating are 7,372 therms per year” (*City of Chicago, Environment*).

4.1.2.3 Previously Wasted Space Now Useable

Most rooftops sit unused, simply wasting space. Incorporating greenroofs into a building’s design can, in essence, reclaim an area roughly equal to the footprint lost from the building’s construction. Likewise, rooftop space does not have to be bought in addition to what is already owned, whereas, constructing comparable green-space at ground level requires additional investment.

Imagine storage space in a small room, if you are only using floor space as a means for storage than you are neglecting wall or vertical space. Similarly, rooftops have all too often sat unused as neglected space, and we are just beginning to realize the opportunities.

4.1.2.4 Increase in Property Values

As property owners make more efficient economic, environmental, and aesthetic use of space there is a correlation with increased property values of both the greened building and the surrounding community. Furthermore, if whole communities or even cities buy into the greenroof concept property values can drastically rise while energy costs decline creating an integrated, self-sufficient economic cycle. “In addition to the increased marketability of office or residential suites for buyers, the installation of a green roof may also help gain planning approval for projects from local building officials, community members, and rate payers associations” (Peck and Kuhn, 2000, p7).

4.1.2.5 Use of Recycled Material

In addition to all environmental benefits, recycling makes economic sense: saving millions of dollars, creating jobs, and providing a healthy future for our children.

The Hanging Gardens of Babylon

“The Hanging Garden has plants cultivated above ground level, and the roots of the trees are embedded in an upper terrace rather than in the earth. The whole mass is supported on stone columns... Streams of water emerging from elevated sources flow down sloping channels... These waters irrigate the whole garden saturating the roots of plants and keeping the whole area moist. Hence the grass is permanently green and the leaves of trees grow firmly attached to supple branches... This is a work of art of royal luxury and its most striking feature is that the labor of cultivation is suspended above the heads of the spectators.”
 –Philo of Byzantium



Image 4.1 Hanging Gardens (photo credit: The Bettman Archive)

“The approach to the Garden sloped like a hillside and the several parts of the structure rose from one another tier on tier... On all this, the earth had been piled... and was thickly planted with trees of every kind that, by their great size and other charm, gave pleasure to the beholder...”
 –Diodorus Siculus

4.2 Human

4.2.1 Aesthetic and Psychological Benefits

4.2.1.1 Less Concrete, Asphalt, & Gravel

Beauty can be remarkably improved from just changing the roof’s characteristic from harsh and bleak to natural and living. We need to build for human’s not machines; creating a humane architecture which is beautiful, hospitable, and harmonious (Hylton, 2000). Along with enhancing individuals’ environments, the “overall richness of the city” could be improved. “A garden in the sky is a rare and delightful place, as witnessed by the accounts of the hanging gardens of Babylon, one of the seven wonders of the ancient world” (Spirn, 1984, p195). [See sidebar - *Hanging Gardens of Babylon*]

4.2.1.2 Endless Design Possibilities

Greenroof projects allow wildly imaginative and unique opportunities for combining form and function. With the institution of a more workable material the design possibilities are only limited by the function and slope of the roof. “There is no reason why our industrial buildings, our commercial and retail buildings, our houses, and our highways can’t be beautiful” (Hylton, 2000, p49).

4.2.1.3 Improved Quality of Life

“Humans have physiological reactions to natural beauty and diversity, to the shapes and colors of nature, especially to green, and to the motions and sounds of other animals” (Frederick Law Olmsted; taken from greenroofs.com). Richard Neutra explains, “design is supposed to improve our lives, yet we have moved farther and farther from nature” (Neutra, 1969, p5). Greenroofs move us closer.

“Public housing agencies can provide senior citizens and families with safe, accessible green space on top of housing projects, as well as improving their quality of life. School boards can integrate curricula and provide added green space for students – outdoor rooftop classrooms” (Peck and Kuhn, 2000, p7). [This idea of “outdoor rooftop classrooms” will resurface as part of the *design project*.]

4.2.1.4 Enhancement of Emotional Health & Mental Stability

People in Western countries have been carrying around with them as part of their mental baggage a deeply felt and despairing assumption that progress demands degraded surroundings... You put up with such surroundings as long as you have to, and you run away from them as soon as you can afford to; but, this belief has it, deteriorated landscapes and debased communities and bad smells and hideous noises are simply a given – something we all have to live with (Tony Hiss, *Experience of Place*, as in Hylton, 2000, p49).

Greenroofs empower us and create healthier surroundings which we no longer must run from.¹⁶ “The simple act of digging garden soil in preparation for spring planting triggers strong emotions: a sense of connection to the earth, to the regeneration of life. It is an act of nurturance and an expression of faith in renewal” (Spirn, 1984, p120). This translates not only into beneficial environments for the everyday person but also opens up the link to enhanced therapeutic connections. “Hospitals and other health care facilities provide opportunities for horticultural therapy, a proven method of speeding recovery rates and reduction of drug use” (Peck and Kuhn, 2000, p8).



Frederick Law Olmsted (1822 - 1903) was born in Hartford, Connecticut and although he never fully attended college became a very learned man and the acknowledged founder of American landscape architecture.

“During the later half of the nineteenth century cities in America underwent tremendous changes. More people were moving to the cities than ever before. It became evident that cities needed to be transformed into more hospitable places, and not just centers of commerce. This movement became known as the City Beautiful Movement and Olmsted was one of its greatest champions. Olmsted’s main goal, no matter what he was doing was to attempt to improve American society. He had visions of vast recreational and cultural achievements in the hearts of cities” (*fredericklawolmsted.com*).

Olmsted’s vision was recognized throughout many U.S. cities, including New York’s Central Park and Boston’s Emerald Necklace. Frederick Law Olmsted passed away on August 28, 1903.

What artist so noble...as he who, with far-reaching conception of beauty, in designing power, sketches the outlines, writes the colors, and directs the shadows of a picture so great that Nature shall be employed upon it for generations, before the work he arranged for her shall realize his intentions. – Frederick Law Olmsted

Barriers to Green Roof Technology Diffusion

Architects, engineers, roofers, developers, manufacturers, policy makers and energy management consultants identified major barriers to technology diffusion at a November 1998 workshop held in Toronto, Canada.

The major types of barriers are:

Lack of knowledge and awareness - Although there are many benefits of these technologies, both quantitative and qualitative, they are not well known among the development industry, municipal officials or the general public.

Lack of incentives to implement - In North America, there are virtually no government incentives in support of green roof technology diffusion, despite their many proven public and private benefits.

Costs-based Barriers – More information needs to be assembled about the full range of ‘traditional’ and ‘public’ costs and benefits of these technologies in different applications. The current market does not recognize many of these benefits.

Technical Issues and Risks Associated with Uncertainty - These types of barriers cover a wide spectrum including: lack of specialized products on the market; few examples of roof and vertical garden installations; and no industry technical standards for green roofs, which means no standards in building codes.

These barriers have resulted in a failure of the Canadian market to adopt these technologies, which are very well established in many countries in Europe. In Germany, for example, over 10 million square metres of green roofs were developed in 1996.

(Peck, Callaghan, et al., 1999)

5.0 Future

So what is the future for greenroofs in America?

“My opinion is that greenroofs will be required in major cities to some extent. Whether it is to reduce urban air temperatures or reduce stormwater runoff, greenroofs will serve large cities well in the future” – *Kimberly Worthington, Assistant Commissioner, Department of Environment, City of Chicago.*

“The future of greenroofs in this country is very bright. There are economic and ecological benefits to be gained, an unbeatable combination. Education of the architectural, development and construction communities is the only barrier to widespread use and acceptance.” – *Karen Morby, Satellite Branch Manager and Senior Project Manager at Church Landscape.*

Most likely, as more projects incorporate greenroofs and include these treatments as more than just architectural accents we will see them rise in popularity as essential components, especially in the urban environment. “Design is the cardinal means by which human beings have long tried to modify their natural environment, piecemeal and wholesale. The physical surroundings had to be made more habitable and more in keeping with rising aspirations. Each design becomes an ancestor to a great number of other designs and engenders a new crop of aspirations” (Neutra, 1969, p5).

There are several reasons greenroofs are not being exploited in the US: 1) lack of ecological concern or understanding, and 2) lack of knowledge of the economic benefits. In other words, lack of *market* understanding.

5.1 Lack of Ecological Concern

Bringing forth a solution to many ecological problems requires societal action on a broad scale. In order to succeed, there is a need for both scientific information and human emotion. Catalysts for such action come in two forms: regulations and incentives (Galatowitsch, 1998, p99). For greenroofs, there exist regulations in other countries, but are less likely in America’s near future. Instead, we should look to incentives. According to Susan M. Galatowitsch, the incentives likely to be the most durable “are those that increase appreciation for environmental quality, either directly through experiences or indirectly through education. This mode relies on people experiencing places, understanding their relevance, and wanting to have more places like them.” Such incentives would be invaluable, and at some point must occur before widespread acceptance of ecological design principles are embraced; nonetheless, this argument may underestimate the power of the almighty buck.

5.2 Lack of knowledge of the economic benefits

As a society, we are driven by economics. We have gone from the land of milk and honey to the land built on the land of milk and honey. Degradation of our environment and natural resources has been spurred on by increased development and pursuit of the dollar. “The technological dynamic is driven by basic economics” (Morris, 1984, p252), and a primary benefit of greenroofs is economics, so once understood, widespread acceptance and use of greenroof technology drives forward.

5.3 Opportunity

Regardless of all arguments on what is the most important and most critical to popularization of greenroofing technologies, the concept remains simple. Save short-term installation costs, greenroofs carry an advantage over conventional roofing systems in every aspect of use. Thus the perfect situation for showcasing the great opportunity of greenroofing systems.

“Each green roof system should be tailored to the specific needs of the client, with the variables determining costs. As more governments come to recognize the wide range of public benefits of green roofs and how they can help to address many of the challenges facing cities, they will increasingly look to providing incentives for private building owners to undertake the additional capital costs associated with these systems. Until then, there are many niche opportunities to implement green roof systems and to help demonstrate the many benefits of this technology” (Peck and Kuhn, 2000, p17).

Niche Opportunity

As explained by Richard Neutra, “each design becomes an ancestor to a great number of other designs and engenders a new crop of aspirations.” It is precisely this thinking that provides such a great niche opportunity for the Thesis Design Project. The incentive for the Design relies on people experiencing the place, understanding its relevance, and wanting more places like it. In order to succeed, there is a need for both scientific information (*Market-forces*) and human emotion (*Human-forces*). The Thesis Design further succeeds by capturing both of these needs.

Before designing could begin a site was required; said site must provide both a “niche opportunity...to help demonstrate the many benefits of this technology,” as well as, a platform for exemplifying human-driven design. Although not fully understood at the time, the choice of site for this project seemed obvious. [see *Chapter 9.0 Site*] Any site presents limitations and liberators depending on how it is perceived, it is only when the designer is able to look beyond or change the limitations that he or she can design a liberated place which becomes an ancestor for others. The obviousness of this particular site came with the perception of near limitlessness, and therefore great niche opportunity.

The BASF™ Connection

BASF, the world’s largest provider of chemicals and related products, coined the popular slogan: “We don’t make a lot of the products you buy. We make a lot of the products you buy better.”™ To understand this slogan requires at least a lay understanding of marketplace influence on product evolution. Typical product evolution progresses from:

- market need (and subsequently, product development)
- to product introduction
- to market saturation (of product)
- to product re-development
- to reintroduction (of both product and market needs).

The Human-Driven Design Position strives to make our greenroof “product” better by thinking beyond – bettering both the product and market. Do as BASF does, “make the product better;” redevelop and reintroduce the product. For extensive greenroofing systems, do so by exploring human aspects of the product which will in turn better complement greenroof technology.

All signs point to an impending “market need” in North America as evinced by the product development occurring to improve functional aspects (waterproofing layers, etc.) of the systems. [For further evidence see *Starting to Change...*] My position advocates improved or at least expanded design development. Design being a part of the greenroof product which can not be divorced, without consequence, from its functional or utilitarian attributes.

If any design could be split into beauty on one side and utility on the other, as now many of us so readily assume, it would not be akin to the organic life in us or around us, which most certainly has no such divisibility. And yet people have had to live, especially these last two centuries, amidst a multitude of designs conceived and executed in just this mistaken spirit and be profoundly affected by it. Factories, railway depots, office buildings, cheap mass-housing schemes, and city plans which were first thrown together or engineered for utility and then dressed up for beauty demonstrate daily that they have painfully little kinship to life and in fact are fairly foreign to it. They cannot really sustain it. From designs like these only meager crumbs can possibly be picked up for the purpose of vital assimilation and sustenance. On the contrary, toxic influences penetrate from them into us every day, every hour, every fraction of a second (Neutra, 1969, p18).

6.0 Moving Forward

If the entire thesis document were broken into halves, the pieces would be the *position paper* and the *design project*.¹⁷ Although the line between is not so clear, the remainder of this document moves into the design project phase. The reason for undertaking a design project is to use design as a form of inquiry. More specifically, this paper has identified two issues holding back the future of greenroof technology (lack of knowledge of the economic benefits and lack of ecological concern). Yet, the position-at-hand assumes eventual dissemination of the technology; aiming, instead, to explore *human-driven* design and how such design can better complement the technology. [See *The BASF Connection*.] After all, technology is only so useful without proper intention.

Using design as a mode of inquiry helps examine, and hopefully explain the underlying concepts and processes of both the *thesis design project* and the *thesis position paper* through the creation of an Analytic Framework. Therefore, the remainder of this document exists as a concurrent venture between *position paper* and the *design project*.

What follows, exhibits the fragmented and evolving, yet targeted design process because design occurs in neither a linear nor an isolated way.¹⁸ Just as the *position* influences the *project*, so does the *project* influence the *position*. Despite relating this document as two pieces (the *position paper* and the *design project*) reality insists that a proper position can not be established without design. William James further explains, “something Forever...must be glimpsed and felt, not told.” Therefore, all parts feed and are fed by one another – constantly revising and reworking – evolving to form a final product.

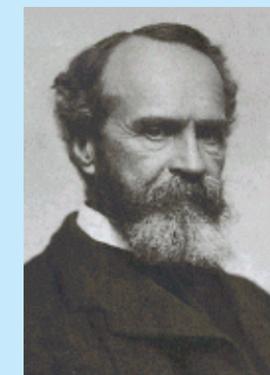
Starting to Change...

“Canada and the United States are at least ten years behind Europe in investing in green roof infrastructure as a viable option for solving many quality of life challenges facing our cities. During the early 1990’s several large European green roof manufacturers started to venture into the North American markets. However, the systems were hard to sell without public education, local research on technical performance, and accessible examples, especially in a cultural and political climate where many individuals, businesses, and governments do not readily invest in green technologies. This has started to change” (Peck and Kuhn, 2000, p3).

The idea that extensive greenroofs have been engineered for *market* forces, leading to a need for *human-driven* design, has been continually revisited. What does this mean for the “unneeded” market forces – are they simply disregarded for *human-driven* greenroof design?

Yes and no. I contend that because, at the very core, extensive greenroofs are engineered for ecological and economic (“market”) benefits, these very benefits will be inherent in any design. Therefore the duality of this answer is: *No*, you do not disregard the market benefits because you can’t – they are built into the system – they are inherent. Yet, because they are inherent; *Yes*, the market benefits are disregarded because they need not be addressed.

William James (1842 – 1910) was the U.S. philosopher and psychologist largely responsible for the doctrine of pragmatism. *Pragmatism* being the philosophical theory of knowledge whose criterion of truth is relative to events and not, as in traditional philosophy, absolute and independent of human experience... All human undertakings are viewed as attempts to solve problems in the world of action; if theories are not trial solutions capable of being tested, they are pointless. The philosophy of pragmatism was developed in reaction to late 19th-century *idealism* (*The New American Desk Encyclopedia*, 1989).

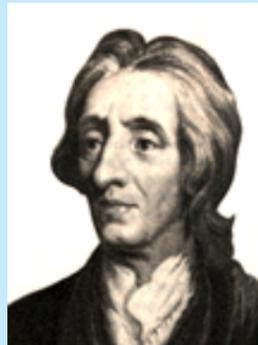


Although James can be called the Father of Pragmatism, the seminal idea came from Charles S. Peirce. Attempting to answer the question, “what makes ideas meaningful?” Peirce concluded that by making some difference in our experience, ideas become meaningful – “our idea of anything is our idea of its sensible effects...” If we say that an orange is sweet, or that a lemon is sour, it is only because these ideas relate to the predictable experience of taste that they are meaningful. If we could not taste the orange or lemon, the ideas would be meaningless. (Christian, 1981, p195).

7.0 Analytic Framework¹⁹

As an introduction to the remaining pages, it is important that the analytic framework be understood as the result of a journey begun through scholarship and literature review, applied to a specific site, and leading to a concept which becomes design. The design simply this student's attempt to further question extensive greenroof technology and what it can become.²⁰ The following sections explore terms and definitions created to answer those questions and explain the human-driven design position.

John Locke's famous *Essay Concerning Human Understanding*, first published in 1690, enhanced his reputation, already great, so far as to put him at the head of the age's intellectual leadership. Many declarations heavily influenced the direction of this document, none more than: *the whole of our knowledge, as individuals, is derived from sensory experience.*



More influences from Mr. Locke:
"Every step the mind takes in its progress towards knowledge makes some discovery, which is not only new, but the best, too, for the time at least."

"...clearing the ground a little, and removing some of the rubbish that lies in the way to knowledge."

7.1 Level of Interaction

Defining Level of Interaction (LOI) is best done through an examination of its evolution.²¹ Initially I defined LOI as only access or viewability; LOI described both the viewability or access of a site (in other words, the vantage points from which the site can be seen), as well as the physical access an individual is afforded by the site. Yet, there seemed several problems with such description. First and foremost, "access" seems to encompass much more than just sight (visual access) and physical access. In fact, access seemed to be any of the senses: visual access, audio access, olfactory access, gustatory access, and tactile access. (Tactile access includes physical access – which is what is often associated with *access*. It is an important distinction to understand *access* as more than just this physical access.)²²

Therefore, LOI meant level of access – any site provides a level of interaction (or access) for the individual. Yet, access encapsulates something more, it was this feeling of an underlying concept which brought out several questions: What happens when the individual has only visual

access to a site? Can we sometimes sense or imagine the texture or smell of an object or place through just vision? Perhaps this notion of *sense*, seemingly so connected to *access*, deserves a closer look.

7.2 Sense and Sensation

As defined by *The American Heritage Dictionary*:

"Sense" = 1. Any of the faculties of hearing, sight, smell, touch, [and] taste. 2. The faculties of sensation as means of providing physical gratification and pleasure. 3. Intuitive or acquired perception.

"Sensation" = 1. A perception associated with stimulation of a sense organ. 2. An indefinite, generalized body feeling.

"Sensible" = 1. Perceptible by the senses or the mind. 2. Readily perceived; appreciable. 4. Aware; cognizant.

"Perceive" = 1. To become aware of through the senses. 2. To achieve understanding of; apprehend.

"Cognizance" = 1. Conscious knowledge or recognition; awareness. 2. Observance; notice.

From these definitions several ideas emerged for describing our term *sense*. First of all, the obvious definition, "any of the faculties of hearing, sight, smell, touch, and taste." Yet, an equally important idea runs underneath the surface: "acquired perception," "an indefinite, generalized body feeling," "perceptible by the senses or the mind," "appreciable," "apprehend," "awareness; notice."

So *sensing* also means perceptible to the mind, or, perhaps, *imagined*.

"Imagination" = 1) The formation of a mental image of something not real or present. Therefore, the perception of "imagined" qualities is a form of *sensing*. To smell something sweet, for example, allows us imagine tasting or seeing it, even if not present. Senses, then, are not solely exclusive; although only one sense receptor (in this example olfactory/smell) is actually engaged, the interconnectedness of the senses and prior sensory experience allow perception (or sensation) of imagined or not present qualities (here, gustatory/taste or visual/sight).

"The process of first sensing our environment, then standing back from our sensory experience to reflect on it, and then returning once again to the world of experience is one of the basic rhythms of human life" (Slawson, 1991, p55). These *imagined* sensations are passive, while those actually engaged are active. Therefore, a division of sensation forms²³ (see *Figures 7.1 & 7.2*):

Active sensation is the immediate, present, unimagined engagement of a specific sense. For example, holding an orange would be active tactile sensation... if you could also smell it then there would also be active olfactory sensation... likewise, if you bit the orange there would obviously be active gustatory (taste) sensation.²⁴

Passive sensation is the imagined perception (sensing) of an object or element. To continue the example of the orange, if upon smelling it (remember, active olfactory sensation) you could imagine the taste then there would be passive gustatory sensation. Passive sensation always requires the presence of an active sensation, yet active sensation does not always invoke passive sensation.²⁵

Dr. Cavoti* explains...

Dear Beau,

What a delight to hear from you. I was fascinated by your email. Until today, I had never heard of a greenroof per se. Intriguing. I want to think over your distinction between passive and active sensation, an interesting idea. Here's what I come up with on short notice...



What you call active sensation I would call simply sensation. I like to think of it as a raw sensory experience without interpretation. In class these days I refer to it as transduction⁽¹⁾ + delivery (to the CNS⁽²⁾).

What you call passive sensation, I would consider to be the perception of a sensory experience. I normally think of perceiving as the taking of raw sensory data (as delivered to the CNS) and then organizing it, interpreting it and structuring a final percept which may or may not be veridical.

⁽¹⁾ *transduction* = transportation of stimuli to nervous system: the conversion of stimuli detected in receptor cells to electrical impulses that are then transported by the nervous system, as occurs when the ear converts sound waves into nerve impulses (Encarta® World English Dictionary [North American Edition] © & (P)2003 Microsoft Corporation. All rights reserved).

⁽²⁾ *CNS* = Central Nervous System

*Dr. Nicholas J. Cavoti is Department Head of the Washington & Jefferson College Psychology Department.

Late winter – I sit on the cool, concrete apartment stoop – a warm, sunny, early afternoon – huge, cottony clouds billowing across a deep, blue sky. The day made that much more beautiful by its fleeting nature. A day that teases of later seasons, an afternoon especially appreciable because, who knows, it may snow by week’s end. Head back, eyes closed, the sun blankets my face – thoughts present only moments before drifting away like balloons lost on a synoptic breeze. I relax, soaking in the paradox of everything and nothing at once...

The smell of a neighbor’s grill wafts around the building to find me – hickory, barbecue, smoke [Active Olfactory Sensation]. The tiniest hint of smile dances across my lips before wetting; Pavlov smiles. Reminded of basic needs – a juicy, charcoal-cooked steak – I imagined the taste and texture [Passive Gustatory and Passive Tactile Sensation]. Transfixed and transported, the comfortably cold, concrete steps [Active Tactile Sensation] transform; stretched as a lawn chair might to accept my body’s weight [Passive Tactile Sensation]. Head back, eyes still closed, the imagined rumbling of lawnmower engine and whirling blade pushed over another neighbor’s yard [Passive Audio and Passive Visual Sensation] – the smell of freshly cut grass [Passive Olfactory Sensation] pretending to be realized.

7.3 Discourse

To conclude, level of interaction entails a two-fold description::

- LOI is Level of Access.
 - Access can be: visual, audio, tactile, olfactory, gustatory.
- LOI is Level of Sensation.
 - Sensation can be: active or passive.

This begs the question, why level of interaction, instead of level of access and level of sensation? Interaction implies connectedness or involvement amongst, between, within several elements, such as an individual and a site.²⁷ And this is exactly what lies at the heart of the human-driven design position, the interactivity of individuals with the greenroof.²⁸

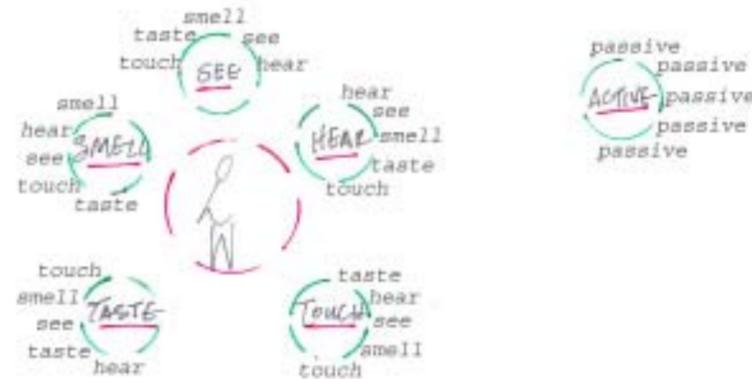
The experience of earth yields transformation. Put another way: to focus one’s thinking on earth recycles the energy that flows through the earth – and through humans as part of the earth – and transmutes human energy such that we know our being-one-with-the-earth, or more generally; our being-connected, connectedness as such, interbeing. Parenthetically, it is my contention that only this experience of connectedness will save the earth – and us with it. Any attempt, however grandiose and with however much commitment to its cause, will fall short if it does not have at its root this transformation of human experience in which human thinking knows connectedness as such and itself within that (Heidegger, as in Wines, 2000, p36).

senses respond to varied stimuli in the physical world³³ — only by understanding the limitations or “defects” of the senses can the landscape artist create a world of intense beauty for the viewer” (Slawson, 1991, p43).

The importance of the preceding quote can not be underestimated as a means to understanding the analytic framework and its connection to design. As defined, Active Sensations are *real* they, therefore, have limits/defects/boundaries; yet, Passive Sensations are *imagined*, and therefore, limitless.³⁴ **Limitless.**³⁵ It is exactly this description which describes the influence of passive sensation. As alluded by William James, “The philosophy which is so important in each of us is not a technical matter; it is our more or less dumb sense of what life honestly and deeply means. It is only partly got from books; it is our individual way of just seeing and feeling the total push and pressure of the cosmos.”³⁶

Passive sensations shape meaningless levels of interaction³⁷—molding access, determining meaning; passive sensations assimilate, sustain.

Figure 7.1. Model of active and passive sensation. Implies that with any active sensation there are passive sensations present; the potential exists for passive sensation. Yet, the passive sensation to emerge is dependent on the individual (refer to Figure 7.2).

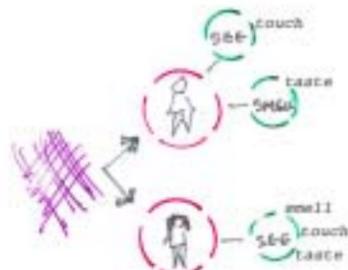


Diagrammatic representation of active and passive sensation.

The discourse thus becomes:²⁹ when designing (a greenroof) how much of the design should engage active sensation? Conversely, how much should attempt to address passive sensation? This avenue of exploration leads to many more questions.³⁰ Is passive sensation most important? Does imagination more closely connect us with pleasure?³¹ What is the give and take between active sensation and imagination?³² Does a very “active” design leave less room for interpretation or passive sensation? [See Dr. Cavoti explains... - p23]

“Even the most advanced advocates of ecological design are still struggling with ways to integrate environmental technology, resource conservation, and aesthetic contact. Without all the components in place, there is little chance for a truly endearing architecture” (Wines, 2000, p20). Furthermore, “the design must have practical knowledge of how the human

Figure 7.2. Describes individual differences in perception²⁶ – both active and passive. Individuals exposed to the same stimuli, “but everything does not hit alike upon every man’s imagination” (Locke, 1690, p7).



Dr. Cavoti explains...

What is the interplay between active and passive sensation, i.e. how much of the design should engage active sensation?

In my view the design should clearly initiate sensation, but then be interesting, beautiful, delightful enough to tantalize the perceptual mechanism of the beholder.

Conversely, how much should attempt to address passive sensation?

Very much; therein are the delights of life. . . . They are both vital. Active sensation starts it all off; without it there is no interpretation. All the joy (and, by the way, disgust) comes I think from what you call passive sensation.

Does imagination more closely connect us with pleasure?

It sure doesn't hurt. You cannot have exquisite joy (or pain) without imagination in my view.

Does a very “active” design leave less room for interpretation or passive sensation?

I believe it encourages it, especially if you include a fair measure of subtlety in your design.

PART II

(a) Design Processes

...but in proportion as a man has anything in him divine, the firmament flows before him and takes his signet and form. Not he is great who can alter matter, but he who can alter my state of mind. They are the kings of the world who give the color of their present thought to all nature and all art, and persuade men by the cheerful serenity of their carrying the matter, that this thing which they do, is the apple which the ages have desired to pluck, now at last ripe, and inviting nations to the harvest. The great man makes the great thing.

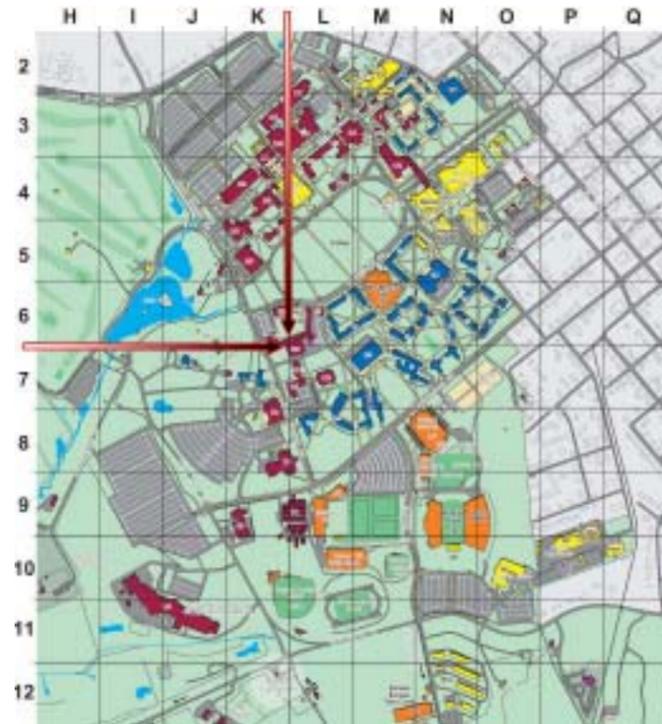
– Ralph Waldo Emerson, lecture, *The American Scholar*.

Every man discriminates between the voluntary acts of his mind, and his involuntary perceptions, and knows that to his involuntary perceptions a perfect faith is due. He may err in the expression of them, but he knows that these things are so, like day and night, not to be disputed.

– Ralph Waldo Emerson, *Essays, First Series, Self-Reliance*.



Above, Image 9.1. Virginia State Map with major routes to Blacksburg.



Right, Image 9.2. Virginia Tech campus map, arrows point to site location on campus.

Below, Figure 9.0. View north over site, photo taken from Fralin Biotechnology Center. (not on List of Objects)



Immediately left, Figure 9.1. Show site, highlighted are Roof 1, 2, and 3 (top to bottom). Below, Figure 9.2. View north towards site along steamtunnel walkway



8.0 Transition

As the design project began many questions were still unresolved³⁸ (see chapter 7.3 *Discourse*) providing an excellent opportunity to engage design as a form of inquiry.³⁹ Although not quite answers, the notions of *limitless-ness* and “our more or less dumb sense” greatly helped shape the design and processes about to be examined.

The examination will touch upon the site, the site within the context of the university, move into a site analysis, visit much of the conceptual and design development process, and culminate in a design. As a departure from most theses, this document contains a section solely addressing the issues raised in the Thesis Defense through textual justification and design charette. Furthermore, many issues of critique find rationale through the magic of footnotes referenced in Appendix A.

9.0 Site⁴⁰

The site selected for the *design project* is located in Blacksburg, Virginia on the Virginia Polytechnic Institute and State University (Virginia Tech) campus. “As Virginia’s largest university with 25,600 students and one of the top 50 research institutions in the nation, [Virginia Tech] is an institution that firmly embraces a history of putting knowledge to work. That tradition is rooted in the motto, *Ut Prosim*: “That I May Serve,” and the land-grant missions of instruction, research, and solving the problems of society through public service and outreach activities” (VPI&SU, website).⁴¹

The site encompasses a series of roofs (see Fig. 9.1) connected to the rear of Seitz Hall.⁴² Many Tech students would recognize the site by the walkway extending over the roof surface, bridging Ag Quad Drive, and linking to the area outside Fralin Biotechnology Center.

This walkway is actually a portion of steam tunnel which runs throughout the Tech campus⁴³ (see Figures 9.0 & 9.2).

10.0 Context Analysis⁴⁴

An analysis of the site’s context revealed several interesting relations which will contribute to the conceptual and design development:

- A. The site is part of land-grant university campus.
- B. The site (as a part of Seitz Hall) is located within the “Ag Quad” which houses many departments from the College of Agriculture and Life Sciences. These departments include: crop and soil environmental sciences; entomology; horticulture; biological systems engineering (formerly known as agricultural engineering); plant pathology, physiology and weed science; and agriculture and applied economics.⁴⁵
- C. The location of this *site* as part of the Ag Quad is analogous to the *proposed design* as part of the philosophical realm of the Ag Quad – this connection alone is enough to justify this site as an appropriate choice for the project.
- D. The site is relatively close to several greenspaces – Ag Quad lawn, greenhouses, drillfield, and duckpond.
- E. As mentioned, the walkway extending over the surface of the site is actually a portion of steam tunnel “serving over five million square feet of campus buildings with heat through six miles of steam and condensate lines” (VPI&SU, website).
- F. Located immediately adjacent to the site is a parking area which lends an urban feel to the site and surrounding environs.⁴⁶

12.0 Concept and Design Development

The overarching theme of the design project embodies the University motto, “Ut Prosim,” translated as “That I May Serve.” This project responds to “That I May Serve” in at least two ways. First of all, extensive greenroofs have at their core the fundamental values of service – serving both the environment and man through many benefits. Secondly, the design project serves as an example of greenroof systems and provides not only an understanding of this technology but also hopes to “instill within each member of the university community an appreciation of the values and obligations of productive citizenship . . . while promoting personal and intellectual development” (VPI&SU, website).⁴⁷

Just as the university looks to reach the goal of “Ut Prosim” through *research*, *outreach*, and *instruction*. So does this design project look to those same concepts. The delineation of three concepts to achieve the university motto perfectly relates to the site’s division into three roof spaces (each an individual but relating to the others in purpose) and the desire for the design to relate the *Ut Prosim*-theme.

The rest of this chapter examines each roof as one of three ideals in achieving the university motto. As it follows, these missions of *research*, *outreach*, and *instruction* become the concepts for creating the design.⁴⁸ The connection between these conceptual missions and the analytic framework are examined at the end of the chapter (12.4 *Connections to Analytic Framework*).

12.1 Roof 1/ Research:

The most obvious representation of the three concepts – *research* – will be represented by providing a setting for research/education/labs/experiment area on the roof space.

Essentially every benefit of greenroofs become classroom opportunities (see chapter 4.2.1.3) – horticultural therapy, urban gardening, as well as chances for more specialized research.⁴⁹

12.2 Roof 2/ Public Service:

Greenroofs, especially extensive, inherently act as a public service through their many benefits (revisit *Chapter 4.0*). The concept of *public service* is to be represented in the design through the use of a rooftop “prairie” (see Image 12.1).

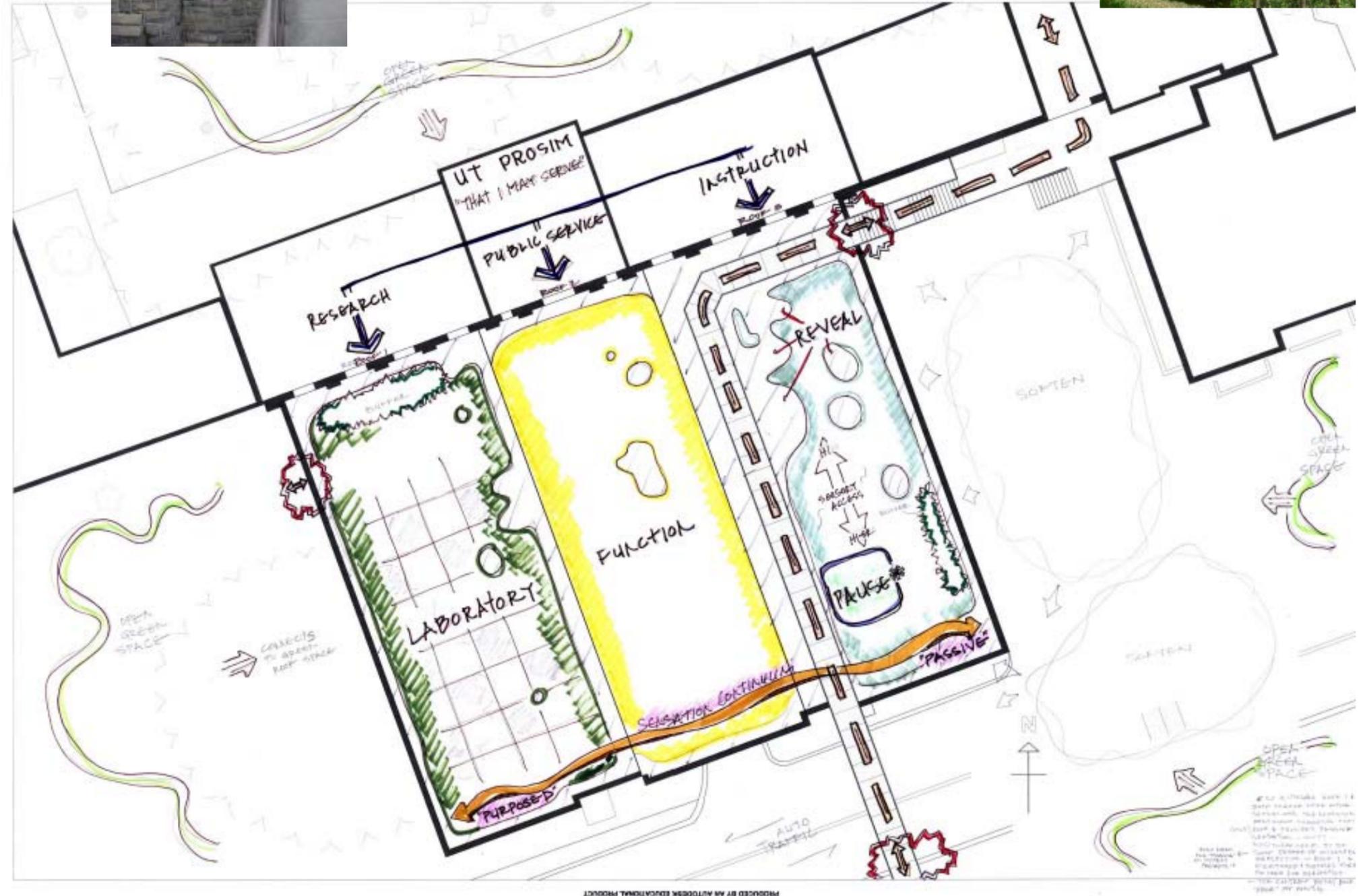


Moreover, the *public service* notion is strengthened by the raised structure of Roof 2 (see Figure 12.1). Understanding *public service* as “outreach” or an “extension” of the university – as opposed to the more introspective or internal functions of instruction and research – correlates to this roof “extending” or “reaching” above the others.

This roof-prairie represents the typical extensive greenroof by acting as a non-accessible and completely functional (*market-based*) system.



Left, Figure 12.1. Shows an elevated Roof 2. Below, Figure 12.2. Concept and Design Development. Right, Image 12.1. Representative example of “roof prairie.”



12.3 Roof 3/ Instruction:

Roof 3 probably requires the most attention⁵⁰ in order to understand. *Instruction*, here, is not just represented through an idea such as “laboratory” or “function” but rather as a process involving “revelation” and “pause.”⁵¹

Roof 3 is an analogy of the entire learning process with *instruction* primarily represented through “revelation.” To explain, the learning process in its entirety can be seen through three notions: “the search for knowledge,” “revelation,” and “pause.” The *search for knowledge* essentially embodies the university’s existence – which is to aid in the search for knowledge. Formal education in America aids this search by providing *instruction* – revealing of facts, figures and ideas. Then, of course, for said *instruction* to be effective the student needs to pause and reflect (give meaning) on what has been revealed.

In summation, the learning process is a search for knowledge with instruction and meaning occurring along the way. Explained as such, this process is clearly seen in the design: the walkway symbolizes the *search for knowledge*, both conceptually and in reality as students use the walkway for moving back and forth on their search. The notions of revelation and pause are conceptualized on the site as two areas atop the roof surface along this

Following are a number of questions and subsequent explanations about the conceptual design development of Roof 3:

Why locate *reveal* where marked? Because of the requisite “fire breaks” [fire breaks are 2’ borders of non-vegetated areas around roof perimeters and penetrations] most of this area is unplatable so it becomes a good opportunity to “reveal” by showing the disparity or difference between *greened* and *ungreened* areas (i.e. before and after greenroof system). The design reveals or instructs as to what a greenroof is.

Why locate *pause* where marked? If the area for pause is about “our individual way of just seeing and feeling the total push and pressure of the cosmos,” then this area should be ideal for seeing and feeling. As indicated by the site analysis, this area provides unobstructed views of distant greenspace and because of the relative lack of roof elements will allow for a larger *greened* area.⁵³

Why will people pause here? If this area is along a route (i.e., movement is the primary activity) how do you get people to pause? The uniqueness of the site will do so as a byproduct, but there should also be an element to

attract or intentionally draw interest. (The attractant envisioned for this area – some form of upright marker or signage with William James’ “The philosophy which is so important in each of us is not a technical matter; it is our more or less dumb sense of what life honestly and deeply means. It is only partly got from books; it is our individual way of just seeing and feeling the total push and pressure of the cosmos.”)

12.4 Connections to Analytic Framework⁵⁴

Several strong connections surface between the analytic framework and conceptual design development:

- The outdoor classroom/ research/ laboratory⁵⁵ type use on Roof 1 is an excellent example of providing active sensory access.
- The prairie of Roof 2, as said, represents the typical extensive greenroof in both function and, often times, in design. The concept demonstrates what extensive greenroof design is (*market-driven*), and as juxtaposed with Roof 3 shows what extensive greenroof design typically lacks (a *human-driven* emphasis).
- The design of Roof 3 (with walkway moving through roof space) is another excellent opportunity for active sensation. Moreover, the *area for pause* presents great opportunity for passive sensation – since passive sensation is dependent on the provision of an active sensation, it follows that as more active senses are engaged more passive sensations are *possible*. There are, of course, innumerable ways to engage active sensation, this area will do so through a variation of plantings and material changes.
- Roofs 1 and 3 are both mentioned as places for highly active sensory experience yet only Roof 3 creates a space of passive sensory experience. Despite both roofs displaying many active sensory opportunities (a necessity for more passive sensory opportunities), the difference between these opportunities is *purpose*. Roof 1 as a place for research is a very structured environment with *purposed* active experiences (in other words, the individual perceives objects/senses as they are; as real.) This individual will be less introspective and therefore less involved in sensory interpretation. This is not to say *purposed* activity can not create passive sensation, but the idea is that passive sensation occurs more freely with a sort of open-mind. Therefore, active sensory opportunities that are less *purposed* or explicitly-*directed* encourage greater passive sensory opportunities. Meaning the individual on Roof 3 is more open to passive sensations because he/she is not required (*directed*) to perceive things as they are

(such as happens in a research or lab setting); he or she is able to imagine.

13.0 Design

13.1 Assumptions

With the stage mostly set for venturing into the design and design rationale, a few key assumptions need understood. As this project is solely an academic undertaking and not burdened by many technical aspects of the proposed greenroofing technology, the following assumptions have been made:⁵⁶

- *Energy savings will allow removal of roof element(s) (AC and vents)
 - ~25% cooling reduction
 - ~10% heating reduction
 - Assumption allows removal of one AC unit and one roof vent

*Building structure will support any increased weight from the extensive greenroof system (containing < 4" of growing medium).

*Site is defined by the perimeter of the roof space – no design work will be done outside these boundaries.⁵⁷

13.2 Rationale

13.2.1 Roof 1

The design of roof 1 has intentionally been left as rather amorphous. The design in this case is presented as an imagining of what could take shape.⁵⁸ The reason for such is that this roof unlike the others (roof 2 and 3) will be designed as part of a greater program including such things as: a forum/ exchange for ideas and projects within and beyond the university, use of donated materials for testing, and department-specific research.

Each “lab” section will have plots for testing different ideas, concepts, and strategies with various greenroofing systems and components – for example, the Horticulture Department may test ornamentals for hardiness on a rooftop setting – the Crop and Soils Sciences Department might conduct research on different soil-blends as growing medium – the Biological Systems Engineering students might develop a system for treating and reusing runoff as irrigation – Entomology researchers could examine different growing



Figure 13.1 Roof 1 Rendered

mediums as insect habitat – the Agriculture and Applied Economics department might analyze profitability or feasibility of rooftop crops – experiments in Plant Pathology, Physiology, and Weed Science might explore weed prevalence or turf health – etc. Likewise, these plots would not be solely for the use of “Ag Quad” departments, but could conceivably find use for any department within the university including Landscape Architecture, Architecture, Art, and Biology to name but a few.

13.2.2 Roof 2

The design idea for roof 2 is quite simple – function. As examined already, the concept of public service is represented through environmental benefits. Therefore this roof will, with no frills, present the typical extensive greenroof – originally developed for those environmental benefits.



Figure 13.2 Roof 2 Rendered

That this is a *functional* roof is further enforced by the ability to see into the building from the walkway. Viewing people inside the building functioning in the workshop space within is a reflection of the functionality of this roof. People can, of course, experience passive

sensation from any active sensations and invariably the market-driven design (such as Roof 2) will result in such. The idea, however is to demonstrate the more meaningful experience of human-driven design (such as emphasized with Roof 3).

13.2.3 Roof 3

The design of Roof 3 is the bulk of the overall design project with much more attention given to details and relationships amongst elements. The reason for a more intense design process and experience on Roof 3 stems from questions related to active vs. passive sensation; specifically the conclusion that passive sensation helps create *limitless* design. It is this conclusion guiding many of the design decisions. With this said, the decisions quite often rationalize using ideas of “push and pressure,” and “just seeing and feeling.” Those parts of James’ quote and indeed the entire quote are frequently relied upon because through just two sentences William James eloquently captures the heart of the analytic framework and importance of sensation, especially passive sensation.

13.2.3.1 A Closer Look at Roof 3

As discussed through the site analysis, several of the existing roof elements were described as *feeling* out-of-place. This feeling however is only concerned with the site as it exists as a blank, black roofscape. But how might those *feelings* change once *green* is introduced to the site? Would a greenroof turn the tables and make the other elements (*infrastructure*-type) feel out of place? To answer this question we should examine our use of greenroofs as a tool.

Greenroofs reflect not only our willingness but our desire and perhaps even physiological need to return to nature – seek out our answers ecologically. On some level the use of greenroofs (especially extensive) idealizes *nature over technology*. The irony being that the “nature” used in this case is itself a new technology. So, really this indicates we are finding answers with an *ecological- or nature-technology*. It is this juxtaposition between technology (as reflected by the *designed* roof units) and nature (exhibited through the use of greenroof) which tells us that despite the introduction of *green* the *designed feel* of these specific roof elements will still seem out-of-place.

Moreover, by allowing the unneeded elements (one AC and one vent; refer to Assumptions) to remain we can create a meaningful commentary on both *nature over technology* and *ecological-technology* by essentially using

these discarded roof features as planters – allow plantings (vines or other creeping-type vegetations) to “overtake” them.⁵⁹

With few exceptions, the remaining design discussion involves elements within the *area of pause*.

Image 13.1 Japanese Garden Influence



Figure 13.3 Japanese Garden Inspired Perspective



13.2.3.2 Japanese Garden Influence

After countless tries at designing the *area of pause* I realized my attempts lacked connections to the *position* and its framework.

Yet, after pausing myself and considering this area as “our individual way of just seeing and feeling the total push and pressure of the cosmos,” many similarities to the ideals of Japanese gardens arose.⁶⁰

The purpose of Japanese gardens is “to provide a place – in lieu of an escape to the countryside – where a person can retreat for moments of solitude and contemplation” (Sunset, 1970, p7). The idealization of the area of pause as an “escape” for “contemplation” connects it the *human-driven design position* and *passive sensation*.⁶¹

Many commonalities⁶² of Japanese gardens would be emulated in the *area of pause*: a) closeness to nature, b) quiet and repose, c) simple, restrained surroundings and, d) beautify an intimate area. “Another point of appeal in the Japanese garden is that it does not attempt too much. Rather than make a complete statement, it suggests a point of departure and leaves the rest up to the viewer ... a Japanese garden is an understatement” (Sunset, 1970, p12).

13.2.3.3 Returning to the Design Rationale⁶³

The conceptual design makes mention of a marker as an attractant, in the design this appears as a large pumice-stone.⁶⁴ Pumice being a lightweight material similar to the inorganic matter of the growing medium. So this large pumice-stone becomes, in a sense, a large piece of the growing medium rising out of the earth. The use of pumice-stone as a material further relates to the design concept as a representation of the “push and pressure” because pumice is a volcanic rock literally formed by “push and pressure.” Also, as a material it is very sensory evoking with a very open and airy quality. Finally, much like a typical roof repels elements, so does stone act the same – yet with both the pumice and greenroof, these materials absorb and accept other elements (such as moisture and vegetation).

The rock firebreak bordering the south and west sides of the “garden” (aka, *area of pause*) appear for several reasons.⁶⁵ Functionally to provide another simple sensory material; conceptually to further represent this idea of *volcanic action* – this rock firebreak moves from the roof vent at the roof’s corner to encompass two sides of the *area of pause*, mirroring the interior space where the pumic-stone and black cobblestones *flow* out along the path. In this conceptualization of *volcanic push and pressure*, the roof vent with its obvious correlation to the steam tunnel represents the push and pressure of the cosmos.

The use of black cobblestones⁶⁶ emphasizes the idea of reflection as well as the idea that one must move deliberately (walk with pause). The path leading to and from the pumice-stone marker consists of roof tiles



Figure 13.5 Pumice elevation



Figure 13.6 Section/Elevation of Marker Area (Section A-A)



Figure 13.4 Roof 3 Rendered

(such as already exist between the steam tunnel and Roof 2 and as on Roof 1) and the inorganic matter of the extensive growing medium.⁶⁷ This inorganic matter as mentioned is very light weight and very much like smaller bits of pumice.⁶⁸

14.0 So what?

As I try to explain the “so what” of this thesis I am struck with this question: If the real intent of this document is to use *design as a form of inquiry*⁶⁹ then does the *so what* need an answer other than “to raise awareness and more questions.”⁷⁰

Probably. So this thesis project looks to challenge current practices⁷¹ – this challenge takes two forms:

Academic – Based on “gut feeling”;⁷² through the position (extensive greenroof design should more appropriately affect human-scale interaction) this thesis challenges current practices of extensive greenroof design. The implication being these current practices “engineer” *market-driven* systems as opposed to designing systems based on *human* benefits.

As stated this is an academic challenge based on gut feeling and may lack a certain verity. Yet, because of the relative lack of knowledge concerning greenroof systems the position flushes out some very important ideas concerning human factors,

especially the concepts of active and passive sensation. With an understanding or even appreciation of how these notions evolved and what the underlying



Immediately left, Image 13.2 Black Cobblestones

Immediately right, Figure 13.7 Photo (view of site from Fralin Biotech. Center)

ideas which shaped them were, the future of extensive greenroof design becomes enriched.

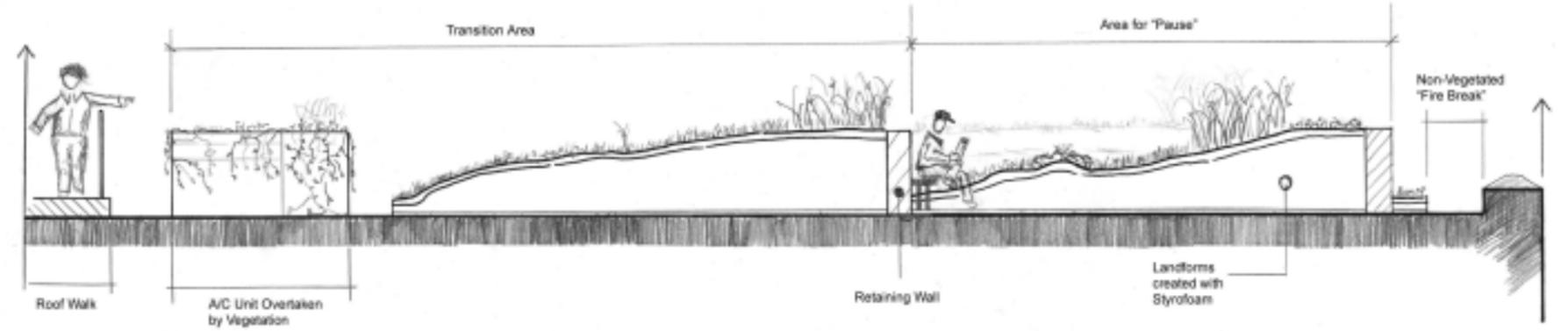
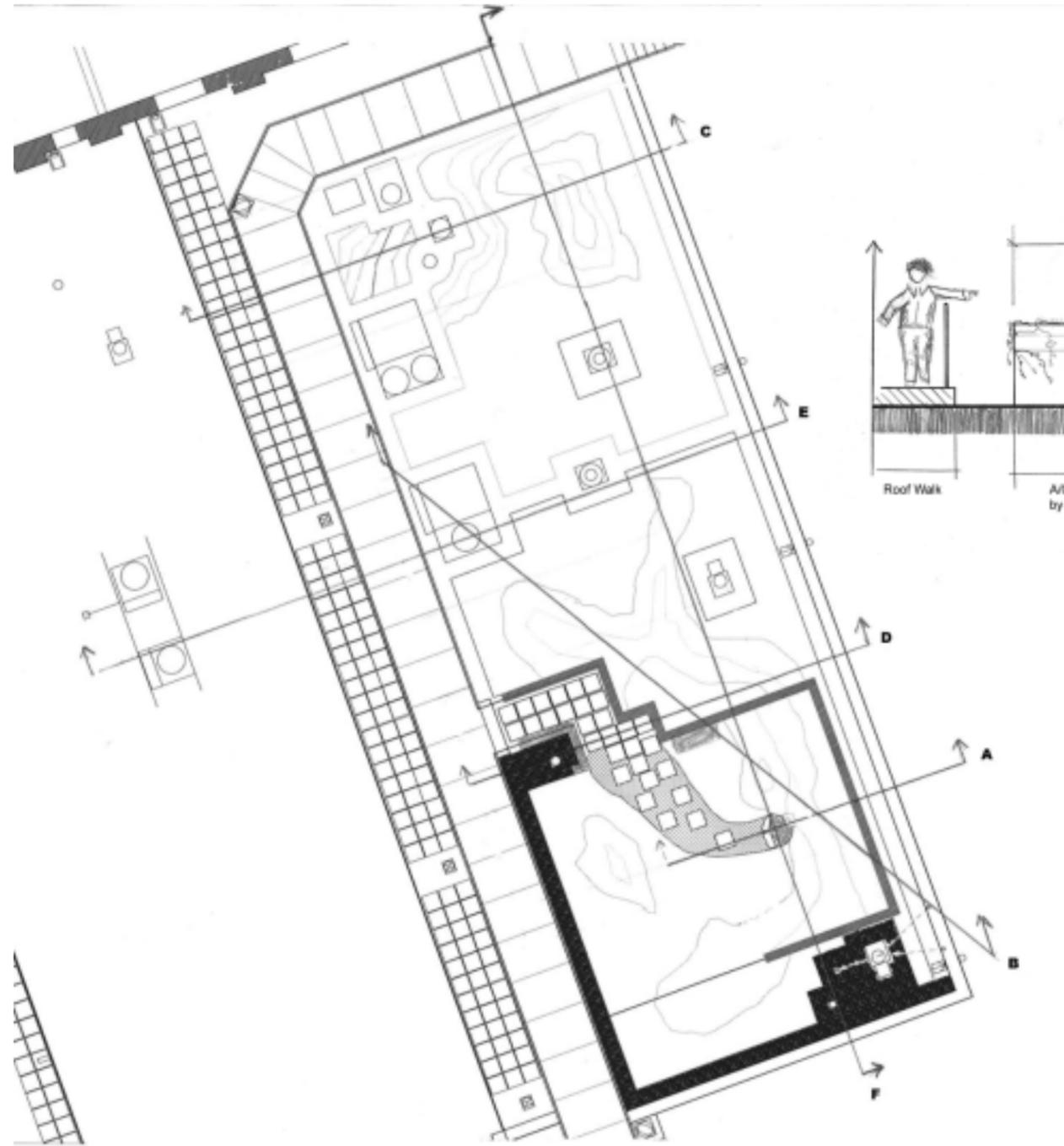
Realistic – In addition to challenging current practices, this thesis challenges the lack of current practices. As evidenced in the design itself (area of reveal), this thesis attempts to disseminate information or, in other words, function as an advertisement for extensive greenroof technology. True, the position introduces a framework which (when incorporated into a design) helps strengthen the value of the advertisement, but by simply making the experience of a place not only memorable but obvious (as a tool) creates a desire for similar places. Therefore, the position is only valuable – for the realistic challenge – in so far as it helps create a memorable place. The real “so what” of the thesis is as an advertisement for extensive greenroof technology.

Hopefully this document addresses many questions through the thesis and design processes; but more importantly, hopefully you, the reader, will be inspired with many more questions and reasons to explore any of the concepts or ideas delivered in this document.



Figure 13.9 Section A-A

Figure 13.8 Roof 3 Section Lines



Above, Figure 13.10 Section B-B;
Below, Figure 13.11 Section C-C.

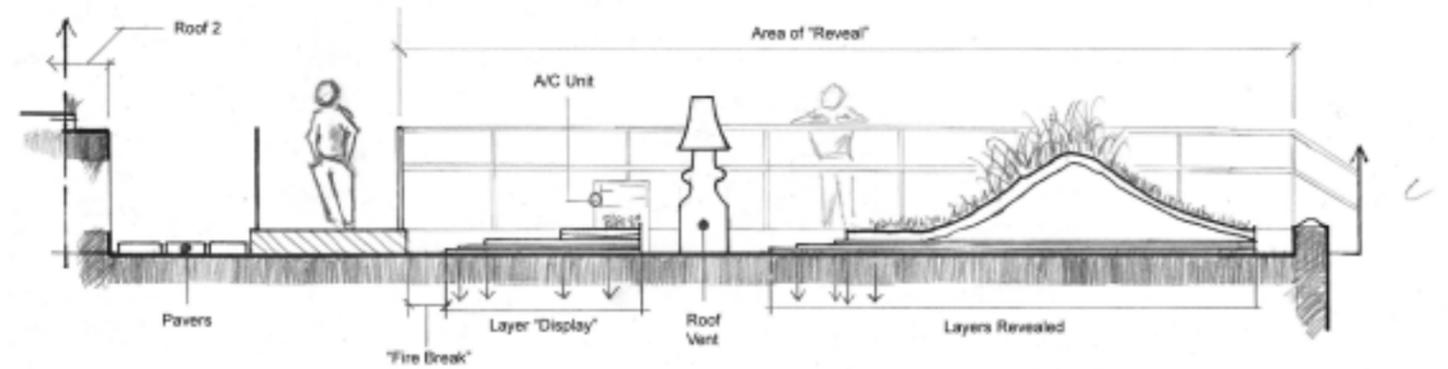
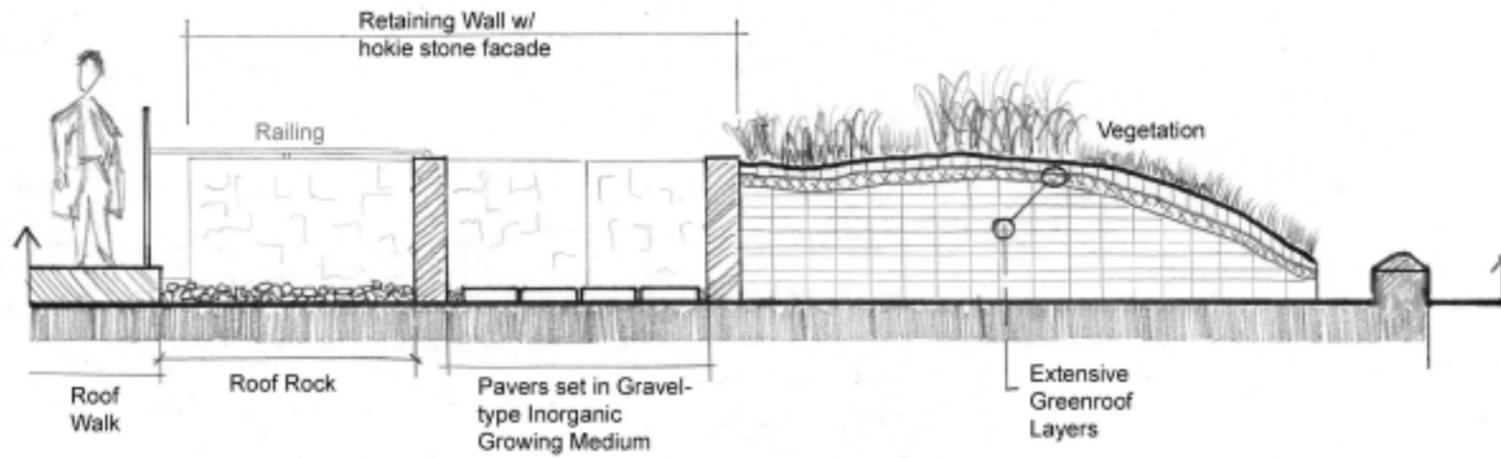


Figure 13.12



This page, left column, from top down, Figure 13.12 Section D-D; Figure 13.13 Section E-E; Figure 13.14 Section F-F. Below, Figure 13.15 Layers Section

Figure 13.13

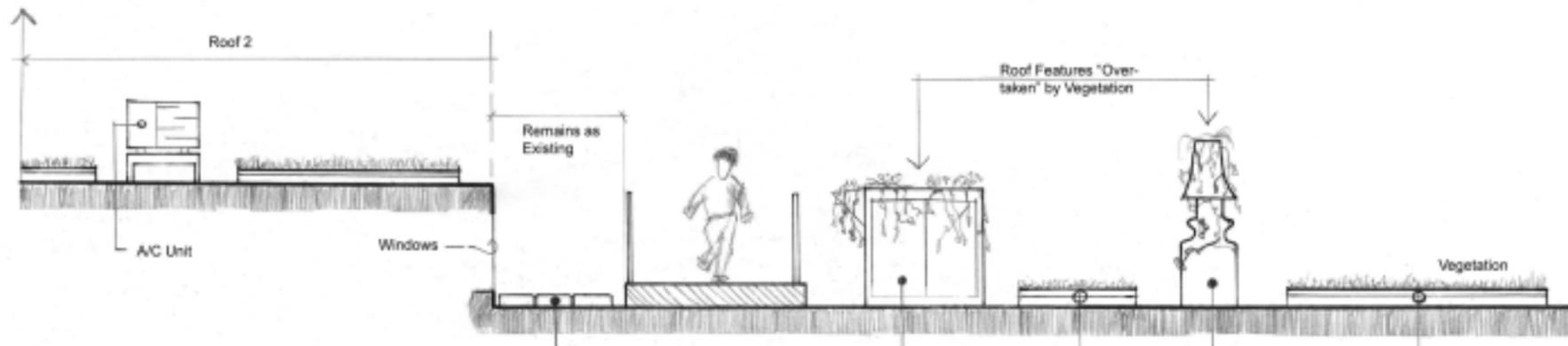


Figure 13.14

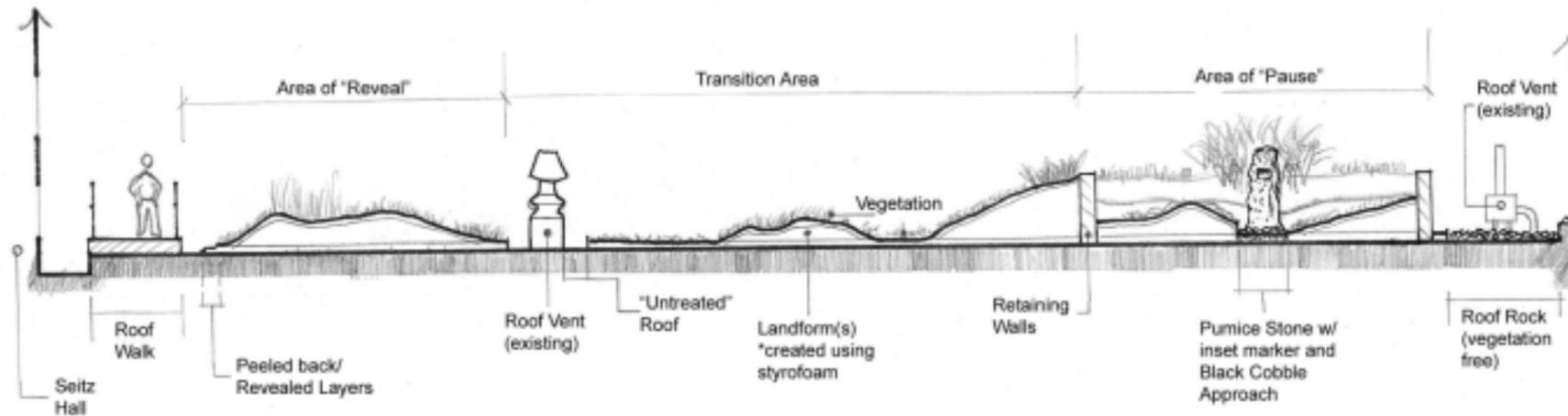
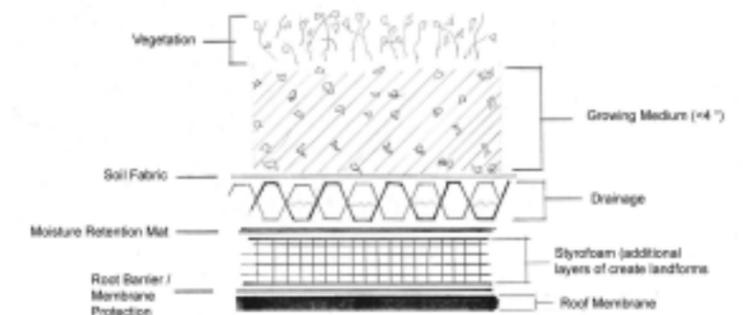


Figure 13.15



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Part II

(b) Post-Defense Processes

Nature is not fixed but fluid. Spirit alters, moulds, makes it... the immobility or bruteness of nature, is the absence of spirit; to pure spirit, it is fluid, it is volatile, it is obedient. Every spirit builds itself a house; and beyond its house a world; and beyond its world, a heaven. Know then, that the world exists for you. For you is the phenomenon perfect. What we are, that only can we see. All that Adam had, all that Caesar could, you have and can do. Adam called his house, heaven and earth; Caesar called his house, Rome; you perhaps call yours, a cobbler's trade; a hundred acres of ploughed land; or a scholar's garret. Yet line for line and point for point, your dominion is as great as theirs, though without fine names. Build, therefore, your own world. As fast as you conform your life to the pure idea in you mind, that will unfold its great proportions. A correspondent revolution in things will attend the influx of the spirit.

– Ralph Waldo Emerson, *Nature*, Chapter VIII, *Prospects*.

15.0 Explanation

The chapters which follow contain questions which arose during my Thesis Defense and my responses through both text and design. The design explores those questions through a three-hour charette (a charette is an intensive effort to complete a design project within a specified time.) The charette drawings and explorations will be used much like the endnotes, in that they will be process-type examinations and inquiries. The ideas and stylings of the charette will be unrefined responses to questions or requests of the Thesis Defense Committee.

16.0 Issues and Response

Before venturing into the design charette, I will directly respond to several questions posed by the Committee:

?Question – *One thing that is confusing is your terminology of active and passive sensation. To achieve passive sensation one's mind has to become active and engage in imagining and reflection. This seems counter intuitive – passive sensation comes from active mind. Others have used other terms to get around this confusion. I thought Dr. Cavoti's explanations were good. The Kaplan's would call passive sensation or experience "reflection." You might consider another less confusing term.*

Response – one of the “ideals” of this entire document was to define my own terms, to stick with these terms and not succumb to the allure of another's definition... this may seem to run counter to my generous use of quotation, but my use of quotation is more of a way of describing, explaining, or exploring my definitions and terms, so they are used in support of not in stead of...

263 – There is a time in every man's education when he arrives at the conviction that envy is ignorance; that imitation is suicide; that he must take himself for better, for worse, as his portion; that though the wide universe is full of good, no kernel of nourishing corn can come to him but through his toil bestowed on that plot of ground which is given to him to till. The power which resides in him is new in nature, and none but he knows what that is which he can do nor does he know until he has tried.

Furthermore, the use of *Passive Sensation* relates to the terms meaning – in that it describes something which is dependent on other stimuli – not necessarily how it (the term) is attained.

Perhaps my use of “reflection” in the text is misleading as this term might imply “actively seeking meaning” and is also why I would be wary of using Kaplan's “reflection.” Passive sensations are more unconsciously or subconsciously “felt” not necessarily assembled as “reflection” might imply. Passive sensation speaks to things that are not really present. The term “reflection” when related to passive sensations explains the idea of reflection as it might be when we see our own reflection in a mirrored surface – what we see is not really present and we must do nothing other than recognize that reflection – as opposed to reflection being the process of remembering or piecing together past experiences – wherein we must more actively involve our minds. When talking about processes of the mind, many arguments for or against the use of certain terms can be made, nonetheless, despite difficulty in describing my reasons for this term I must stand by its use as it at least *feels* right for me

Similarly, active sensation as I've defined it could be thought of as counter-intuitive because an active mind is not required... active sensations require no thought at all as these are bodily perceptions to existing stimuli – only by identifying them do we engage our “active mind.”

?Question – *A bigger problem is that you do not maintain your connection to active/passive sensation all the way through. The use of the university motto of research/outreach/learning are appropriate, because the design is at a particular place (university), but that should not become the driving idea for this design. It is a vehicle for active/passive experience. You need to show how these two concepts relate. At the present it is glossed over.*

Response – Yes, I wholeheartedly agree. These comments exposed some of my own thoughts and strugglings with the design. Many times throughout I found myself thinking that I was on the right track and making those desired connections but, as I think this critique so aptly points out, those connections were only glossed over at best. And almost as soon as I felt I was on track the thoughts would fade from my mind or simply crumble under closer

examination. For these reasons, I believe we once again expose the value of design as inquiry, and the charette will try to further explore this issue.

?Question – *Also, in the design you come back to passive experience in the learning roof, but it is dealt with too broadly. How should a passive learning experience be unique or appropriate for a greenroof? What is the essence of a greenroof and how can you design a physical environment that will reveal that essence through passive experience.*

Response: Greenroofs can become a powerful tool for helping explain what life honestly and deeply means (and that is we are just one tiny part of a vast collection of resources, components, and influences which shape the world we live in and the lives we lead) and the most appropriate way to do so is through passive sensations and experiences.

But why? Well, I think as William James explains, to truly understand something you need to become mentally engaged... (see Sidebar The Book is Better).

17.0 Design Charette Issues

Following is a list of issues and concerns to be explored through the post-defense design charette:

What is meaning? How do you give or explain meaning? How so at this site?

What meaning would one take away from visiting the area of pause?

Explore what it means to be on a roof, and on this roof specifically.

What does area of pause say about being on a roof? So what?

Uniqueness of site – views from roof as opposed to ground.

Maintenance – Where? What kind? How often? – idealization of irrigation and maintenance systems – incorporation of “management” layers.

How do you irrigate or circulate air and water?

18.0 The Charette

18.1 Roof 3

Roof = lid – ceiling – top – protection
 On a Roof = atop – above – precarious – vantage point – escape

What is meaning? **The essence of... what makes something what it is...**

Meaning of Roof = structural overhead protection of a building interior.
 = along with walls, defines “building”

Meaning of Being On a Roof = feeling of “power” (?perhaps power is wrong term)
 - feeling of being somewhere “surreal” perhaps?
 - Exhilarating? Fortunate? Careful?
 - Same feeling as with any place of height.
 - ***Reminds us of our mortality or frailty and in this sense makes us feel alive.***

So how can you design for this sense of feeling alive? – Human-driven design...hit upon the senses.

What does this mean for this site?

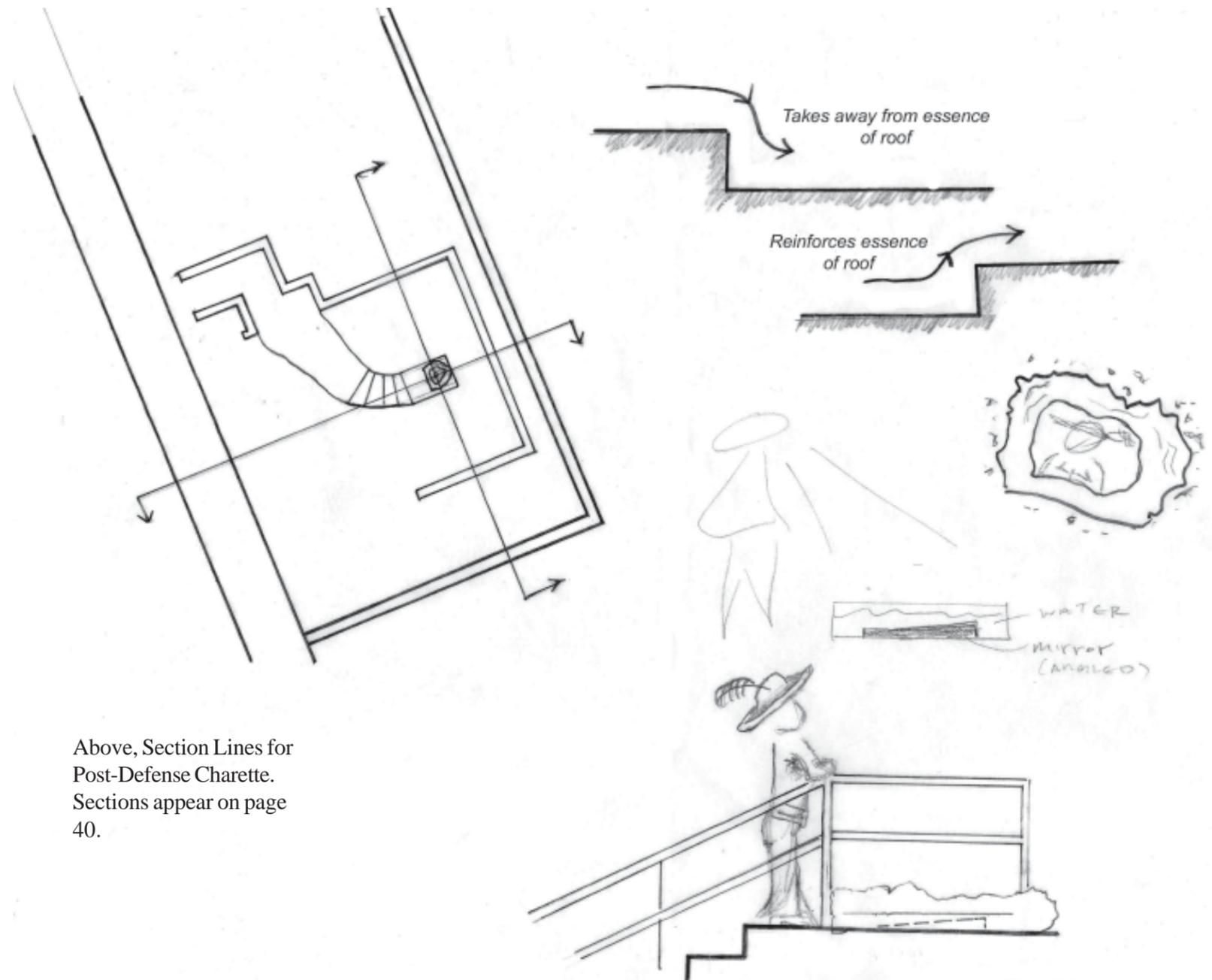
- allowing physical access onto the roof surface is effective – but there is a need to reaffirm the space as “being on a roof”... **instead of stepping down into the roof, have steps leading atop or onto the roof** – reinforce those associations of atop, above, precarious, vantage point, escape.

What about the notions of passive sensation/finding meaning/reflection? What elements can accomplish or accommodate these concepts?

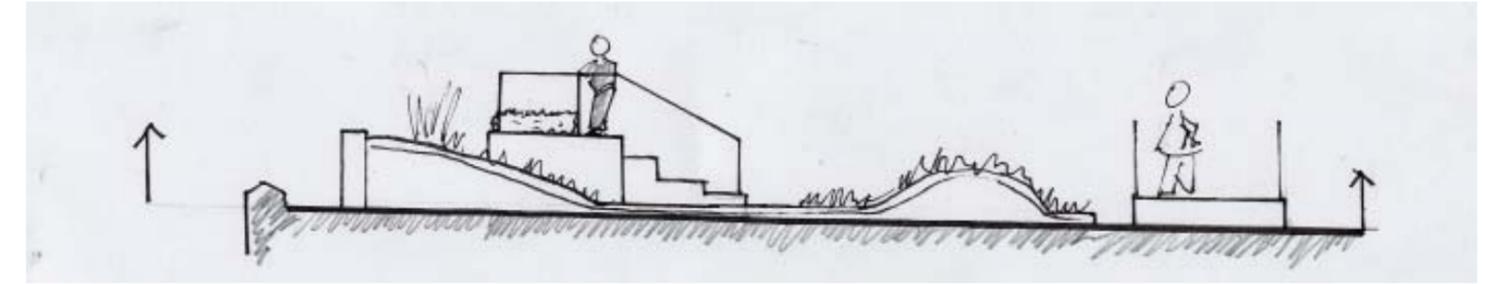
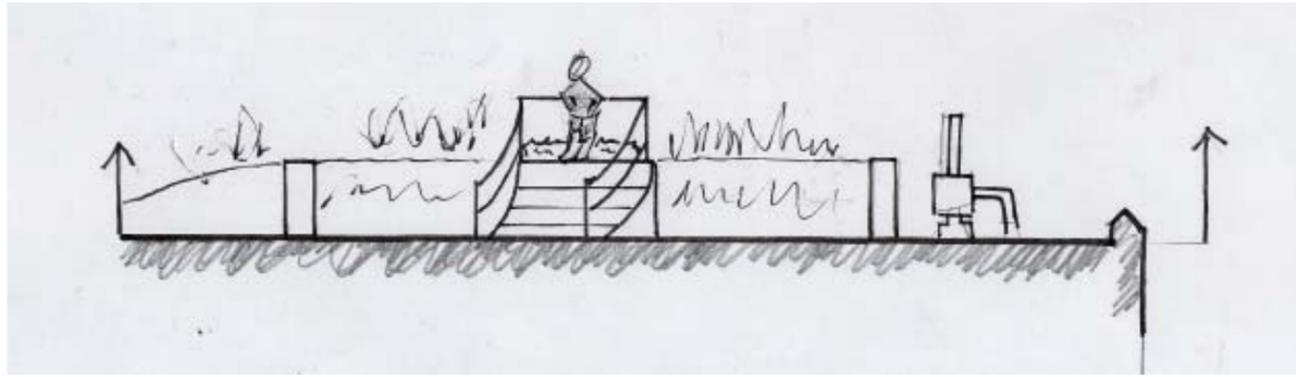
Playing with the idea of reflection we can literally use a reflective surface – mirror or still water. Going back to the idea of “feeling alive” and reminding us of our mortality by seeing our own reflection. Also, reflected behind our own image would be the heavens or sky – this makes a statement about our “spirit” and our “unlimited potential,” i.e., “the sky’s the limit,”

(further harkens back to the limitlessness of passive sensation) – also the expression “the world is at your feet.” I still enjoy the use of pumice as a material for not only all previously related reasons but also as it reflects the essence of a roof as an “airy,” “lightweight” material.

Moreover, the ability to see the elements around us as they are reflected is a different experience than our usual first-person method of sensing. As we see reflected elements we can see ourselves within their context or as others might see us (a sort of 3rd person viewing) reinforcing the idea of feeling alive through our own mortality or being – a very different sensory experience; we become more aware.



Above, Section Lines for Post-Defense Charette. Sections appear on page 40.



A roof in its essence is the perfect place to just see and feel because it is usually a solitary place which affords us the opportunity to move away from the hectic atmosphere of our daily experience. We can see and hear things differently. We can smell and feel things differently – The Drifters’ “Up On The Roof” –

Drifters Up On The Roof Lyrics

*When this old world starts getting me down
And people are just too much for me to face
I climb way up to the top of the stairs
And all my cares just drift right into space
On the roof, it's peaceful as can be
And there the world below can't bother me
Let me tell you now*

*When I come home feelin' tired and beat
I go up where the air is fresh and sweet (up on the roof)
I get away from the hustling crowd
And all that rat-race noise down in the street (up on the roof)
On the roof, the only place I know
Where you just have to wish to make it so
Let's go up on the roof (up on the roof)*

*At night the stars put on a show for free
And, darling, you can share it all with me*

I keep a-tellin' you

*Right smack dab in the middle of town
I've found a paradise that's trouble proof (up on the roof)
And if this world starts getting you down
There's room enough for two
Up on the roof (up on the roof)
Up on the roo-oo-oof (up on the roof)
Oh, come on, baby (up on the roof)
Oh, come on, honey (up on the roof)
FADE*

Everything is all right (up on the roof)

These ideas are nice for representing learning as an experiential process but what about literally learning of greenroofs? One of the stronger points of the original design was the area of reveal, so this area we will leave unaltered for this exercise as it does a nice job of instructing about greenroofs.

Yet, what about the ideas of management and maintenance? Do I even feel these concepts are important to convey? If this roof is viewed as an “advertisement” and therefore an idealized version of an extensive greenroof, should these ideas be conveyed? Something seems to be holding me back from accepting this idea – so lets look a little closer.

How can you represent management? First of all, how much more maintenance will be required assuming the vegetation used is established?... I don't know, the plantings for the most part will be those typical to extensive greenroof systems and so should inherently require minimal maintenance. There will be a greater importance placed on irrigation because of the need to advertise this roof as ideal. We could, to show these management layers, expose the irrigation system – similar to the exposing of the greenroof layers in the area of reveal. Or we could simply string a garden hose up somewhere to relay the idea of functionality and relate the idea of a sort of minimalist maintenance as opposed to the requirements of a more intensive irrigation system.

Yet, if this is an “idealized” version of an extensive greenroof system one of the ideal tenets would be minimal maintenance. And in such a case would we want to expose a complicated irrigation system or heavy management? Sure there would in reality be greater maintenance or management but should these disincentives be advertised?

Likewise the comparison of this roof to a high maintenance athletic field (specifically, VT's Lane Stadium football field) was brought up during the defense. The football field uses a series of interlocking grids which provide many of the same layers of a greenroof (and in fact, the actual product used on the football field is also marketed for use in greenroof systems) – but I contend that the management requirements between athletic fields and greenroofs can hardly be compared because of the product used to contain the vegetation. I do concede that because of the design of Roof 3 more maintenance will be required to keep it *ideal*, yet, the problem with the

comparison lies in the vegetative material established. An athletic field is made up of grasses which must be carefully and properly fretted over, while the extensive greenroof uses native grasses, sedums, wildflowers and such which by their nature are inherently lower maintenance – much lower maintenance. Therefore, when I concede the higher management requirements of Roof 3 I do so in comparison to the typical extensive greenroof.

The Supremes – Up the Ladder to the Roof lyrics

*Come with me
And we shall run across the sky
And illuminate the night*

*O-h-h-h, I will try and guide you
To better times and brighter days
Don't be afraid...*

*Come up the ladder to the roof
Where we can see heaven much better
Come up the ladder to the roof
Where we can be (where we can be) mmm...
(where we can be)...closer to heaven
(To heaven—stay)*

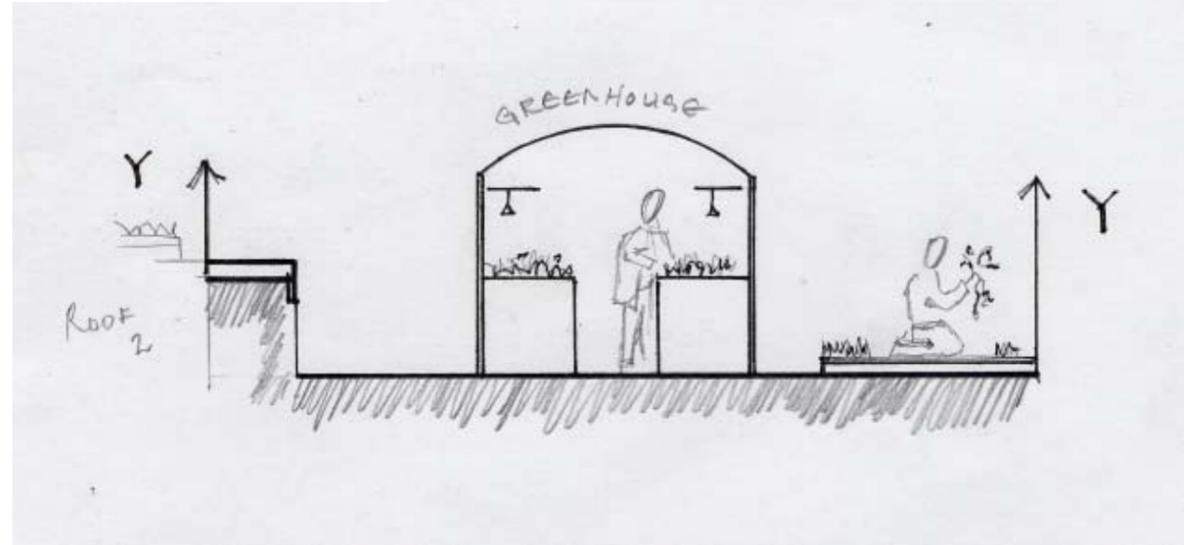
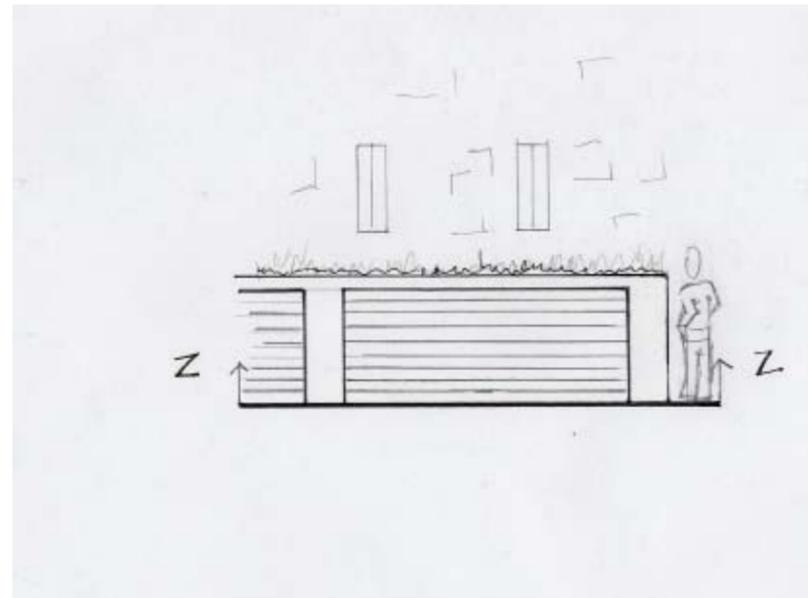
*Stay with me
And we shall let expression
("sing")*

*Can't you hear 'em ring
Ooh
(Memories of yesterday)
Yesterday's broken dreams
Dont you know, they'll all fade away
If you'll come...*

*Up the ladder to the roof
Where we can see heaven much better
Come up the ladder to the roof
Where we can be
Mary: (where we can be)
Cindy: (where we can be)
aahh... closer to heaven*

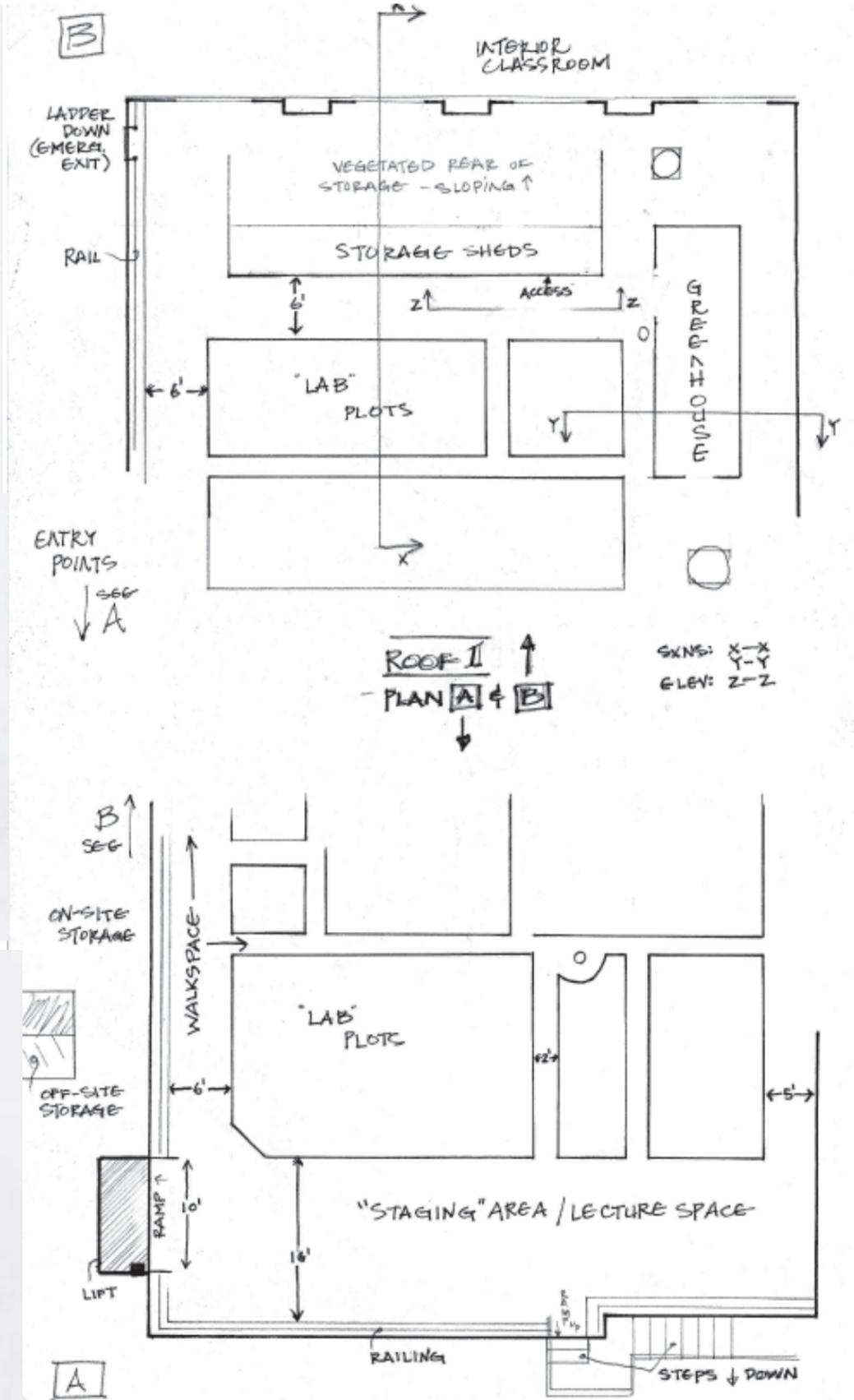
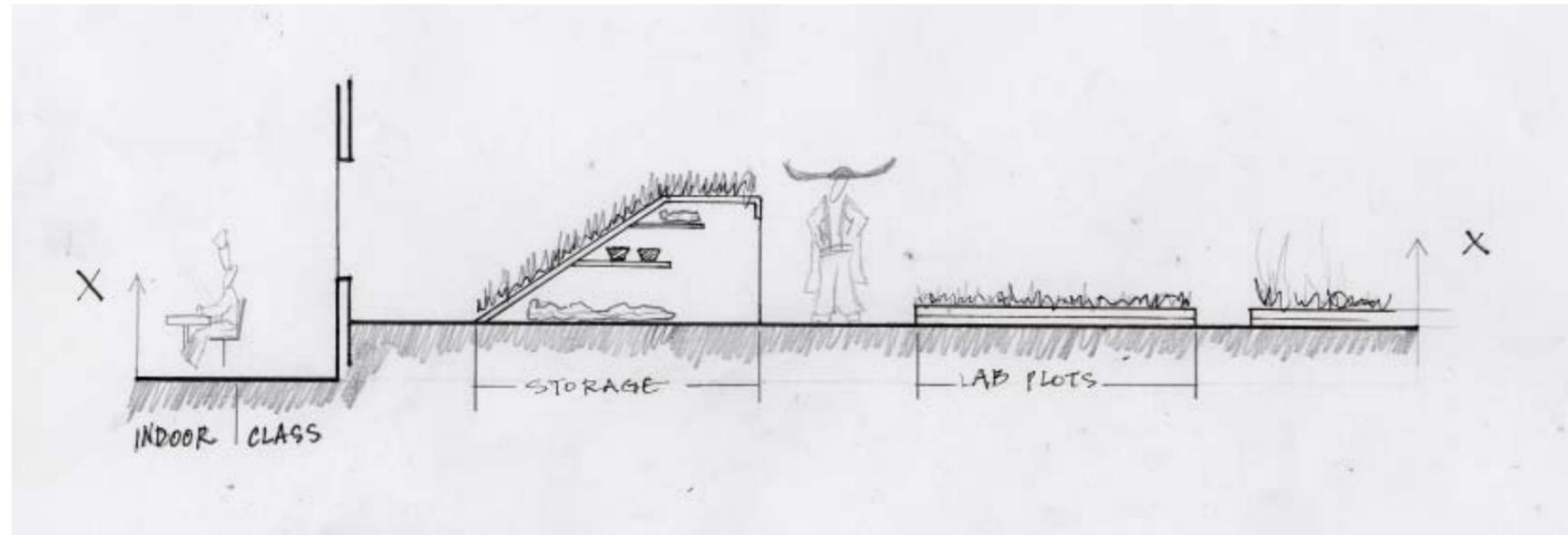
*We'll laugh and I tell you the story of love—how it
is—and the
happiness in it baby
We'll combine our thoughts
And together we'll travel the roads to the fountain of*

loveliness
 I will never ever ever leave you leave you alone to wonder
 As we go on our love it will grow much stronger and stronger
 Don't you wanna go...
 Up the ladder to the roof
 Where we can see heaven much better
 Up the ladder where we can be closer to heaven
 Aah
 Up the...
 (up the)
 ooh hoo
 Up the
 (up the)
 Ooh come on and walk
 Come on and talk
 Come on and sing about love and understanding
 ooh ooh ooh



18.2 Roof 1

More shape and thus more design was requested for Roof 1. These drawings address that request.



19.0 Conclusions

...To reflect is to receive truth immediately from God without any medium... (Emerson, journal entry, July 29, 1831; Gilman, 1965)

If the imagination intoxicates the poet, it is not inactive in other men. The metamorphosis excites in the beholder an emotion of joy. The use of symbols has a certain power of emancipation and exhilaration for all men. We seem to be touched by a wand, which makes us dance and run about happily, like children. We are like persons who come out of a cave or cellar into the open air.

Therefore we love the poet, the inventor, who in any form, whether in an ode, or in an action, or in looks and behavior, has yielded us a new thought. He unlocks our chains, and admits us to a new scene.

This emancipation is dear to all men, and the power to impart it, as it must come from greater depth and scope of thought, is a measure of intellect. Therefore all books of the imagination endure, all which ascend to that truth, that the writer sees nature beneath him, and uses it as his exponent. Every verse or sentence, possessing this virtue, will take care of its own immortality. (Emerson, Essays, Second Series, The Poet; p. 327 and 329 in Gilman, 1965)

Epilogue

I have a deep belief that the most important examination arriving from this thesis document is the primacy of process over product, as W.H. Gilman explains of Emerson: “the fascination with the ways and the effects of thought rather than the thought itself.” In Emerson’s words, “Not so much matter *what* as *how* men do and speak... Style not matter gives immortality;” further proclaiming, “the one thing in the world, of value, is the active soul.”

I think we can compare design as a form of inquiry to both Emerson’s “style” and “active soul,” all of these notions insisting upon the same thing – a deeper exploration and thereby a deeper understanding (even if the understanding is that we don’t really understand) of the world about us.

September 17, 1840. I am only an experimenter. Do not, I pray you, set the least value on what I do, or the least discredit on what I do not, as if I had settled anything as true or false. I unsettle all things. No facts are to me sacred, none are profane; I simply experiment, an endless seeker, with no Past at my back. -Ralph Waldo Emerson

Likewise, this document does at many points depart from perhaps its stated impetus – the exploration of extensive greenroof design – and dwell more on the ideas and examination of human-driven design concepts, particularly passive sensation. In that sense, the framework of this document easily transfers to all realms of design and gains greater value. As is Emerson, we are only experimenters, endless seekers, we have no past and can foretell no future; what we do can not be predicted. Design as inquiry typifies the unpredictability of process over product – and we should not be intimidated by its nature.

Free should the scholar be, —free and brave. Free even to the definition of freedom, “without any hindrance that does not arise out of his own constitution.” Brave; for fear is a thing which a scholar by his very function puts behind him. Fear always springs from ignorance. It is a shame to him if his tranquility, amid dangerous times, arise from the presumption, that, like children and women, his is a protected class; or if he seek a temporary peace by the diversion of his thoughts from politics or vexed questions, hiding his head like an ostrich in the flowering bushes, peeping into microscopes, and turning rhymes, as a boy whistles to keep his courage up. So is the danger a danger still; so is the fear worse. Manlike let him turn and face it. Let him look into its eye and search its nature, inspect its origin, —see the whelping of this lion, —which lies no great way back; he will then find himself a perfect comprehension of its nature and extent; he will have made his hands meet on the other side, and can henceforth defy it, and pass on superior. The world is his, who can see through its pretension. What deafness, what stone-blind custom, what overgrown error you behold is there only by sufferance, —by your sufferance. See it to be a lie, and you have already dealt it its mortal blow. (Emerson, as in Gilman, p. 239)

Brushfire fairytales
Itsy bitsy diamond wells
Big fat hurricanes
Yellow bellied given names
Well shortcuts can slow you down
And in the end we're bound
To rebound off of we
Well dust off your thinking caps
Solar powered plastic plants
Pretty pictures of things we ate
We are only what we hate
But in the long run we have found
Silent films are full of sound
Inaudibly free
Slow down everyone
You're moving too fast
Frames can't catch you when
You're moving like that

Inaudible melodies
Serve narrational strategies
Unobtrusive tones
Help to notice nothing but the zone
Of visual relevancy
Frame-lines tell me what to see
Chopping like an axe
Or maybe Eisenstein should just relax
Slow down everyone
You're moving too fast
Frames can't catch you when
You're moving like that

Well Plato's cave is full of freaks
Demanding refunds for the things they've seen
I wish they could believe
In all the things that never made the screen
And just slow down everyone
You're moving too fast
Frames can't catch you when
You're moving like that
Slow down everyone
You're moving too fast
Frames can't catch you when
You're moving like that
Moving Too...

– Jack Johnson, “Inaudible Melodies”

Appendices

Appendix A. Endnotes	46-51
Appendix B. Components	52
Appendix C. Plant Lists	53
Appendix D. Thesis Guidelines	54
Appendix E. Scholarship	55-59

Appendix A. Endnotes

The text of this appendix has in many instances been left as it first appeared in my notes and has not been revised or explained further. Being as such, many instances/entries will make little to no sense to some, which is fine as that is not necessarily the point of inclusion. Yet others will greatly clarify or seem necessary. The reality of this appendix hopes to once again and in a different way represent the omnipresent theme of this document – *design as a form of inquiry*.

Emerson's method was to write down in the heat of inspired vision the truth as it seemed to him at the moment, regardless of contrary perceptions he might have had at other moments. The thought might be a single sentence; it might be a paragraph, even an incomplete one; it might be three or four pages. It might be authentic, it might not. Emerson tended to believe that it was. The value of a journal to him was that each individual act of composition arose from experience immediate or remote, felt at the moment or recalled from the past. Sentences could be written at any time, without seeming to have any relation to each other. Eventually some question would pose itself, and show that the sentences all belonged together, were parts of a whole (Gilman, 1965, p.xvii).

“Men who make themselves felt in the world avail themselves of a certain fate in their constitution, which they know how to use. But they never deeply interest us, unless they lift a corner of the curtain, or betray never so slightly their penetration of what is behind it.” (Emerson, *Conduct of Life*, Illusions; p. 417 in Gilman, 1965.)

¹...invariably massive, windowless, bunker-like buildings, surrounded by huge expanses of treeless blacktop, surrounded by multilane highways. (Hylton, p.25)

² American notion that nature must either be totally controlled or totally left alone – a polarity that denies us the deepened and satisfying relationship with nature that we yearn for. (Slawson, p.58)

³ The genius of the place (Alex Pope)

⁴ Man carries in his genes the blueprint for a complicated nervous system molded over millions of years by natural selection. It has not changed significantly for many thousands of years and will not change for other thousands. But we are pushing the limits of the adaptability of that nervous system by our man-made environment. We notice to some extent the constant mechanical noise around us, the smog which stings our eyes, and the strain of hectic traffic, but we are precariously unconscious of many other subliminal effects which are cumulative. (Neutra, p.x)

⁵ To me, the objective of landscape is to create a work of art. True, it is not an insular art that does not serve people in a functional way like architecture, it is an art of the service of people. (Susan Child in *Paradise Transformed*, 53)
— Greenroofs can truly be an art of both function and the people (own)

⁶ Physiological tonus is more valid than philosophical claim. (Neutra, p.11)

⁷ Time, nature, sky, rain, plants, dirt, debris, people of all types, and man-made elements that intensify and abstract what is already here will become the focus of simpler, more receptive compositions and non-compositions. (Hargreaves in *Paradise Transformed*, 14)

⁸ Are there reliable values which are at least sharply silhouetted against the horizon of the future? Can we define such values beyond those which are commercially advertised? (Neutra, 20)

⁹ ...more than 1,600 scientists, including 101 Nobel Laureates, signed a World Scientists' Warning to Humanity stating that 'A new ethic is required, a new attitude toward discharging our responsibility for caring for ourselves and for the earth...' (Hylton, p.34)

¹⁰ The building of shelter consumes one-sixth of the world's fresh water supply, one-quarter of its wood harvest, and two-fifths of its fossil fuels and manufactured materials. As a result, architecture has become one of the primary targets of ecological reform. (Wines, *Green Architecture*, Preface)

¹¹ “oneness” with nature (Wines, 14)

¹² ...buildings as hybrid fusions of representation and abstraction, and buildings as “environmental sponges” which absorb their imagistic clues from the widest possible range of contextual sources. (Wines, 14)

¹³ Compared to the environmental crisis, all other social, political, economic, and scientific issues pale into insignificance. (Wines, foreword)

¹⁴ Integrated systems – interactive cooperation (Green Architecture, 26)

¹⁵ “According to Green Roofs for Healthy Cities, 80% of the greenroofs are extensive, involving low growing media, plant diversity and lower costs.” (greenroofs.com)

¹⁶ ...subtle relationship between physical structures and man's nervous behavior. (Neutra, 26)

¹⁷ “The Romantic mode is primarily inspirational, imaginative, creative, intuitive. Feelings rather than facts predominate. “art” when it is opposed to Science” is often romantic. It does not proceed by reason or by laws. It proceeds by feeling, intuition and esthetic conscience.”...”The classic mode, by contrast, proceeds by reason and by laws—which are themselves underlying forms of thought and behavior.”...”although surface ugliness is often found in the classic mode of understanding it is not inherent in it. There is a classic esthetic which romantics often miss because of its subtlety. The classic style is straightforward, unadorned, unemotional, economical and carefully proportioned. Its purpose is not to inspire emotionally, but to bring order out of chaos and make the unknown known.”(Robert Persig, zen and the art of motorcycle maintenance, p.61)

¹⁸ It wasn't until late in the document's forming that a serious text appeared. At its inception this document was conceived (at least for explaining the design) as a series of scattered or random thoughts...this idea was thought of because that is how I relate to design and the design process. Although a design has at its heart a universal or connecting element underlying it...I look at a design and appreciate the random or almost disconnected elements and certainly it is this sort of non-linear or jumping around type process which typifies how I design. Yet, I firmly realized that this document needed to do more than just string broken thoughts together...it needed to closely connect all elements through a more linear textual style. And this document attempts to do just that. Nonetheless, it is this appendix that many ideas abandoned or more closely examined in the body of the document find a home.

¹⁹ [essentially the paragraphs which follow were gonna replace chapter 7.1 and much of 7.3 – really to take out the LOI sections and references because it is still somewhat confusing... but something about its inclusion seemed necessary to me in the end...and so it has been included]

To understand the human-based needs of a design project, I should explain the heart of my analytic framework: the division of sensation. Obviously, the five (5) sensations are touch (tactile), sight (visual), smell (olfactory), sound (audio), and taste (gustatory). Beyond this, the sensations can be broken into active sensation and passive sensation. **definitions of active and passive...(chapter 7.2)

diagram of sensation – “active” = real, imagined, immediate, given, engaged, present / “passive” = imagined, thought, remembered, taken, interpretation*(figs 7.1 and 7.2)

This analytic framework is a result of a journey begun through scholarship and literature review, especially memorable along this journey, John Locke and “the whole of our knowledge, as individuals, is derived from sensory experience.” This analytic framework as applied to a specific site led to a concept which then became the design. The design is simply this student's attempt to further inquire about extensive greenroof technology and what it can become.

²⁰ ...So how do you do it? Don't know...can only provide an example of how it was attempted by this student... we can really only do just that, examine, in an attempt to understand. Afterall...

There are no ethical truths; there are just clarifications of particular ethical problems. Take advantage of these clarifications and work out your own existence. You are mistaken to think that anyone ever had the answers. There are no answers. Be brave and face up to it. – Donald Kalish

²¹ [what follows is the bones of an early presentation (perhaps for scholarship) which I gave as I tried to figure out the ideas for the thesis]

Let me begin by getting everyone on the same page... And I think that could best be accomplished by explaining the evolution off this current project. First, let me start by describing some general concepts.

- Roof Garden
- Greenroof (extensive, intensive)....
- Benefits...

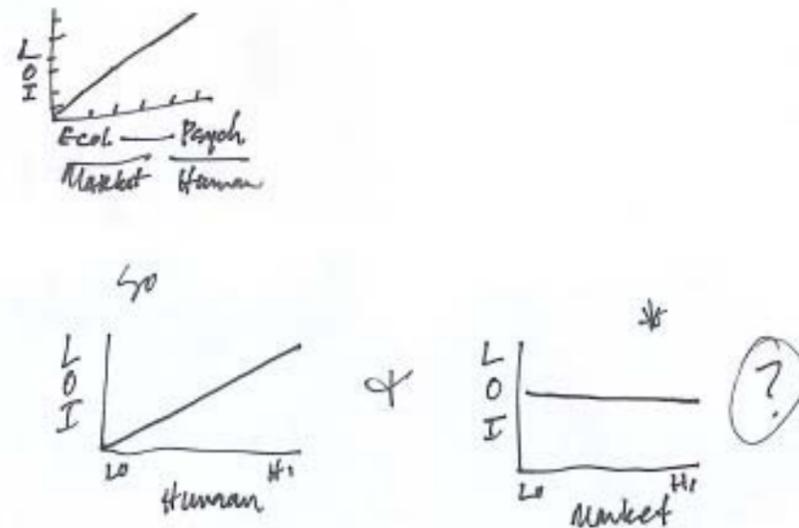
So from the initial research I did on the subject I concluded that for greenroof technology to really gain momentum that 1)Most importantly more research needed done on the economic benefits 2) High profile projects needed done...

Obviously, from this point I felt the next step should be to expound on economic benefits and so I sought probably too ambitiously, of building a test greenroof... Needless to say I couldn't invest the money, time, or desire to see this project to fruition...but I didn't feel this would keep me from being able to somehow do a master's design thesis... Yet, the more I read the more confused I became... Here I am a student of a design profession and I couldn't think past the importance of economic benefits of greenroof technology.

Basically, I became paralyzed and had no clue what the next step should be... and I had no idea how the specific site I was looking at using was connected....So not knowing what to do next I started considering the site and its potential...

Discuss the site...it was this interaction that I liked. At this point I started addressing access or viewability of the site as level of interaction or LOI... and the site was generally greenroof especially extensive greenroofing. Now let me say that at some point I classified the advantages/benefits/goals into two categories: Market and Human. The market were the economic and ecologic, the human were the aesthetic and psychological. So I next attempted to graph

The first graph gave me my biggest revelation....



The ubiquitous nature of market features in extensive greenroofs

...Does the visual perception of something being /having tactile (textural) qualities count as connecting to the sense of tactile or touch?.. Especially if something is out-of-reach or inaccessible?... because isn't all “sense” perceptual? (at least to the individual) ...

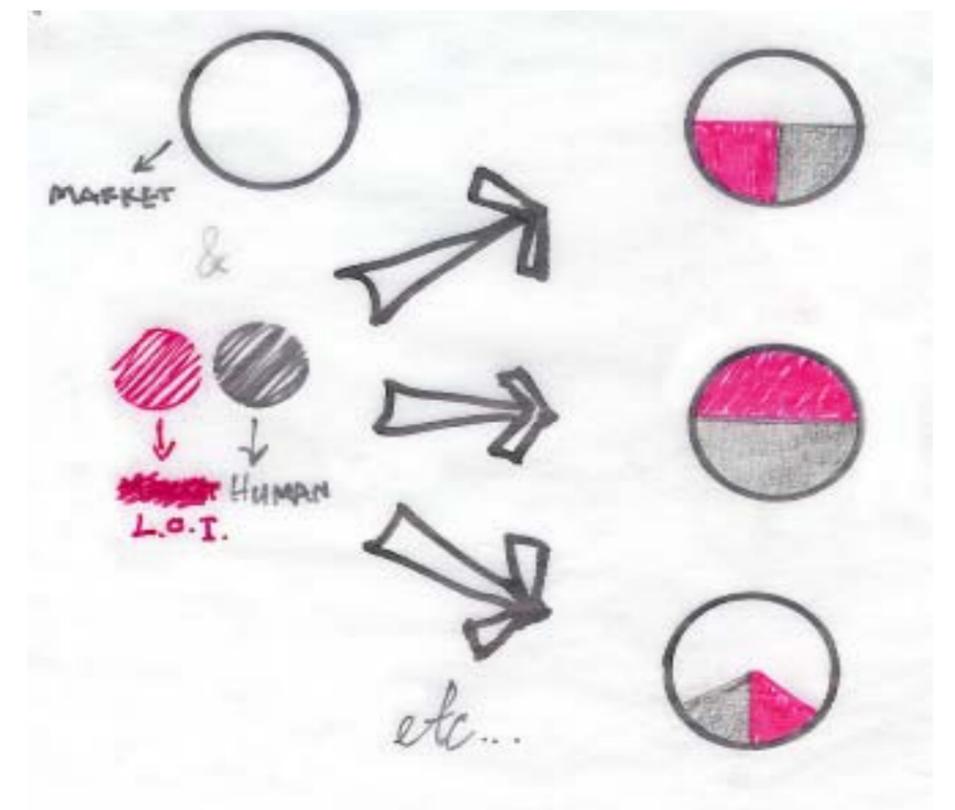
graphs....notes on graphs.... Level of interaction (access—viewability)

graph.... Not right because ecological (“market”) are inherent and always present so can get rid of as factor. Essentially becomes a non-factor due to its omnipresence or ubiquitousness. * *Take a look at other LA pursuits...different because in almost any other case all four components {econ/ecol/aesth/psych adv} are pursued and attempted to create. Whereas greenroofs, especially extensive, have the economic and ecologic (“market”) forces built in.. Sure research in these areas is important but to design for these purposes is redundant. Instead, the “human” forces need better examination/consideration.

How is ecologic = market?... well, essentially nature's market. Economic budgeting = conserving or preserving ...while ecologic conserving = budgeting....

Graphs.... Or it can't even be graphed because LOI and market are not correlated. — *this implies correlation and a LOI as constant whereas it really doesn't matter.

So how would you graph the ecological and economic (market) factors?...Circle diagrams... Diagrams.... So that “market” is always present while the amount of LOI and human which are directly correlated determine the “design” (or the final color makeup)...



LOI = human

²² tactile access would also include “physical” access.. in the case of the bridge/walkway over Seitz roof the ability to walk over (and in essence, within) the roof is a form of tactile sensing (feet to walkway)

²³ -Sir Thomas Browne: Thus is man that great and true Amphibium, whose nature is disposed to live...in divided and distinguished worlds; for though there be but one [world] to sense, there are two to reason; the one visible; the other invisible. –religio medici, part I, sec.34.

²⁴ ! active objects vs. passive objects (objects=sensation?) – active objects would be those acting upon our senses...levels of activity differ –completely active objects would be engaging all senses (watching yourself eat...completely active objects are not common...more common would be seeing something but not being able to smell or taste it... but this perception of its taste would make it passive??)

! So senses are not solely exclusive...meaning although only one sense receptor is actually engaged, the interconnectedness of senses allow us to perceive or sense imagined or not completely active objects...

²⁵ ___what if through a combination of active sensation and not just one do we experience passive sensation.

.....sense diagrams.... *this diagram [fig 7.1]implies that with any active sensation there are passive sensations present.. This is true; there is the potential for passive sensation. Yet, it does not always become engaged...depends on the individual

—every individual has the capacity or potential to experience at least all of the passive sensations and the same active (or in this case present) sensations... but which become engaged depend on the individual.

²⁶ ___*Diagram [7.2] shows individual differences in perception. Both active and passive sensation. Individuals exposed to some stimuli but perceiving or sensing differently. ...what does this mean for LOI?-should design for the ideal???What is that???
...For any design, individuals will experience different levels of interaction...nonetheless, the design should allow for some imagination since this is key to passive sensation – Occam’s razor...

²⁷ Any rooftop space provides a certain level of interaction or potential for interaction... If a space has a given low level of interaction (i.e. only seen through a closed window) then should the design of the space be less simple (more intricate) to engage the passive senses...conversely, if a space has a higher level of interaction should the design be simpler to accommodate for imagination (instead of trying to “give” to many sensations, and thus not allowing the individual to use imagination)....

²⁸ People want environments that are humane, more pedestrian friendly, more interactive with people... (Tony Neelson, as in Hylton, 60)

²⁹ Does there have to be a designated way to design by active &/vs passive sensation?.. Can just the explanation of each and some exploration suffice? ... Is just providing enough or must there be more/... every site and especially context will be different and much more important.. but then where does loi com in? It seems more should be said about loi?...

Perhaps LOI is not specifically defined as anything more than the type and intensity?(not right word) of : 1) site potential for providing interaction [also called “level of access” because interaction here refers to “access”]

2) interaction of individual’s senses with design [also called “level of sensation” because deals with design concept addressing “division of sensation” – active vs. passive] —*Does access really refer to just active sensation?...YES...Passive sense doesn’t fall under access because access is “real” while passive is “imagined”

³⁰ What about the combination of inanimate (not plants) objects with plants... if there are such objects which engage active sensation coupled with plants (especially plants on say a roof where not typically present) how does this bring out passive sensation...or even how does it (the combination) help to engage active sensation perhaps previously unnoticed.

³¹what about the role of association?.. how important/beneficial would sensation be t the environment or surrounding area of the roof ... (e.g. if you could just smell the roof everyday going to work how would you benefit with this association daily... how would it influence you or get you started on the right foot....

³² So what is the connection with active sensation and imagination? Is there less room for interpretation or is there still significant “room” for interpretation?

And even with enough room to imagine/interpret will we always try to find the pleasurable sensation?

I would guess yes..if all things being equal we will choose the most pleasant emotions? We are pleasure seekers....

But not all things will be equal because we all have different experiences (with design elements)....

³³ Evoking some of the same feeling (sensory experience) as when actually viewing them in nature (recreation of natural scenery) (Slawson, 58 – own wording)

³⁴ -Jacques Anatole Francois Thibault [anatole france]: To know is nothing at all; to imagine is everything.

³⁵ “Limitless” may not be the best word. They are limited by the innate capabilities of the human mind and by what we have experienced. I would say, however, that permeations and combinations of possible imagined thoughts are for all practical purposes infinite.” (Patrick’s comments, 6.12.03)

³⁶ “Body learning” rooted in sensory experience. (Slawson, 54)

³⁷ Is Passive Sensation MOST important??

Does imagination more closely connect us with pleasure..... Sensations (of any kind – active or passive) are either pleasurable (desirable) or unpleasant (undesirable) because they are connected to past experience?... a massage may feel good to one person but hurt another... everyone has different tastes....

³⁸ Entering into a design project with so many unresolved questions (see chapter xxxx), might at first glance bring the analytic framework under suspicion. Afterall, isn’t the thesis design project supposed to test (read: prove) the position and its analytic framework. Perhaps. But isn’t it our role as design students to test (read: examine) the analytic framework through design. Similar, but different modus operandi. As alluded to before, this entire thesis document was not performed in a linear way. Meaning, a position and analysis were not established before design began. Rather, the position and accompanying analytic framework surfaced in response to many of the questions and ideas arising from the design process. In that sense, the design is not just a product of a developed framework (or end result) – the design is both product and influence on a developing framework. Of course, to compile the entire process as a document implies a linearity which was not always present.

³⁹ As the transition into designing begins many ideas have not been resolved (see previous chapter *Discourse*). Revisiting those questions finds many – if not all – still unanswered. At first glance this might bring the analytic framework under suspicion, but closer inspection reveals an excellent opportunity to engage design as a form of inquiry. Indeed, establishing a framework which solves no questions indicates no failure; but simply lends relevance to exploring and demonstrating greenroof potential through design.

⁴⁰ ?why did I choose this roof?

Common sense dictated it.. I wasn’t looking for a site and happened upon this one.. on the contrary this site informed my choice of thesis topic.. After thinking about why this roof was so obvious as a project site brought me back to the idea of limitations and liberators – great opportunity to exemplify my position.

⁴¹ **Statement of Mission and Purpose**

Virginia Polytechnic Institute and State University, commonly known as Virginia Tech, a publicly supported, comprehensive, land-grant university, serves the commonwealth of Virginia, the nation, and the international community by generating and disseminating knowledge in the humanities, arts, social sciences, scientific, and professional disciplines, through instruction, research and extension.

Inspired by its motto, “UT PROSIM” — That I May Serve, the university instills within each member of the university community an appreciation of the values and obligations of productive citizenship and the responsibilities of leadership while promoting personal and intellectual development.

Its scholastic programs are accessible to all who demonstrate academic merit to gain entrance.

To achieve this mission, as the university moves toward the year 2000, it will identify and build on strengths across the university. It will forge innovative and mutually productive relationships with industry and government, manage resources efficiently, and establish a clear identity as a forward-thinking, high-quality institution that systematically guides and evaluates its future.

BACKGROUND

Founded in 1872 as a land-grant college, Virginia Tech is located in Montgomery County, 38 miles southwest of Roanoke in the New River Valley. The university has the largest full-time student population in Virginia, more than 100 campus buildings, a 2,600-acre main campus, and a 1,700-acre agriculture research farm. Through a combination of its three missions of instruction, research and public service, Virginia Tech accomplishes the charge of its motto: “Ut Prosim” — “That I May Serve.” (vt website)

⁴² the building itself is a “workshop” use inside – lots of vents/exhaust bec/ path is part of steam tunnel – this building is very functional in use...as opposed to say a classroom which may be more “theoretical”

⁴³ **Virginia Tech Power Plant**

Our cogeneration power plant is a mixed fuel, moderately high pressure steam generating facility. The plant contains four boilers with superheaters, rated at 60,000 to 80,000 pounds of steam per hour, which operate at 600 psig and 825 degrees Fahrenheit. This high pressure, superheated steam output is matched to a 6,250 kilowatt, 12,470 volt steam turbine powered generator, which was brought on line in 1975.

Steam Turbine

The turbine exhausts steam at 15 psig directly into a steam header serving an underground steam tunnel distribution network. This tunnel network serves over five million square feet of campus buildings with heat through six miles of steam and condensate lines. The turbine also provides steam extraction at 90 psig, which is distributed through the same underground network, to be used as process steam for cooking, sterilization, autoclaving, pressing, and other industrial requirements.

Plant Operation

Total plant capacity is 325,000 pounds per hour with peak winter demand in excess of 225,000 pounds per hour, while minimum summer loads can be less than 20,000 pounds per hour. These widely varying loads result in a “dual” power plant operation.

Eight months per year the plant is running in a maximum operational mode with steam production passing through the turbine generator and exhausting to the campus heating system.

The other four months per year are representative of a minimum operational mode with the turbine inoperative for lack of exhaust steam application.

Community Involvement

Few universities serve the electrical needs of their surrounding communities; none to the extent of Virginia Tech and the Virginia Tech Electric Service. And, no other University supplies part of the community requirements from a University owned cogeneration plant. (Vt website)

44 Context

What do I mean, context? Essentially, everything not covered by the LOI framework, specifically, the influences which give meaning to the conceptual and built design. Afterall, what good is meaningless sensation?

Context includes, but is not limited to the following ideas: Why? Who is the design for? Who will it serve? What is the setting? What gives meaning to the design? What “tools” or elements can be used? What is remarkable? What informs the spatial makeup of the design?

If any design could be split into beauty on one side and utility on the other, as now many of us so readily assume, it would not be akin to the organic life in us or around us, which most certainly has no such divisibility. And yet people have had to live, especially these last two centuries, amidst a multitude of designs conceived and executed in just this mistaken spirit and be profoundly affected by it. Factories, railway depots, office buildings, cheap mass-housing schemes, and city plans which were first thrown together or engineered for utility and then dressed up for beauty demonstrate daily that they have painfully little kinship to life and in fact are fairly foreign to it. They cannot really sustain it. From designs like these only meager crumbs can possibly be picked up for the purpose of vital assimilation and sustenance. On the contrary, toxic influences penetrate from them into us every day, every hour, every fraction of a second (Neutra, 1969).

Context lends to the indivisibility Neutra describes; context shapes meaningless levels of interaction—molding access, determining sensations; context assimilates, sustains.

“Even the most advanced advocates of ecological design are still struggling with ways to integrate environmental technology, resource conservation, and aesthetic contact. Without all the components in place, there is little chance for a truly endearing architecture” (Wines, 2000). Furthermore, “the design must have practical knowledge of how the human senses respond to varied stimuli in the physical world — only by understanding the limitations or “defects” of the senses can the landscape artist create a world of intense beauty for the viewer (Slawson, 1991).”

45 Statement of Programs:

* **Biological Systems Engineering:** Biological Systems Engineering offers a curriculum based on a foundation of math, biology, chemistry, physics, and engineering courses followed by one of two main specialty areas, Land and Water Resource Engineering or Bio-process Engineering. The Land and Water Resource Engineering option includes such areas as non-point source pollution control; surface and groundwater protection, management, and quality modeling; the use of geographic information systems; erosion control; animal waste management; and sensors and controls in agriculture and aquaculture. The Bio-process Engineering option involves the design and development of equipment and procedures for the environmentally responsible manufacture of food and industrial products (e.g., polymers, plastics, fuels, pharmaceuticals) from biological materials. This option encompasses food and aquacultural engineering.

* **Crop and Soil Environmental Sciences:** Undergraduate majors may choose from six options: soils (soil properties, taxonomy, conservation); environmental (human impact on the environment, land- use planning, groundwater pollution); crops (biology and technology of food, feed, and fiber production); turf management; biotechnology; or international agriculture. Areas in graduate research include environmental resources management and control; crop physiology and ecology; breeding and genetics of agronomic crops; and the mineralogy, fertility, and chemistry of soils.

* **Entomology:** Graduate research programs may deal with a variety of entomological topics, including basic biological studies (ecology, systematics, toxicology); environmental assessment and pesticide management; biological control; sustainable agriculture and integrated pest management; computer-aided decision making; bio-control of weeds; and urban, aquatic, and

forest entomology. In addition to these areas, research is conducted on specific insects, such as the honey bee, gypsy moth, and cockroach.

* **Horticulture:** Research in horticulture involves all commodities and disciplines related to horticulture, including tree and small fruit, vegetable, nursery, and floral production; viticulture; all landscape services (design, construction, installation, maintenance); and horticulture therapy and education. This broad range of topics is reflected in the curriculum, allowing undergraduates to choose from one of the following specializations: horticulture crops; landscape contracting; horticulture science; or horticulture therapy and education.

* **Plant Pathology, Physiology and Weed Science:** Research in this department is varied and includes plant biotechnology; plant stress physiology; fungal toxicants and interactions; plant bacteriology and virology; air pollution damage to plants; and plant nematology.

46 In spite of technological progress, or perhaps because of its spottiness, our man-made environment has shown an ominous tendency to slip more and more out of control. The farther man has moved away from the balanced integration of nature, the more his physical environment has become harmful. Nervous friction and wreckage have multiplied in the metropolitan type of surroundings. (Neutra, 24)

47 Lastly, the design serves as a tool for the achievement of a master’s degree and in so doing serves to contribute to the field of knowledge – enriching the profession.

48 The concept and design development will at this point move away from the ideas of the framework explicitly...remaining in the back of our minds, as an underlying current – meanwhile, we will look at concept with a heavy contextual relevance. In order to do so we will view the site not as the unique rooftop space it is, but as simply a site designed as if on the ground perhaps... once established we will flush out the connections of these concepts and design development with the notions of active and passive sensation. Furthermore, we will look to, in a final design, demonstrate the gravity of this place as a rooftop experience as well.

49 How about effluent treated in an adjacent sewage pond (using “biotechnology” [in re: fralin biotech center]) and then used as irrigation and nutrient source... also take “classroom” idea and incorporate on western roof...

50 requires the most attention ... appropriately enough looking at pause etc as the best way for gaining meaning (which occurs here on Roof 3) also must be done to just understand this roof as the learning process...—by most attention I am saying must be open to the ideas or representations to find meaning of the concept of this roof.

51 Good landscape design is often about encouraging visitors to move somewhat unconsciously from point to point through a garden, stopping to admire a view and then continuing their exploration. (para 53)

52 This of course, is one way to represent the learning process, especially that of formal education in the U.S. Yet as the design played out and the influences of Japanese gardens were introduced, an alternate understanding of the concepts of Roof 3 arose. As diagram xxx shows, the importance of experiential learning is largely untapped by formal U.S. education. The creation of the Japanese garden introduces a highly experiential place and more closely relates to eastern educational methods. This commentary on the educational system relates to the earlier discussed ideas of active and passive sensation, by allowing the student to get off the walkway and walk onto the roof into the area of pause we are saying that to learn we must sometimes get off the path and experience things for ourselves ...** and by.... (See Image A.1)

53 Over many centuries, these religious roots [deep reverence for nature], limited ground space, and the development of the particular type of Japanese architecture which placed the house or Buddhist temple within an enclosed private courtyard were central to the evolution of the traditional Japanese garden. (para 46)

54 “It’s the small details that delight the eye and make a garden an interesting place to be in... a place for people” (Sunset, 20).

55 Laboratory can be defined as a building, room, or space used for scientific work or research... furthermore, such a setting provides an excellent opportunity for establishing many active sensory opportunities but little passive sensations. (this will be further discussed in connections to analy.fr.sxn)

56 Really, one of my assumptions is limitations of materials (as typified by extensive greenroofs) – so I speak of this human-driven design I also imagine have very little material to work with – which, is perhaps the design appears so sparse... and maybe an unfair assumption for a design such as this [**see post-defense Charette]

57 —Parking lot— treat parking lot by not treating parking lot ...or ground.
-this position is on “roof”...so want a dichotomy between roof and ground.
-also just “treat” transitions – walkway or steps? and building façade as can be treated from roof top.
-treat as if roof is property boundary so everything else can’t be touched.

58 other questions?
What is the significance (contextual remarkableness) of layout on roof 1?
It is a relation to hokie stone patterns...”tech exhibits its character and pride every day via its buildings, most of which are made of hokie stone.” ... “no two stones are the same color...”

This is reflected in the design by the uneven (herringbone) pattern on facades, as well as, the varying uses of the plots which will each have different uses.

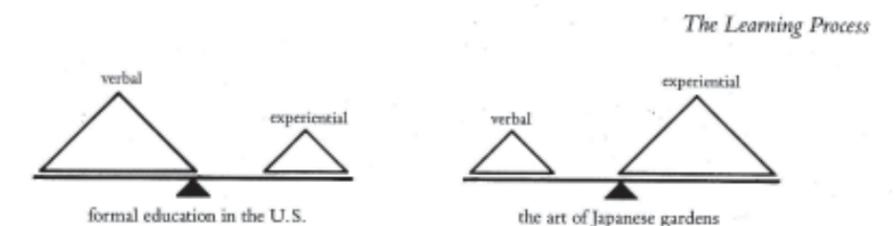
59 These themes of nature trumping technology and an ecological-technology are then reflected in the design’s use plantings overtaking these “designed” elements. Because what is more human than design?

60 The Passage Garden (symbolic of instruction as the passage to knowledge)

- simple
- few or no man-accessories
- a few key stones
- avoid bushy trees and shrubs
- open forms and slender shapes
- if water, merest trickle

[Sunset?]

Image A.1, below, as taken from Slawson.



⁶¹ David Slawson spent many years in apprenticeship learning the principles and values of Japanese gardens. The following passages help explain the similarities between Japanese gardens and the human-driven design position, which the area of pause emulates.

Physiologically, the human body is tailored to the earth's physical environment. Our bodies are the media by which we know ourselves and the world: our sensations of pleasure and pain tell us whether our inner needs are being met or deprived and whether we are safe in our surroundings or in some way threatened by them. From earliest childhood, we learn the powers and limitations of our bodies, not by rational observation but in a highly immediate, sensory way. We do not have to understand the principle of gravitational attraction in order to recognize and respond to it. The forces of nature – such as heat and gravity – are real to us only to the extent we experience them. We embody them, which is to say that we interiorize them through our sensations so that they become our own, highly personal and absolute. When we stumble on a staircase what we feel is not an invisible force pulling us toward the center of the earth but a sudden loss of balance coupled with a sensation of falling. There are hundreds of such physiological responses that we all learn through firsthand experiences in childhood.

People who choose to be visual artists tend to be acutely attuned to sensory experience; they also must have the capacity to shape materials to express their vision in a concrete form that others may enjoy. When producing sensory effects for others to experience, designers rely on intuition, for their own bodily responses are part and parcel of the human condition. Without the landscape designer's sensitivity to the effects of the forms, textures, and colors relative to one another in the spatial composition, the created object would lack the concentrated power of art. Effects of scale, such as immensity and intimacy; effects of spacing and shape, such as rhythm and movement; effects of texture and color intensity; such as an enhanced sense of depth and luminescence—all these and more play an especially vital role in the art of the Japanese garden. They are at the heart of its power to create an illusion of physical reality by teasing our perceptual systems into belief (Slawson, 1991).

⁶² “Japanese design ideas that work anywhere:

- restraint
- avoids clutter
- relates house and garden
- utilizes texture and form
- creates center of interest
- uses small details
- stimulates the senses (Sunset, 143)

⁶³ Heavily influenced by Japanese gardens and thus classic elements... the first conception of the roof design contained a triangular rock arrangement with the marker placed on the center rock (...name of rock) much like finally evolved ...but the center rock was supported by the two other rocks (...names...). There seemed to be much disregard between these elements and surrounding environs. The design was no longer only influenced by Jap. Gardens but was becoming one and losing authenticity as a greenroof (or so I felt). This “pause” area of roof was seemingly more and more disconnected from rest of roof...and although, the analogy of this whole roof and the pause area itself were a sort of commentary on move away from rigidity and western biased education system, there was nothing common amongst elements and features (such as roof features, i.e. ac/vents, railing...) [the idea is to keep intact as much as possible so that the design is a concentration on the roof...creating a greenroof as a space and making it a place...correlating it with the rest of the surroundings by making it more pleasing – the knock being that these roofs are unpleasant as compared to areas adjacent ...and so soften something like the parking by softening the roof, the “bad” parking lot works to further strengthen the roof by highlighting it as a nicer urban space...the idea further being that when designing in an urban setting on a rooftop there will be many of these harsh areas that will be set beside but untouchable for the designer...the comparison being that if an entire area is harsh/bleak...then if you can make an adjacent area “nicer” you have improved on the harshness, etc of that entire area.]

The next idea took the rocks away and thought of them as elements similar to those existing now... seemed too contrived...trying too hard.... Moving away from the simplicity... so now back to just a marker, which will remain the larger center stone...but how does this stone connect to entirety of site? Make it a large pumice stone ...shaped in the “heroic” upright mode of the Japanese garden... pumice to relate it to the growing medium used in the greenroof...so sort of this large piece rising out of the earth...or even can see it as father of all the rest of the smaller pieces making up the growing medium—the idea being that this large piece with the quote on push and pressure of the cosmos doubly related because the pumice itself is literally created from the push and pressure of the earth...but also related as symbol of passive sensation true father of knowledge...and as a material very sensory evoking with its airiness...furthermore, the pumice stone is a stone but it has this airy quality it is full of holes which is a commentary on the firmness and rigidity of the hokie stone and how although it is stone it is full of holes or inconsistencies?...also, much like the typical roof which just repels elements, so does stone act the same- but with the pumice and the greenroof, these elements absorb and accept the elements (elements being weather etc)...

So maybe use plant materials to represent the other supporting stones which have been cut out...this will help to lend some conceptual framing for the planting plan.

The square in the north western corner will remain “square” so as to emphasize that it is a display. Whereas on the rest of the revealed area it will be rounded and more natural looking to emphasize that this is also about creating a place...

Hokie Stone

Tech exhibits its character and pride every day via its buildings, most of which are made of Hokie Stone. Hokie Stone is actually several types of limestone common in Southwest Virginia and parts of Tennessee and Alabama. No two stones are the same color, varying from grays, browns, and blacks to pinks and reds. Since the mid-1950s, Tech has operated its own quarry, and a resolution passed by the Board of Visitors during the 1990s decrees that the limestone must now appear on every building. (tech website)

The hokie stone façade retaining wall represents the American education system – heavily biased by a lecture style instruction. Whereas the Japanese garden represents the notion of experiential learning which is “not a technical matter...not from books.” So we can see that as entering the area for pause the hokie stone façade is completely visible but as we move into the site the wall begins to be consumed or hidden by the landform to a point where it is not visible at all in some areas representing this move from formal us education to a more eastern style learning or rather a move towards more passive sensation, “the total push and pressure of the cosmos...” because this is a limitless type of learning or education.

⁶⁴ —Stone as center of interest (Slawson, 148)

⁶⁵ The large cobble firebreak bordering the south and west sides of the “garden” have several reasons...one of which is to provide another simple sensory material; also to further represent this idea of sort of “volcanic flow” moving from vent which is staked down towards pipe? Which is surrounded by retaining wall just south of step down into garden space...mirrors the interior where the pumice marker moves into the black cobbles which then “flow” out through the path. The rest of the roof where there are fire breaks and such will just be the roof acting as it does now with its simple black roof surface not to be filled with cobble as above paragraph states.

⁶⁶ Also still want a material change in the path directly in front of the marker stone to evoke more sensory experience and to indicate pause... use a material that is analogous to pause/reflection/etc... maybe sand –with some gravel right before so move from sound to no sound ... or maybe use shiny cobble stones (black like ones in pic from japgard book) to emphasize this idea of reflection and also the idea that must move deliberately (walk with pause) so as not to slip or stumble on this surface.)

⁶⁷ __Reason for block/gravel type path – trying to mix rigidity and existing pavers with idea of ornament? – unity between existing path and “area of pause” – maybe progressively less like existing concrete pathway – sound of gravel

⁶⁸ Fence piece to frame a view and highlight a centerpiece plant or serve as a backdrop... ...so de-gaki = “sleeve fence” (sunset, 115). **ABANDONED**

⁶⁹ design as a form of inquiry – here I am inquiring about human driven design (creating a place for passive sensation) ultimately this inquiry was successful in creating questions but not so much in creating a place which is perceived as effective...

⁷⁰ In the words of Bertrand Russell, “morally, a professional who uses his professional competence for anything except a disinterested search for the truth is guilty of a kind of treachery.” Voltaire continues, “it is only charlatans who are certain... Doubt is not a very agreeable state, but certainty is a ridiculous one” (both, as quoted in *Philosophy*).

⁷¹ As I’ve heard explained by departmental faculty, the thesis studio is designed to challenge current practices; then in whatever form this “challenge” occurs answers the question “so what?” So the thesis project looks to challenge not how current practices are performed but challenge the lack of current practice.

The challenge takes two forms:

Academic – based on “gut feeling”; this challenge comes about as the position which aims to improve the greenroof product through an understanding and appreciation of human-based factors. (since the technology now seems so rooted in economical and ecological (Market) benefits)

Realistic – grounded in reality as opposed to academic which is grounded on intuition; challenges lack of practice by turning a roof from space to place.

⁷² See appendix – thesis guidelines for reference on “gut feeling” but also on the recommended structure of the thesis...

Additional Endnotes (uncredited in text)

72

... not just experience a set of sensations but have those sensations be emotive. I believe that those things which are most important to us are exactly those things which we have great emotion for. In my case those things would include family, friends – and on a more material level certain fascinations, such as sports teams... and with such we see a good example of this phenomenon: I could watch two football teams play in the Super Bowl – lets say the Arizona Cardinals and the Houston Texans, and feel or understand little about the experience of that game. On the other hand, if the game matched the Arizona Cardinals and the Pittsburgh Steelers, I wouldn't just feel or better understand the experience of Super Bowl Sunday but also the weeks leading up to and following the game. Assuming a Steelers' victory I would understand the terms "elation" and "triumph" – probably even be brought to tears... Likewise, in the disastrous event of a Steelers' loss I would better understand what is meant by "defeat" and "sadness" – definitely be reduced to tears...

As a way to explain the emotive qualities of something in order to help its understanding we turn to passive imagery or passive sensation: The loss would not be just "deflating" to the fans but rather "a kick in the guts," and it are those types of imagery which help us understand or experience things not actively engaging us.

Sidebar – I would guess that at some point or another we have all either said or been told "the book is better than the movie" – and why is this so? Because a book provides imagery which we can (each in our own way) provide our own conclusions, thoughts, additional imagery for – we can imagine perceiving the objects or elements or action described. The book is almost always better than the movie because of the limitlessness of passive sensation. Movies provide the imagery for us – and although these images are not real, we accept them as such thereby limiting them and ourselves.

When the mind is braced by labor and invention, the page of whatever book we read becomes luminous with manifold allusion. Every sentence is doubly significant, and the sense of our author is as broad as the world. (Emerson, *The American Scholar*; p. 234 in Gilman)

73

Consent yourself to be an organ of your highest thought, and lo! Suddenly you put all men in your debt, and are the fountain of an energy that goes pulsing on with waves of benefit to the borders of society, to the circumference of things. (Emerson, *Lectures and Biographical Sketches*, Education; p. 448 in Gilman, 1965)

74

Why we give everything meaning:

Peace Of Mind (Persig, zen & the...)-- the opposite of which is stress... rationalize meaning ex post facto... not all artists create with an intended meaning other than to delight the senses so to speak... there is not always a deeper, philosophical explanation to art, instead it is our bent to seek it out and give it such... I have had the pleasure and opportunity to experience the work and working of Robin Grass, an artist local to my hometown, during which time i began wondering why we always seek to give a deeper meaning to man-made sensory delights,so to speak... viewing his paintings which are what i would conversationally describe as "fantastical" because they remind me of much of the fantasy literature i have read (terry pratchett?-- terry brooks' landover-- narnia--disney) --hitting upon many of our senses with the vivid



colors but more precisely the seemingly vivid characters, we immediately begin are ponderings on the deeper meaning behind each... certainly these near-incomprehensible characters and stories told on the canvas must explain something deeper, something hidden... when in reality, these characters are completely comprehensible --they are what they are and nothing more, there is no deeper, hidden meaning ... "if you see a dog hidden somewhere because of the meaning you create, that's great, but its not really there"... "if you know what a character is thinking then you know more than i do"...(paraphrasing)
...i would say this is one of the major differences between landscape architecture and art or landscape design... We must seek to unify all the ponderings and iterations and the final evolution of our work (as Landscape Architects) into one cohesive, tied-together meaning. Such was the case with this Thesis Document -- many things were being pulled together and perhaps not so effectively in the final product... but it was this search which led to the design -- the inquiries and process that made this document successful...the means justify the ends...

RWE

Ralph Waldo Emerson, born in Boston, Massachussetts, 1803, would suffer through temporary loss of vision, lung disease, and the passing of many friends and family to become one of the most influential voices of the 19th Century.

Essayist, lecturer, and poet, Emerson's works ranged from simple descriptions of daily life to deep philosophical ponderings. "Except for Whitman, perhaps no American in the nineteenth century was so responsive to all experiences, all occupations, all interests and powers of the body, soul, and mind. Emerson wanted to be the universal sensibility, the one man who stood for all men" (Gilman, 1965, vii). Ralph Waldo Emerson died in 1882.



Robin Grass prints (top left to bottom right):
Pilgrims, The Race, Barbara
--prints appear by permission of the artist.

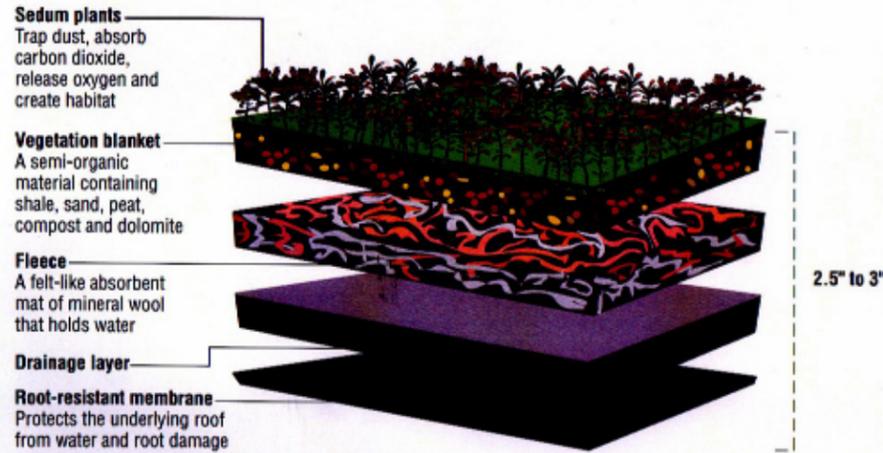
Appendix B. Layers/Components

This appendix is really just a chance to demonstrate many of the extensive greenroof systems marketed by different companies. Each graphic is credited to said company.

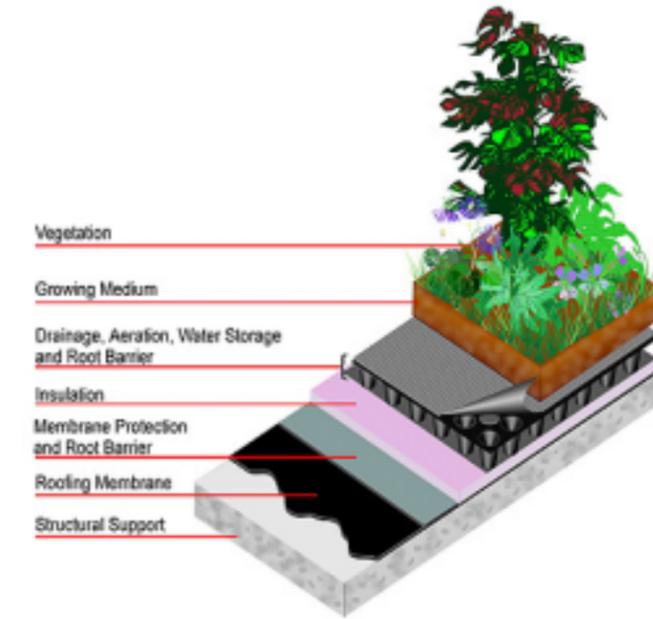
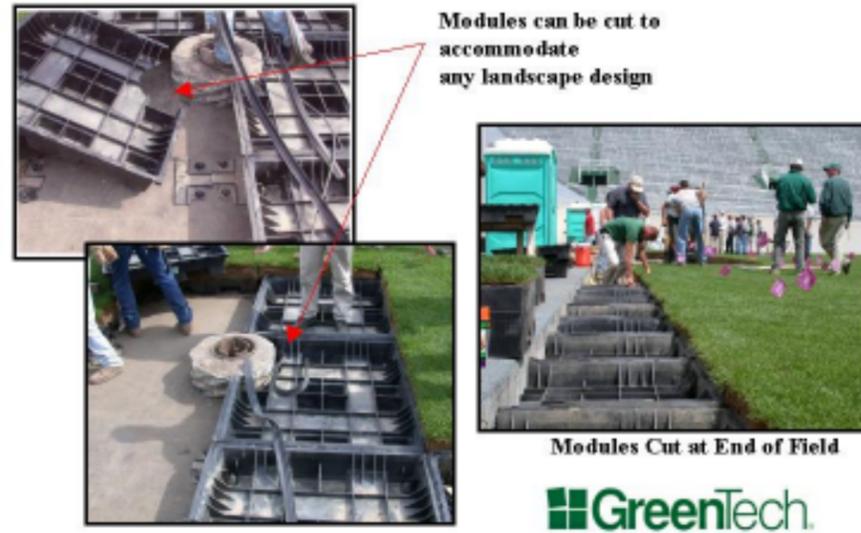
GreenTech® makes the interlocking grid module system referred to in the post-defense charette. Below are images from a slide presentation found at their website: <http://www.greentechitm.com/>

American Wick Drain Corporation's AMERDRAIN™ Garden Roof system was the inspiration for the Area of Reveal, as shown below.

FORD ROUGE CENTER LIVING ROOF DESIGN



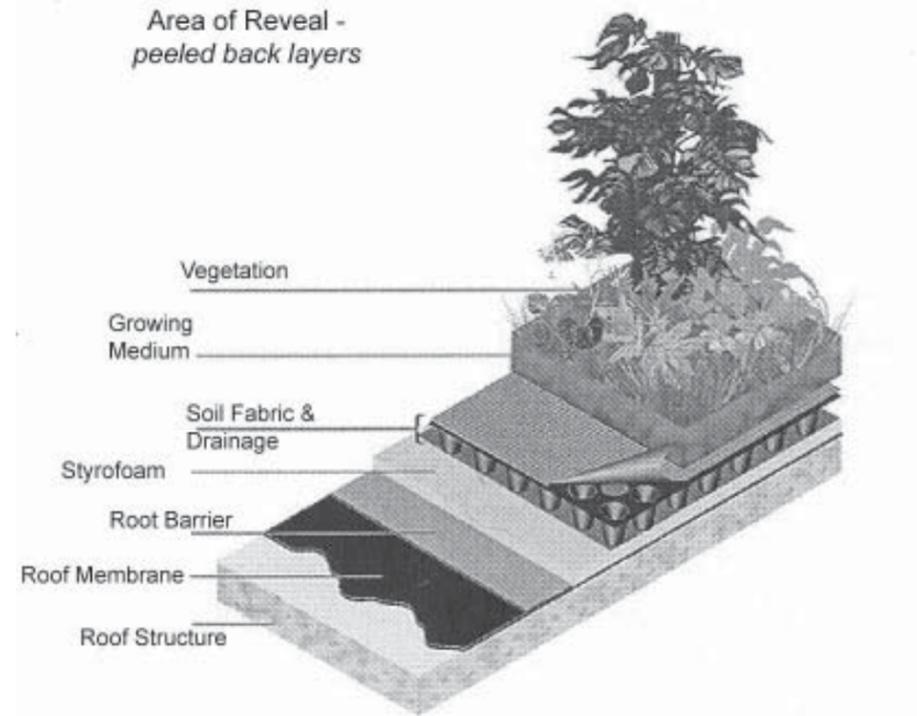
Module Contouring



Above are the components from the Ford Motor Company's Rouge River Plant. This is an excellent diagram for describing the seemingly simple components of an extensive greenroof. The components of a greenroof system can vary greatly.

Below is the theoretical system used for the purposes of this project. This is most closely adapted from American Hydrotech, Inc's Garden Roof® which is seen immediately on the right.

American Hydrotech, Inc's Garden Roof®



Adapted from www.americanwick.com

Appendix C. Plant Lists

Potential Plant lists for North American greenroofs (source: greenroofs.com)

Rock Plants and Wildflowers	
BOTANICAL NAME	NATURAL HABITAT & NOTES
<i>Achillea millefolium</i>	Native to Europe & Asia, Yarrow is naturalized here in the U.S. Once established, it's very drought tolerant.
<i>Allium bivalve</i>	Native to the U. S. Granite Outcrops
<i>Centaurea cyanus</i>	Annual; Coneflower or Bachelor's Button.
<i>Chrysanthemum leucanthemum</i>	Native to Asia, Ox-Eye Daisy needs well drained soil.
<i>Coreopsis lanceolata, tinctoria</i>	U.S. native of the S.E.; also <i>C. auriculata, grandiflora, major, nundata, rosea, verticillata</i>
<i>Cosmos bipinnatus, sulphureus</i>	Native to Mexico, a self-seeding annual
<i>Echinacea purpurea</i>	U.S. native of the S.E.; also <i>E. pallida, paradoxa</i>
<i>Gaillardia aristata, pulchella</i>	Annual & perennial, Firewheel likes well drained soil
<i>Hieracium venosum</i>	Native to the U. S. Granite Outcrops
<i>Liatris microcephala</i>	Gayfeather is native to the U. S. Granite Outcrops
<i>Oenothera speciosa</i>	Showy Primrose is a native of North America east of the Mississippi; also <i>O. fruticosa, tetragona</i>
<i>Opuntia drummondii</i>	Prickly Pear is a native of U. S. Granite Outcrops
<i>Phlox drummondii</i>	U. S. native of the S.E.; also <i>P. carolina</i> complex, <i>glaberrima, maculata, paniculata, pilosa. P. divaricata</i> native to eastern North America
<i>Potentilla canadensis</i>	Native of U. S. Granite Outcrops
<i>Rudbeckia hirta</i>	Black Eyed Susan is a U. S. native of eastern U. S.; also <i>R. fulgida, lacinat, maxima, nitida, triloba</i>
<i>Sedum pusillum, smallii</i>	Native of U.S. Granite Outcrops
<i>Senecio smallii, tomentosa</i>	Ragwort is native of U.S. Granite Outcrops; also <i>S. aureus, glabellus, obovatus</i> , native to eastern North America
<i>Solidago spp.</i>	Goldenrod is native to the eastern U.S. with numerous spp., such as <i>S. nemoralis, odora, pintorum, rigida, rugosa, sempervirens, speciosa, and ulmifolia</i>
<i>Tradescantia hirsutocaulis</i>	Spiderwort is native to U. S. Granite Outcrops
<i>Yucca filamentosa</i>	Native of U.S. Granite Outcrops
Grasses	
<i>Andropogon ternarius, virginicus</i>	Native of eastern U.S. & Granite Outcrops, abandoned fields; widely distributed, many species
<i>Aristida purpurascens</i>	Native from N. Carolina to Mississippi
<i>Bouteloua curtipendula, hirsuta</i>	Sideoats Grama and Hairy Grama are native to the Texas area
<i>Panicum lithophilum, and spp.</i>	Switchgrass is native to North America; also <i>P. virgatum</i>

Appendix D. About Thesis Studio

This appendix contains much of the “instruction” for undertaking the thesis project. The text here is pieced from departmental handouts.

About Thesis and Thesis Studio:

The department offers a choice of capstone opportunities to MLA students: the thesis or the thesis studio. The term *thesis* generally evokes images of basic research, reasoned argument, or theory building. The thesis is an appropriate vehicle where the student’s work, by its nature, suggests primary emphasis be placed on such traditional models of scholarship. By contrast, the thesis studio assumes the use of design and/or planning approaches and methods as vehicles for the conduct of scholastic inquiry. This distinction between thesis and thesis studio is admittedly fuzzy. The challenges confronting our discipline do not have clean edges. It is very typical for a combination of methods to be employed in satisfactory investigations of complex problems. Therefore, the distinction between thesis and thesis studio, where approaches and methods are concerned, is one of emphasis rather than exclusion.

The thesis studio is completed under the direction of a major professor with participation of designated reviewers as outlined in this document.

Overview of Thesis Studio:

The purpose of the studio work is to demonstrate, develop or evaluate the theoretical position developed during the previous semester. ...By contrast, students in the thesis studio will typically use one or more context specific projects as vehicles to derive understandings that are applicable beyond the projects themselves. ...The products of the spring semester will include documentation of the studio work along with written conclusions that discuss the broader significance of the thesis investigation.

Product:

In addition to meeting the Graduate School criteria for submissions a thesis studio document will generally be expected to contain the following:

A brief introductory statement that describes the structure of the thesis work and its significance to the discipline.

Since the purpose of the project work is to demonstrate, develop or test a position it follows that there must be a position to be tested. The position paper develops and defines an assertion or set of assertions to be examined by the student through design or planning project work. For example, it may be asserted that some aspect of sustainable residential development, such as retention of habitat for certain species of fauna, are best achieved in developments of a specified size range. Studio projects are then proposed on the basis of their potential to respond to that assertion. The position itself may be a hypothesis grounded in intuition or a “gut feeling”. It is something that needs to be tested. However, positions should be held within the context of our current knowledge of the subject. For this reason, position papers will generally include an analysis and interpretation of the literature and/or case studies related to the thesis issue/question. This analysis and interpretation of our current state of understanding provokes a particular stance or assertion relative to the thesis topic.

The actual studio project work should be documented as appropriate to the overall objectives of the thesis.

A summary statement and conclusions: the findings and their significance.

Appendix E. Scholarship

The text which follows is the final iteration of a paper written for a class titled Scholarship in Landscape Architecture. Completed in the spring of 2002, this paper became the impetus for much of the thesis document.

City dwellers have demonstrated a sustained interest in nature throughout history. Today that interest has been heightened by a growing consciousness across society of the costs to health and welfare exacted by continued environmental degradation. It is time to expand what has been a romantic attachment to the ornaments of nature into a commitment to reshape the city in harmony with the workings of nature. – Anne Whiston Spirn, The Granite Garden

Indeed, it is well past time for such a “commitment,” fortunately, it is not too late.

Introduction

Throughout history, a utopian ideal has existed promoting nature as a necessary affect for better aesthetic and psychological being. As civilization advances we begin understanding the effects of nature in promoting better ecologic and economic being. Despite this increased understanding, as human populations climb so do stresses upon the natural environment, therefore, finding a way to bring “the city in harmony with the workings of nature” becomes more challenging.

Over millions of years, nature has been able to regulate toward the creation of stable ecosystems, natural changes tend to be gradual. Yet man, through technological advances has been able to introduce change much more rapidly and with potentially devastating repercussions.

We face a sharp bend in the road. Behind us lies the landscape we inherit, before us the landscape that, in due time, we will bequeath. Looking back, we see important flaws in the relationship between the human-dominated landscape and the natural world. Looking ahead, we see a need to reform that relationship but find it hard to know just how we might alter our direction, shift our momentum, adjust our speed. We seek a more careful “harmony” of social and natural systems, but we have no sure map to guide us (Meine, 47).

When we do develop this map of “social and natural harmony,” like any map it will have a legend identifying each element, in essence, serving as a list of tools for reforming and reshaping our landscape.

As our understanding and knowledge base grows, so do the elements for our legend. Especially over the last twenty years our toolbox has become increasingly full with bio-engineering, geo-textiles, smart growth, recycling, green building techniques, and various sustainable promotions. (Unfortunately, the idea and products of “sustainability” have become buzzwords and popular almost to a fault as the term is exploited for marketing potential, not necessarily ecological potential.)

This paper, will deal with just one of these tools, greenroofs and focus primarily on its ecological and economic benefits. With this said, the form of the paper will begin with a history and definition, then discuss advantages, and finally speak to the future of greenroofs in America. All the while addressing two problems: 1) practical: greenroof technology is not being exploited in the U.S., and, 2) research: could knowledge and increased awareness of the benefits of greenroofs, especially the economic, promote usage.

Greenroofs**History**

The history of greenroofs could probably be traced as far back as the history of buildings. The first constructed homes made use of earthen materials such as wood, stone, dirt, mud and sod. Therefore, it only makes sense that within and among these natural materials vegetative life would attempt to take root. Although these conjectures to the rudimentary beginnings of greenroofs seem plausible, the strongest evolutionary connection to present day greenroofs comes from Iceland. As one can imagine, the Icelandic architectural style is typified by a lack of natural resources. Meaning, the best building materials were those readily at hand: stone and sod. Typically, what could be encountered were roofs completely turfed over to provide a good protection against the rain, wind and snow of the region, but also serving as an excellent means of insulation. With these noticeable benefits and a certain natural aesthetic, greenroofs found use for hundreds of years and spread throughout Scandinavia.

Eventually, the concept sprang up in Europe, primarily in Germany, and it is there that it has taken on the greatest prominence as an effective tool. Indeed, since the 1960’s the evolution of greenroofs has been shaped into its current manifestations primarily in Germany. Many German provinces and cities now require greenroofs in building codes or provide stipends to encourage usage.

Undoubtedly, it is at this point when the question arises, “Why don’t we see greenroofs in the U.S. if they have been so effective and popular in Europe?” Well, perhaps the best way to address this question is to avoid the politics and economics of modern day America, and, instead refer to an opinion poll of Europeans which asked what they hold most important. This poll found that Europeans ranked the environment with more priority than even unemployment, poverty, and insecurity (*greenroofs.com, History*). Needless to say, most Americans do not give the environment such importance, but hope does exist for greenroofs as we will see.

Definition

Greenroofs consist of “a thin veneer of living vegetation installed on top of a conventional roof.” (*Charlie Miller, correspondence*). (For a more thorough examination of greenroofing components refer to the Appendix.)

There are two kinds of greenroofs: intensive and extensive. The intensive are designed to be accessible for use as parks, or other higher intensity treatments. Therefore, they are higher maintenance and require a minimum of one-foot soil depth to be planted with large trees and shrubs (see Figure

1). Although technically classified as greenroofs, these are perhaps more akin to traditional rooftop gardens.

On the other hand, the extensive greenroofing systems are primarily used for their environmental benefits and perhaps a more pure instance of greenroofs, at least in line with the benefits discussed later in this paper. Extensive greenroofs are typically non-accessible except for maintenance, sometimes occurring as infrequently as once a year. They require only one to five inches of soil depth and are planted with a thin vegetation layer, often native grasses and sedum varieties (see Figure 2).



Figure 1. Intensive greenroof (source, both figures: greenroofs.com)



Figure 2. Extensive greenroof

Greenroofs vs. Roof Gardens and Eco-roofs

As mentioned earlier, roof gardens are similar to intensive greenroofs, yet the usual roof garden is simply the incorporation of container plants and/or other systems to allow for deep-rooted plants. Rooftop gardens do share most of the benefits associated with greenroofs but since the gardens are not integral to the buildings structure they can not be classified as greenroofs.

Beyond this, the term eco-roof is sometimes used interchangeably with greenroof. Eco-roofs, however, are defined as roof treatments involving natural, renewable materials. So, eco-roofs could include anything from greenroofs to something as simple as wood shingles.

Benefits/Advantages/Goals

Ecological Benefits

Stormwater management

Maybe the greatest of ecological benefits is the stormwater management capacity of greenroofs. Obviously, as urbanization increases there is an increase in the amount of impervious surface cover. As a result, cities have developed overstressed sewer systems with very urgent stormwater management problems. Nonetheless, depending on rain intensity, soil depth, and plant types, runoff can be absorbed as much as 15% to 90% with an average of 50% to 60% runoff absorption from greenroofs (*greenroofs.com, Ecological Advantages & roofmeadow.com, Benefits*).

In a September 2000 article appearing in LA magazine, J. William Thompson explains,

Two years ago...about the only functioning green roof we could find in this country was on top of Tom Liptan's garage...Liptan, ASLA, a stormwater-management professional in Portland, Oregon, believed that putting absorbent plants and soil on top of buildings could keep a percentage of urban rainfall from gushing into storm sewers and causing rivers and streams to flood. Because there was no such roof to study in Portland, he rigged up an experiment on his garage using a thin layer of soil from his backyard carpeted with sedums and other plants and monitored it to see how much water the roof actually retained.

The roof functions remarkably well by retaining stormwater anywhere from 10-90% depending on the intensity of the storm event (*greenroofs.com, North American Case Studies*).

Reduction of the Urban Heat Island Effect

Pavement, rooftops, and other dark surfaces absorb solar radiation only to reradiate the heat. When these surfaces dominate an urban environment they can raise summer temperatures 6 to 10 degrees. When these increased temperatures meet air pollutants, the result is an accumulation of smog, damaging both the environment as well as human health. NASA has conducted studies of the Urban Heat Island Effect in the metro-Atlanta region and found that in downtown the temperature is on average ten degrees warmer than in outlying regions.

Many factors contribute to the urban heat island effect, the typical materials used for development include asphalt, concrete and brick. These manmade tools of development absorb heat quicker and store it in greater quantity than natural elements. Therefore, the use of plants and vegetative cover can

help to reduce ambient air temperature, through less absorption of solar radiation, as well as evapotranspiration.

Pollutant Absorption and Filtering

The verticality, narrowness, and harshness of the urban landscape creates an environment characterized by wind inversions and air pockets full of the pollution made by the urban inhabitants. These pollutants can remain suspended in the air for days waiting to be washed away or absorbed. With this in mind, studies show that "one square meter of grass roof can remove approximately 0.2 kg of airborne particles from the air every year" (*greenroofs.com, Ecological Advantages*). Furthermore, "vegetation can remove 95% of cadmium, copper, and lead and 16% of zinc out of rainfall, as well as substantial amounts of nitrogen" (*greenroofs.com, Ecological Advantages*).

Noise Reduction

The soft plant levels of greenroofs can reduce noise pollution anywhere from 8 dB to 50 dB. (*greenroofs.com, Economic Advantages*). This reduction is not only effective as noise insulation for the greened building but also has ancillary benefits for surrounding environments. This idea has found increasing use in and around airports for obvious reasons.

Use of Recycled Materials

Most companies involved with greenroofs use at least some recycled material in their product components, thereby, saving disposal or landfill sites from unneeded burden. For example, Roofscapes, Inc. offer products made from recycled polyethylene (*roofmeadow.com, Products*).

Creation of Wildlife Habitat

Although the habitat being lost from building construction can never be regained or replaced, through the use of greenroofs, habitat substitutes can be found. Greenroofs create an artificial or manmade edge to serve as a vegetative habitat patch. Beyond vegetation, these edges prove to serve as wildlife habitats. Studies in the U.S. have shown that butterflies will visit rooftop gardens as high as 20 stories and birds have been shown to go as high as 19 stories (*greenroofs.com, Ecological Advantages*).

Economic Benefits

Extend the Life of Underlying Roof Structure

The typical roof takes a lot of wear from the elements be it sun, rain, wind, snow, or ice, all these actions can have quite an effect. Whereas, a properly laid greenroof, despite higher initial costs, can dramatically improve the life of roofs. Most estimates state that greenroof installation can double the life of underlying roof structures, in practical terms this equates to 20 additional years of life. Less conservative estimates expound the tripling of roof life (greenroofs.com). In a February 2002 lecture by Clayton Rugh, he states that “1/3 of all industrial costs are spent on roof maintenance.” From this we can see the importance of protecting and extending roof life.

Reduction of Building Energy Costs

“Approximately 1/6 of the electricity consumed in the United States is used to cool buildings” (*City of Chicago, Environment*). As mentioned earlier, greenroofs provide excellent thermal insulation, as a result, buildings are cooler in the summer and warmer in the winter. Studies suggest that for a one-story structure with a greenroof cooling costs could be cut between 20-30%. Likewise, a study done by the Weston Design Consultants for the City of Chicago estimated that if all of downtown Chicago’s roofs were greened, the result would be an estimated savings of \$100,000,000 annually (*greenroofs.com, Economic Advantages*).

The City of Chicago Department of Environment (DOE) is using a rooftop garden as part of its Urban Heat Island Initiative. The 20,300 square foot area being tested for benefits sits atop the Chicago City Hall building and contains over 20,000 plants of more than 150 varieties including 112 shrubs, 40 vines and 2 trees (City of Chicago, Environment).

Although this would fall more in the realm of an intensive greenroof, or, as named, a rooftop garden, the fact that it is being used as a means to test environmental and economic benefits speaks mightily about its functioning. Chicago is in fact the only of several cities participating in the UHII to be using greenroofs as a means to reduce energy demand and lower area temperatures. The City estimates that the rooftop garden will save City Hall over \$4000 annually from its energy bills (*City of Chicago, expired link*). This test roof will be compared to the black tar roof that sits on the adjoining Cook County Administration building.

Previously Wasted Space Now Useable

As can be imagined, most rooftops sit unused, simply wasting space. By incorporating greenroofs into a buildings design we can, in essence, reclaim an area roughly equal to the footprint lost from the building’s construction.

Likewise, rooftop space does not have to be bought in addition to what is already owned, whereas, to build comparable green-space at ground level will require additional investment. Imagine, if you will, storage space in a small room, if you are only using floor space as a means for storage than you are neglecting wall space. Similarly, rooftops have all too often sat unused as neglected space, and we are just beginning to realize the opportunities.

Increase in Property Values

As property owners make more efficient economic, environmental, and aesthetic use of space there is a correlation with an increase in property values of the greened building and the surrounding community. Furthermore, if whole communities or even cities buy into the greenroof concept property values can drastically rise while energy costs decline creating a more integrated, self-sufficient economic cycle.

Use of Recycled Material

In addition to all environmental benefits, “recycling just makes good economic sense.”

Aesthetic and Psychological Benefits

Less Concrete, Asphalt, & Gravel

Beauty can be remarkably improved just from changing the roof’s characteristic from harsh and bleak to natural and living.

Endless Design Possibilities

Following from the previous benefit, with the institution of a more workable material the design possibilities are only limited by the function and slope of the roof.

Various Planting Plans

Once again, as with the previous two benefits the use of greenroofs allows for wildly imaginative and unique opportunities to combine form and function.

Improved Quality of Life

“Humans have physiological reactions to natural beauty and diversity, to the shapes and colors of nature, especially to green, and to the motions and sounds of other animals.” (Quote by Frederick Law Olmstead; taken from greenroofs.com)

Enhancement of Emotional Health & Mental Stability

“The simple act of digging garden soil in preparation for spring planting triggers strong emotions: a sense of connection to the earth, to the regeneration of life. It is an act of nurturance and an expression of faith in renewal” (*Spirn, 120*). This translates not only into beneficial environments for the everyday person but also opens up the link to enhanced therapeutic connections.

Colorful Views instead of Concrete and Asphalt

Along with enhancing individuals’ environments, the “overall richness of the city” could be improved. “A garden in the sky is a rare and delightful place, as witnessed by the accounts of the hanging gardens of Babylon, one of the seven wonders of the ancient world” (*Spirn, 195*).

Future

So what is the future for greenroofs in America?

“My opinion is that greenroofs will be required in major cities to some extent. Whether it is to reduce urban air temperatures or reduce stormwater runoff, greenroofs will serve large cities well in the future” – *Kimberly Worthington, Assistant Commissioner, Department of Environment, City of Chicago.*

“The future of [g]reenroofs in this country is very bright. There are economic and ecological benefits to be gained, an unbeatable combination. Education of the architectural, development and construction communities is the only barrier to widespread use and acceptance.” – *Karen Morby, Satellite Branch Manager and Senior Project Manager at Church Landscape.*

Most likely, as more projects incorporate greenroofs and/or are including these treatments as more than just architectural accents we will see them rise in popularity as essential components especially in the urban environment. There are several reasons greenroofs are not being exploited: 1) a lack of ecological concern or understanding, and 2) a lack of knowledge of the benefits of greenroofs.

Lack of Ecological Concern

Bringing forth a solution to many ecological problems requires societal action on a broad scale. In order to succeed, there is a need for both scientific information and human emotion. Catalysts for such action comes in two forms: regulations and incentives (Galatowitsch, 99). For greenroofs, there exist regulations in other countries, but are less likely in America's near future. Instead, we should look to incentives. According to Susan M. Galatowitsch, the incentives likely to be the most durable "are those that increase appreciation for environmental quality, either directly through experiences or indirectly through education. This mode relies on people experiencing places, understanding their relevance, and wanting to have more places like them." Such incentives would be invaluable and at some point must occur before widespread acceptance of ecological design principles are embraced, nonetheless, this position may underestimate the power of the almighty buck.

Lack of knowledge of the economic benefits

As a society, we are driven by economics. We have gone from 'the land of milk and honey' to 'the land built on the land of milk and honey.' Degradation of our environment and natural resources has been spurred on by increasing development and pursuit of the dollar. Obviously, there is a great interrelation between incentives. But, "the technological dynamic is driven by basic economics" (Morris, p.252), meaning that once we have taken the maximum value from an object we search for new ways to find value. So, for greenroofs, this means that once the basic economics are understood the widespread acceptance and use will occur.

Although environmental awareness is creeping into the national consciousness, greenroofs won't truly become valuable players until the economic benefits are understood. Once the economics are expounded then we will see greater use on all levels of scale.

Regardless of all arguments on what benefit is the most important and most critical to popularization of greenroofing technologies, the concept should be simple. Save short-term installation costs, greenroofs carry an advantage over conventional roofing systems in every aspect of use.

The realization that nature is ubiquitous, a whole that embraces the city, has powerful implications for how the city is built and maintained and for the health, safety, and welfare of every resident. Unfortunately, tradition has set the city against nature, and nature against the city. The belief that the city is an entity apart from nature and even antithetical to it has dominated the way in which the city is perceived and continues to affect how it is built. This attitude has aggravated and even created many of the city's environmental problems: poisoned air and water; depleted or irretrievable resources; more frequent and more destructive floods; increased energy demands and higher construction and maintenance costs than existed prior to urbanization; and, in many cities, a pervasive ugliness. Modern urban problems are no different, in essence, from those that plagued ancient cities, except in degree, in the toxicity and persistence of new contaminants, and in the extent of the earth that is now urbanized. As cities grow, these issues have become more pressing. Yet they continue to be treated as isolated phenomena, rather than as related phenomena arising from common human activities, exacerbated by a disregard for the processes of nature. Nature has been seen as a superficial embellishment, as a luxury, rather than as an essential force that permeates the city. Even those who have sought to introduce nature to the city in the form of parks and gardens have frequently viewed the city as something foreign to nature, have seen themselves as bringing a piece of nature to the city.

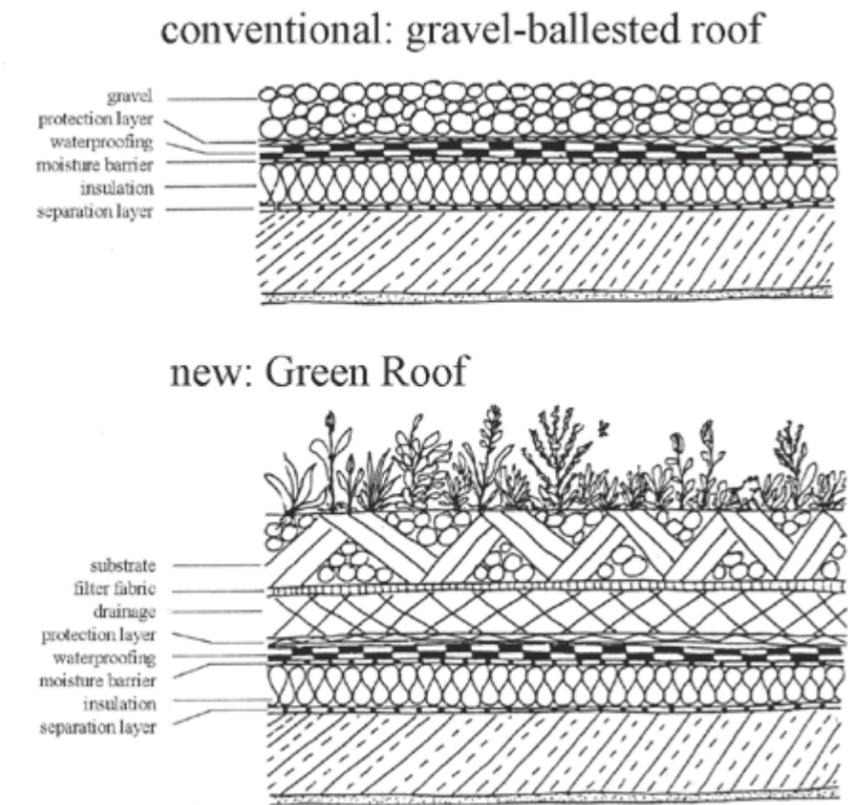
To seize the opportunities inherent in the city's natural environment, to see beyond short-term costs and benefits, to perceive the consequences of the myriad, seemingly unrelated actions that make up daily city life, and to coordinate thousands of incremental improvements, a fresh attitude to the city and the molding of its form is necessary. The city must be recognized as part of nature and designed accordingly. The city, suburbs and the countryside must be viewed as a single, evolving system within nature, as must every individual park and building within that larger whole. The social value of nature must be recognized and its power harnessed, rather than resisted. Nature in the city must be cultivated, like a garden, rather than ignored or subdued. —Anne Whiston Spirn, The Granite Garden

APPENDIX

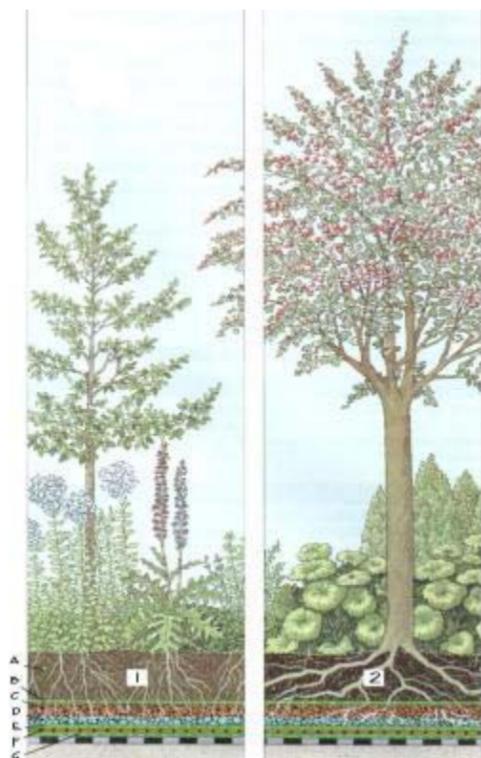
Technology/Components

Different companies and sources make varying distinctions on what components are exactly needed for greenroof installation but one thing is certain, intensive and extensive greenroofs can vary widely. Generally speaking, there are seven basic layers comprising greenroof construction. As explained by Linda Velasquez, the seven basic layers are a waterproof membrane, insulation layer, drainage layer, filter membrane, soil substrate, plant material, and water storage & insulation.

Figure 3 & 4. Roof treatment comparison. (Source unknown)



Figures 5 & 6. Intensive and Extensive greenroofing components (source: Optima Planungs-Unterlage 9/97).



Height: 36 inches – 15 feet 1 – Lighter Weight 2 – Heavier Weight A – “Optima-Kennkorper” Intensive Soil Substrate B – Fleece Filter Fabric Screen C – “Optima Perlite” Drainage Layer D – Rainwater Retention Layer E – Insulation Layer F – Root Barrier Course G – Waterproof Membrane Protective Barrier



Simple Plant Communities: Height: 2 – 3 inches
 A – “Optima-Kennkorper” Extensive Soil Substrate
 B – Insulation Layer
 C – Root Barrier Course
 D – Waterproof Membrane Protective Barrier

Literature Review

The actual concept of greenroofs as related in several of the articles actually dates back to Nordic traditions of planting sod on roofs to counter the harsh climatic conditions of their environment. From these rudimentary beginnings the green roof movement found its way into Germany where over the past several decades it has become a widely accepted means to achieve ecologic, economic, psychological and aesthetic benefits. In the United States, however, as explained by J. William Thompson the idea of greenroofs is but a fledgling idea. Because of this, the resources available are somewhat limited especially within journals of landscape architecture.

The typical article encompasses the use of greenroofs more as an accent or a means to achieve certain appearances. Two such examples are from *Architecture Journal* in which the authors refer to the greenroof systems installed as a way to “not encroach on the archeologically sensitive site” and “reduce the impact of the new construction on the two [adjacent] listed buildings.” The use of these roofs as a way for thermal insulation and to stabilize internal room temperatures is mentioned as a secondary consideration. Indeed, all articles used for this literature review, save two from *Landscape Architecture Magazine* (both authored by J. William Thompson), came from Architecture journals.

The books encountered where about rooftop architecture or rooftop opportunities and only touched upon greenroofs if even mentioning them at all. The traditional reference to rooftop greening involves the use of rooftop gardens and not necessarily greenroofs.

Overall, most of the material I’ve come across on greenroofs speaks to the aesthetic and ecological aspects of the movement. What seems to be lacking are writings on the psychological and especially the economic benefits of greenroofs. In actuality, the best reference I’ve come across involving greenroofs is a website by Linda Valesquez listed as greenroofs.com which does a nice job of explaining the history, benefits, and past and present projects related to the greenroofs movement. It was an invaluable resource for this project as it is the most comprehensive source of information available.

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Personal Correspondence

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Kimberly Worthington, Assistant Commissioner, Department of Environment, City of Chicago; spring 2001.

Charlie Miller, Principal, Roofscapes, Inc.; spring 2001.

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Intern – Summer 1997 and January 1998

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