Technology as 'Praxis of Inquiry' in Architectural Design: Adaptability | Modulation | Emergence

by
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Abstract

The formal break in our 'connection' to the natural world, by virtue of the barriers we construct to enclose space and control our environment, and the constant effort to embody that connection back into the built environment while accommodating the essential needs of the inhabitant, is rationalized through the rigorous integration of art and technology in architecture. This ongoing dialogue of inquiry, encompassing exploration and experimentation, of and between the disciplines of science –the pragmatic real of technology– and, culture –art as the emergent real of the idea, takes place throughout the entire process of the architectural 'event'. Drawing on several theories that reflect on the dialectic of science and culture (or technology and art) as well as those that address architecture as a series of processes or objects in time, architectural design is addressed as a reconciliation of planes, a series of seamless connections of parts, addressed through *inquiry and innovation* to create form. Inspiration, technology and process, acting on, or re-acting to what has come before, what exists, or, what it now aspires to be, as matter fuses in time and space as a 'series of events' that is architecture. Successful design examples are best when art and technology come to embody the other, and as such reveals a promise for new adaptations, topological modulations and emergent potentialities of progress to those who follow.

Acknowledgements

I wish to give thanks to the following people for their support, guidance and encouragement during this process: James W. Strutt for your inspirational body of work, keen intellect, warm humour and willingness to share your 'praxis of inquiry;' Manuel Báez, my advisor, for your unwavering support and for alternately pushing me to the edge and pulling me back to ground during the evolution of this thesis; Phillip Thurtle, because you brought back that sense of wonder of the interconnectivity and 'recursivity' of it all; Charles Gordon, for recognizing my interest in technology as a social construct rather than an inclination to a specific design sensibility; Gulzar Haider, for your vision, kindred enthusiasm, and for giving me the opportunity to fulfill this dream; John Adjeleian for his gracious support and encouragement; faculty and staff at the School of Architecture for your enthusiasm and dedication to your roles as educators of the intangible; my parents, siblings and extended families for their ongoing love, encouragement and support; my peers and friends, for being both; and, with infinite love and depths of gratitude, Quintino, Sofia, Natasha and Quintin Colaiacovo, my family, most of all, for being you.

Dedicated

to

Audrey Strutt

for re-affirming the value of intellectual discourse 'for the fun of it'…and for sharing herself so effortlessly.

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ADAPTABILITY | MODULATION | EMERGENCE

> ***"Design takes the results of past production as the resource for shaping, and remaking. Design sets aside past agendas and treats them and their products as resources in setting an agenda of future aims, and in assembling means and resources for implementing that."* (Gunther Kress)[i]**

Introduction

> *"I would argue further that when technology is applied to an art it ultimately shares in and influences that art's aesthetic dimension."*[1]

The title of this paper could have been inverted to read 'Architectural Design as 'Praxis of Inquiry' in Technology'. As such, and taking creative license with the above quote, *'I would argue further that when artistic thought (or inquiry) is applied to technology it ultimately shares in and influences that technology's innovative development.'* The inter-changeability of these terms should give the reader a good idea of the proposition of the following text. Analytic and intellectual inquiry into both these areas –and the balance achieved one to the other– is what determines the strength of the object's gesture, posture and juxtaposition, and that ultimately determines the success or failure of the architectural 'event.'

In *The Tell-the-Tale Detail*, author Marco Frascari refers specifically to the architectural detail, which is presented as a joint or juncture of parts and/or materials at

[1] Odoerfer, Joseph B. "The Poetics of thermal Technology." On Architecture, the City, and Technology. Ed. Marc M. Angelil. Stoneham, MA: Butterworth-Heinemann, 1990. 106

all scales, dimensions and angles. To extrapolate, his theory then applies to all the conceptual and technological elements of the architectural object as, per his article, the detail serves as the 'unification of construction –the product of *logos of techné*- and construing -the product of the *techné of logos*.' He claims that it is this "*double-faced role of technology…which unifies the tangible and the intangible of architecture.*"[2] He refines this premise in a footnote that states:

> "*In the architectural detail, the practical norms (technology) and the aesthetic norms (semiotics) come together in a dialectical relationship.*" [3]

This relationship is defined through inquiry as the 'unification of the constructing and the construing.' Novelty is achieved through the process of inquiry, or, as stated by Frascari, through study, to achieve an assembly of 'spaces and materials in a meaningful manner' and by the 'violation of functional canons'[4] where the making of the architectural artifact serves a 'functional advancement.'

Normally, before proceeding with such a proposal, it would be common practice to commence with succinct definitions of the terms 'technology', 'inquiry' and 'event' in the context of this paper and/or Architecture. However, the definitions herein will be cursory at best, it is actually the premise of this paper that even though the terms are definable –each has a multitude of lexicon applications and endless definitions– both are considered in the broadest, all-inclusive sense of each term. A closer look at the impact of

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[2] Frascari, Marco. "The Tell-the-tale-detail," Semiotics 1981, J.N. Deely and M.D. Lenhart, eds. New York, Plenum Press, 500.
[3] Ibid. 512.
[4] Ibid. "Function and Representation in Architecture," Design Methods and Theories, Vol 19. 1985. pg 212

one on the other, and the resulting modulations of the 'idea' and the 'technology' in the 'design process', will show a complex and endless progression of simultaneous 'recursivity' and productivity during the manifestation of an architectural idea, as it evolves through the process to an 'emergent real'.

What is technology? Traditionally, technology included a reduction in the physical effort required to produce work(s), even if accompanied by an increase in cerebral activity –to be cognitive of the appropriate action to complete or apply the required technology. Simply, as '*techné*' and '*logos*', it can be any 'technique, process, tool, machine or material' applied with 'intent, knowledge or thought' –and vice versa- to achieve any task or work with greater ease or precision and/or less time. The work produced by the technology may be a product in and of itself, or, a source of raw material for other technologies. There is a property of potential that can be an influence, a problematic, a consideration, or a prospect, understood to be present in any existing technology, and may impact on or 'effect' the designer, the structure, the form, the services, the user, and even the technologies themselves.

'Inquiry' in the context of architectural design, is the process of thought as it is applied to the problematic of producing a programmatic solution in the ongoing quest to enclose space to define its use and to accommodate, in the most poetic manner possible, the inhabitants. This can include scientific research, creative contemplation, pragmatic thought, or any combination of the above. This inquiry, born of concept or inspiration, will impact on the technology selection and/or modification processes chosen to resolve the design problematic by determining which technology may be used, changed, innovated or rejected, to best realize the 'idea'.

'Event' is addressed as it relates to architecture as events in the process of design, in the construction of the object, and in its use, evolution, changes and eventually its demise or demolition. Architecture is a constantly evolving representation of progressive instances of time. Adopting the scientific 'quantum gravity theory' of time, this paper attempts to show how the process of architectural design is a process of inquiry, the process itself a series of events, influenced by past, current and yet to be realized potentialities to produce an architecture that is a synthesis of both art and technology. It is in the lessons of failure, or success, partial or implied, that the evolution in the next iteration is propagated, and it is in the potentialities to change, improve or innovate what has come before that serves as an influence on what is to follow. Architecture, therefore, forms a series of discrete events that can be seen as 'style' only when regarded with a backward glance from the future.

As vague as the above short definitions are, and in spite of the customary practice to define a term to its nth degree, for the purpose of this paper, these sweeping definitions may not even be broad enough. The above define only a small part of the dialectic between a given technology and/or the creative thought process, not the potential it has to percept or effect change, on itself and anything that may be affected by its use and/or any subsequent innovative application resulting from its existence, 'virtual' or 'real'.

Additionally, this text is not about a specific technology or a specific or critical style of design. It proposes, however, that the practice of architectural design is a process, a process that is a series of events leading ultimately to the manifestation, or edification, of the 'idea' as an architectural object. An ongoing dialogue of inquiry, encompassing exploration and experimentation, of and between the disciplines of science –the pragmatic real of technology– and, culture –the emergent real of the idea. Design manifests itself as the contiguous assembly of planes in space as form, and by the articulated transition of these disparate elements, at various scales, into a cohesive whole. It is in the realm of architecture, through the process of inquiry, that art and technology come to embody each other, and as such, reveal promise(s) of new adaptations, topological modulations and emergent potentialities, simultaneously representing and acting as inspiration on those of the present and future eras.

Theory

Three theorists considered during this effort offer a connecting theme through the plethora of ideas that have evolved to theoretically address the domain of technology and culture. The first raises the issue of both the scientific and cultural milieu using multi-disciplinary education as a facilitator to dialogue, the second offers constructs for members of society to influence and/or effect change at the systemic level, while the last addresses the constructive (and destructive) properties of time as an emergent potential of influence on both the built and natural environment.

Theorists

C.P. Snow

CP Snow, in '*The Two Cultures*'[5] takes a close look at the philosophical divide between the Literary and Scientific communities. A seminal work of the 1950s and 1960s, Snow, a scientist and author, was intimately involved in both fields and brings a keen perspective on the differences between the two "cultures". When Snow was first presenting this issue to both disciplines, it was not a new topic of consideration. The dialectic, or (as the case may be) the dichotomy, between the arts and 'natural sciences' have been the fodder of many a philosopher, sociologist and historian over time. It is Snow however, who re-animated the dialogue in the twentieth century, first through an article in the mid 1950's, and then with his presentation at the 1959 Rede Lecture, one of Cambridge's most prestigious events.

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[5] Snow, C.P. The Two Cultures: and a Second Look. Cambridge University Press. London. 1963

In Snow's article on 'two cultures' published in *The Statesman* on the 6th of October 1956, the split between the two cultures, dealt more with the perceived indifference to science (and scientists) by the 'literary intellectuals' who Snow saw as highly educated elitists, the political 'power' class of the country. The Rede Lecture of 1959, when published, set off a thirty-year period of discourse and controversy over the issue of the 'two cultures'. Snow addressed the issues of the day and how both disciplines were trying to address these problems. Each was contributing a great deal of effort to solve problems of social unrest, poverty and the impacts of industrialization and technology; however, they were doing it in isolation. He called upon the politicians and power brokers of the day to implement more interdisciplinary studies into the educational system as the most appropriate method to achieve the most beneficial advancements in both the sciences and the arts.

Following the publication, Snow received many accolades and published endorsements to his concept. These gave way to more intense discourse and, as it is with all polemics of the day, scholarly criticism. The initial critics of Snow, primarily literary academics, were quick to point out the weakness in Snows arguments, data and statistics. Regardless to the criticisms, the main or 'big idea' of the cultural divide was seen to be one of the critical issues of the time and many scholars, scientists and representatives of the arts joined in the discussion. Snow -and many of his detractors- felt that the ongoing 'specialization' or 'exclusivity' that was happening in both disciplines would have long-term detrimental effects without more interdisciplinary studies and/or cooperative exchanges between the two 'divides' of the arts and sciences.

Snow later added that he was not satisfied with solely an academic solution to the issue, and admitted that the split between the cultures was an indication of additional issues of class and political power.

> " *Changes in education are not going to produce miracles. The division of our culture is making us more obtuse than we need be: we can repair communications to some extent: but, as I have said before, we are not going to turn out men and women who understand as much of our world as Piero della Francesca did of his, or Pascal, or Goethe. With good fortune, however, we can educate a large proportion of our better minds so that they are not ignorant of imaginative experience, both in the arts and in science, nor ignorant either of the endowments of applied science, of the remediable suffering of most of their fellow humans, and of the responsibilities which, once they are seen, cannot be denied.*"[6]

Stefan Collini, who wrote the introduction to the 1993 Canto edition of "*The two Cultures - CP Snow*" suggests that Snow had started to address those larger global issues so as to refine his basic concept later in life. Quoting him from one of his last public statements, taken from 'The State of Siege' (1968), *Public* Affairs, p.220, delivered at Fulton, Missouri, Collini sums up C.P. Snow's final cause d'etre:

> " *'One often hears young people asking for a cause', Snow observed. He offered to give an answer in the simplest terms, and he emphasised that he had intended his idea of 'the two cultures' to help contribute to the realization of these goals. 'Peace. Food. No more people than the earth can take. That is the cause.'* "[7]

He always felt that the best minds of the past had been those that were not only aware of the 'other' culture but who had actively followed a dialectic inquiry between the

[6] Snow, C. P. The Two Cultures. Canto Edition. Introduction by Stefan Collini. Cambridge University Press, New York, 1993, p 100.
[7] Snow, C. P. The Two Cultures. Canto Edition. Introduction by Stefan Collini. Cambridge University Press, New York, 1993, p lxxi.

two. Snow wanted the youth of the day to take up the 'cause' and felt that real success would only be possible when problems were addressed from the perspective of both 'cultures' because it is in the fusion of art and science that the evolution of mankind would be at its most progressive.

Andrew Feenberg

In the book, *Questioning Technology,* Andrew Feenberg explores similar issues relevant to this discourse from the critical theories of technology, philosophy and politics. Starting with the student revolt in Paris of May 1968, which he presents as the start of the 'modern' technological critique, he takes us on a 'socially conscious revisionist foray' into existing philosophical critiques of technology and technological progress.

Feenberg presents us with both social and cultural issues that have driven the development of technologies/technocracies, and the political events initiated because of the impact of these technologies/technocracies on social and cultural issues. Feenberg states in the Preface of his book:

> *"Every major technical change reverberates at many levels, economic, political, religious, cultural. Insofar as we continue to see the technical and social as separate domains, important aspects of these dimensions of our existence will remain beyond our reach as a democratic society. The fate of democracy is therefore bound up in our understanding of technology."* [8]

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[8] Feenberg, Andrew Questioning Technology, New York, Routledge, 1999 (pg vii)

However, rather than the educational system Feenberg foresees the 'needs and wants of the many' being tactically enforced on the networks of today, by the users of the 'system' to bring about technological and systemic transformations which, in their turn, will be modified to suit new ideals just being imagined to better our political, social, cultural and environmental potential. One of the initial points that Feenberg takes issue with is the fact that technology has often been presented as an autonomous entity of efficiency, and/or rational controls, imposed on society in the form of tools or devices. However, he feels it is the influence of society that is, and should be, imposed on technology.

> *"...at any given stage of its development, a device will express a range of these meanings gathered not from "technical rationality" but from past practices of its users. Technology as a total phenomenon thus must include an experiential dimension since experience with devices influences the evolution of their design."*[9]

He also points out that this 'influence' is currently in a subordinate position in the technical system, and it is critical that we, as 'society', recognize the importance of our contribution to technology. Feenberg asserts that we have not only the opportunity to take a more conscious and active role in the development of technology, but that we must *"intervene in the design process in the defense of the conditions of a meaningful life and a liveable environment"* [10]

The 1980s saw technology being critically assessed as a 'normal social phenomenon' rather than some external force. Constructivist theory, which proposed that

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[9] Feenberg, Andrew Questioning Technology, New York, Routledge, 1999 (pg xiv)
[10] Ibid (pg xiv)

there are always alternatives to technological advancements, studied the issues that led to technological change. Constructivists focused on the social alliances that lay behind the technical choices made. They confined themselves to the *"...study of the strategic problems of building and winning acceptance for particular devices and systems."* [11] However their studies where limited to the *'few official actors'* that were involved in the production, or marketing, of a given technology, and as a result the ongoing social acceptance/resistance to the technology or society's influence on change was not addressed.

> *"The frequent rejection of macro-sociological concepts such as class and culture further armors the research against politics by making it almost impossible to introduce the broad society-wide factors that shape technology behind the backs of actors."* [12]

Feenberg revisits this premise later in the book and suggests that these same actor networks (business-persons, technicians, customers, politicians and bureaucrats) can be used as a basis for a new take on constructivist theory that includes micro-political resistance as part of our understanding of technology. He also suggests that technology is circuitous to solutions for any of our ethical, cultural and environmental matters *"since technology is routinely adapted to changing social and economic conditions, there is no reason of principle why it should not be redesigned to conform to the requirements of such a culture."* [13]

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[11] Ibid. (pg 11)
[12] Feenberg, Andrew Questioning Technology, New York, Routledge, 1999 (pg 11)
[13] Ibid. (pgs 66 & 67)

Feenberg describes this process as the 'pathos of gathering and revealing' the 'needs' and the 'wants' being transformed into new technologies that become more effective, efficient or, as the case may be, amusing, but which in their turn will be modified as they reveal new or unforeseen possibilities.

> *"This encounter is not simply another instance of the goal-oriented pursuit of efficiency, but constitutes an essential dimension of the contemporary struggle for a humane and livable world."* [14]

Feenberg has presented an authoritative and optimistic view of technology and modernity. He has given us a heads up regarding the opportunity, *and responsibility* for the development of technology that will be beneficial to the creative development of environmental/social/cultural/political/democratic advancements of humankind.

> *"In that future technology is not a fate one must chose for or against, but a challenge to political and social creativity."* [15]

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[14] Feenberg, Andrew Questioning Technology, New York, Routledge, 1999 (pg 199)
[15] Ibid. (pg 225)

Sanford Kwinter

In Sanford Kwinter's *Architectures of Time* he proposes that all things 'change and arrive in time'. Kwinter suggests five areas of 'interrogation'[16] that relate to architecture: '*novelty'*, that which is new or that which is presented in a new way so as to bring notice to itself; *' the object, '* as novelty or continuum, is the manifestation of the design or 'idea'; *'time'* as a quantum measurement or as a point independent of 'real' time, from which to look at discrete instances of events from a specific perspective. The moment we reflect on what has just come about, the 'thing' as opposed to the 'event', we abstract and spatialize time, time becomes an instrument of measurement. 'Real' time is more like the duration of the event coming into being, or expressed as the process of becoming, *' movement',* the actual act or motion, up to, through, or away from an object that is completed in time, and '*event,'* as the object coming into being, and the subjective experience of the individuals movement in time through the object.

Kwinter states that rather than a preformed, pre-existing morphology that realizes a 'predetermined' event, or a limited set of possibilities, novelty is the result of an ongoing blitz of transformations and differentiations over time. These are qualitative processes that result in innovation and invention on, and to, existing (quantitative) matter, and it is only through the passage of 'time' that the new, or novel, becomes possible.

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[16] Sanford Kwinter, Architectures of Time: Toward a Theory of the Event in Modernist Culture, The MIT Press, Cambridge, Massachusetts, 2001, p 11.

> *"The relation of the virtual to the actual is therefore not one of resemblance but rather of difference, innovation, or creation (every complex, or moment-event, is unique and new)."*[17]

Novelty is a product of time, in the same manner as time is the principle that "*corrupts, transforms, and diminishes Forms, evolving them towards disuse, decrepitude, and disappearance, also gives, produces, and creates.*"[18] Everything that emerges may begin in a 'realm of the possible' but through a "*...continuous, positive, and dynamic process of transmission, differentiation, and evolution...*"[19] matter becomes a novel object through time. It is subject to a process of variant morphogenesis, a reality of endless creative variables, which compound themselves at every successive step in the process of their coming into being. From the iteration of the idea to the actual emergence of the object, it is qualified by discontinuities, innovation, invention, and, even if minutely, the ceaseless upheavals that take place in the world around them.

This is similar to what scientists and physicists are proposing today in 'Loop Quantum Gravity' theories. Space is not a 'fixed' geometry, but a background independent "*evolving, dynamical quantity*".[20] This new theory unites Einstein's theory of general relativity and quantum mechanics. Space is proposed as a series of quantum states of area and volume, discrete units, not a continuous element. Concentrations of energy or fragments of matter can distort the geometry of space and cause a deflection toward themselves, this is known as the phenomenon of gravity (typically a large object or

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[17] Sanford Kwinter, Architectures of Time: Toward a Theory of the Event in Modernist Culture, The MIT Press, Cambridge, Massachusetts, 2001, p 8.
[18] Ibid, p 7.
[19] Ibid, p 10.
[20] Lee Smolin. Atoms of Space and Time, Scientific American: Volume 290, Number 1 January 2004

blackhole). Similarly, the units adjoining, merging and separating cause the shape, or distortions in the shape, of the unit, as matter or energy move around within them, or when gravitational waves flow by. These changes, or phenomena, are a series of events that are both simultaneous and contiguous, which create a rich texture of networks, called spin networks. Each network is formed from the existing field or matrix. It is in the process of coming together, the forces it is subject to, and other objects in the field that impact on it, that influence the 'form' of the new network (object). The form evolves from the concatenation of discrete objects through a series of events and is always subject to change as a result of impacts from other discrete elements or formed objects.

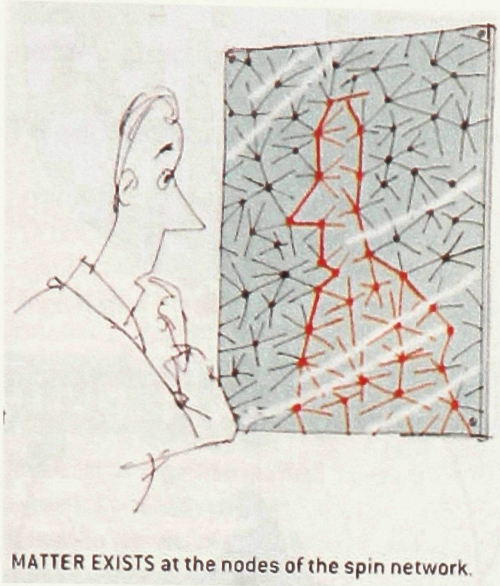

Figure 1 Spin Networks describe the geometry of space (Smolin, 2004, 71)

> "*What is real is the continual* ***change*** *of form:* ***form is only a snapshot view of a transition.***" (Henri Bergson)[21]

In the scientific world these spin networks are represented mathematically as graphs. A single line represents one quantum of area, volume is represented by a node (or point) as the centre of the

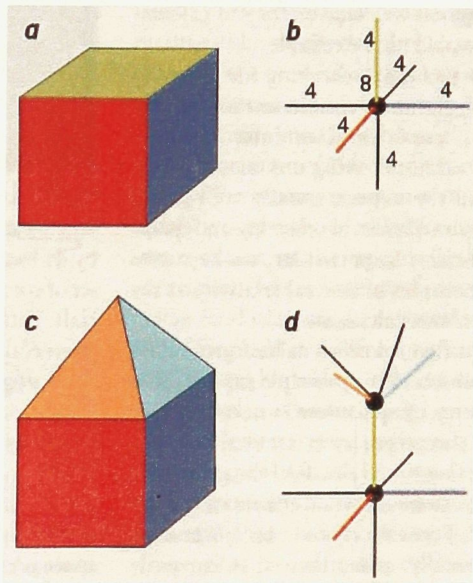

Figure 2 States of volume shown as graphs (Smolin, 2004, 70)

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[21] Kwinter, Sanford. Architectures of Time: Toward a Theory of the Event in Modernist Culture, The MIT Press, Cambridge, Massachusetts, 2001, p 33.

volume with lines representing each of the surface areas of the volume (see Figure 2). To add the component 'time' to these spin networks the lines are extended into planes (see Figure 3, a) and the nodes into lines, a plane representing time is added to the network. This new network (called spin foam) can be sliced perpendicularly through the node and the planes, at particular intervals (like frames of a movie) resulting in a series of spin networks that show the significance is not the period of 'time' once established, but in the difference of the network with time or without (see Figure 3, b). Time, like matter, is shown to be a series of 'discreet moves, not by a continuous flow' but by a discontinuity in the discrete geometry, that rearranges the network. Time is similar to the "ticks" of a clock rather than a smooth continuous flow.

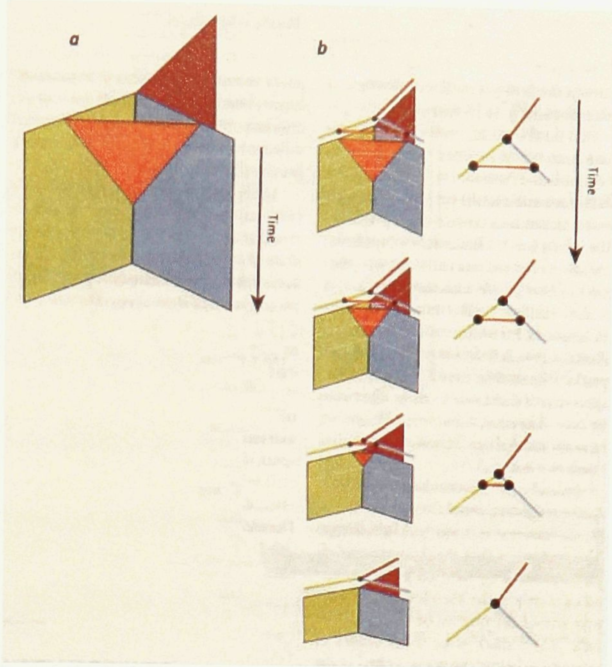

Figure 3 Intersections of time and space shown as discrete events (Smolin, 2004, 73)

> "*Or, more precisely, time in our universe flows by the ticking of innumerable clocks -in a sense, at every location in the spin foam where a quantum "move" takes place, a clock at that location has ticked once.*"[22]

In the process of 'formation' a series of discrete moves takes place, each an event uniting time and matter. Changes, influenced by the cacophony of forces within and around the object and by other objects that surround them, 'form' the object as it comes into being, generating the emergent potentialities within it that embody time.

[22] Lee Smolin. Atoms of Space and Time, Scientific American: Volume 290, Number 1 January 2004

Architecture as a process is much the same. It is not just technology applied to a quantity of matter, but a qualitative process based on the knowledge, and practices of an Architect and his/her team, the site, its conditions and climate, the program(s), the budget, the technology, the materials, expected lifecycle, and current cultural conditions, all to achieve an 'ideal'. Additionally, according to Kwinter, 'real' time is not only in the process of design and build, or just *'in the emergence process of architecture as an event'.* He proposes that in the case of existing architecture, there is a potential in the emergent properties of the existing to impact on the yet to be created, a static state of pending connection, an immanent cause for that yet to come, a modality to the principal of change.

The resulting architecture, or unity of time and matter, will age and decay as nothing is static in this world of evolving dynamic matter, and, as previously mentioned, the same forces exist in creation and destruction. However, the sense of continuity is in the property within architecture to propel potentialities into the future. In subsequent projects, the conceptually based 'ideal' is fashioned in the mind of the designer and is influenced by a reaction (positive or negative) to the emergent potentialities or possibilities within existing or past events. It then evolves subject to the innovative and inventive blitz of transformations and differentiations as the technology, materials and methods take form. Each stage of the architectural process is equivalent to an event in time, from design to decay, and each stage can have sub-stages. Issues must be addressed at all stages, and results are most successful when both the scientific/technology and the cultural/art elements are seamlessly integrated.

If space is a realm of evolving dynamic quantities of matter, then time can be seen to be a particle of the same dynamic quantity, the background or in-between of the matter. Time comes into being with the emergence of the object, embodied in the 'event' of the object coming into being. As matter comes together and 'forms' the network (or object) time is encapsulated within the form. As the form, the network that is the object, begins to breakdown and decay, encapsulated time reverts to the cosmos; eventually the final event of the object is the last letting go of the network and the reversion of time back to the undulating matter of unformed space. Real time is equal to the 'event'.

The object as a 'space-time event' represents all the fluctuations, modulations and influences that have caused it to come into being. Influences, be they forces of matter or meta-physics, have affected architecture throughout the history of 'Western Civilization'. Climate, site and materials have been modulated not only by 'natural evolution' but also by 'cultural evolutions', often, but not exclusively, from, or of, a religious foundation. From the monumentality of the Egyptian cities of the dead, the classicism of the early Greek 'Polis' of temples and governing institutions of the people, the impact of the Dark-ages, and through to the periods of the Renaissance and Enlightenment in Europe at which point science started to upset religion as the dominant cultural influence.

Throughout the modern era, the culture of the 'machine' has dominated most of our arts and as a result, the technological influence has been represented in the built form from both a scientific and cultural perspective. The 'modernists' of architecture were influenced as much as, and by, what was happening in both the arts and scientific communities of this period. Without reiterating the whole body of thought in modernist discourse and theory, it is sufficient to say that the 'machine', new material products and the resulting new modes of transportation, were to have significant impact on the 'ideals' of fragmentation, deconstruction, and metaphor in the architectural environment.

Theory Summary

Snow, Feenberg and Kwinter's theories show that it is in the potentiality, or emergent properties, within the existing world around us that influences what and how we design, what and how we integrate technology, and, what and how materials will be manipulated to best realize the 'ideal' as a 'novelty'. There is a necessary, and ongoing, dialogue between art and technology, and it is the successful synthesis of the two, that we find the most potential for influence and 'evolution' of the object.

Frank Lloyd Wright proposed a similar philosophy in 1908, in the initial article in his series '*In the Cause of* Architecture,' and he expanded on the roles of both architect and machine in a series of follow-up articles in the same series. Wright states that it is in the pursuit of the ideal, that architects must rigorously explore possibilities of what technology can do to assist in the manifestation of their concept, and to adapt, innovate or invent where necessary, to overcome its limitations, so as to never compromise to technology or become slave to the machine as Master.

> "*The machine is the architects tool –whether he likes it or not. Unless he masters it, the machine has mastered him.*" [23]

The formal break with our 'connection' to the natural world, by virtue of the planes we construct to enclose space and control -or suspend- the environment directly around us, and the constant effort to embody that connection back into the built

[23] Frank Lloyd Wright. In the Cause of Architecture: The Architect and the Machine. Article printed in The Architectural Record, May 1927.

environment while accommodating the essential requirement of comfort (both physical and spiritual) for the inhabitant, must be rationalized through a careful integration of art and technology. Wright goes on to state that it is only in this fashion that the architect actually influences the architecture; it is only in hindsight that the style of the designer is made evident. It is the concept, whether or not the ideal is achievable, that must influence the technologies chosen to produce our enclosed world.

Once manifested in built form, critical thought, technology, environment and users will continue to affect the architectural object (and by continuity, the original idea/the original construct), and its ongoing dialogue with its world will influence new explorations of inquiry. Time is now infinite in the emergence of the idea. Even after demolition, the lessons learned from that iteration are carried forth as a basis of consideration for what is to follow. Continuity in architecture is therefore infinite. The design lessons learned are considered in context of upcoming technologies, technologies that evolve based on implementation, innovative use and 'by design.'

In the evolutionary progression of architectural design, and even at the more radical junctures of change, what is proposed is a reaction to what has come before. At times a rejection of the past, at others, a folding back on itself and embracing its past, and even as a projection into the future, the continuity is not in the 'style' but in the very construct of architectural design itself: emergent potentialities and time embodied ... ad infinitum.

Peter Wong gives us an illustration of how this dialectic between design and technology happens with an example from Louis Kahn, as Kahn recounts a personal experience that brought home a personal revelation of the concept.

> *"One day waiting for a friend, I watched the crane lifting heavy (concrete) members at the (Richards) Medical Building at the University. On previous days, watching its movement, I resented its presence –a red painted monster, out of scale with the buildings and the members it was lifting into place. It imposed its image on every progress photograph, but because I had to hang around it, it gave me a chance to reflect on its meaning and I realized that the design of a building could have a direct bearing on how capable the crane. I thought of columns a few hundred feet away from each other carrying great spans. No longer did they appear as columns really but as stations, a composite grouping of service rooms composed of large prefabricated and intricate parts ... the column formed a space itself designed to serve a greater space ... Because the members were so big, weighing even more than the crane before could carry, I imagined that I would demand bigger cranes and forget resentment ... suddenly the crane became a friend."* (Kahn, Louis. 1986)[24]

Here Kahn reveals an example of the 'essence of technology' being recognized, and stimulating the resulting conceptual 'inquiry', inspiring a new concept of design and the design revealing a new requirement –'the bigger crane'- of the technology. Much as technology may relate to a specific or intended project, it also effects a stimulus to the process of imagination inspired both by what the technology is 'doing' and the recognized potential of what a similar (faster, slower, bigger, or smaller) technology can be applied to accomplish. This is by no means a new concept. The influences of the machine, and the impact of technological advancements in 'materials', have been part of architectural discourse even before the industrial era.

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[24] Wong, Peter. "In Transitu: Material Simulation in the Design Studio" On Architecture, the City, and Technology. Ed. Marc M. Angelil. Stoneham, MA: Butterworth-Heinemann, 1990. 69-70.

Technology: Machine and Material

Perhaps two of the most influential 'technological' events that had, and continue to have, impact on the development of architecture of the modern age, are Otis's development of the 'safety brake' and Paxton's Crystal Palace. The safety brake, which led to the development of the passenger elevator as we know it today, and Paxton's exhibition hall, which has led to new component assembly methodologies and the current use of glazing systems that serve as both structural elements and building envelopes, were developed using existing and new materials in unexpected and unconventional ways. Both were technological developments that came about as innovative applications and modifications to existing technologies. It is in the integration of these two technologies into architecture that has since pushed the limits of the two.

In architectural design, both machine and material are considered for their technological, as well as aesthetic, qualities. In the following section I review two architectural technologies which been addressed in the design project of this thesis. Although this section reveals the introduction of the elevator and glass to be two significant milestones in the production of architecture as we know it today, they both existed in various forms and applications in their respective areas of development for much longer periods. However, even if each has had a significant impact on architecture, it is in the small evolutionary developments of these two technologies at the hands of designers that have resulted in the products as we have come to know them.

"...the very essence of invention is commonly misunderstood, not alone by the laity, but often by inventors, engineers and sociologists. Above all its outstanding characteristic, its evolutionary nature, its being almost wholly an age-old, multitudinous accretion of little details, modifications, perfectings, minute additions, is not fully appreciated by even the best authorities."[25]

As reflected in the above quote from S.C. Gilfillan, the nature of invention is a combination of accretion, evolution, and/or innovative use of elements and/or diverse and complex process that may influence, alter, stimulate or restrict a 'new combination' based on a prior object, idea or even, artform.

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[25] Gilfillan, S.C. The Sociology of invention; an essay in the social causes of technic invention and some of its social results; especially as demonstrated in the history of the ship. Chicago: Follet Publishing Company, 1935

Machine

Today *"an elevator is defined as a conveyance designed to lift people and/or material vertically."*[26] Essentially, regardless of its size and or its degree of sophistication, the elevation device has traditionally been for the conveyance of commodities, for getting products out of their place of origin, to storage, onto and off their mode(s) of transportation, and into their point of distribution or consumption.

Figure 4 "An ingenious form of elevator, vintage about the eighteenth century…note the guides for the one 'manpower'." (Strakosch, 1998, 2-3)

The origin of the hoist is unclear, however, it is commonly accepted that versions of straight rope hoists and 'block and tackle' type hoists, were used by the ancient Egyptians, Greeks, and Romans in both their construction projects and theatre spectacles, as well as by some of the native traditional construction traditions in both the eastern and western world. Often the counterweight for these older versions would be a stone, some rubble, or people on a platform –the size of the stone, height of the pile of rubble and/or quantity of people would be directly proportional to the weight they were attempting to raise, using whatever form of power (human or animal) was available. Mountain fortresses in Tibet, and other places throughout the world, have used versions of the windlass and 'manpower' to haul people and provisions up shear stone walls for many centuries.

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[26] Strakosch, George R. The Vertical Transportation handbook. 3rd Ed. New York: John Wiley & Sons, Inc. 1998. 1 (Original Footnote on the word 'elevator': The legally recognized definition of an elevator can be found in ANSI/ASME A17.1, Safety Code for Elevators and Escalators.)

One of the earliest recorded references to a lift was in reference to the throne-lift of Emperor Constantine VII. Luidprand von Cremona writes about his visit to the imperial court in 949 C.E., and although he is considered one of the most bona fide reporters of his time, his writings tended to be more about their entertainment value than faithfulness to accuracy. He writes of a throne that rose high above the court when the heads of envoys bowed on presentation to the Emperor. When they raised their heads, the Emperor would be so high that he was forced to address his visitors through his chancellor. In Drepper's account von Cremona refers to "*A hidden mechanism – which according to Luidprand's vague technical report, was similar to the device with which the masts of the wine presses were operated – had conveyed the throne upward.*"[27]

Lifts continued to develop in the secular and non-secular factions of society; however, most of the development was in aid of enhancing the experience of a 'spectacle'. The religious 'enactment' of the Ascension, produced by Brunelleschi in 1439, led to a great deal of similar type elevation devices being used in the 'bawdy' theatre of the day.

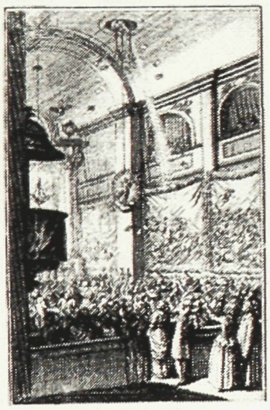

Figure 5 "An ironic-allegorical representation of an Ascension celebration." (Lampugnani, 1994, 118)

Leupold's *Theatrum Machinarum,* first published in 1724, used many of the images that had been produced over the previous hundred and fifty years to establish general principles from 'machines of similar functions.' Those devices with similar

[27] Drepper, Uwe. "Baroque Machineries for comfort." Vertical: Lift Escalator Paternoster: A cultural History of Vertical Transport. Ed.Vittorio Magnago Lampugnani and Lutz Hartwig. Berlin: Ernst & Sohn, 1994. 117

works, assembled together, some sectioned and/or given detailed views, were used to establish "*how to design machines that will do most efficiently the task at hand.*"[28] We find in this manuscript the first 'technologically' documented passenger elevator, evidence that several existed, in one version or another, by that time.

> *"The inventions which revolutionize a device or industry are commonly made by men* ***outsiders*** *to it yet informed regarding it; the far greater and more valuable mass of perfecting inventions are made by* ***insiders****."*[29]

Based on the above quote, Elisha Graves Otis would be considered one of the *outsiders* of the elevator world, at least prior to his invention of the safety brake. One can see from the evidence found in the vast majority of tall buildings today, that Otis is now synonymous with the term 'elevator'. Two other events were to have as significant an impact on the development of the elevator: the invention of the electric motor by Siemens and Halske; and, the friction (disc) drive developed by Koepe. These three developments all happened within twenty-five years of each other and were the result of ingenious resolutions to identified needs in the specific industry or business within which the inventors were participants, rather than some unified effort.

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[28] Drepper, Uwe. "Baroque Machineries for comfort." Vertical: Lift Escalator Paternoster: A cultural History of Vertical Transport. Ed.Vittorio Magnago Lampugnani and Lutz Hartwig. Berlin: Ernst & Sohn, 1994. 117

[29] Gilfillan, S.C. The Sociology of Invention. Chicago, Follet Publishing Company, 1935. pg 11

E.G. Otis was a craftsman who worked in a factory that had just had a 'lift accident' and he was tasked with finding a way to stop a plunging lift. The solution had to be one that did not require that the operator, who, due to an assumed 'elevated' state of panic at the time of the event would understandably not have the clarity of mind to pull the brake, an action required to stop the plummeting platform. He developed an '*automated safety catch*' which would stop any lift, not secured, and thus transformed the freight lift.

> *"There was certainly nothing novel about Otis' invention. The automatic spring mechanism had been a familiar device ever since the invention of the mouse trap. However, it was combined in a new way by Otis, so that it no longer served the normal but the exceptional situation."*[30]

Figure 6 *"The inventor demonstrates the safe lift: E.G. Otis, 1853, during the free-fall test at the Crystal Palace."* (Lampugnani, 1994, 57)

The potential for alternate applications was not lost on Otis, or on any other person who saw the dramatic public demonstration of this new technology in 1853.

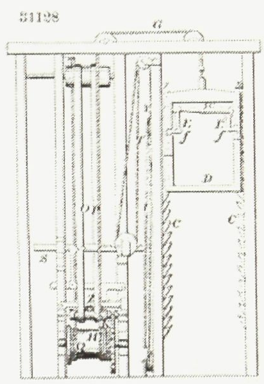
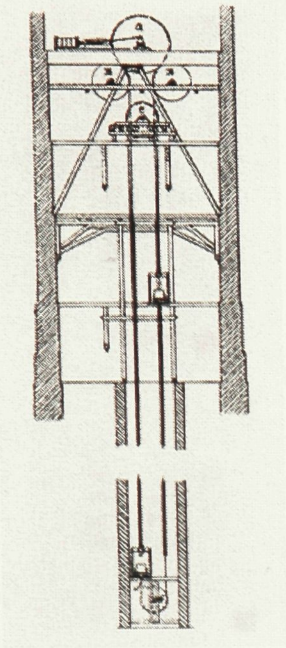


Figure 7 *"Patent specification by Otis, 1861"* (Lampugnani, 1994, 57)

[30] Lampugnani , Vittorio Magnano, and Lutz Hartwig, Vertical: Lift Escalator Paternoster. A Cultural History of Vertical Transport. Ernst & Sohn, Berlin. 1994



As previously mentioned the electric drive introduced by Siemans & Halske in 1880, and the friction disk drive, developed by Friedrich Koepe –for the mining industry to go 'down' versus up– contributed greatly to bringing the elevator to the swift and silent vertical machine we know today. There was to be additional technological advancement of this same technology, and other forms of both vertical and horizontal 'transport' have evolved as well. Some advancement has been strictly technical in nature, but many applications of this technology have been driven by the will of an architect, pushing the technology to accommodate a conceptual idea. As the ability to move vertically became more reliable and even profitable, the 'skyscraper' became a reality. The height of a building is now only limited to the physics of gravity and mass, and it has been the ambition of architects since, to dematerialize the building as much as possible.

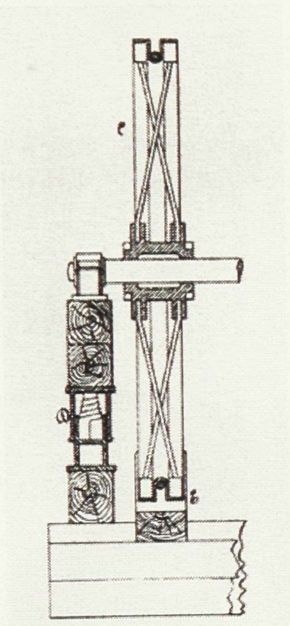


Figure 8 *"Friedrich Koepe, patent specification 218,1877; the hoisting cable ran in a dovetailed groove."* (Lampugnani, 1994, 60)

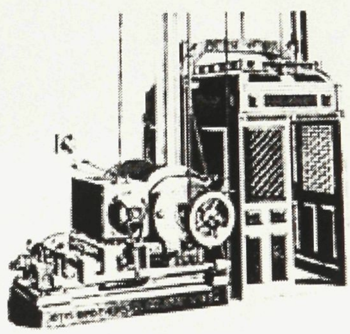
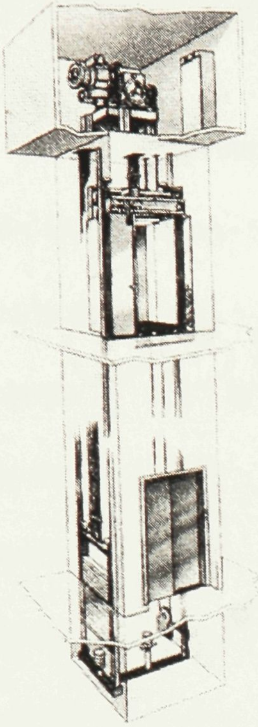


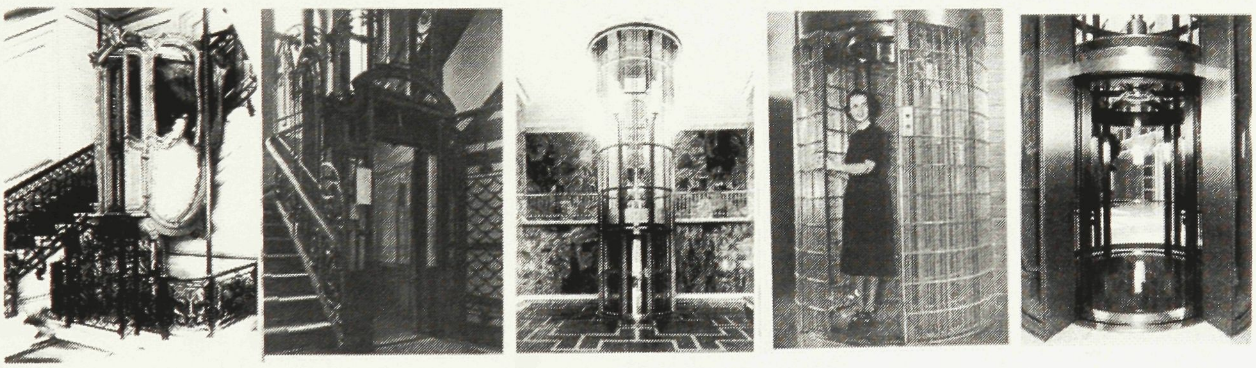
Figure 9 *"Early electrically-driven hoisting machine."* (Strakosch, 1998, 14)

The elevator has been treated as simply a required or functional system by some, and as a major consideration in the overall conceptual design of a building by others. Aesthetics of the elevator have often reflected the culture and materials of the era of the



original installation. As with any object of design the more invested in the design at all levels, from conceptual to functional, at all scales of use, the better the product. Much like the buildings they form part of, the spatial qualities of the elevator lobbies and carriages add to the sensory experience of the elevator. It may be even more obvious with so illustrious or 'uplifting' a motion as elevation. Any vertical transportation device is best when the two minutes of 'elevation' are delivered with lofty intentions, equally for the body, mind and spirit.

Figure 10 The modern *"Passenger Lift, Schema representation, THYSSEN 1986."* (Lampugnani, 1994, 57)



1901	1910	1937	1937	1994
"Salon Car, Hotel Plaza-Athéné, Paris"	*"Lift Car, around 1910, (photo: Michael Lippert, Hamburg)"*	*"Otto Firle: Functionalistic lift installation, Nordstern-Versicherung, Berlin"*	*"Frank Lloyd Wright: Lift cage in the administration building of Johnson Wax Company, Racine (Wisconsin)"*	*"Dresdner Bank, Frankfurt on the Main, THYSSEN Aufzüge"*

Figure 11 Lofty Intensions (Images from: Lampugnani, 1994, 50, 7, 50, 73, 50)

Material

The advancements in material processing and mass production brought about by the industrial age (in metal and glass manufacturing specifically), and the development of railway systems were to provide architecture with the principles of standard component assembly. However, one of the most significant effects of the advancements of a material is that it will often cause additional advancements in related materials and processes, as well as innovative applications of the material. In the case of glass, its application to greenhouses and conservatories and the resulting creation of artificial environments, and all the associated equipment and processes of microclimate controls, went through significant advancements as the new and improved material was used in both traditional and innovative ways. The advancement of glass is almost single-handedly responsible for the development of water, heating and cooling systems still used today.

Benefiting from his collaborations with John Claudius Loudon, the inventor of the iron sash, many critical theorists have recognized Sir Joseph Paxton's Crystal Palace, as the first large scale architectural application of these principles. A new glass technology had just become available to Paxton, which allowed for this ambitious project, however the evolution of glass for use in architecture had been going on for thousands of years.

Tiberius Caesar loved cucumbers. He was guaranteed an almost year round supply by his innovative gardeners who used mica stone, split into thin transparent sheets, placed over wooden planters. These planters, wheeled so that they could be placed outside on clear days during the winter months,[31] allowed Tiberius to indulge in this kind of gastronomical extravagance because of his power, stature and wealth. The glasshouse and its predecessor have traditionally been a trapping of the very wealthiest of the wealthy, especially before the industrial revolution. Following the industrial revolution component manufacturing and advancements in the standard of glass, its commercial viability and availability to the merchant and industrialist classes, led to a whole new sector of society who bought land and country estates with large gardens as they aspired to the same lifestyle as the aristocracy. As glass technology advanced, so did opportunities for architectural application, and as new uses where conceived, there would have been an accompanying push to advance the technology.

The history of glass goes back to ancient Syria. When Egypt conquered Syria in 1500 BCE, glass artisans were brought back as captives[32]. Pressed and molded glass was later developed around 1200 BCE. When Syria and Egypt became part of the Roman Empire, the Romans used glass mostly for mosaics, pipes and architectural decoration – especially tiles. Mica, alabaster and shells were still used for glazing up until the third or fourth century. Glassmaking spread to Gaul, Spain and Portugal but it was not until it reached the more northern climes that it began to flourish as glazing. By the fourth century, a thick transparent green coloured glass was used in many Roman villas, especially

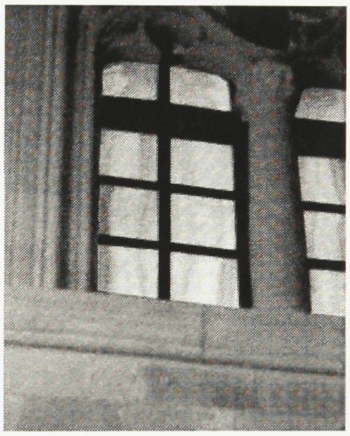


Figure 12 Transparent Mica Windows in the Palace of the Knights, Rhodes Greece.

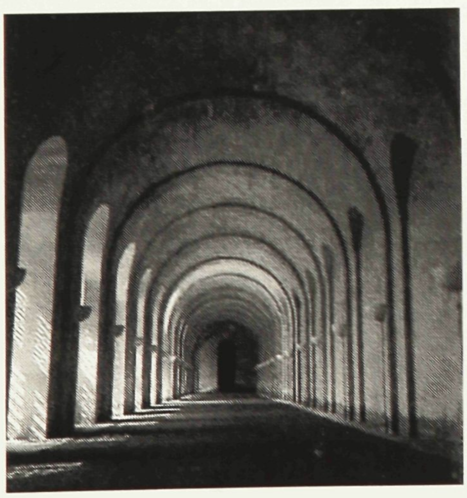
[31] Hix, John, The Glasshouse, Phaidon Press Ltd., London 1996. pg 10
[32] John Peter, Design with Glass, 1964. pg 8-9

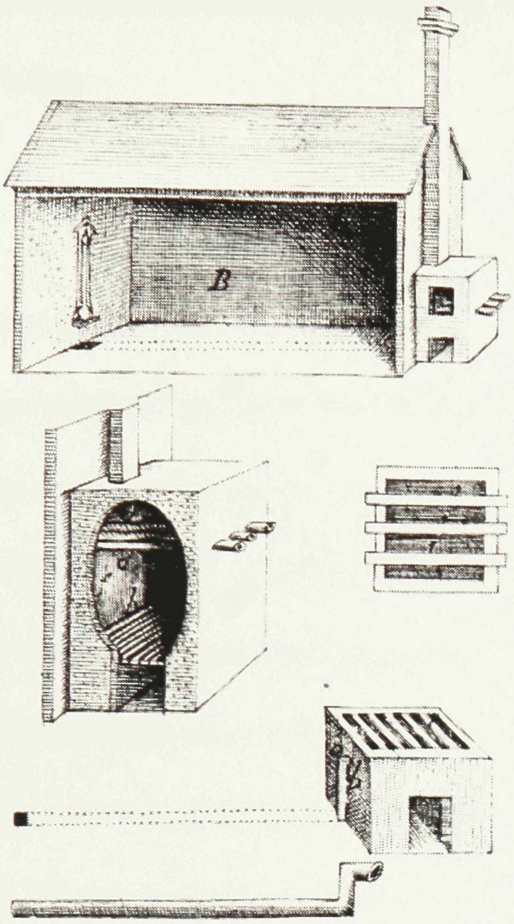
those farther north where it was more important than in the southern temperate climates to extend the growing period of fruits and vegetables. Following the fall of the Roman Empire glass use declined, being largely restricted to mosaics and stained glass windows of churches. Gothic builders created walls of light and clerestories that brought the *glory of glass to light*. It was not until the Renaissance that glass began to be used in homes and it was not until the end of the seventeenth century that Bernard Perrot, of France, invented casting glass, numbering the days of oiled paper or muslim.

By the end of the seventeenth century more glass started to be used in the forcing of fruit and vegetation and the difference between orangeries and greenhouses (forcing sheds) less and less obvious. The use of glazing expanded to cover not only the south wall but most of the roof as well. The primary difference was in the style of the building, as orangeries were often built onto, or in the same style as the primary building of the estate, and/or to compliment it if added later. The orangery was used for family leisure activities and sometimes, as in the case of Versailles, to serve state dinners and grand events. The greenhouse, or glasshouse, was function specific, was designed with a purpose and was

Figure 13 *"The ancient Orto Botanico, Pavia, started in 1556."* (Hix, 1996, 17)

Figure 14 *"The interior of the Orangery at Versailles, Jules Hardouin Mansart, 1685."* (Hix, 1996, 15)





independent of the architectural style of the day. They were built, if possible, at the best location to collect the suns rays, and yet, as a service building, placed so as not to be intrusive on the *easthetic* of the estate. That is not to say they were devoid of any style, some being as ornate as a well set gem, and or as technically explicit in their structure as any modernist could have dreamed, but they were not, generally, where the patrons spent their leisure hours or entertained.

Figure 15 Greenhouse by John Evelyn notable for the use of an early heat exchange system. Internal cold air is drawn into the stove through a floor level duct. Resulting negative air pressure draws fresh air in through the three heated intake pipes. Originally published in *Kalendarium Hortense.* (Hix, 1996, 45)

George MacKenzie designed the first domed (half circle dome) glass roof using the new iron application, and Loudon, even though he found fault with some of MacKenzie's proposal, was impressed enough to suggest an improvement and improved his sash design to allow for curvilinear glass construction. Loudon also went on to write *Remarks on the Construction of Hot-Houses*, which contained several different solutions for almost every type of glazed 'forcing' enclosure. His suggestions were as sophisticated as any hot-house one could find today. He had derived solutions for condensation, water collection, solar tracking, solar blocking, heating, cooling, venting and even accommodation for the two daily medians. Loudon's 'ridge and furrow' glazing design would later be used by Paxton at both Chatsworth and eventually in his Crystal Palace design.

Loudon recognized the commercial viability of the glasshouse and created a partnership with the construction company W & D Bailey, and hired a young architectural apprentice to sell his glasshouse designs throughout the British Isles while he concentrated on the urban centres around London. He built a prototype building just outside London, at his home, that spanned a brook. In this building he reflected many architectural styles and various applications of materials to demonstrate the possibilities for uses other than hot-house applications. Loudon perceived that one day glass would be used for schools, theatres, churches and even covered markets. He challenged architects of the day to produce a new style of architecture:

> *"..that may be beautiful without exhibiting any of the orders of Grecian or of Gothic ... may not therefore glass roofs be rendered expressive of ideas of a higher and more appropriate kind, than those which are suggested by mere sheds, or a glazed arcade."* (Loudon) [33]

In his *An Encyclopedia of Gardening* Loudon even proposed that one day, specifically in countries of northern climates, whole towns and country estates would be covered with *immense teguments of glass*, providing artificial rain, steam heat and vents, and *the enclosed air common to all inhabitants,* human and animal alike. He continued, throughout his life, to write articles for the prominent garden and architectural reviews of the day and at the time of his death he had written thirty *'voluminous published works'.*

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[33] Hix, John, The Glasshouse, Phaidon Press Ltd., London 1996. pg 34

The glasshouse as 'conservatory,' continued to increase in grandeur and beauty, their primary purpose often being obscurred by their dramatic impact, but for the horticulturalist, gardener and garden architect, never forgotten. These enthusiasts immersed themselves in all the latest technologies of heating, venting, lighting and watering systems in their search to recreate a constant environment that was as close to a *foreign* climate as a replica could be. When current methods were not sufficient they developed the finely tuned environmental controls essential to maintain the *artificial climate* (a term coined by Loudon) with the ability to immediately respond to changes in the exterior local climate, being critical.

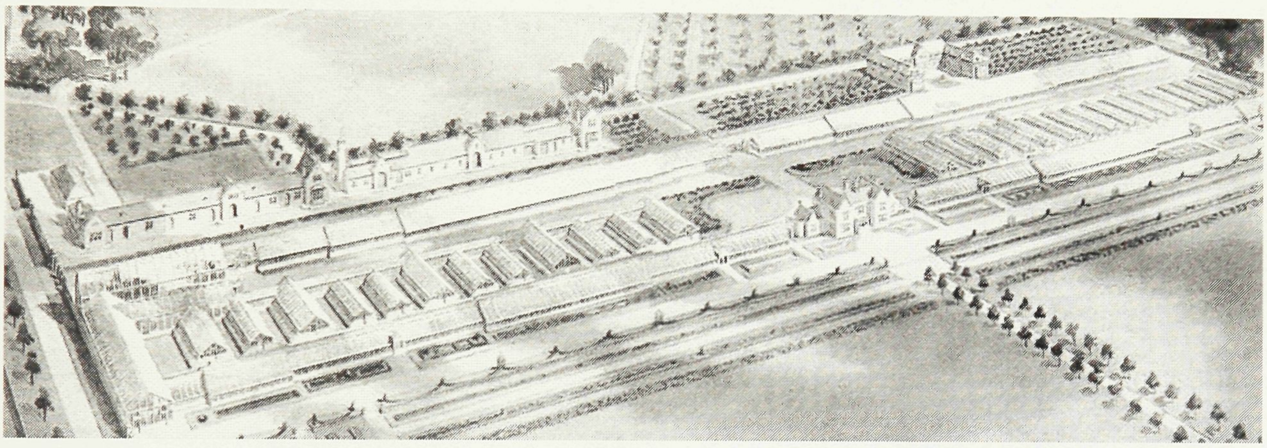

Figure 16 *"Range of greenhouses, Royal Gardens, Windsor (Frogmore), as extended by Mackenzie and Moncur Ltd...c 1860s."* (Hix, 1996, 68)

By the 1850s huge horticultural glass ranges were evident throughout most of the Northern European countryside for the purpose of harvesting vegetables, fruits and flowers. These same utilitarian structures were also becoming common in the urban landscape to accomodate the demands of a wealthier working class. The buildings, being strictly functional raised the ire of the likes of John Ruskin who considered glasshouse forcing *'a vile and glutonous modern habit'*[34]. These structures were not designed to

[34] Hix, John, The Glasshouse, Phaidon Press Ltd., London 1996. pg 67

satisfy any architectural style, they were factories for the year round supply of food. Where space was limited, these *kitchen glasshouses*, as they were to become known, attached themselves to the south walls of existing structures or appeared on roof tops. Any building would do, from private residences, commercial buildings even garages. Although the roof-top garden in theory was ideal, the pollution from coal-fired energy in the industrial urban centres was so bad that they were difficult to maintain.

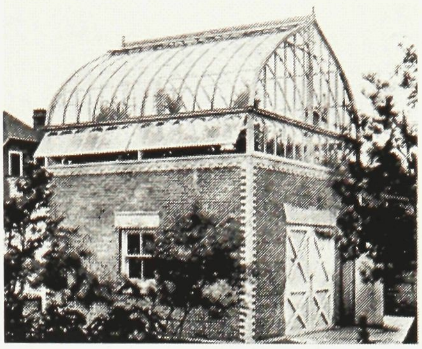

Figure 17 *"Greenhouse over a garage in Richmond Hill, Long Island, from Lord & Burnham's catalogue."* (Hix, 1996, 113)

If not the ultimate application of glass and new technology, Paxton's Crystal Palace, built as an exhibition hall in 1851, has become symbolic of the industrial age and the impact of technology on materials.

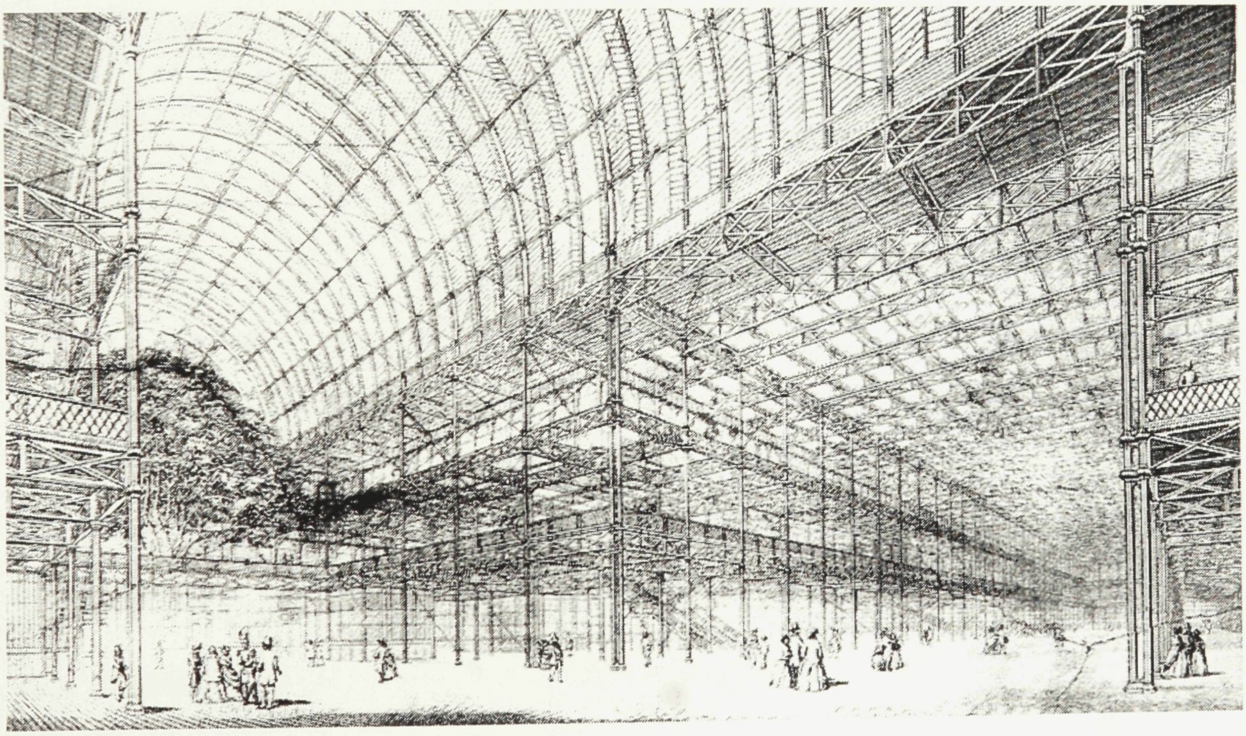

Figure 18 The Crystal Palace, an Engraving *"The most virtuosic of all drawings of the interior, made by W.G. Brounger before any contents were introduced (and reproduced from the only known surviving, and torn, engraving by R.P. Cuff)."* (Durant, 1999)

The Crystal Palace was not only the largest building ever built at that time, but also reflected a hybrid of materials, -iron, glass and wood- and methods of assembly, some from the recent past and some previously unused.

> *"It was in the Crystal Palace ... that iron was used both for its own technical merits and secondly for ornamental purposes. Both cast iron and rolled iron were used (which again was an innovation); the shorter spans were cast iron, the longer wrought iron. Furthermore, and perhaps most ingeniously, the building was constructed in a way that allowed it to be disassembled. ... As a temporary structure built from uncompromisingly modern materials, the Crystal Palace challenged accepted ideas of what civic structures should be. Moreover, it was a civic building that was truly of the people: all of Britain could watch its progress in drawings of its construction published in the 'Illustrated London News'...both the iron and the glass of the Crystal Palace had become emblematic of the Brilliance of Britsih engineering."*[35]

Paxton, gardener as architect, designed the Crystal Palace based on one of his existing 'glass houses' "*The Great Conservatory*" at Chatsworth, England, built for the Duke of Devonshire in 1836. For this building Paxton had developed a sash cutting machine that shaped groves into the forty miles of glazing bars required, and as a result saved thousands of hours of labour. It is not clear what methods were used to paint and glaze the structure, but Paxton would go on to advance the technologies for these tasks during the construction of the Crystal Palace Exhibition Hall. Being asked to produce a building in a 'style' not too radically removed from the classical style of the day, and with his knowledge of the technology of greenhouse structure, heating mechanisms and their environmental controls, he produced a bridge between past and future, and even if

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[35] Dunlop, Beth and Denis Hector, Eds. "Introduction." Lost Masterpieces. Durant, Stuart et al. Phaidon Press Ltd., London. 1999

his influence was not acknowledged until much later, his integration of design and technology was to set the stage for the era of 'modern architecture' that was to follow.

The design was based on prefabrication and standardization of all the parts. Only three sizes of trusses were used and all the glass, all 300,000 panes, were the same size. Paxton's design of composite wood and iron rainwater gutter was the basic element spanning between the iron girders. The erection procedures were planned in advance, much of the credit for this going to Charles Fox, who together with Paxton created a prototype of each component, test loaded it for strength and planned the optimum time and place of assembly/erection.

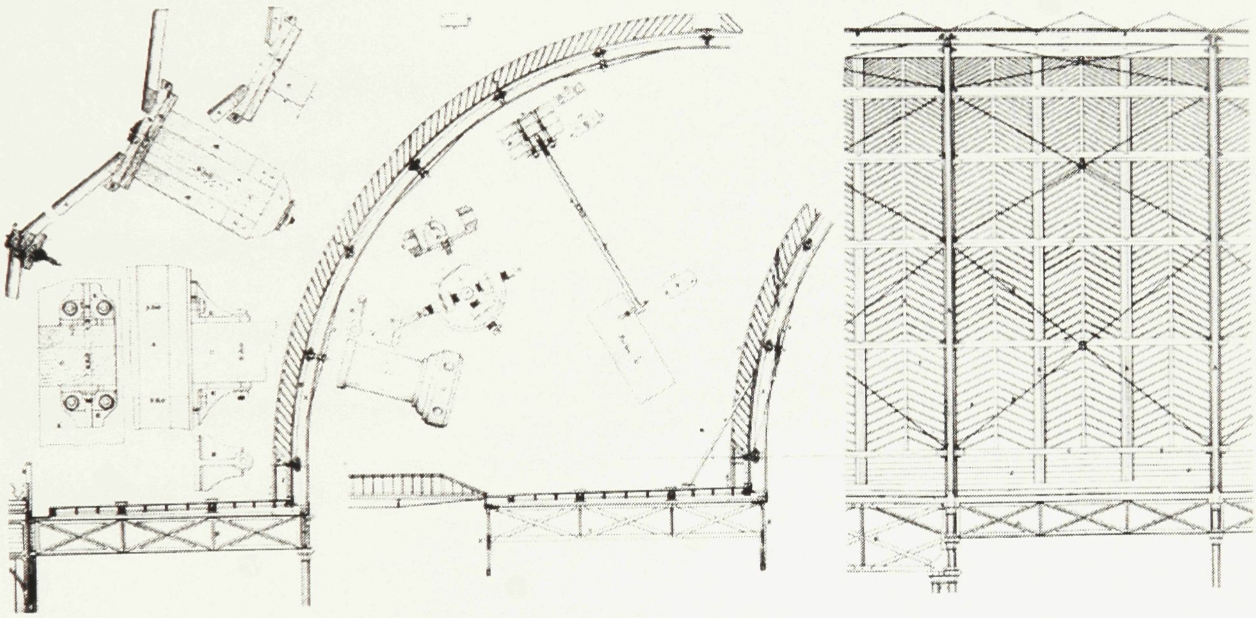

Figure 19 *"Details of the Crystal Palace transcept made from Sir Charles Fox's workin drawings, published in 1852."* (Hix, 1996, 184)

Construction began September 1850 and the building was completed by January 1851. The Exhibition opened on time and when it was over, the entire building was dismantled and re-assembled in Sydenham, a suburb south of London.

"The building is almost empty. The canvas is entirely removed and the beauty of the building, with the sun shining through, was never seen to greater advantage". (Queen Victoria on November 11th 1851, as quoted by McKean, John) [36]

Queen Victoria was perhaps more astute than many of the architectural critics of the day. It was not that Paxton was not applauded for the Crystal Palace but many felt it was not, as a temporary building, true architecture. Ruskin was particularly harsh in his assessment of it saying that it expressed itself as 'an engineered and very large greenhouse', calling it a considered if *single* thought. Unfortunately, for all, the Crystal Palace, in its new location in Sydenham, was destroyed by fire November 30th 1936.

The Crystal Palace did however set a precedent for modular construction and the application of modern materials to functional yet elegant architecture, at a scale previously unheard of, and to a broader international audience then previously possible. The very reason for the building was to 'show-off the future', and as such encouraged the beginning of the architectural academic dialogue leading to *Modernism, Post-Modernism* and much of the architecture of today.

Frank Lloyd Wright wrote in his July 1928 article for Architectural Record that architects had not yet given glass its proper architectural recognition. He claims that often it is used only to replace the mica or opaque glasses previously used for light transmission, but has not been addressed for its brilliance, transparency and reflective qualities as an architectural material. Wright sees glass as a crystal, a gem waiting for the

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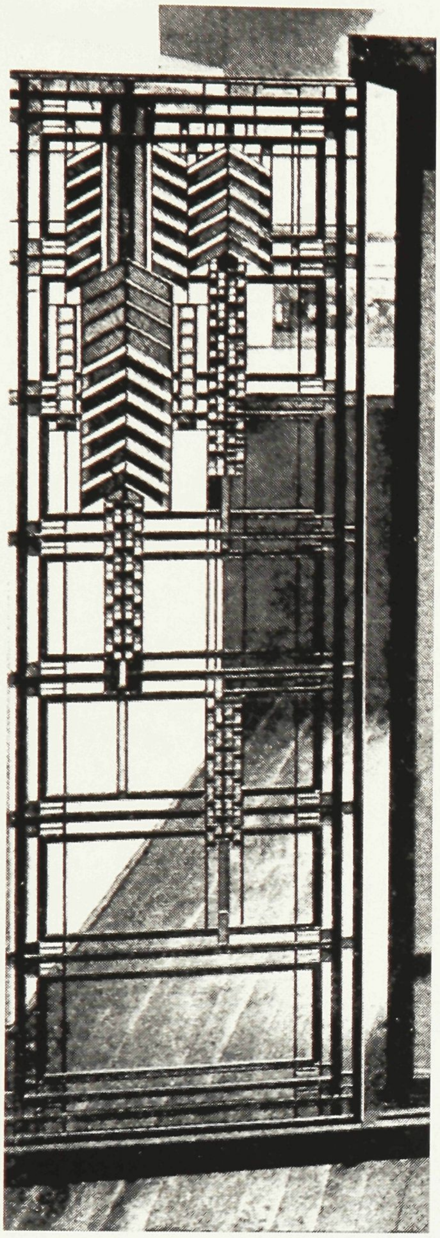
[36] Durant, Stuart, John McKean and Steven Parissien. Lost Masterpieces. Phaidon Press Ltd., London 1999.



right setting. It is then that the 'natural' properties of the glass -mounted in steel, wood, concrete, or in glass itself- really find true expression.

"Every new material means a new form, a new use if used according to its nature."[37]

Figure 20 Frank Lloyd Wright used brass bars and coloured glass to define the windows in the Dana House in 1899. (Wright, 1975, 202)

Figure 21 James W. Strutt creates a transparent grid to filter light from the courtyard. The Loeb House, Ottawa, Canada 1953. (J.W. Strutt, Personal collection.)

From the early roman 'forcing sheds', through to the commonplace glass technologies of today: smart glass assemblies, clear solar collectors and structural glass; most, if not all, have evolved based on the potential found in previous innovations and advancements. The novelty, the yet to be discovered use or evolution of the material and/or its associated technology, that adapts to the concept, is the nature of design.

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[37] Wright, Frank Lloyd. "In the Cause of Architecture: Meaning of Materials - Glass" In the Cause of Architecture, Frank Lloyd Wright. Eds. Hugh S. Donlan and Martin Filler. New York: Architectural Record, 1975. 198.

Technology & Material Summary

The advancements in technology(ies) and material(s) have significant impact on the way we design, use, modify and then design again. Today we are entering a new era of 'smart' materials and technologies.

> "*Smart materials represent the epitome of the new paradigm of materials science whereby structural materials are being superseded by functional ones. Smart materials carry out their tasks as a result of their intrinsic properties. In many situations they will replace mechanical operations.*"[38]

How these will be integrated into, or developed to accommodate a design ideal is the current challenge to architects. As the technologies and materials are becoming increasingly complex, they must be considered early in the design process to be 'holistically' integrated in the design.

The 'Modernists', especially the European 'International' association CIAM, had an affinity for technology, and specifically the machine, that is well documented. They embraced both the possibilities of mass production, modern materials and the 'universal' ideal. Some critics have said this 'infatuation' was less an embrace and more a straight jacket of deterministic 'points of architecture'. However, the increases in architectural discourse, and the attempt to understand and adjust to the machine age was a very exciting era of both the design 'ideal' and technological advancements, and encouraged an era of experimentation and exploration rarely seen before.

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[38] Smith, Peter F. Sustainability at the Cutting Edge: Emerging technologies for low energy buildings. Oxford: Architectural Press, 2003. 131

The later architects of the modern era, or post-modernists, were to rebel against what they saw as limitations of the early modernist doctrine(s) and would begin to redress the past, through history, memory and classical form as they attempted to reflect the growing cultural awareness of the delicate balance between ‘body and spirit’ and ‘machine and technology’ –the most prevelant cultural issue throughout the nineteeth and twentieth century.

In the last three decades of the twentieth century the architectural community again produced a new vision to what culture and science can do together. Annette LeCuyer suggests that

Figure 22 Centre Georges Pompidou, by Piano & Rogers, Paris, France 1972-75 “*East Service wall fromRue du Renard*” (Bachman, 2003, 359)

the Centre Pompideau, by Renzo Piano and Richard Rogers, and the Sainsbury Centre by Sir Norman Foster (Foster Associates), in 1977 and 1978 respectively, signify the end of the era initiated by Paxton.[39] Although

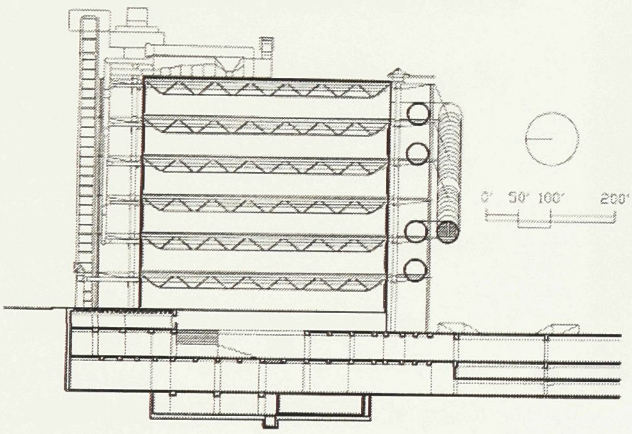

Figure 23 Centre Georges Pompidou, by Piano & Rogers. Section (Bachman, 2003, 350)

still very much 'system' type architecture, they are very much 'one-of' buildings, assembled from uniquely designed components, consistent with the 'ideal' of the building to which they are applied. Some of

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39 LeCuyer, Annette W. Steel and Beyond: New Strategies for Metals in Architecture. Basel, Boston 2003

this early work, often referred to as 'high-tech' architecture, exposes the diversity of technology as environmental control systems, and/or material and

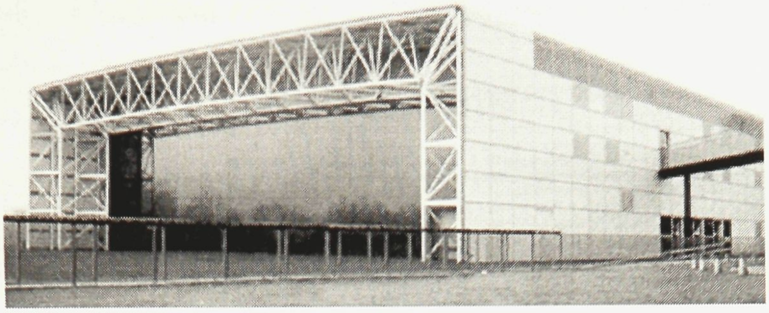

Figure 24 Sainsbury Centre for Visual Arts, 1976-1977, Norwich, England, by Norman Foster & Partners (Bachman, 2003, 361)

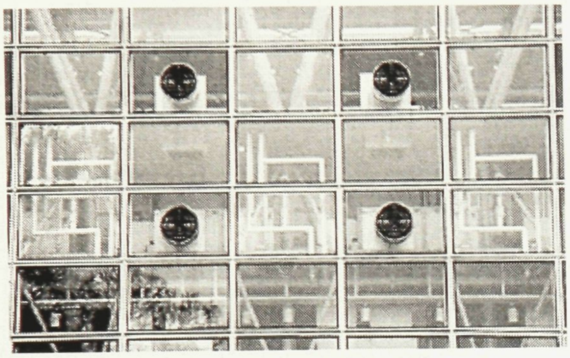

Figure 25 Sainsbury Centre for Visual Arts by Norman Foster & Partners. "*Ventilation system… meshed in the structural frame…*" (Bachman, 2003, 370)

structural innovations, and do so to express, and to heighten the awareness of, these elements that we have become so dependent on to accommodate –in as 'natural an environment' as possible– the inhabitants. Others, like the Guggenheim Museum, by Frank O.Gehry, incorporate the advancements of high-technology design tools and innovative applications of materials to push familiar boundaries of design to create undulating masses of sculptural form.

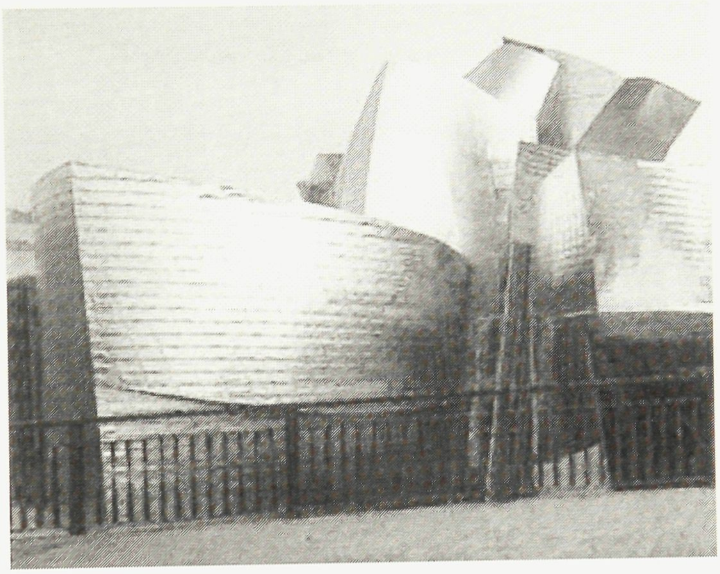

Figure 26 Guggenheim Museum Bilbao, Spain 1993-98 by Frank O. Gehry. (Sebestyen, 2003, Plate 6)

Unlike the monumental facades of classical architecture, or the minimalist and layered planes of modernism, the cultural persona of both these types of architectural objects are reflected in their complexity. Attaining meaningful form and function while creating stabilized interior environments that accommodate the body in comfort -and elevate the spirit of the inhabitant- while mitigating the negative environmental impacts on either nature or the man-made world that surrounds us was the fundamental task of these architects. These testaments to the capacity of technology and scientific advancements were developed to unite the built environment with the natural world, and are a representation of their time that have inspired many to emulate their progressive efforts.

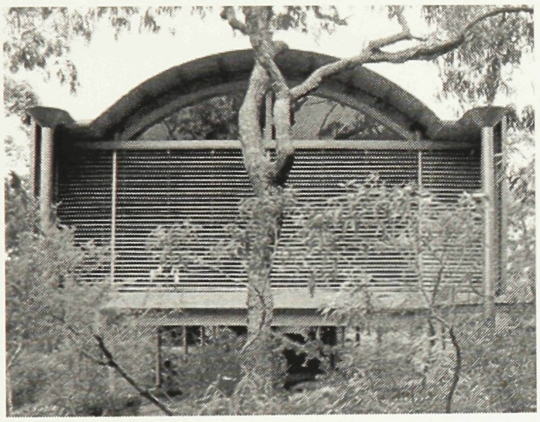

Figure 27 House for two Artists, Glenorie, Australia by Glenn Murcutt, 1980-83. End Elevation (Gili, 1995, 103)

Similarly, residential architecture has also seen the application of innovative technologies and materials to express the conceptual design ideal. The work of architects Glenn Murcutt, Shim & Sutcliffe, Sverre Fehn and Herzog & De Meuron, although producing very distinctly different representatives of this faction are not unique in their ability to be sensitive to their site and innovative in their execution of the projects technology and materials. By the end of the century and into the new millennium, a

Figure 28 House in Toronto, Ontario, Canada, by Shim•Sutcliffe Architects, 1994. (Schittich, 2000, 73)

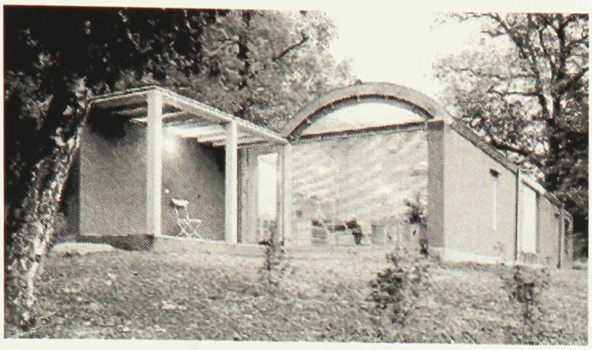

Figure 29 Experimental House, Mauritzberg Manor, Norrkoping, Sweden, by Sverre Fehn, 1992. Straw and clay brick from site. (Gili, 1995, 55)

subtle shift has developed where the significance of the technology is being articulated in a more holistic balance with either the conceptual ideal and/or the contextual environmental (urban or rural). The 'universal' ideal of the modernists transitioned more in alignment with the 'think globally, act locally' ideal of the environmentalists. Using advanced materials, methods and design technologies, many of these same architects are attempting to push (or pull as the case may be) the cultural awareness of the masses to understand the importance of our environment in the context of the programmatic schema of the architectural object. Architecture is not just a 'realization' of built form: programmatically reproducing what is there; but a 'creation of the ideal': through invention and a positive and dynamic process of transmission, differentiation and evolution which occurs in time with time, with potential to yet again inform the future. Whether architecture has reached the 'post-post modern' age, or not, is a subject for philosophers and sociologists, but it is clear that architects must strive to create meaningful forms to inform, heighten our awareness of our immediate

Figure 30 Stone House, Tavole, Italy, by Herzog and De Meuron, 1985-1988. Stones collected from the site connect the east facade to the landscape. (Berrizbeitia, 1999, 58)

surroundings, and to seriously address our responsibility to it, as part of the current 'ideal' of sustainability, for now and for the future.

> *"This brings to mind another myth about technology. The feeling that technological choice is always the result of a predetermined logic. The feeling that there is a correct solution to a technical question is common. But a technical solution like any other decision is a moment in time. It is not definitive. The decision is the result of a complex process where a lot of information is analyzed and examined and choices are made on the evidence. It is a moment in space and time where the people, their background and their talent is paramount. What is often missing is the evidence of human intervention, the black box syndrome. So by looking at new material, or at old materials in a new way we change the rules. People become visable again."* (Peter Rice)[40]

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[40] Frampton, Kenneth. "The Owl of Minerva: An Epilogue." Studies in Tectonic Culture: The Poetics of Construction in Nineteenth and Twentieth Century Architecture. Cambridge, Massachusetts: The MIT Press, 1995. 387.

Architects

As stated earlier, architects draw on past experiences (or examples) of what has been done before, whether similar or dissimilar in nature, to determine the applicability and use in the next conceptual project. An ongoing influence of concept, itself evolving through the processes of consideration, acceptance and dismissal of ideas, impacts on the applicability, modification and/or selection of the technology (ies) being used and/or being considered for current or future applications.

The work of two architects, who have been inspired by those who preceded them, and have since inspired many who have followed, are presented as examples of visionary inquiry into the philosophies and technologies of their times. Through the creation of organic geometries both have followed their 'ideal' of what architecture is using the 'Praxis of Inquiry' as their design process. Each have addressed both the scientific/technical and cultural/artistic issues of their era, and have each produced a life's work of meaningful form –inspiration- for those that follow. The work of American Frank Lloyd Wright and Canadian James W. Strutt are offered as exemplars of visionary architecture where the environment has played a primary role, and whose design process, or 'Praxis of Inquiry,' has resulted in the production of unique architecture that reflect their time and space, yet serve as 'events of influence in discrete space and time'.

With both architects, technology has been modulated by intellectual inquiry. Both tool and thought, through an ongoing dialogue, or loop, of input and feedback, are used simultaneously, and alternately, to resolve a given problematic: a dialogue constantly in a virtual state of flux, a state of pending emergence. Throughout the process, inquiry and technology evolve in the 'image' of the original concept through a series of infinitesimal displacements that is this fluctuating process of emergence. Their meaningful forms are derived from memories of the past, knowledge of the present and visions of the future, all as intellectual integration of program, function, local environment and materials according to a concept: Nature as an 'Ideal' worth savouring/saving.

Frank Lloyd Wright

Today with this increasing awareness of the impact, both short and long term that architecture has on our environment, the work of Frank Lloyd Wright begins to take on, if not new, additional significance. Arguably, the most prolific architect of the modern era, Wright looked to nature, the 'organic' world, as the origin for his 'ideals'. As an apprentice under Louis H. Sullivan (Sadler and Sullivan) Wright credits him with initiating him into the world of natural, or organic, and 'principled' architecture.

> *"The intimation of organic life in subverting the rules of decorum. Sullivan achieved his truly mature style, the one that completely matched his concept of architecture as a phenomenon from nature and in many ways equal to it, as it followed "rules of design" that he saw first in nature."* [41]

Although Sullivan fired Wright after seven years for taking on outside work while in his employ they reconciled seventeen years later and Wright always referred to Sullivan as 'the Master.' Wright felt that he carried into the residential realm those principles learned during his apprenticeship, which Sullivan had applied to his commercial projects. Deeply grateful to Sullivan, Wright attributes his earlier work as influenced by him, eventually growing into his own 'advanced principles' but always drawing on some fundamentals first introduced by Sullivan. When Sullivan passed away, Wright wrote a tribute to his genius, stating it is through his work that one recognizes "*that spirit and matter are one…that form and idea are one*"[41] and that Sullivan and his work had influenced those around him and will do so for many generations yet to come:

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[41] Menocal, Narciso G. "The Iconography of Architecture: Sullivan's Views" Louis Sullivan: The Poetry of Architecture. Twombly, Robert and Narcisco G. Menocal. New York: W.W. Norton & Company, 2000. 121.

"What he represented has lived in spite of all drift…in this sense will the divine spark, given to him from the deep centre of the universe and to which he held true, be handed on the fresher, more vital, more potent, enriched a little, perhaps much, by the individuality that was his…The light that was in him lives—and will go on—forever."[42]

"As a pebble cast into the ocean sets up reactions lost in distance and time, so one man's genius goes on infinitely forever, because it is always an expression of principle. *And therefore, in no way does it ever run counter to another's genius. The Master's genius is perhaps itself a reaction, the initial force of which we can not—need not—see.*

Of one thing we may be sure—the intuitions of such a nature, the work to which he put his hand, no less then the suggestion he himself was to kindred or aspiring natures, is worth more to the future in all conservative or progressive sense than all the work of all the schools, just as example is more valuable than precept."[43]

All this being said Wright firmly believed that it was not possible to imitate the work of a great mind, but that one should take the principles of someone like Sullivan, add your own architectural concept and then address those issues of material, site and technology with rigour and integrity. "*Whoso has the temerity to undertake to imitate will fail. Take his principle who will, none will do better—and try the wings that nature gave to you. Do not try to soar with his.*" [42]

Wrights work, both built and written, reveals a synthesis of the 'ideal', materials and technology as a testament to his time and place. Wright intuitively understood the implicit dialectic between culture and technology. His sensitivity to the environment resulted in an understanding of, and compatibility with, the environment rather than 'mastery' over it (even if not done for reasons of 'ecology'). His discord with the

[42] Wright , Frank Lloyd. "Louis Henry Sullivan: Beloved Master" Frank Lloyd Wright Collected Writings. Vol 1, 1894-1930. Ed. Bruce Brooks Pfeiffer. New York: Rizzoli, 1992. 196.
[43] Ibid. "Louis Henry Sullivan: His Work" Frank Lloyd Wright Collected Writings. Vol 1, 1894-1930. Ed. Bruce Brooks Pfeiffer. New York: Rizzoli, 1992. 199.

'perpetrators' of the 'International Style Doctrine' is no secret, although a firm believer in technology and the need for a 'new architecture', Wright vehemently disagreed with any limitations imposed to produce a 'style'.

> *"Nothing to my mind could be worse imposition than to have some individual, even temporarily, deliberately fix the outward forms of his concept of beauty upon the future of a free people or even a growing city."*[44]

As stated earlier in this paper, starting in 1908 and concluding in 1952, Frank Lloyd Wright wrote a series of articles entitled '*In The Cause of Architecture'* for '*The Architectural Record'*. His opinions, always strongly presented, still resonate with meaning that may be even truer today then when he first wrote them. His disagreement with much of what he was seeing from the European Modernists, stemmed as much from his 'organic' philosophy as from his wish that America would finally grow out from under the shadow of a 'euro-centric arts influence' and start to recognize her own indigenous artistic merit, specifically that of the individual. In his first article, inspired by a quote from Thomas Carlyle –"*The Ideal is within thyself, thy condition is but the stuff thou art to shape that same Ideal out of"*– Wright offers the following three quotes which refer to the influence of the available technologies (the 'machine') as they are applied to: the principles of organic architecture; process and materials to achieve, as closely as possible, the ideal of the architect; and, finally the advancement of civilization.

> *"Above all, integrity. The machine is the normal tool of our civilization, give it work that it can do well –nothing is of greater importance. To do this will be to formulate new industrial ideals, sadly needed."*[45]

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[44] Wright, Frank Lloyd. "In the Cause of Architecture: Style, Therefore, Will Be The Man, It Is His. Let His Forms Alone" The Architectural Record 35.5 (1914): 408.
[45] Ibid. "In the Cause of Architecture" The Architectural Record 23.3 (1908):157.

"The present industrial condition is constantly studied in the practical application of these architectural ideals and the treatment simplified and arranged to fit modern processes and to utilize to the best advantage the work of the machine...Certain facilities, too, of the machine, which it would be interesting to enlarge upon, are taken advantage of and the nature of the materials is usually revealed in the process." [46]

"An artist's limitations are his best friends. The machine is here to stay. It is the forerunner of the democracy that is our dearest hope. There is no more important work before the architect now that to use this normal tool of civilization to the best advantage instead of prostituting it as he has hitherto done in reproducing with murderous ubiquity forms born of other times and other conditions and which it can only serve to destroy."[47]

In his follow-up article, he states, as he reflects back on his work done in the first twenty-one years of his career, which followed a six year apprenticeship under his mentor Louis Sullivan that:

"I still believe that the ideal of an organic architecture forms the origin and source, the strength and, fundamentally, the significance of everything ever worthy the name of architecture...These forms were the result of a conscientious study of materials and of the machine which is the real tool, whether we like it or not, that we must use to give shape to our ideals –a tool which at that time had received no such artistic consideration from artist or architect."* (*original footnote: By organic architecture I mean an architecture that *develops* from within outward in harmony with the conditions of its being as distinguished from one that is *applied* from without.) [48]

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[46] Wright, Frank Lloyd. "In the Cause of Architecture" The Architectural Record 23.3 (1908):162..
[47] Ibid. 163.
[48] Ibid. "In the Cause of Architecture: Style, Therefore, Will Be The Man, It Is His. Let His Forms Alone" The Architectural Record 35.5 (1914): 406.

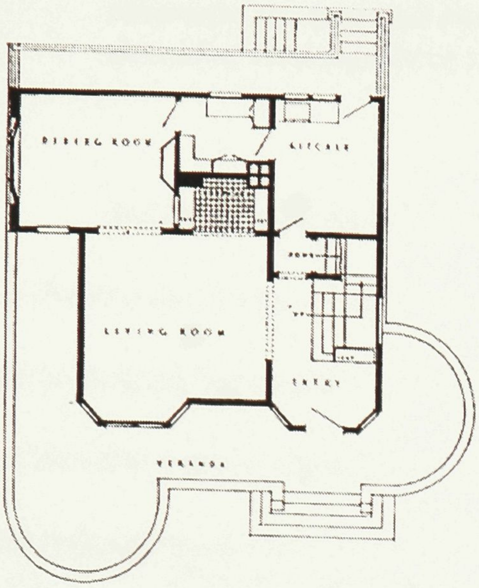

Figure 31 The Wright House (1889) original 'foursquare' Plan. (McCarter, 1991, XX)

Max Underwood proposes that Wright constantly evolved his own 'style' by constantly updating his existing practices with new materials and methodologies. By focusing on two essential areas in the process of architectural design: 'Appearance' (deconstruction of traditional box 'shingle style' residences to incorporate large overhangs, the puncturing and offset of facades and platform frame construction); and 'Innovation' (invention of new materials, construction methods and structural systems); Wright achieved 'The Technology of Synthesis'[49], the evolution of his own formal style with a technical 'language' and sensitivity to site and program.

Figure 32 The Wright House (1889) originally a 'foursquare' plan with later additions. Even this first home had large overhangs and punctured facade. (Storrer, 2002)

> *"I do not believe we will ever again have the uniformity of type which has characterized the so-called great "styles." Conditions have changed; our ideal is Democracy, the highest possible expression of the individual as a unit not inconsistent with a harmonious whole. The average of human intelligence rises steadily, and as the individual unit grows more and more to be trusted we will have an architecture with richer variety in unity than has ever arisen before; but the forms must be born out of our changed conditions, they must be 'true' forms,*

[49] Underwood, Max. "Appearance – Innovation – Synthesis: The Technology of Frank Lloyd Wright's Residential Work." On Architecture, the City, and Technology. Ed. Marc M. Angelil. Stoneham, MA: Butterworth-Heinemann, 1990. 121

otherwise the best that tradition has to offer is only an inglorious masquerade, devoid of vital significance or true spiritual value."

Wright's architecture was rooted to place, drew upon the potentialities that existed in the site and the program being requested. Through the process of material and technological exploration, Wright experimented, invented or innovated existing methods of construction and structural systems. He would analyse and re-analyse plans during their development and following their construction. He would improve on what he felt worked and eliminate what did not.

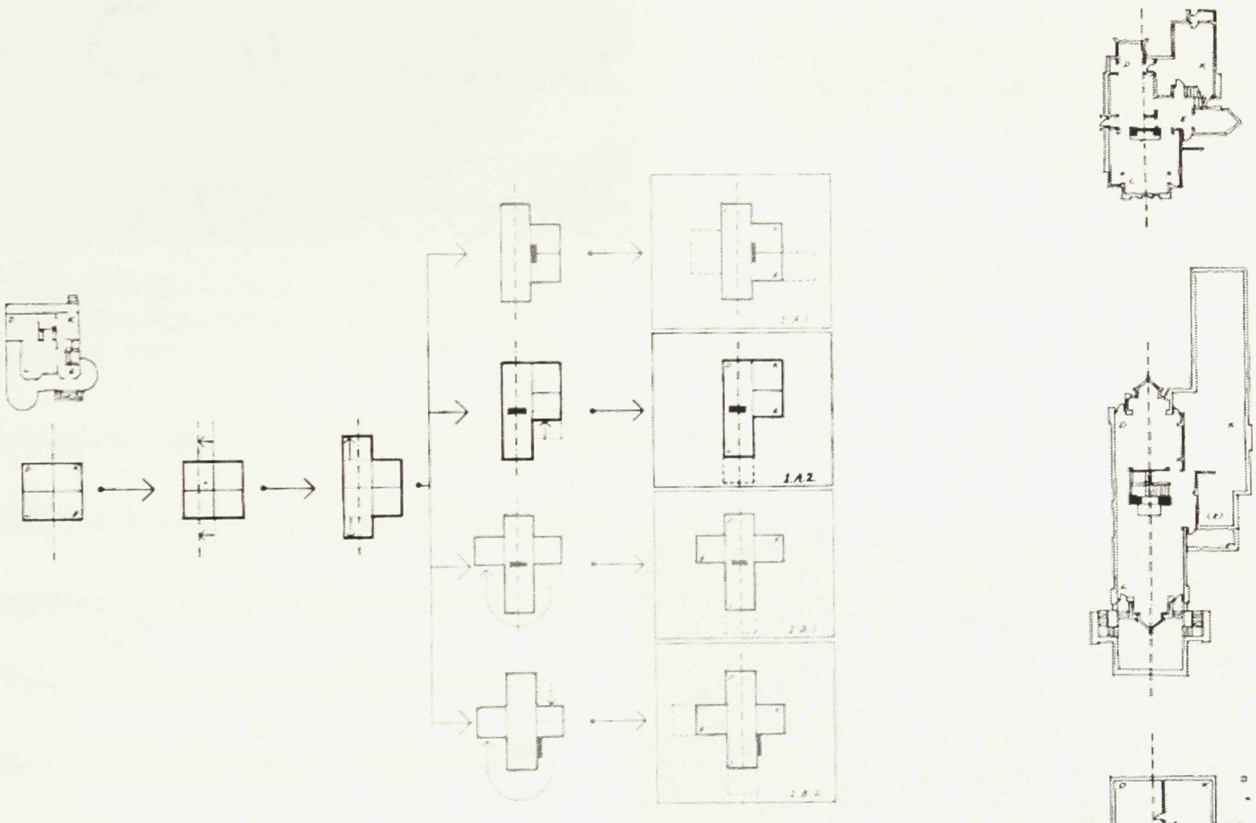
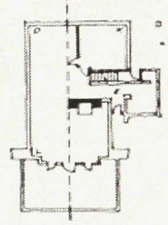

Figure 33 Wright usually did a series of analysis of his plans to determine possible 'variants' of 'types'. Shown above is one of two first level analysis he did on his own home. The three on the right show the second level of analysis of the 1.A.2 plan of the first analysis. The middle plan is a close mirror image of the Frederic C. Robie House built in 1908. (McCarter, 1991, 49-51)

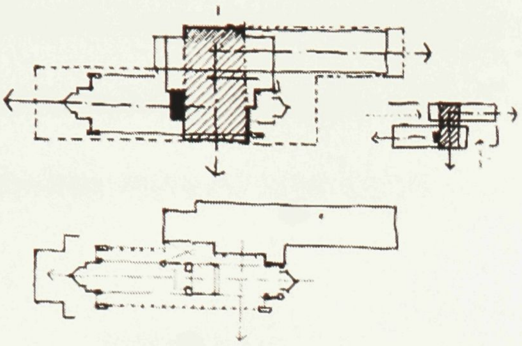

Figure 34 Initial analysis sketch for the Frederic C. Robie House. (McCarter, 1991, 98)

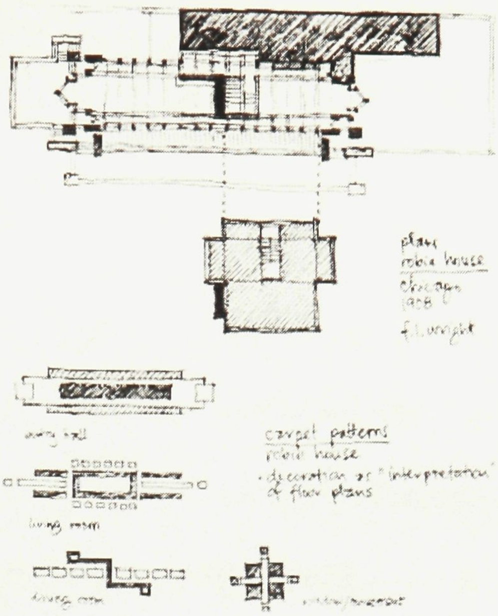

Figure 35 Plan analysis of "*decoration as interpretation*" for the plans of the Frederic C. Robie House by Frank Lloyd Wright. (McCarter, 1991, 250)

Figure 36 The Frederic C. Robie House, Oak Park, Illinois by Frank Lloyd Wright, 1908. (Storrer, 2002)

Although his authenticity of place was not the norm of the euro centric modernist's manifestos of time and space, he was very much aware of the importance of 'time' and used the narrative (even if of the romantic or fairytale type) to present time. Taliesin West, a place of ruin and myth, tied history to nature by combining a 'rubble construction' technique, reminiscent of ancient ruins, with a modern superstructure framed over it, lending a sense of the present protecting

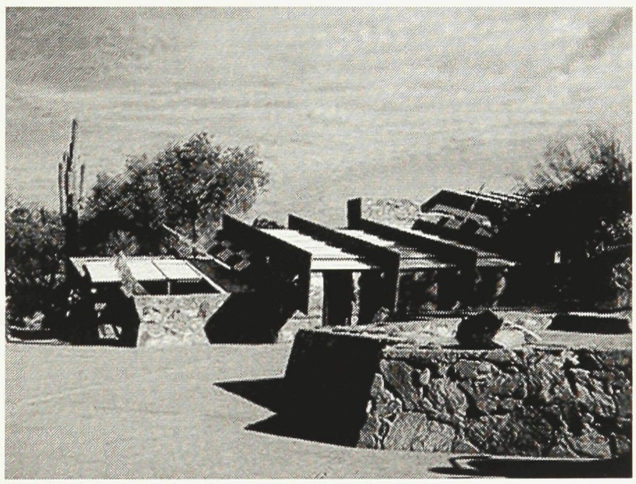

Figure 37 Taliesin West, by Frank Lloyd Wright, Date (Photo Credit: http://architecture.about.com)

the past. Large sentinel stones stand at the periphery integrating the existing environment to the buildings as if they were permanent guardians of place from the past, standing in the here and now, to be there well into the future.[50]

Wright firmly believed that by being true to the purpose, tool and material and by uniting these in the concept developed from within (in his case the 'ideal' of organic architecture), one would achieve integrity with the site, regardless to its urban or isolated setting. As a result, each project would contain emergent properties that would demonstrate potentiality to be used in future projects. Time would be embodied in the built form, and reflected in the resulting style.

Wright's work, even today, is exemplary of a synthesis of the idea and technology. His organic architecture, and his sensitivity to site and environment acted as an incentive for his technological exploration, experimentation, innovation and invention especially as it applied to materials, methods and structure. His life's work demonstrates an evolution of his growing facility with technology and the refinement of his aesthetic style. It was his aim to establish a new 'Indigenous American Organic Architecture' that would represent the aesthetic of the architect, the client and the surrounding environment rather than a style.

> *"First, a study of nature of materials you elect to use and the tools you must use with them, searching to find the characteristic qualities in both that are suited to your purpose. Second, with an ideal of organic nature as a guide, so to unite these qualities to serve that purpose, that the fashion of what you do has*

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[50] Levine, Neil. The Architecture of Frank Lloyd Wright. Princeton, New Jersey: Princeton University Press, 1996. 295.

integrity or is 'natively fit', regardless of preconceived notions of style. "Style' is a by-product of the process and comes of the man or the mind in the process. The style of the thing, therefore, will be the man –it is his. 'Let his forms alone.'

To adopt a "style" as a motive is to put the cart before the horse and get nowhere beyond the "Styles" –never to reach 'Style'."[51]

Followers of Wright, occasionally referred to as his 'disciples' by his detractors, especially those trained in his principles of organic architecture at the Taliesin School, have gone on to produce some of the finest architectural works on the North American continent. Wright has also influenced, in one way or another, for the past ninety years, most students of architecture, just through the existence of his work. There is not a student of architecture, on the North American continent, who has not studied the Kaufman Residence (Fallingwater) or the Johnsons' Wax Corporate Headquarters at one time in their education.

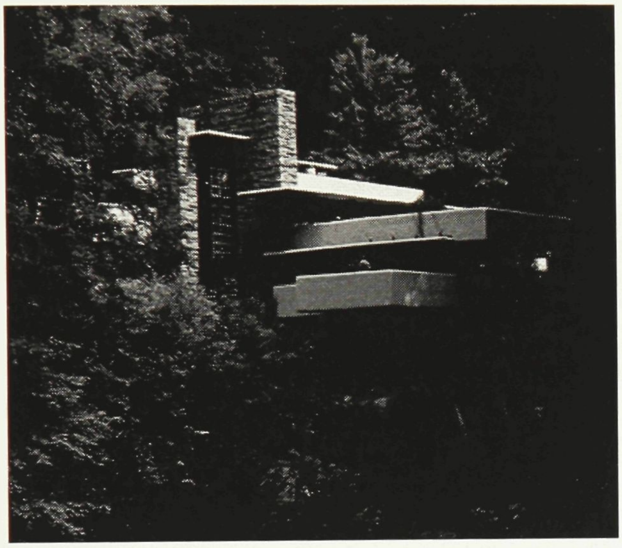

Figure 38 The Kaufman Residence (Fallingwater), Bear Run, Pennsylvania, 1936. (Photo credit: Chris Davis)

According to Kenneth Frampton, Wright's influence is more than his rendering of the 'mechanical services' at the same level of importance as 'structural frame,' but also how he addresses the hearth, 'servant-served' and the connections of land and sky and body and horizon[52]. Only by considering the problematic of the project thoroughly through inquiry, from the technological and conceptual perspective can the architect

[51] Frank Lloyd Wright, In the Cause of Architecture: 2nd Paper "Style, Therefore, Will Be The Man, It Is His. Let His Forms Alone", Article printed in The Architectural Record, Vol. 35, No. 5, May 1914, p. 413.
[52] Frampton, Kenneth. "Rappel à l'Ordre: The Case for the Tectonic." Labour, Work and Architecture, Collected Essays on Architecture and Design. London: Phaidon, 2002.

arrive at the natural (or organic) solution for the project, an 'authenticity of time and space'[53]. Perhaps Wright himself has said it best, first when he addressed the Architectural League in 1900:

> *"In the Arts every problem carries within its own solution and the only way yet discovered to reach it is a painstaking way—to look sympathetically within the thing itself, to proceed to analyze and sift it, to extract its own consistent and essential beauty, which means its common sense truthfully idealized."*[54]

and finally in 1955 towards the end of his life:

> "*Of course what is vitally important in all that I have tried to say and to explain cannot be explained at all…But here in this searching process may be seen the architect's mind at work.*" —Frank Lloyd Wright. [55]

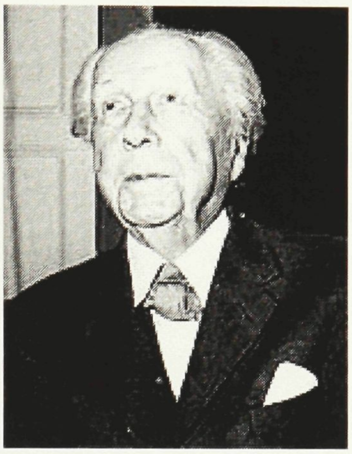

Figure 39 Frank Lloyd Wright, 1867- 1959 (photo: New York Times, Obituary)

One such architect who—as a student of architecture re-drew Wrights entire portfolio to understand his work—has picked up the illuminating principles of Wright, evolved them into his own interpretation of what the 'ideal of the organic' is, and has brought them forth into the 21st century, is James W. Strutt.

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[53] Levine, Neil. The Architecture of Frank Lloyd Wright. Princeton, New Jersey: Princeton University Press, 1996. 433.
[54] Wright, Frank Lloyd. "The Architect." Frank Lloyd Wright Collected Writings. Vol 1, 1894-1930 Ed. Bruce Brooks Pfeiffer. New York: Rizzoli, 1992. 52.
[55] McCarter, Robert. "The Integrated Ideal, Ordering Principles in the architecture of Frank Lloyd Wright" Frank Lloyd Wright, A Primer on Architectural Principles. Ed. Robert McCarter. New York: Princeton Architectural Press, 1991. 241.

James W. Strutt

A prime example of an architect who has looked to the master architects of his time and studied what has come before to create a synthesis of his own understanding of the world around him is James W. Strutt. His architectural projects show a mixture of influences that include Frank Lloyd Wright, Buckminster Fuller, and others like Pier Luigi Nervi and Eduardo Catalano, yet they manage to attain a sense of holistic integration of technology and environmental sensitivity, that are exclusively Strutt's.

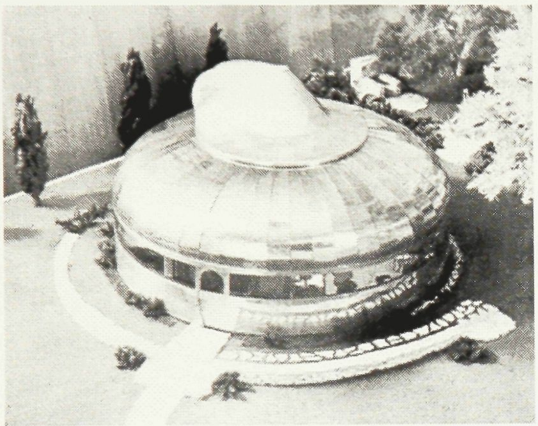

Figure 40 Dymaxion Dwelling Machine (Wichita House), Buckminster Fuller, 1944. (Marks, 1960, 120)

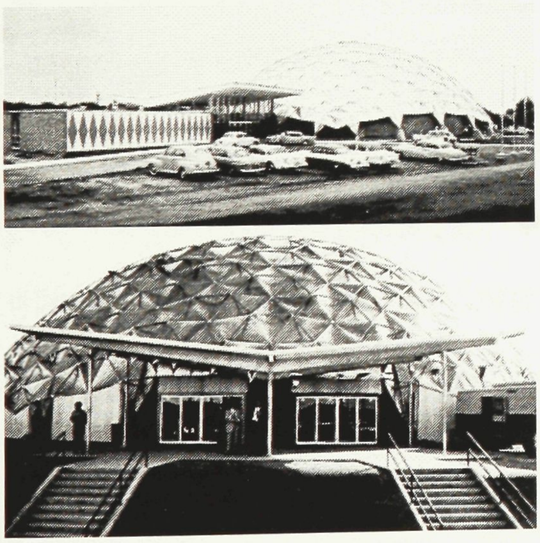

Figure 42 "*Kaiser 145-foot Geodesic municipal auditorium, Virginia Beach, Virginia, 1957.*" Buckminster Fuller (Marks, 1960, 220)

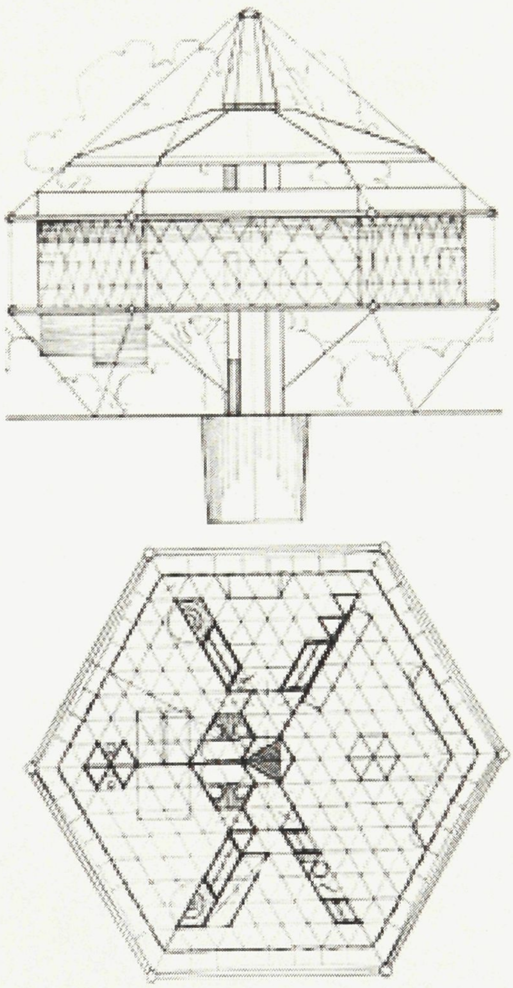

Figure 41 "*Elevation and floor plan of the 4D Dymaxion House; 1928.*" By Buckminster Fuller, note the central services core and open plan public spaces. (Marks, 1960, 80)

Strutt was impressed, not only by Wright's body of work, but by the intellectual discourse of a new and exiting architecture, indigenous to the North American continent. As a student at the University of Toronto, he helped arrange a lecture and studio visit by Wright and Fuller. He travelled everywhere across Canada and the United States to catch guest lectures by many of the prominent architects of the day and to make 'architectural pilgrimages' to whatever 'sites' were close by. While at a Nervi Lecture in Raleigh, North Carolina, he and his companions made a side trip to see Catalano's 'Hypar' House. These trips were to have significant impact on much of Strutt's future work.

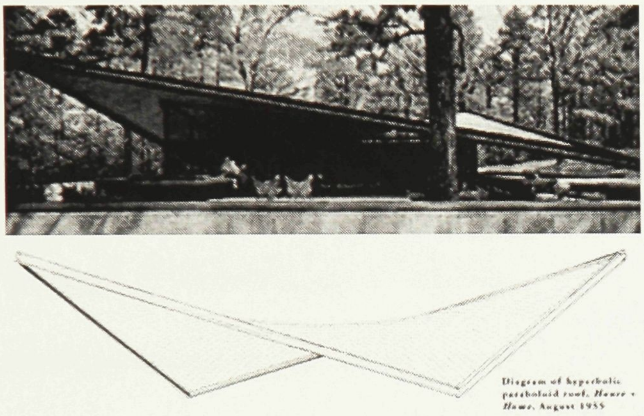

Figure 43 The Hypar House, by Eduardo Catalano, 1954 (destroyed March 2001.) Photo credit: www.designcommunity.com

Strutt began a lifelong inquiry, judiciously extracting elements from the world around him as he developed his own sense of what architecture should be. Through meticulous integrations and innovations of technology, and the sensitive application of materials, geometries and craft, Strutt has explored his art through the act of building. Drawing on the 'systems integration' and 'weight efficiency ratios' of Fuller, the 'organic architecture' principles of Wright, and explorations in geometries inspired by Catalano's

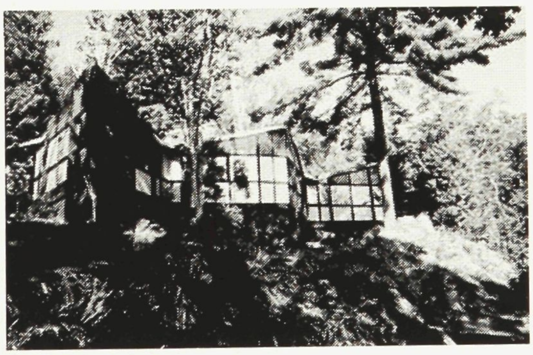

Figure 44 Strutt House, Gatineau, Quebec, 1952. On a plateau just below the final rise of the mountain, the house sets into, yet projects out of the ground plane, much like the surrounding outcrops, the occupants look out through the trees to catch glimpses of the city far below from a secluded and natural setting. (Courtesy J.W. Strutt Personal Collection)

'Hypar' roof, Strutt has proven the basic premise of Frank Lloyd Wrights 'architectural integrity' as he has taken emergent properties from each, evolved an organic geometry, which applied with his personal sensibilities has become his own. His geometries and inquisitive nature are applied to the technologies, materials, place and time of his projects. Space in the hands of Strutt is moulded, not in a 'fixed' or static geometry, but in an organic geometry, independent and dynamic. Wright himself refers to this type of 'transfer of principles' and the likeliness of this eventuality happening in his second contribution to his series of articles "In the Cause of Architecture" in The Architectural Record (1914), even if originally referring to those that trained under him.

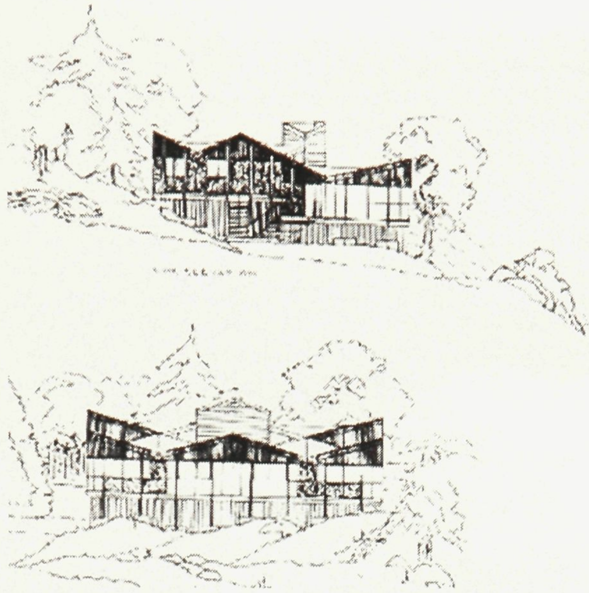

Figure 45 Strutt House, by James W. Strutt. West & South Elevation Drawing. Self-supporting Rhombi & Hyperbolic Paraboloid Roof 1956. All exterior walls, glazing and partition units based on pre-assembled 4 x 4 panels. (Courtesy J.W. Strutt Personal Collection)

Figure 46 Waring House, by James W. Strutt, 1954. A Packing of Tetrahedrons, often referred to as the handkerchief house because of the graceful folds of the roof, the tips of which lightly touch the ground plane, as if just dropped to the surface. (Courtesy J.W. Strutt Personal Collection)

> *"That some uniformity in performance should have obtained for some years is natural; it could not be otherwise...But when the genius arrives nobody will take his work for mine -least of all will he mistake my work for his."*[56]

[56] Frank Lloyd Wright, In the Cause of Architecture: 2nd Paper "Style, Therefore, Will Be The Man, It Is His. Let His Forms Alone", Article printed in The Architectural Record, Vol. 35, No. 5, May 1914, p. 410.

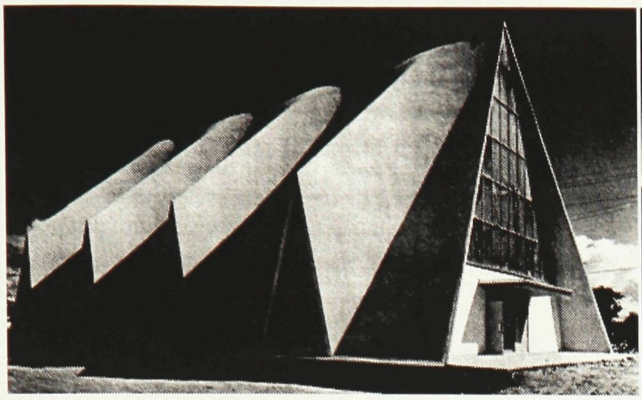

Figure 47 St Peter's Anglican, by J. W. Strutt, 1959. Wires were stretched from point to point, creating a wire frame structure that was covered with burlap and a thin coating of gunnite applied to create 'in situ' the structural skin/form of the soaring Concrete Hypars. (Courtesy J.W. Strutt Personal Collection)

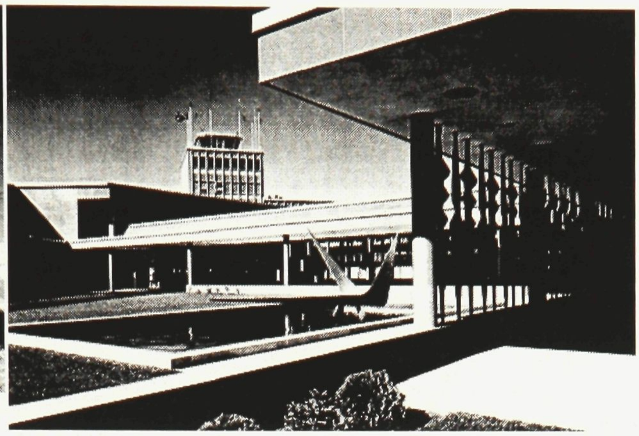

Figure 48 Uplands Air Terminal, by J.W. Strutt, 1956. Strutt took a novel approach to commercial/civic space with the integration of the art of Louis Archambault as both sculptural and structural elements. (Courtesy J.W. Strutt Personal Collection)

The phenomenological organic growth patterns of geometric forms and a natural empathy for site have also influenced Strutt's work. His natural empathy for the environment, both interior and exterior, and to the well being of the inhabitants is articulated with a sensitivity that was, and is still today, a product of the declared requirements, and, an anticipation of the changing needs of both. Even with all the advanced technologies and materials' explorations that Strutt undertook, he never compromised the integrity of his design concept, but used his intellect and natural curiosity to mine any technology for its potential to accommodate his vision. A vast majority of the homes he designed still stand in testament to his creative genius.

> *"He was constantly trying something new. There was always an exchange with Jim, a chemistry, between him and all who worked for and with him. He was a mature Architect without an ego. He had the ability to work with all involved. We always had a respect for each other, a trust...It didn't matter if it was a small house or a 10 million dollar building...there was always a back and forth...give and take...try this, or that...always looking for a new form of expression, new finishes...innovative in the application of new technology, always with good*

architecture and cost in mind...would always find a way to make it cost effective and work out." (J Adjeleian)[57]

"*Jim approached every job with the same degree of attention and dedication to task. It was most important to him to satisfy the clients' needs both personal and programmatic as well as doing so in the most economical and inventive fashion. He was big on structures, how forms and materials went together, traditionally, organically and geometrically.*" (T. Griffiths)[58]

Strutt was offered a faculty position with the School of Architecture at Carleton University in 1971. By 1974, he was the acting Director and became the Director in 1977. While at Carleton, Strutt also developed the 'Forms Studies' program with Prof. Gulzar Haider. Together they authored the "Learned papers on the application of Geometry to the areas of pure research, structures and planning."

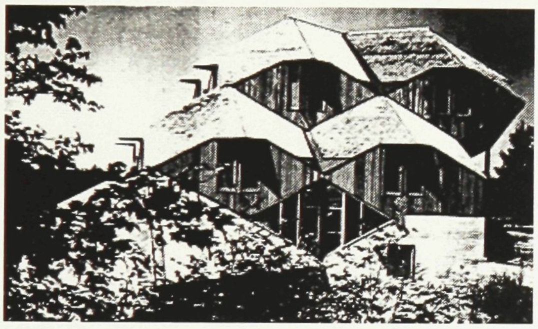

Figure 49 The Rochester House, by J.W. Strutt, 1976. A 12 connected network of Rhombi Dodecahedrons, completed as a research project at Carleton University. (Courtesy J.W. Strutt Personal Collection)

Strutt looks back on this time as most satisfying from both a personal and professional perspective. He enjoyed the students and his enthusiasm was inspiring to those that studied with him. His natural inquisitiveness and willingness to share his ideas and propositions were nurtured in the academic environment. Following his retirement from the School of Architecture, Strutt continued to apply his skill and expertise to his profession as well as commercial and research projects. His later works would expand on his weight efficiency studies of materials and use of stabilizing geometries. He has designed housing for

[57] Adjeleian, John. Personal Interview. 24 Jan. 2001
[58] Griffiths, Tony. Personal Interview. 30 Nov. 2000

hurricane and earthquake resistance using industrialized production that allows for domestic or export construction.

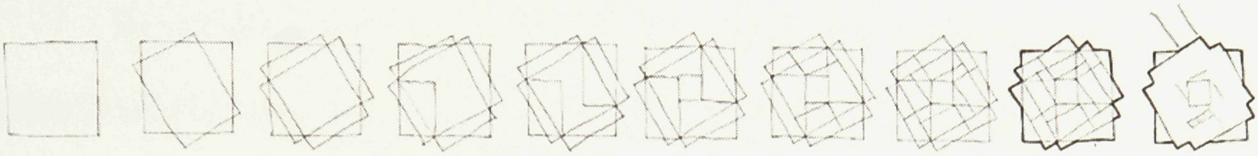

Figure 50 Ten studies of a Strutt 'sketch'. The evolution of simple geometry from an original multi-layered 'doodle' that was a first phase exploration for one of the cube based hyperbolicparaboloid series houses.

Strutt has been, and continues to be, an educator to any who wish to see the true potential of architecture. Throughout his years in practice, as well as the time spent in academia, Strutt has taught by example, and encouraged the exploration of technologies, physical or virtual, as a means to enhance the 'ideal' of what architecture is.

There is a genius in the integrity of Strutt's work that is true to the ideal, the program, the technology, the material, and its time of emergence. Additionally, in Strutt's case, the solution is always faithful to the user (or client). There is a level of uniqueness and individuality, not only to his style, but also to each and every project that he has produced. Whether it is his residential work, his commercial, industrial or religious institutions, Strutt has always managed to encapsulate a programmatic solution that is sensitive to its environment, simultaneously technologically advanced and warm and embracing to the users, using discrete geometries, in, and of, its place and time. His process has been the praxis of exploration and design, design and exploration. His solutions have always been an innovative and inventive 'Architecture' at its finest. As a professional and as an academic he has brought the same level of integrity to his work, with an enthusiasm and respect for his profession that resonates in all he does.

Project: ADAPTABILITY | MODULATION | EMERGENCE

The preceding analysis has informed and even influenced many of the decisions taken during the praxis of inquiry of the project component of this thesis.

The theoretical component has re-enforced the supposition that as architects we can, and do, influence the development of both the technological and cultural artifacts of our built environment. As such, those technologies that were required to address the programmatic, or functional, requirements of the project have been considered not only for how and what is to be used but what innovation or enhancement could enhance either its technological or aesthetic properties regardless to scale.

Many of the processes, practices and analytical tools discovered in the work of James W. Strutt and Frank Lloyd Wright were used to develop the original concept to the final object. Some moves in the process have more relevance to specific examples of precedence that are clearer in retrospect then they were obvious attempts to emulate. However, whether the same moves would have been taken without the extensive theoretical research is, in my personal opinion, doubtful.

Background

During the energy crisis of the late 1970's, primarily due to the fear of depleting stocks of fossil fuels, there were concerted efforts to develop 'alternative resources'. This included some moves to new, sustainable, or minimally renewable, energy sources/resources. A great deal of money was invested in passive and active solar energy research, and for the most part it was the industrial bureaucracies of the engineering and scientific communities that conducted this research. New political alliances and 'finds' of traditional energy sources relieved the sense of urgency that accompanied these first technological advances, and the bulk of the advancements were never developed to the point of economic feasibility.

As the impact that we, as a collective, are having on our planet becomes clearer, the ramifications of the 'western status quo' is revealing itself to be unsustainable and detrimental to the whole planet. The 'environmental movement' of the last two decades, infiltrating the public psyche through the participation and endorsements of popular culture celebrities, has created a new interest in all things 'sustainable' and have caused the re-evaluation, and additional development of a great deal of the product research that had been dormant for almost thirty years. However, there still exists a resistance to the implementation of 'alternatives' because of the perceived negative economic benefits, unreliable performance, and the 'technology driven packaging' of these older, or first iteration, technologies. The lack of aesthetic appeal to the masses, and the accompanying low public demand for these 'technological marvels' is evidence that simply addressing the issue of sustainable technologies is not enough for most consumers. Additionally, many of the new solutions

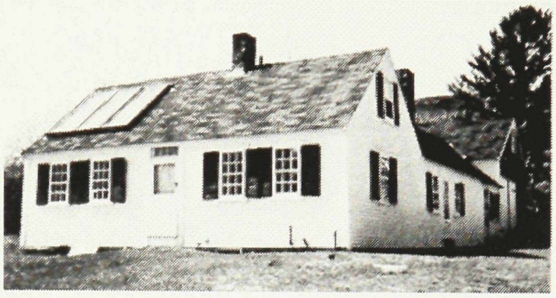

Figure 51 Solar Hot Water System mounted on home, late 1970s. (Photo from Solar Age March 1980. 23.)

being discovered today are not making it off the drawing board due to a lack of financial backing[59]. As a result many of the commercially available energy technologies still reflect the period of their technological development and present a challenge to 'designed integration'.

Exceptions to the above can be found in some of the work that preceded –and some that follow– these 'waves' of socio-political awareness, by architects who have managed to incorporate technology without subjugating their conceptual ideal. Having produced a legacy of aesthetically diverse integrations of sustainable technologies and the

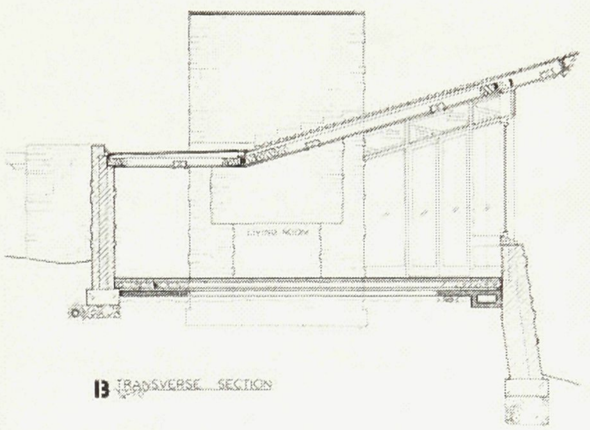

Figure 52 Seth Peterson Cottage, Frank Lloyd Wright, 1958. Site sensitive passive solar design. Section shows fireplace and blocked off utility spaces (kitchen and bath) that also serve as the thermal storage mass. (Gili, 1995, 129-130)

design 'ideal', their works remain today as testament to a process of design that relies not only on the technical requirements of sustainability, but also to inquiry, exploration and experimentation, to modify, innovate, or design, the appropriate tools and materials to accommodate their vision. Those who follow must learn from these Architects, to address the issue of 'sustainable architecture' as a 'holistic' approach to the integration of

[59] Jaimet, Kate. "Lack of funding leaves 'green' inventions on the drawing board." The Ottawa Citizen. [Ottawa] 10 Nov. 2002.

Figure 53 House R128, Werner Sobek Ingenieure, Stuggart, Germany. A Transparent high performance envelope, completely recycleable easy to erect and disassemble structure (above), and roof surface PV system (below).

sustainable technologies into meaningful forms, which can adapt, modulate and re-emerge, as functional and inspiring spaces for the inhabitants.

Various new (or re-visited) technologies are currently in development. Fuel cell and wind technology, and advancements in photovoltaic electricity generation using nano-technology are some of the areas receiving critical and media attention. Primarily large commercial development interests and the transportation industries sectors of the economy are driving fuel cell development but it may soon be considered as a viable alternative for smaller applications in the built environment. Wind energy is very promising, especially for small hydro on exposed or remote sites, or as large community type implementations as wind farms. Active solar technologies, heating or power, continue to develop and a great deal of effort is being invested to reduce production costs and the resulting production and disposal waste issues. Nanorod solar technology is also being developed by several research interests, and at the University of California, Berkley, Professor Paul Alivisatos, a chemist, is trying to 'produce photovoltaic material that can be spread like paint, ink-jet printed, or rolled out as a plastic wrap for integration into or with other building materials.'[60] Nevertheless, even if they are anticipating, or minimally considering, the wants and requirements of the design community, according to Prof Alivisatos it will be 'quite a few years before these products are fully developed, let alone commercially available.'[61] However, he was optimistic about some of the development by Nanosys Inc. and Matsuhita Electric Works on 'natural roof tiles' using some of the earlier development work from their current research.

As designers we must look to what is available on the market today, consider appropriateness to the concept, and to the technological capability of the client. However it is only by constantly researching what is available, within our own profession and other sectors of development as well, that one not only discovers what is on the drawing board but also what can be used (or re-purposed) to suit current requirements. Queries to those who are currently developing products, even if about a product still in the initial development stage, can influence, even if indirectly, that technologies development.

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[60] Scigliano, Eric. "Paul Alivistos, Nano Solar Cells." Technology Review. Feb 2003: 39
[61] Alivistatos, Paul. E-mail Correspondence. 31 May 2004

Program

This is to be a progressive project, in that it must adapt to various programmatic changes over both short and long term periods. The design component of the project initially consists of a seasonal cottage that allows for and includes future expansion to a four-season fully accessible retirement home for a couple and their visiting family. The site is on Lac Morissette, in the Municipality of Blue Sea, Québec. The program is for a flexible home that has minimal environmental impact, that is energy efficient with passive and/or active solar, alternative source power (with the ability to function 'off-grid' and potential to feed back into the grid as a possibility), complete with 'green' water and waste treatment. The house, to be 'phased-in' over time, to accommodate the changing lifestyles of the inhabitants, is to be 'up in the trees' as much as possible, with 'accessibility' being a key consideration for future years when aging will affect mobility. This thesis project attempts to use technologies that are consistent with, or will augment, the design intent.

Phase 1: A place of escape: a seasonal weekend retreat, where a family of five, can stay for short periods. Minimal 'footprint', ease of access to existing 'outdoor natural room' and fire pit. Occupants require protection from the elements and wildlife, low maintenance and use of local resources.

Phase 2: A place of play: a cottage, a retreat to get away from the urban frenzy, a place of refuge to recharge on the occasions that the urban tangle releases the inhabitants from its grasp. Primarily three seasons with occasional year round access.

Phase 3: A place of work and play: a full time residence. The cottage must allow future expansion to accommodate full time residents and guests. The residents will eventually work from the premises during a period of semi-retirement.

Phase 4: A place of care, work and play. Move from semi-retirement to a fully accessible facility. Must accommodate impairments common to elderly and require minimal effort for energy resources/source and reliable back-up systems.

Functionally the residence must be flexible and adaptable to short-term daily, mid-term seasonal, and long-term lifestyle, cycles and changes. A home with flexible multi-purpose spaces that inform the residents of their connection to, dependence on, and responsibility for their environment. To have sustainable technologies fully integrated and 'celebrated' in the design.

Technology

As the environment is the 'environs and conditions' in which we function, be it to work, play, eat, sleep, or socialize, and the human body has the same basic needs regardless to local, then the technological requirement of the internal environment is comparable whether it is an urban or rural site. Yet, even when much of the technological and operational considerations are the same, and there may be similarities in the methods of application and degree of active verses passive technology, the design is specific to the known functional requirements and conceptual vision of the 'designer'.

Sustainable technologies are considered first as the method of meeting the needs of the program, but the most appropriate solution will be the one that best embodies the concept. Solutions should heighten, where possible, the awareness and ease of adjustment of the enclosed environment, while matching needs, both physical and spiritual, to the technology, so as to benefit most from, and impact least on, the surrounding natural environment. Commonly available solutions are considered where possible, to allow for ease of maintenance and support and common understanding of systems, however innovative applications, modulations or invention, or combination strategies will be considered as required.

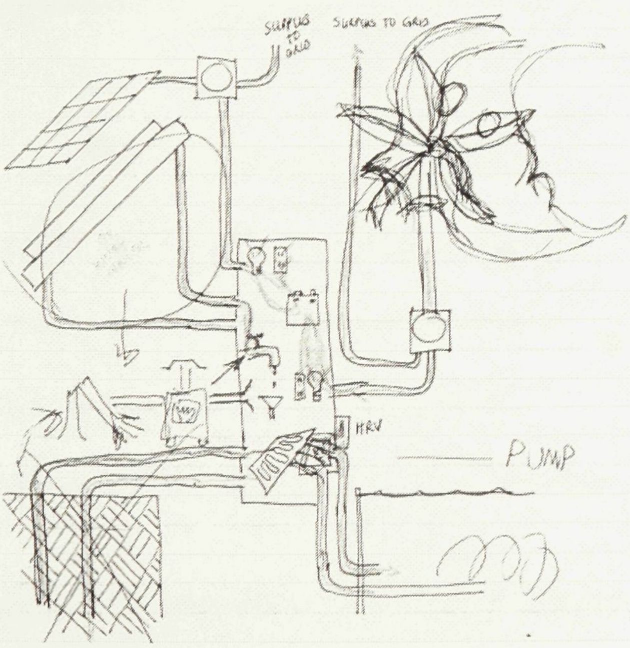

Figure 54 Initial 'green' technology schematic considering resources local to thesis project.

Local, or on site, materials are: trees (wood), earth (stone) and water (lake and ground). The existing canopy serves as a substantial –nearly continuous– sunshade, and soundboard for the rain, in summer. There is a heightened awareness of the ground plane, which is heightened by the scattered rugs of rust coloured leaves and needles on the dark earth, that spreads out from below the birches and pines, punctuated by the protruding edges of light coloured limestone outcrops. The water of the lake glimmers through the sparse undergrowth, the earth terracing itself as it pores down to the water's edge. The deciduous canopy clears in the winter exposing the ground to a covering of snow, and allows the sun to penetrate down through the trees.

Materials considered for use are based on local availability and applicability to the concept. On site, there is a large quantity of full growth trees that can be milled locally to produce the structural timber. Transportation, as an embodied energy, would be minimized and quantity used would reflect good forest husbandry practices.

The environmental technologies and material applications addressed in this project are derived from past and current practices of 'green' or 'sustainable' practices. The requirements of the selected materials and systems is that they minimally impact the surrounding environment, use

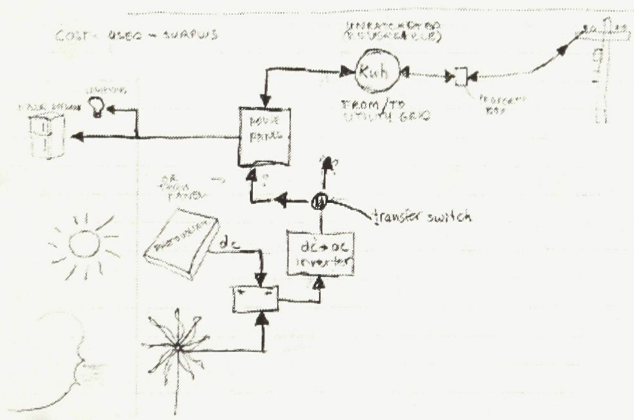

Figure 55 Second level 'green' technology schematic for thesis project.

renewable resources where possible, and serve to accommodate the inhabitants while increasing their awareness of: their control of; impact on; and, responsibility for the stewardship of their surrounding environment(s).

(See Appendix 'A' for Technological and Material Considerations.)

Site

There is a deep-rooted connection between humankind and nature. Lifelong dwellers of the city still have a compelling connection to nature. We come to understand 'naturally' that there is a world much larger than us, and our own temporal projection through it. Even in the depths of the 'concrete jungle', nature is cultivated and/or invades at will. From the rectangles of turf nurtured on small parcels of suburban frontage, to foliage filled planters that line up as sentinels in front of urban edifices, and little shoots of green that creep up through the joints in our layered paths of concrete and asphalt, nature defiantly asserts itself in the phenomena of growth, reinforced by wind, sun and 'weather'.

An isolated site where 'nature permeates' all around, or an urban infill site surrounded by concrete, glass, and steel, is addressed specifically in response to the local terrain (context), available material resources, and the climate. (While considered at a micro and macro scale climate is addressed locally even if 'thinking globally'.) However, in addition to the technologies employed, another common factor, is our attempt to reconnect to our surrounding environment, be it a grassy glade, a wooded slope, a suburban streetscape, or an urban view.

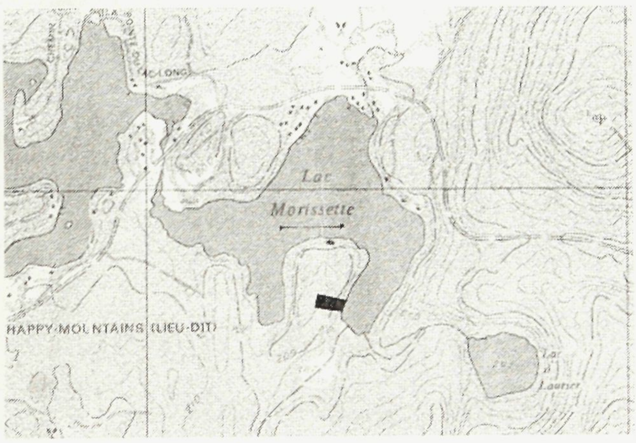

Figure 56 Project Site Map. Lac Morissette, near Blue Sea Quebec.

The site of this project is a heavily wooded, isolated rural lake frontage. The lot slopes steeply to a small plateau, then again slopes steeply to the lakefront. It is

Figure 57 First site study: summer. The canopy of the deciduous trees is thick overhead, a real sense of the horizontal planes, of forest floor and ceiling, and the room in between. Image by author.

heavily treed with approximately 50/50 white pine (coniferous), and birch (deciduous). A dense summer canopy sits above an arcade of trunks, spaced so that the large rooms between allow a view through, in all directions, to the solid that they become. The sensation of compression between the canopy and the ground add to the impression of

Figure 58 Second site study: late summer/early fall. The canopy is thinning, there is a stronger sense of the vertical, the lines of the trees penetrating the roof of the forest.

‘natural enclosure’. The ‘coolness’ of the pine-needled carpet forest floor is speckled with tiny flares of light that penetrate the filtered green glow, tossed off the flickering leaves by the gentle breeze that comes off the lake. Glimpses of its glittering glazed surface, reflects the full brilliance of the summer sun.

The rooms of winter open to the lowered sky expressing the verticality of the giant leafless trees, which sway ever so lightly in the gusts of wind. The massive trunks draw the eye upward as they soar into the translucent light gently brushing the cool white surface of the sky, releasing the scrapings of light snow to flutter in the wind. The white-blanketed ground plane hints at forms beneath as it undulates down, frozen to the smooth gray plane of the lake.

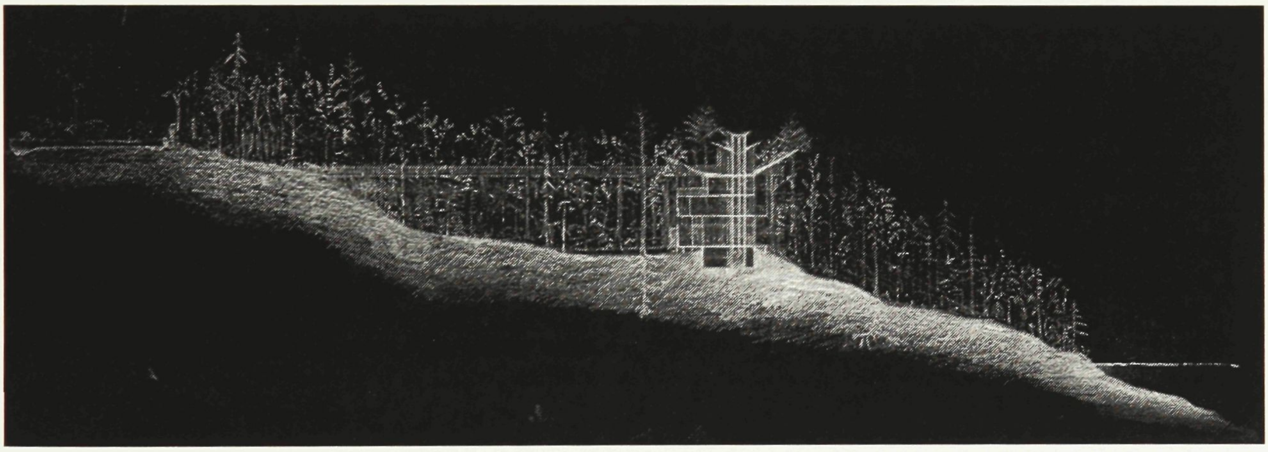

Figure 59 Initial longitudinal site section placing tree house and entry/bridge.

(See Appendix ‘B’ for site considerations.)

Concept

The 'Tree'-house

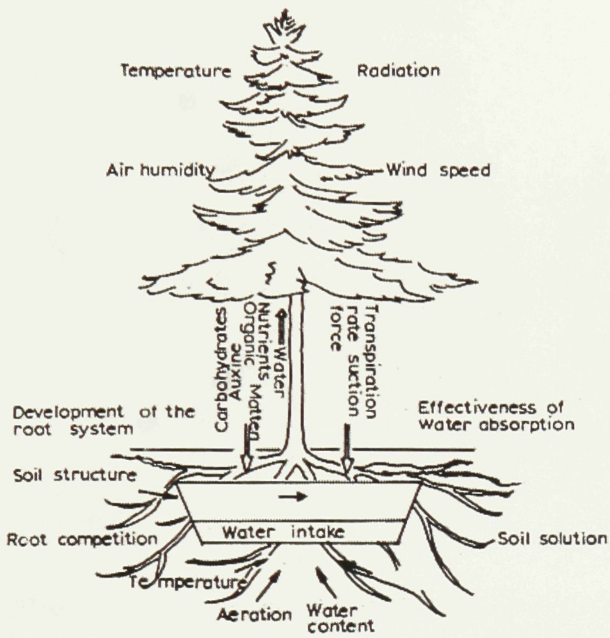

Figure 60 "*Schematic illustration of the factors controlling absorption of water (after Lyr and Klemim in Lyr et al., 1967.)*" (Bernatzky, 1978, 39)

As a tree drinks from the sky and draws from the earth, it takes only what it needs to survive and contributes its surplus product to the eco-system within which it exists. Its core, the point of circulation for its energy use and production, alternately draws and expires from its roots and foliage, accepting and replacing the energy and sustenance of, and to, both earth and sky (sun, rain and the earth.)

Trees have thought to be the dwelling place of spirits and sprites, and the rod (or branch) of the tree has symbolized both a sign off peace or treaty and the 'healing' powers of medicine and science in even our earliest civilizations. Over time different trees have been assigned to different deities but they have usually represented renewal, growth , fertility, resurrection, and even the ladder to eternal life within many different cultures.

The 'tree' holds center place in many of our past and present spiritual beliefs. Revered in most religions, the 'Tree of Life' has been documented in many forms.

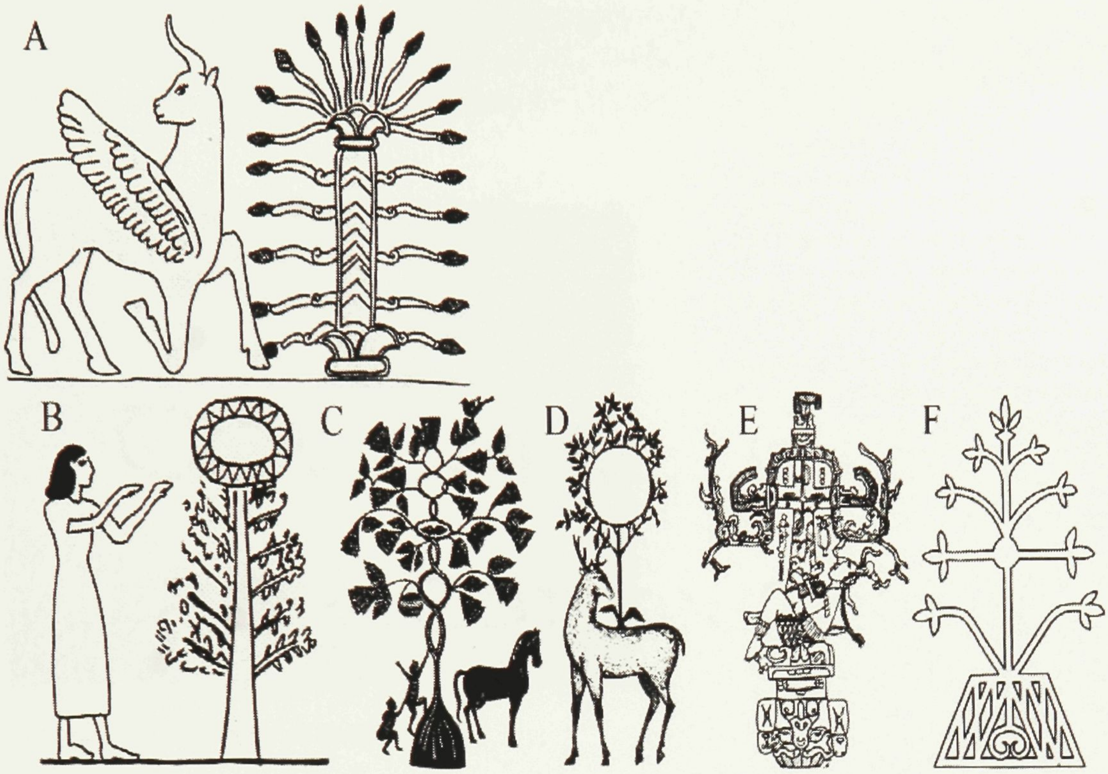

Figure 61: Tree of Life. A: "*Winged bull unicorn kneeling before the tree of life. Assyrian stone relief.*" **B:** "*Egyptian Woman worshipping the sun tree.*" 18th Dynasty papyrus scroll. **C:** "*Chinese version of a tree of life. Taken from a tomb of the Han Dynasty, ca. 200 B.C.E.*" **D:** "*God's Deer bearing Japanese tree of life.*" Drawn in the Kasuga Mandara, ca. 700 C.E. **E:** "*Pacal, ruler of the Aztecs, is captured in death by the cosmic tree.*" From his limestone sarcophagus dated 683 C.E. **F:** "*Combination of Tree of Life and the Cross.*" Romanian house decoration from 17th century. (Klein, 1979, 127-130)

Drawing an analogy to the tree, the project will be addressed as a place of refuge and renewal for all, approached by rising up into the canopy, and through the foliage as the forest floor drops away to reveal the slope from the horizontal plane that bridges entry to destination. The core of the building will act as the trunk, grounding the structure, and serving as its circulatory system much like the tree. The inhabitants will move down the tree to the cool summer forest floor, and up the tree closer to the sun's rays as the snow covered ground becomes more inhospitable during the winter months.

> *"Only when we begin to understand ourselves as something more than a spatial being, know ourselves in the deeper imaginative sense of being organic unities, temporal as well as spatial, will our art too be more*

than the bare present of intellect. It will then begin to contain all the richness of the past, all the inner music of prophecy, and all the unity of style. It will transcend its creator and stand alone."[62]

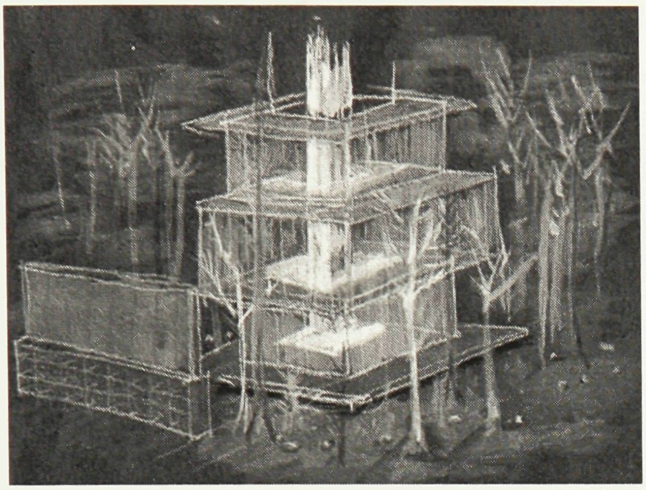

Figure 62 First 'core' concept sketch.

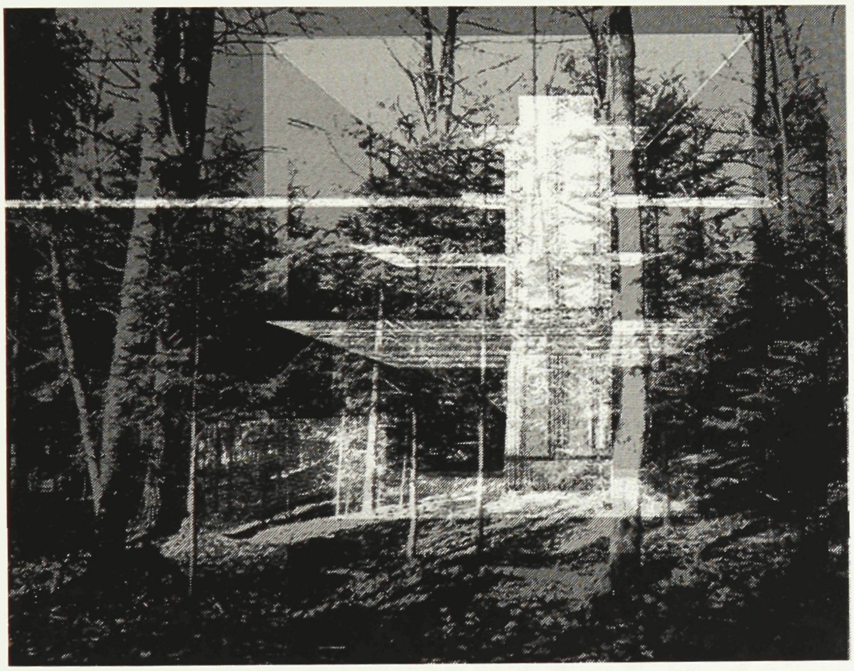

Figure 63 Midterm 'core' concept sketch on site.

For the results of this thesis' project exploration please see Appendix C.

[62] Strutt, James W. "The Search for Style." Fifth year essay, B.Arch Program, University of Toronto. 1949. 11-12.

Summary

If the role of architecture is not just to shelter, but to inform, and if the concept is initiated by a 'will' to accommodate the needs of the users, the known program, an aesthetic desire, and the integration of progressive technologies, then all these ideals must be seamlessly incorporated. The process if successful, results in the best possible solution for the given conditions and reveals it so.

Critical review of the architectural object should reveal indeterminate potentialities to formulate adaptations or modulations to improve the process of the event, whether by a progressive leap forward or by folding back into or onto itself, revealing new ways to compose (and recompose) from concept to built form, and beyond. Thought, both critical and consumer, and the technologies embodied in the design-build-and-operations processes, evolve throughout the 'life-cycle' of the built form, and affect and are affected by the users, owners, designer and the built form itself. From the moment the requirement is known until the memory of its existence ceases to be, architecture has an ongoing influence on the world we live in, 'real' or 'virtual'. Meaningful forms, those that inform us, are derived from the integration of the program, function, local environment and materials according to a concept: Nature as an 'Ideal' worth saving.

> "*The architect becomes a prospector of formative continuity, a tracker in an elusive field of generative deformation. The abstract field of variation takes on a certain post-Platonic thickness, in and by its very elusiveness, by becoming a field of hands-on exploration and experimentation. New form is not conceived. It*

is coaxed out, flushed from its virtuality. The architect's job is in a sense catalytic, no longer orchestrating."[63]

I would suggest more like the composer, whose grasp of the modulations possible, allow for exploration and experimentation as arrangements and re-arrangements of the elements are attempted until just the right melody has been 'discovered' that not only expresses the idea but its emergent self. Referring to Carlos Scarpa's work, Frascari proposes that more than just rational structures and functional spaces, Scarpa merges Frank Lloyd Wright's organic principles, his own knowledge of local craftsmanship, blended with technologies -both ancient and modern- where

> "*...the functionality is mediated by the search for representation and expression through the making...the union of representation and function...a constant search set between the actual form (the built one) and the virtual form (the perceived one). The constant manipulation of discrepancies between virtual and actual forms is the method used for achieving expression.*" [64]

Many theorists have similarly argued eloquently that the tectonics; joint, surface, structure, ornament, light, void or other element, is the most central to the core of what architecture is. They often adopt a construct of philosophy, language, mathematics, geometry, physics or meta-physics to explain specific movements of the evolution in architectural styles. Current theoretical forays on 'modernism' and 'postmodernism' afford a focus of de-construction of the manifestos that left an era of exciting change,

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[63] Massumi, Brian. "Sensing the Virtual, Building as Insensible." AD: Architecture and Science. Ed. Giuseppa Di Cristina. Chicester: Wiley-Academy, 2001, p. 204
[64] Frascari, Marco. "The Tell-the-tale-detail," Semiotics 1981, J.N. Deely and M.D. Lenhart, eds. New York, Plenum Press.

with its own burden of rigidity and conformity which has been quickly followed by reflective and representational constructs of memory and phenomenology. These reflect the world of philosophy, sociology, politics and economic democracy during a period of intense self-reflection and self-analysis.

During this same period the tremendous explosion of communications and other mass-media technologies has turned us into voyeurs of humanity. The 'world' around us is no longer limited to the area we can access through traditional norms of travel. The impact of our understanding of the world as 'global' is really just starting to show-up in critical discourse.

Conclusion

"Only through time time is conquered."
The Four Quartets, T.S. Eliot, 1943[65]

Current sociological theorists are starting to reflect upon the existing 'global' socio-economic condition, and the impact of the imbalance of the haves and have-nots and the potential long term impact this model holds for our environment, natural and built. As the impact that we, as a collective, are having on our planet becomes clearer, the ramifications of the 'western status quo' are being shown to be unsustainable and detrimental to the whole planet. We are seeing socio-economic disparity and resulting unrest not only in far-off-lands but in our own backyards. As the ethical dilemma of the excessive western lifestyle being supported at-all-costs is rearing its head in the form of 'just wars' and 'communications as control'[66], the requirements of the 'ethical' architect become clearer. LeCorbusier used the analogy of Revolution or Architecture, and it would appear even more relevant today that architects must take responsibility to correct or mitigate the negative impacts of the built environment, the revolution is inevitable, why should it not include the contemporary architectural event.

> *"The defining characteristic of a revolution is not that it is stronger than the state, but that it abruptly calls the existing society into question in the minds of the millions and effectively presses them into action."* [67]

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[65] Levine, Neil. The Architecture of Frank Lloyd Wright. Princeton, New Jersey: Princeton University Press, 1996. 294.
[66] Hardt, Michael, and Antonio Neggri. Empire. Cambridge, Massachusetts: Harvard University Press. 2000.
[67] Feenberg, Andrew. Questioning Technology. New York: Routledge, 1999. 41.

We must address these issues urgently, with creative and innovative solutions. Addressing the issue of sustainable technologies is not enough. Architects must address the issue of 'sustainable architecture' as a 'holistic' approach to the integration of sustainable technologies into meaningful forms. Meaningful forms derived from the integration of the program, function, local environment and materials according to a concept. According to Wright:

> *"I do not believe we will ever again have the uniformity of type which has characterized the so-called great "styles." Conditions have changed; our ideal is Democracy, the highest possible expression of the individual as a unit not inconsistent with a harmonious whole. The average of human intelligence rises steadily, and as the individual unit grows more and more to be trusted we will have an architecture with richer variety in unity than has ever arisen before; but the forms must be born out of our changed conditions, they must be 'true' forms, otherwise the best that tradition has to offer is only an inglorious masquerade, devoid of vital significance or true spiritual value."*[68]

From the initial concept though design, construction, habitation, upkeep, renovation, demolition and even after their demolition, Architecture, unlike a 'building', is never just an assemblage of materials serving a function, they affect and are effected by the world around them. They exert, and are subject to, both internal and external actions, forces, events and affects. Brian Massumi, in consideration of both Bergson and Deleuze & Guattari's take on 'virtual', says that "*its reality is the reality of change: the event.*"[69] Thought, both critical and consumer, and the technologies embodied in the design-build-and-operations processes, evolve throughout the 'life-cycle' of the built form, and affect and are affected by the users, owners, designer and the built form itself. From the

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[68] Frank Lloyd Wright, In the Cause of Architecture", Article printed in The Architectural Record, Vol. 23, No. 3, March 1908, p. 158.
[69] Massumi, Brian. "Sensing the Virtual, Building as Insensible." AD: Architecture and Science. Ed. Giuseppa Di Cristina. Chicester: Wiley-Academy, 2001, p. 204

moment the requirement is known until the memory of its existence seizes to be, architecture has an ongoing influence on the world we live in, as ‘real’ or ‘virtual’.

Today architects must strive to produce 'Architecture of Integrity', one of their time and place. That would be an architecture that seamlessly integrates the 'ideal', the program, the material and the technology, at its best representing both art and science at the forefront of its era as an embodiment of time and matter in space. The conceptual or virtual idea, as a product of the existing, burgeoning or aspired-to culture of the era within which it is built, and the technology, as a product of the science of materials and methodologies as existing, with innovation or as new invention, must be represented through the needs of the program, together they must overcome the limitations and take advantage of opportunities that exist in the environment within which they are formed. It is a simple formula, and integrations that have achieved the above, synchronized with their era, have been praised immediately by the masses. If, through time, some of the progressive visionaries have not been understood for a generation or more, the prophecy of their manifestation has eventually become clear, even if only in retrospect from the culture they were projecting toward. However, their projects represent the event of coming into being at the time that they did, and it is in these examples that the emergent property of potentiality is strongest. That they will inspire successive generations of designers to push the existing 'known' to look forward to what the integration of their art and science can be. To create events as statements of progress, as it is 'only through time time is conquered'.

I would argue that it is in the 'process' of determining how much art and how much technology can be mutually and beneficially embodied in each element, at every scale, that is truly the fundamental core of architecture.

> "*Only in the highest art are the Idea and the representation genuinely adequate to one another, in the sense that the outward shape given the Idea is in itself essentially and actually the true shape, because of the content of the Idea.*"[70]

[70] GWF Hegel, On Art, pg 109

"A People without history
Is not redeemed from time, for history
is a pattern
Of timeless moments."
Complete Poems, T.S. Eliot[71]

[71] Levine, Neil. The Architecture of Frank Lloyd Wright. Princeton, New Jersey: Princeton University Press, 1996. 297.

Appendix A

Technological and Material Considerations

> "*...that architecture, as the domain of human existence, must embrace the totality of what it is to be a human being; a totality which includes bodily as well as intellectual experience.*"[72]

Many of the technologies considered for use in this project were of the building science or building technology, heating, ventilation, and air conditioning (HVAC) genre. New and traditional green, or sustainable, solutions were considered as applicable, and 'smart technologies' i.e., communications, security and command-control systems have also been integrated, or considered for future installation.

Resources used to assess each of the technologies considered for inclusion in this project included course material from both the Carleton School of Architecture Undergrad Technology Stream courses and the Graduate Advanced Building Systems Course. Much of the initial information on specific technologies was acquired from the iiSBE R& D database, the beta version of The Sustainable Building Information System, which I was generously given access to by Mr. Nils Larsson, the Executive Director and Canadian Representative of The International Initiative for a Sustainable Built Environment. The Government of Canada web sites for Natural Resources Canada, Environment Canada, and the National Research Council's various sites were of great value as well. Web addresses have been listed at the end of this appendix. Additionally

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[72] Odoerfer, Joseph B. "The Poetics of thermal Technology." On Architecture, the City, and Technology. Ed. Marc M. Angelil. Stoneham, MA: Butterworth-Heinemann, 1990. 108.

and specifically for the radiant floor heating, the web site at www.Taunton.com was a useful resource. Supplementary information was acquired from Uponor Canada Inc., from their Wirsbo Product Catalogue courtesy of Boone Plumbing and Heating, a local commercial supplier of radiant floor heating systems. Additional information reviewed was collected from various government/institutional organizations and private industry web sites, as listed at the end of this appendix.

The concept of the house as an analogy to the tree allows for future –a fourth branch– integration into the existing circulation core for wiring, cabling, wireless repeaters or hubs, as may be required. Many of the systems considered for selection have a great deal of overlap one to another, either as object or impact. As an example, windows are considered in respect to heat loss/gain, daylighting/glare, ventilation, building envelope and security. Each technology is considered in respect to the amount of automation and/or hands-on intervention that is required, or desired, to be functional, the impact–detrimental or beneficial– on both the inhabitants and local wildlife and, if it is in accordance with the conceptual ideal whether derived from, or as it emerges through the process.

Technologies

Sources of Energy to Consider: Cooling/Heating and Electricity

Radiant floor heating: Integrated and isolated zones.

Frank Lloyd Wright had installed radiant floor heating in the wood platform construction of several of his earlier home designs, these and several different systems/configurations were considered. Although the wood only flooring was the first consideration the additional material and work to install the under-floor reflective foil pans, insulation and finish surface treatment would have added a significant labour cost to the technology with a lower energy saving yield, so the application methodology selected, although more traditional, was modified to suit the project. The solution still demands additional labour for the insulated sub sub-floor insulation, however, preassembled as panels, installation can be simplified and finished to be consistent with the existing conditions.

Natural Ventilation: windows will be operable and the skylight at the top of the tower is operable to create a stack effect for cooling during the summer months. It will be fitted with a translucent insulated panel to reduce heat loss at night and during the winter.

Daylighting: south and east facing fenestration allow for plenty of natural daylight to penetrate into most areas of the building. Private areas have either direct windows or overhead skylights. Glare is reduced through the use of built on external shading devices and removable reflective glazing panels (allowing for daily and seasonal adaptation).

Solar: both passive and back-up solar photovoltaic systems have been accommodated in the design. (See Appendix B for siting considerations)

Passive system uses the radiant floor mass as a heat collector and distribution system.(see Appendix B for siting considerations)

Glazing: orientation for gain

Shading: internal and external

Thermal Mass: additional mass in fireplace and sistern

Active system uses a marine (or RV cottage) package.

Solar Panels Placement & Orientation

Surplus Energy Storage/Integration

Wind: Wind speed is at the low range for sole power source generation, however as a supplemental system the long term advantages may be more beneficial, especially during winter when the solar gains are lower and the average wind speeds higher.

Passive use of wind through stack effect ventilation and operable openings which allow for cross ventilation

Active system was considered for future installation at edge of entry to property. As most of the equipment other than the turbine, wiring and tower is the same as the peripheral equipment used for the active solar system, future implementation is simplified.

Geo-Thermal

Heating: Radiant heating system will be a closed loop system. Use of both lake water thermal mass and cistern for pre-heating of circulation fluid. Same system will allow for pre-conditioning of household water

Wood Burning Device

Heating: an airtight high efficiency wood-burning boiler will serve as auxiliary heating source for radiant floor and hot water heating. This solution was determined to be beneficial as new environmental standards for high temperature combustion (minimizing off-gassing), and availability of renewable resource weighed in this decision. Fireplace in living area will also be high efficiency although it was determined that a less efficient multi-sided version would better suit the design allowing access from different areas of the home.

Building Structure & Envelope: Over all a grid system was used so that all structural members, enclosure panels and glazing elements could be sized to certain proportions allowing for re-use of most components as the home transitions through its various phases.

Glazing. Conceptually, upon entering the house a connection to all that is nature that surrounds the dwelling is achieved through the large expanse of glass on the east and south walls. This glazing, critical to the passive solar gain is also addressed as a concern for heat loss, solar damage and security. Most windows are double paned with a reversible third panel that can be used to reflect radiation out or in as required. Translucent insulation panels are in all skylight locations to minimized heat loss while maintaining as much natural lighting as possible. Lower level decks fold up to a locked position when the cottage is empty or in the winter months these also have the potential to serve as thermal breaks.

Hybrid Composite Wall and Roof Panels. Because of the glazing on the south and east walls, and the availability of timber on site, post and beam construction in addition to standard platform framing is used in the project. All large timbers are assembled using metal plates, or, mortise and tendon connections, which will allow for their eventual disassembly and re-use. The thermal envelope includes advanced building system air and vapour barrier technology, and all the walls, floors and cantilevered branches of the home have additional insulation. The foundation walls have both interior and exterior insulation. Roof treatment at the upper level is a low growth 'green' flat roof as compensation for the foundation footprint. Joints, junctions and connections have been designed with a primary and secondary seal.

Waste And Water Management

Potable water supply is gathered from an on site fresh water well, and the lake water is still potable at this time.

Reclaimed water from roofs is collected to maintain minimum cistern levels and the balance is to be used for landscaping/greywater applications in a later phase of the home's development. (The green roof above the gallery level uses two layers of water conservation material to nourish the low growth garden.)

Waste Treatment: Initially a micro 'living machine' was considered for 'black water' waste treatment. Research revealed that a substantial amount of understanding and technical aptitude was required for the operation and maintenance of most living machine installations, however composting waste appliances have gone through a phase of significant development and achieve equivalent results with a substantially lower user intervention requirement. Several systems are available as hybrid greywater use and compost appliances, unfortunately during the research of this project I was unable to find any information on excelerator requirements or environmental impact data for these systems.

Security for the inhabitants and the wildlife on site, and off site monitoring of critical systems must be addressed in the project. The local inhabitants include various large rodents, wild canines, deer and bears. Walking on site is not done without bear repellant as the members of the family orsa have no compunction about continuing to use their territory regardless to human presence. The cottage as refuge must also serve as a safe retreat when the natural inhabitants are claiming their share of the place. Off-site control mechanism for monitoring remotely, once the four season facility is fully constructed, are anticipated in the design whether for temporarily absentee owners and/or closing for holidays or snowbird winters. Web cameras and centralized controls are also considered.

Material

The material palette for this project drew inspiration form the site. However, some of the materials have been modified to suit the overall context of the site, sometimes to reflect the natural state of one material more than the state we transform them too for our use, or vice versa. When non site specific material is used, consideration for locally produced, supplied and transported material is included to minimize the 'embodied energy' of the products. A local mill is to supply additional wood products and a local quarry, the stone not produced on site.

Trees: Material is wood. On site they define space and enclosure and lend a sense of energy and continuity. They serve naturally as both the structure and surface of the site, canopy above, rusted needles and leaves below.

Structure and surface: Local White Pine and Birch

Earth: Rock as stone and tile. The bedrock projects through the carpet of the forest floor revealing its solidity, its 'grounding'.

Structure and surface: Local stone

Lake Water/Ice: Material is glass or metal. The lake is alternately both a flat smooth reflective and, rippled fragmented undulating surface. Both clear views and speckled reflections peeking through the trees are its visage. The presence of the lake defines the edges and surfaces of the site, it is synonymous to the site existing.

Structure and surface: Metal and glass

Relevant Sustainable Technology Web Resources

National Research Council and the NRC Institute for Research in Construction (www.nrc.ca and www.irc.nrc.ca),
Natural Resources Canada and NRCan Office of Energy Efficiency: R-2000 (www.nrcan.gc.ca and www.oee.nrcan.gc.ca),
Canada Mortgage and Housing Corporation (www.cmhc.ca), Environment Canada's 'The Green Lane' and 'Sustainable Development Strategy 2004-2006' (www.climate.weatheroffice.ec.gc.ca and www.ec.gc.ca/sd-dd_consult/SDS2004),
The International Initiative for Sustainable Built Environment (www.iisbe.org),
Environmental Building News (www.buildinggreen.com),
Geothermal Heat Pump Consortium, Inc. (www.geoexchange.org),
The Canadian Solar Energy Society (www.solarenergysociety.ca),
U.S. Department of Energy, Energy Efficiency and Renewable Energy (www.eere.energy.gov/erec) and,
Mother Earth News - The original guide to living wisely (www.motherearthnews.com).

Appendix B

Siting Considerations:

Access

All but the last road leading into the area of the site are paved, and the approach road is in good condition following three years of use and seasonal exposure. Hydro lines are on the road that runs past the lots, so electricity is available to the site, however it will require a substantial run into the property to bring power to the house.

The previously clear-cut forest has re-grown and from the condition and size of the trees appears to be back to mature growth status. Occasionally the original logging road, which crosses about midway down the lot, is evidenced by a regulated line of same size trees, but for the most part is invisible due to the well-established growth. The entry into the site has a slight incline for about fifteen to twenty feet and then drops steeply to a good-sized plateau area that levels off for twenty to thirty feet before dropping again to the lakefront. The ridge of the plateau is about five feet back of the required setbacks for the local Municipality of Blue Sea zoning authority.

The steep drops in grade make access to the plateau difficult and in some areas not possible without the support of the existing trees. A great deal of terracing, steps and strategic landscaping would be required to access the lower site using a ground level approach, which would have significant impact on the rugged beauty of the site. As the trees are the strongest presence on the site, destroying them for access purposes seems inappropriate, whereas, accessing the site by entering a walkway that slowly raises up into the trees, becoming the bridge between public and private is much more appealing.

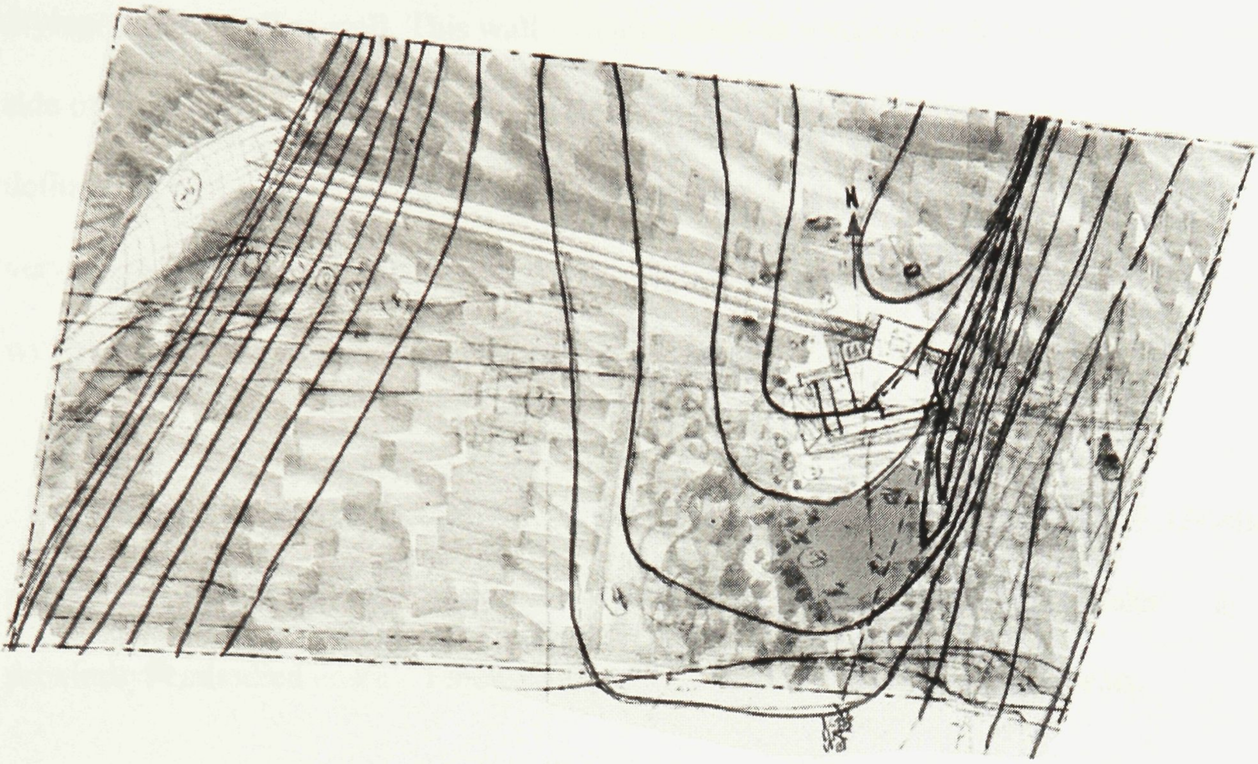

Figure 64 Site Orientation Sketch: Angle of Approach and Passive Solar gain

Orientation: The angle of approach to the core of the building is a little under 30° off the best angle for southern exposure on the plan, so the core was skewed to accommodate the direction of entry, and the original plan elongated to best frame the views, access the natural outdoor room at the edge of the plateau, and to maximize solar gain. This also sets up a good scenario for cross ventilation based on the predominant wind pattern.

Local climatic conditions were monitored over the year of this project, and additional data was used to determine average climatic conditions from the Canadian Climate Normals: 1971-2000 on the Environment Canada, National Climate Data and Information Archive web site, using the Maniwaki, Quebec station statistics. A windbreak would be beneficial on the west side of the house, and will serve as a wood drying/storage wall as well. This wall will also serve as a boundary definition for the west side of the natural enclosure that flows from the south side of the house. The ridge defines the east side where the land mass drops away to the lakefront. As the canopy is very thick in the summer, there is very little underbrush so very little ground maintenance will be required to benefit from this natural enclosure.

Source materials available on site are addressed in Appendix A, page 95. On-site materials available will be selectively used and sources from off site will consider proximity, embodied energy, renewable qualities and maintenance requirements.

Thesis Project Exploration

Site Plan Model

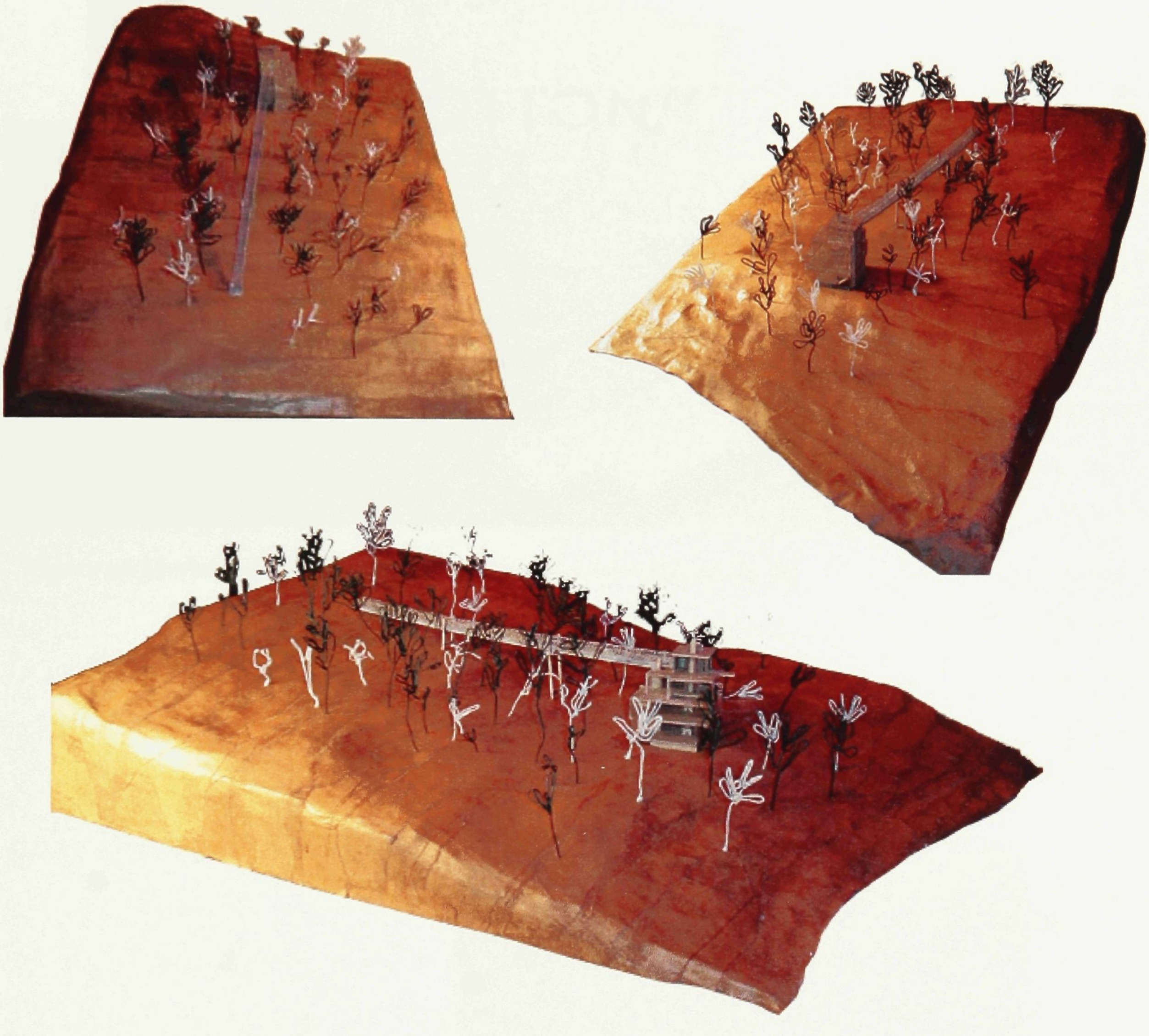

Figure 65 Site Model. Top left: approach from the Northwest. Top Right: View from east corner at lake. Bottom Centre: View from Southerly direction.

Final ¼ Scale Model

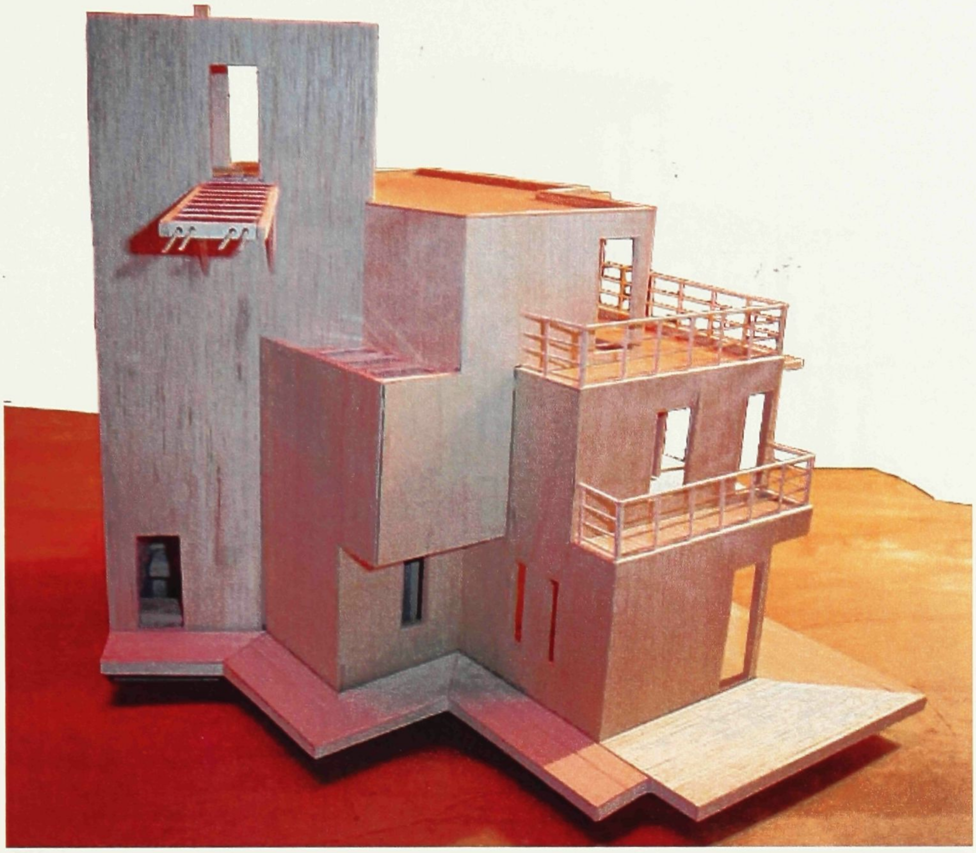

Figure 66 Model: Northwest bridge approach to Tree House Home.

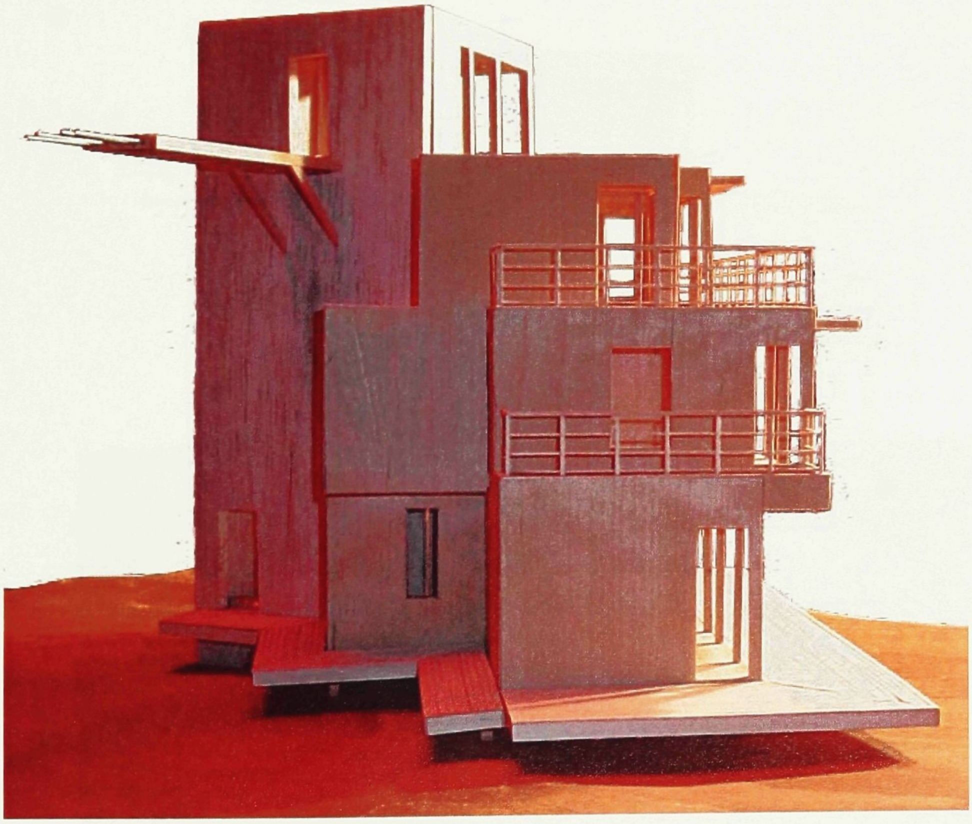

Figure 67 Model: West elevation of Tree House Home.

Final ¼ Scale Model (continued)

Figure 68 Model: Southwest elevation of the Tree House Home.

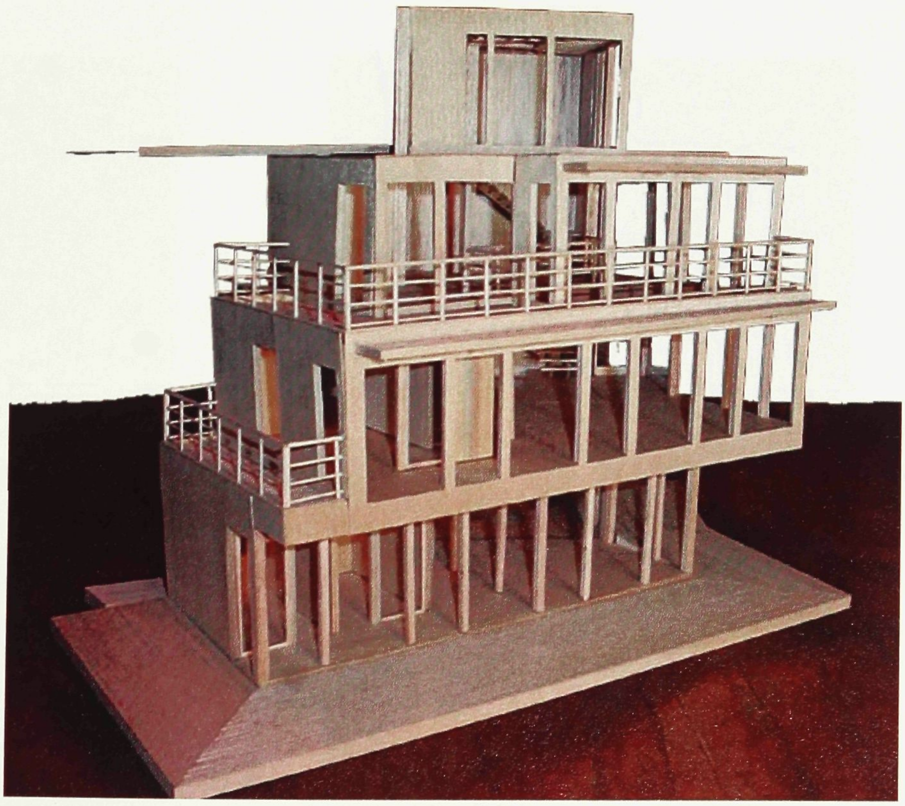

Figure 69 Model: South elevation of the Tree House Home.

Final ¼ Scale Model (continued)

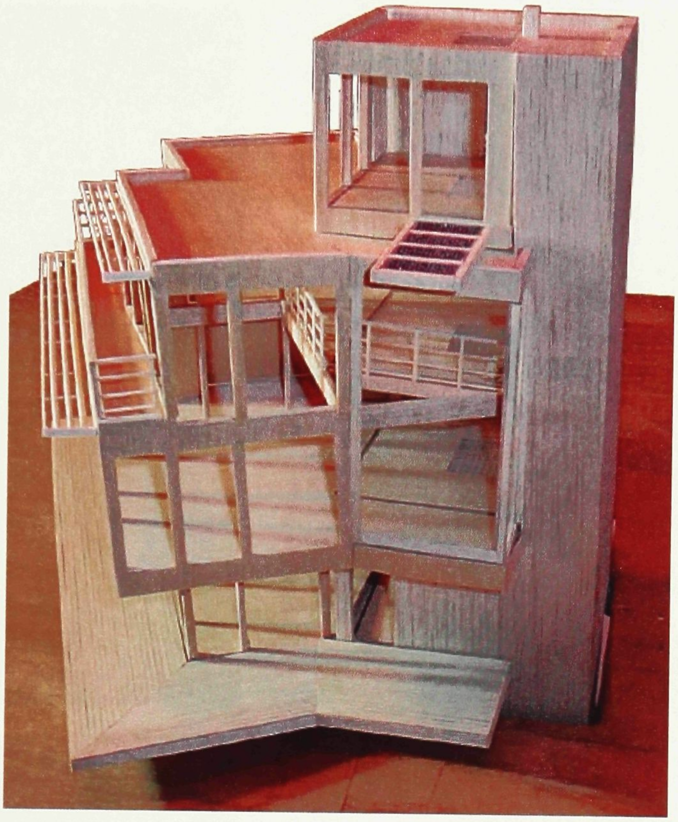

Figure 70 Model: East elevation of the Tree House Home.

Model Interior Views

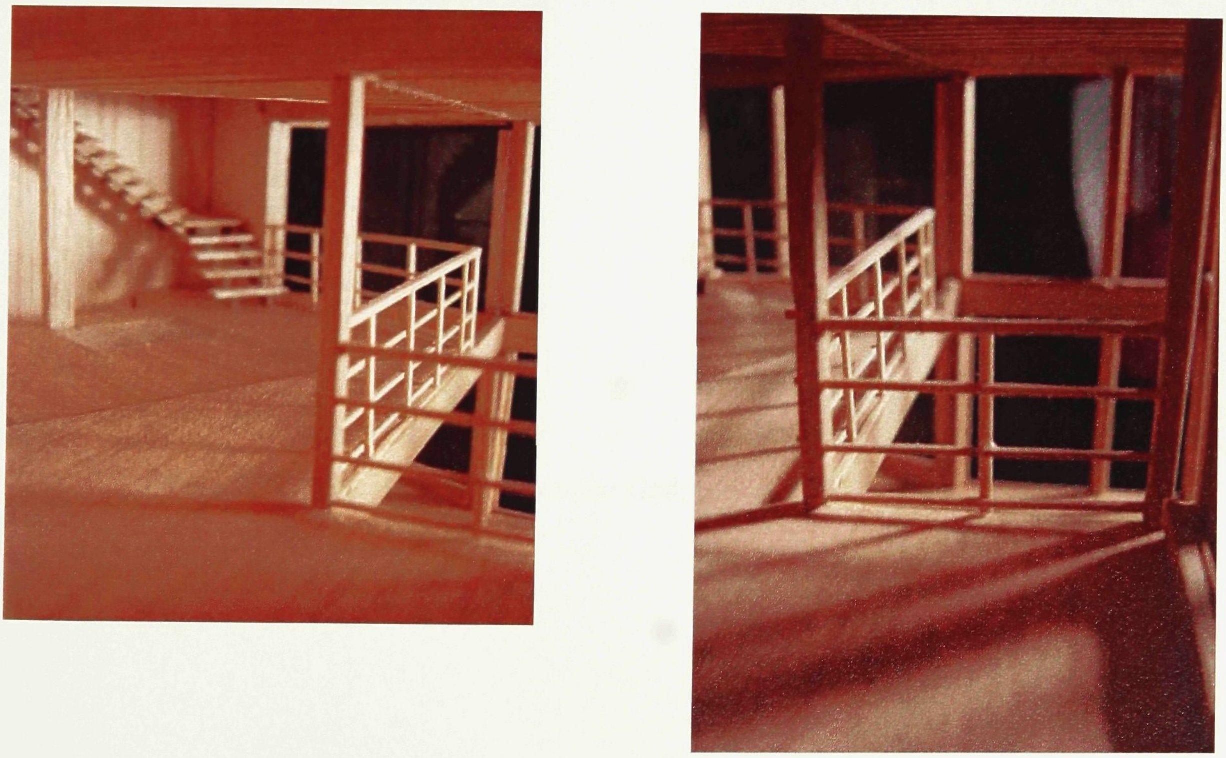

Figure 71Model Interior Views (1): Stairs down from tower room to gallery level (left) and

Model Interior Views (continued)

Figure 72 Model Interior Views (2): Gallery and Winter Level at Tower.

Phase I: Weekend Tree House

Figure 73 West Elevation Weekend Tree House

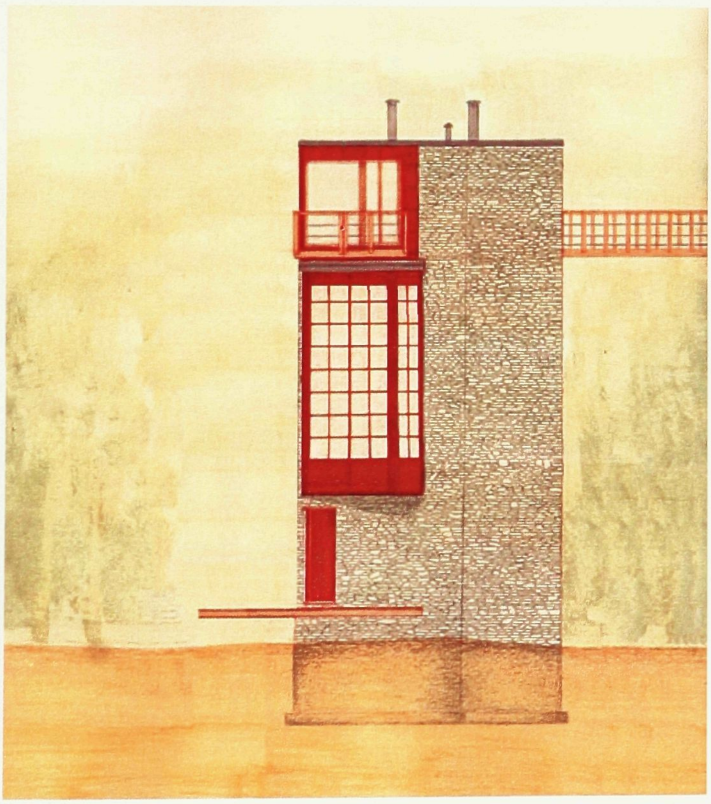

Figure 74 East Elevation Weekend Tree House

Phase II: Summer Tree House Retreat

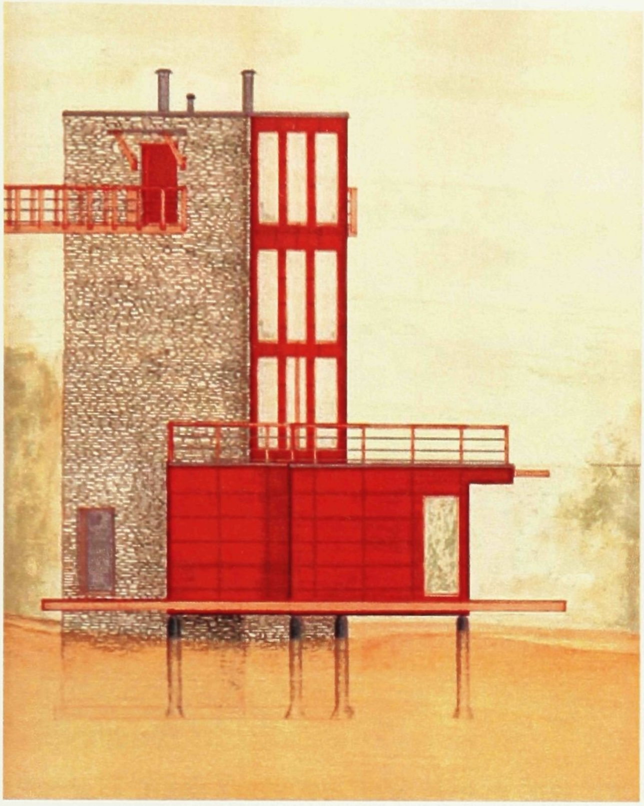

Figure 75 West Elevation Summer Tree House Retreat

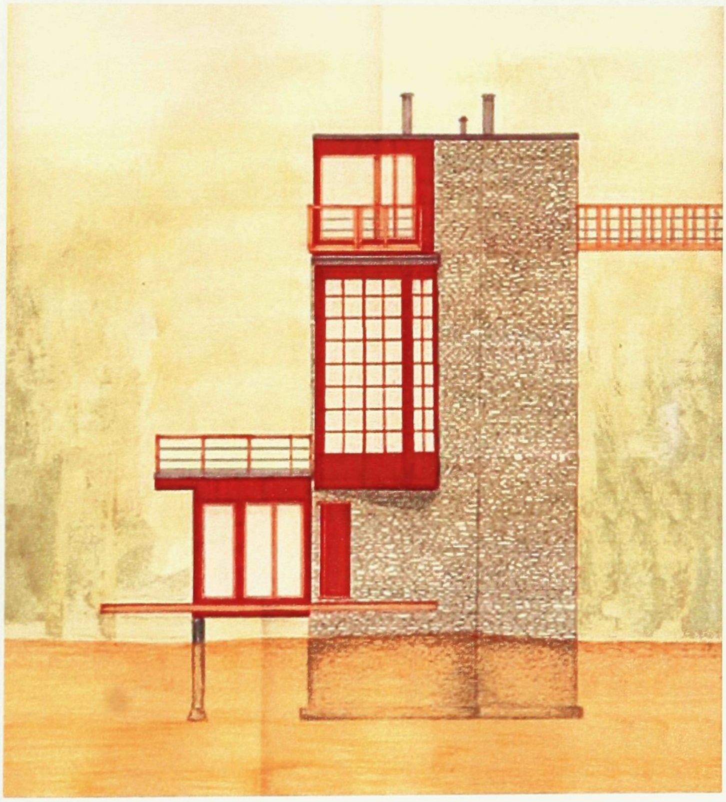

Figure 76 East Elevation Summer Tree House Retreat

Phase III: Year Round Tree House Home: Elevations

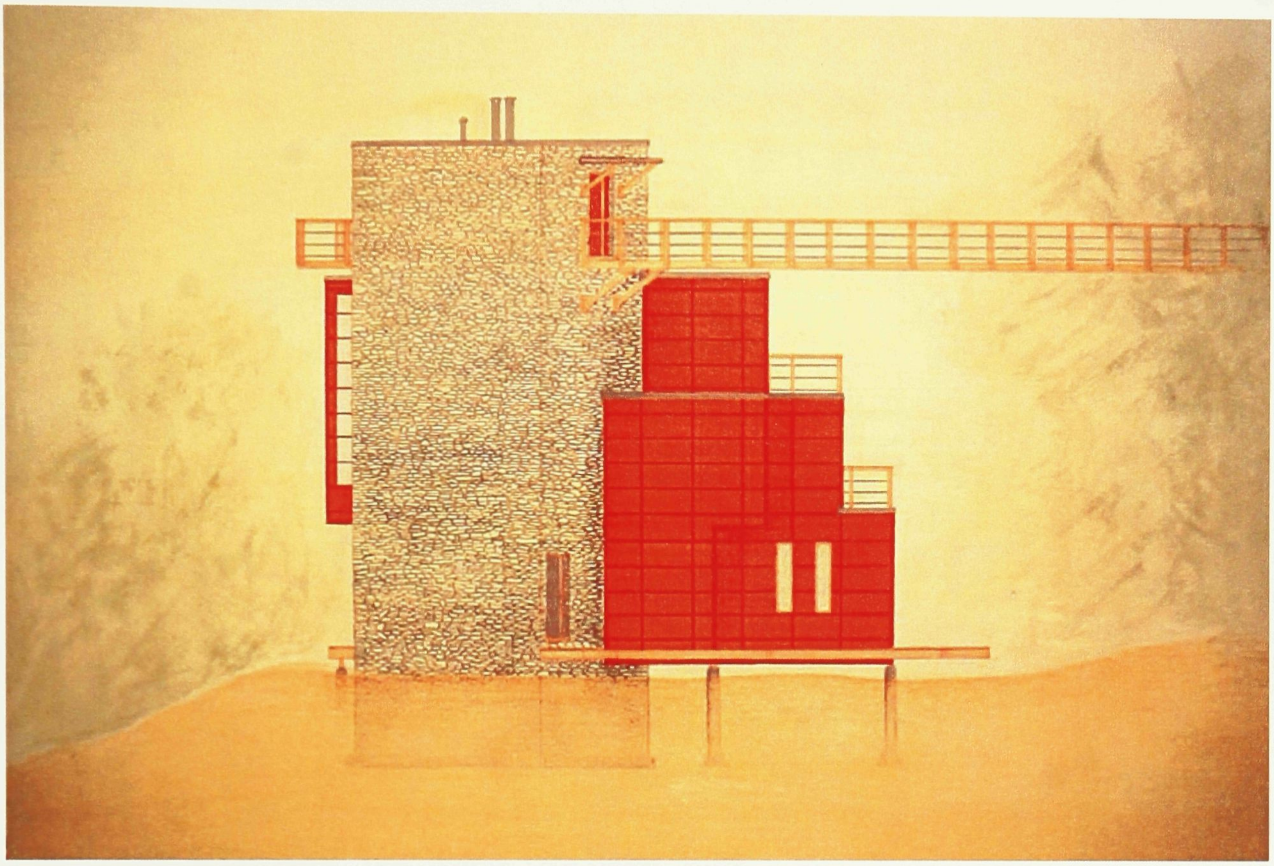

Figure 77 North Elevation: Year Round Tree House Home

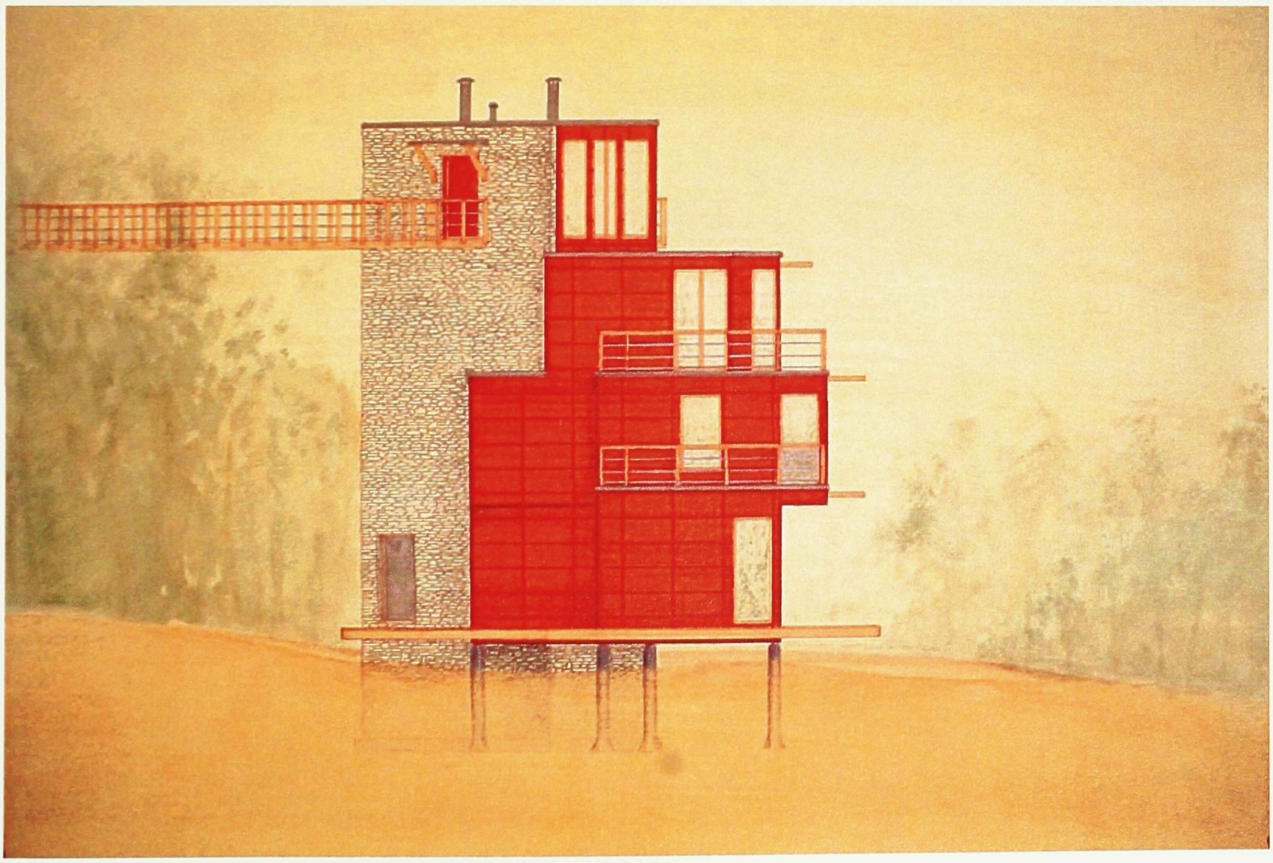

Figure 78 West Elevation: Year Round Tree House Home

Phase III: Year Round Tree House Home: Elevations (continued)

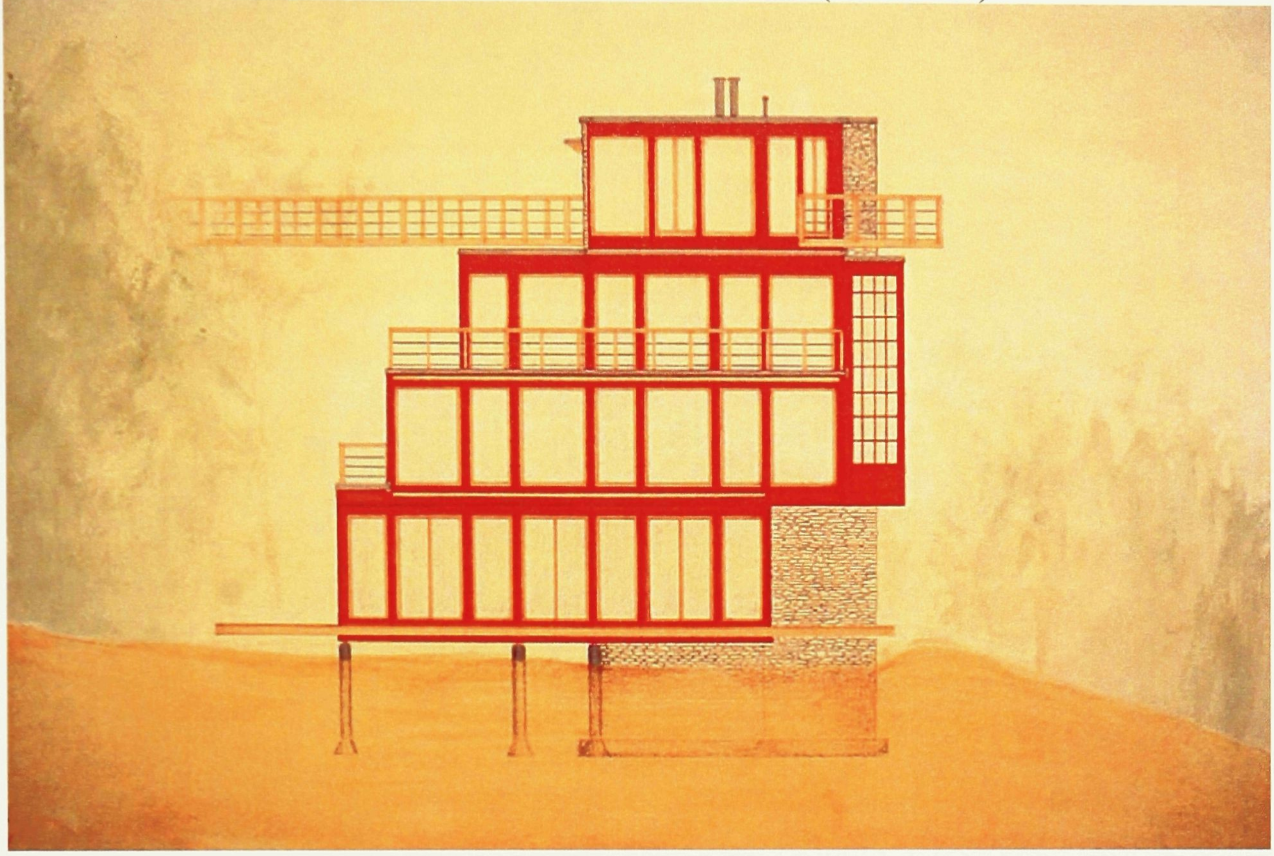

Figure 79 South Elevation: Year Round Tree House Home

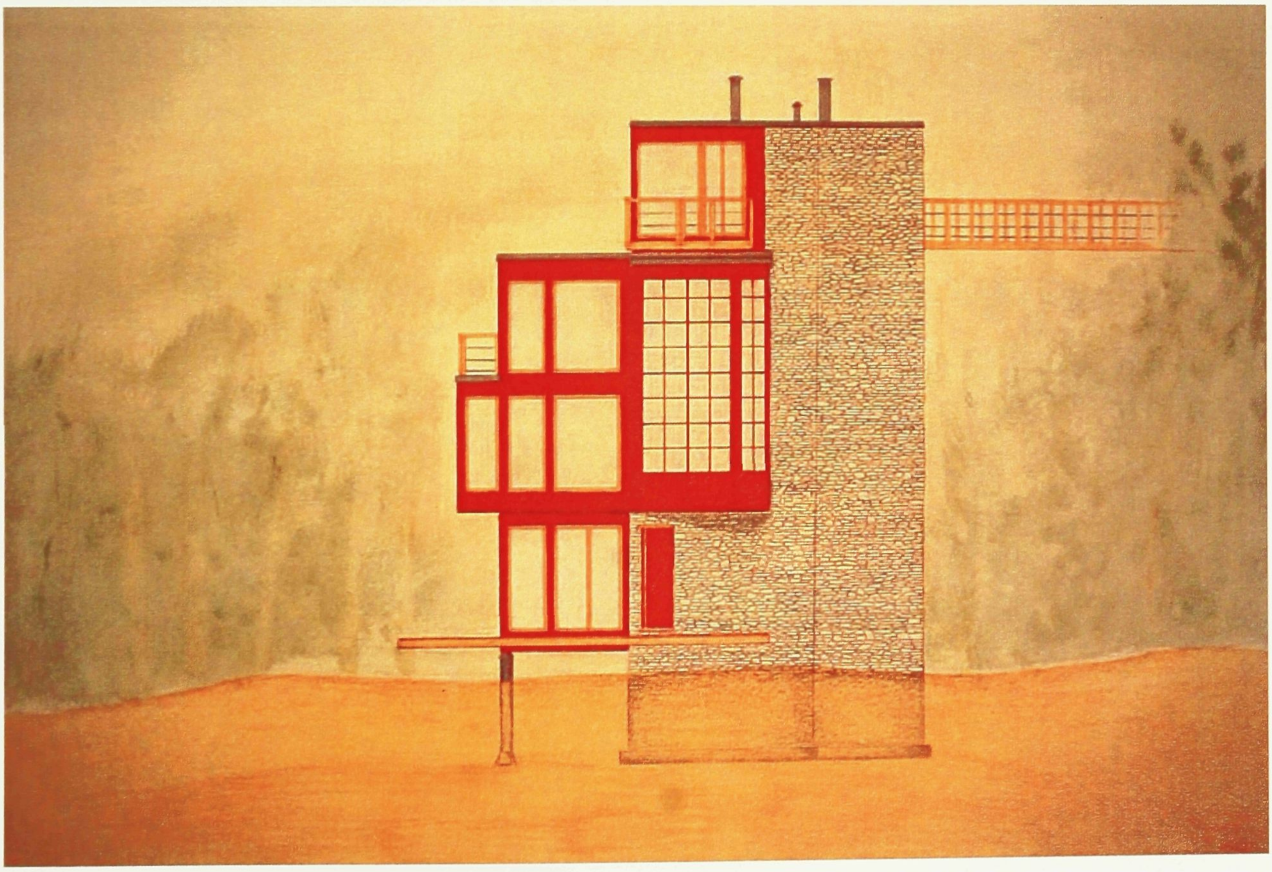

Figure 80 East Elevation: Year Round Tree House Home

Phase III: Year Round Tree House Home: Plans

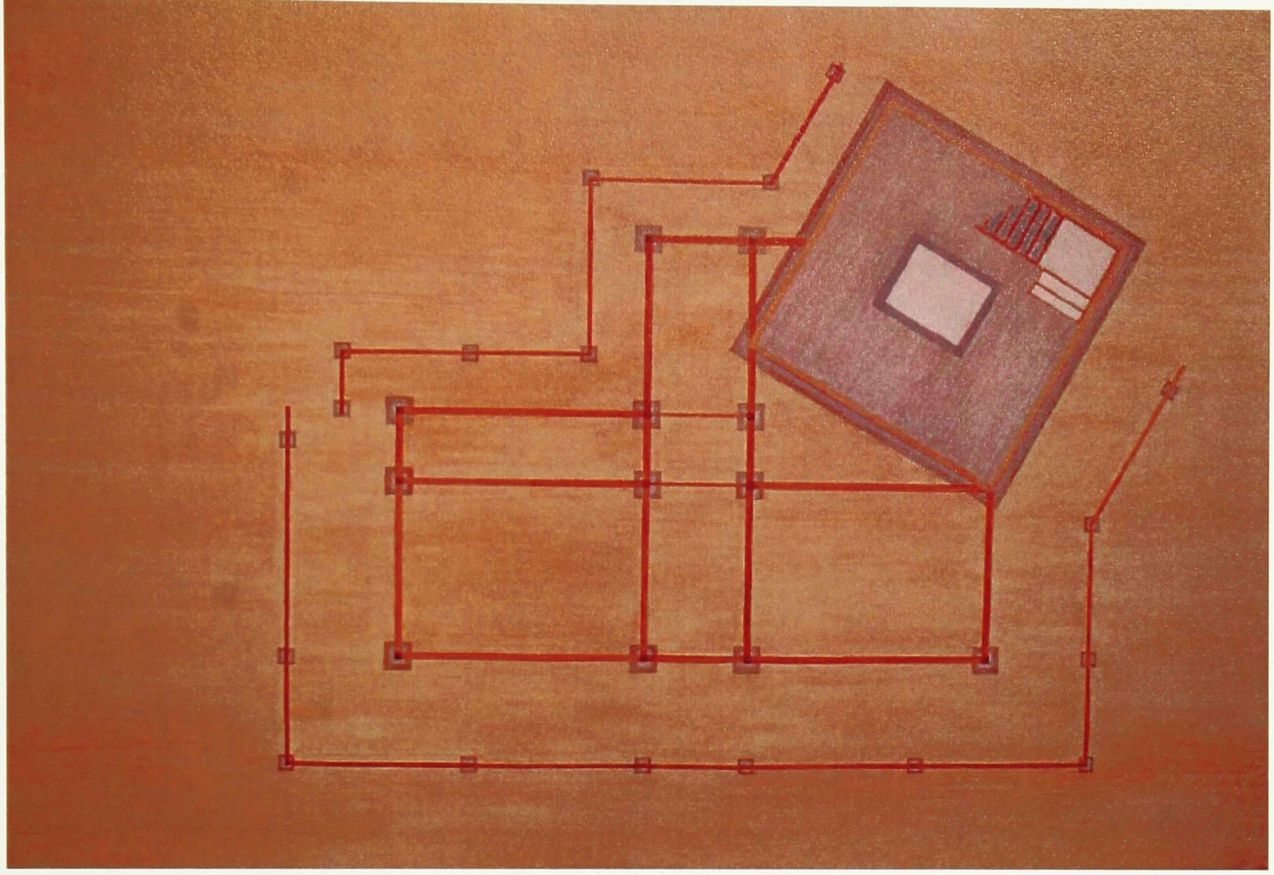

Figure 81 Plan: Foundation (full and piers) of Year Round Tree House Home

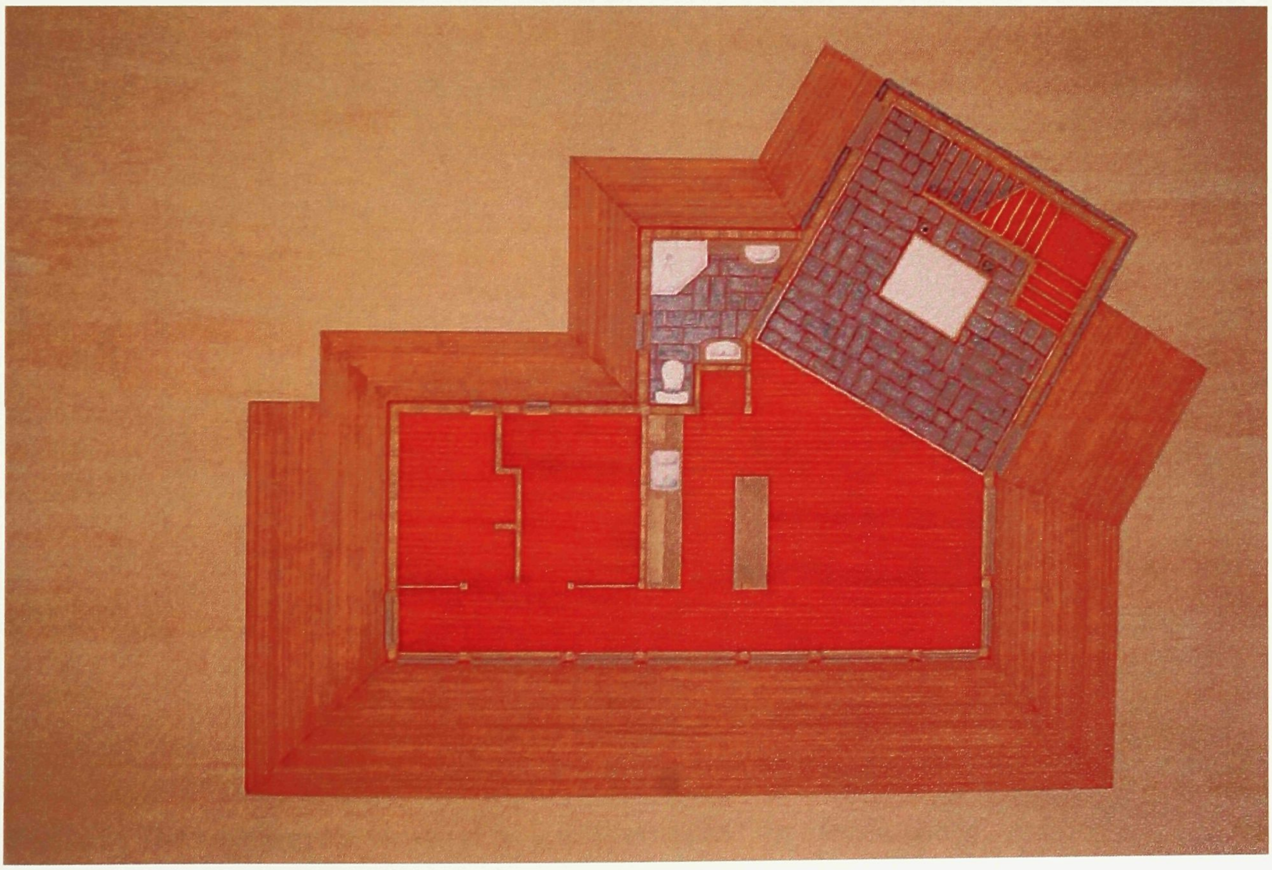

Figure 82 Plan: Summer Level of Year Round Tree House Home

Phase III: Year Round Tree House Home: Plans (continued)

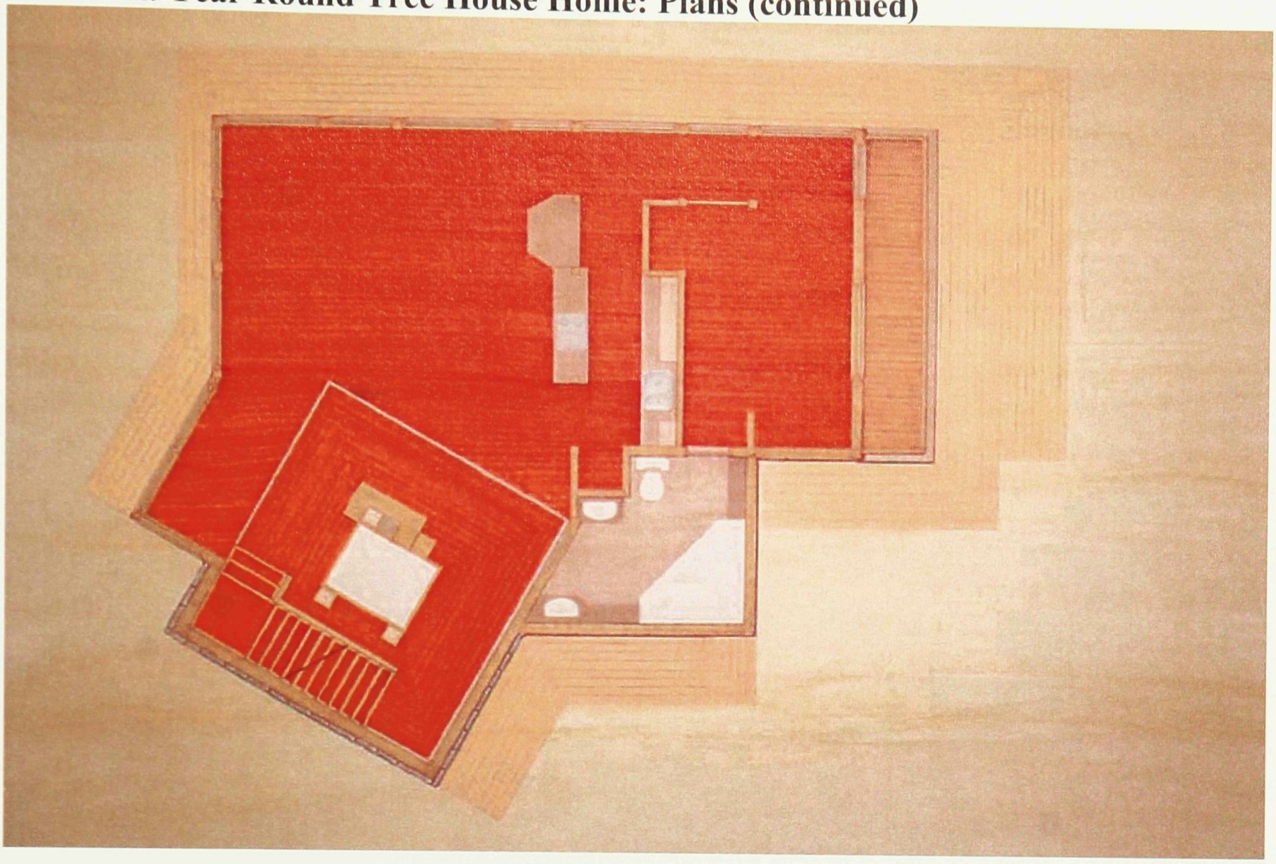

Figure 83 Plan: Winter Level of Year Round Tree House Home

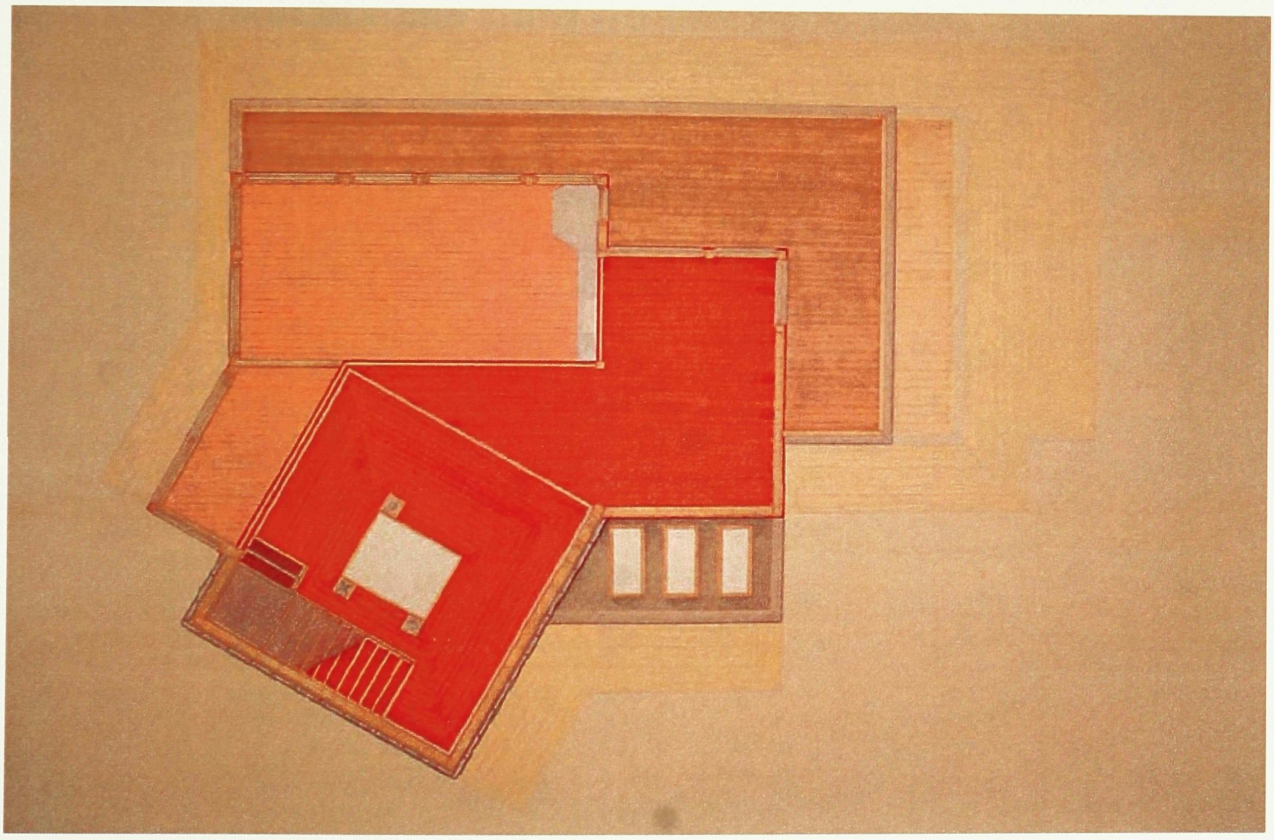

Figure 84 Plan: Gallery above winter level of Year Round Tree House Home

Phase III: Year Round Tree House Home: Plans (continued)

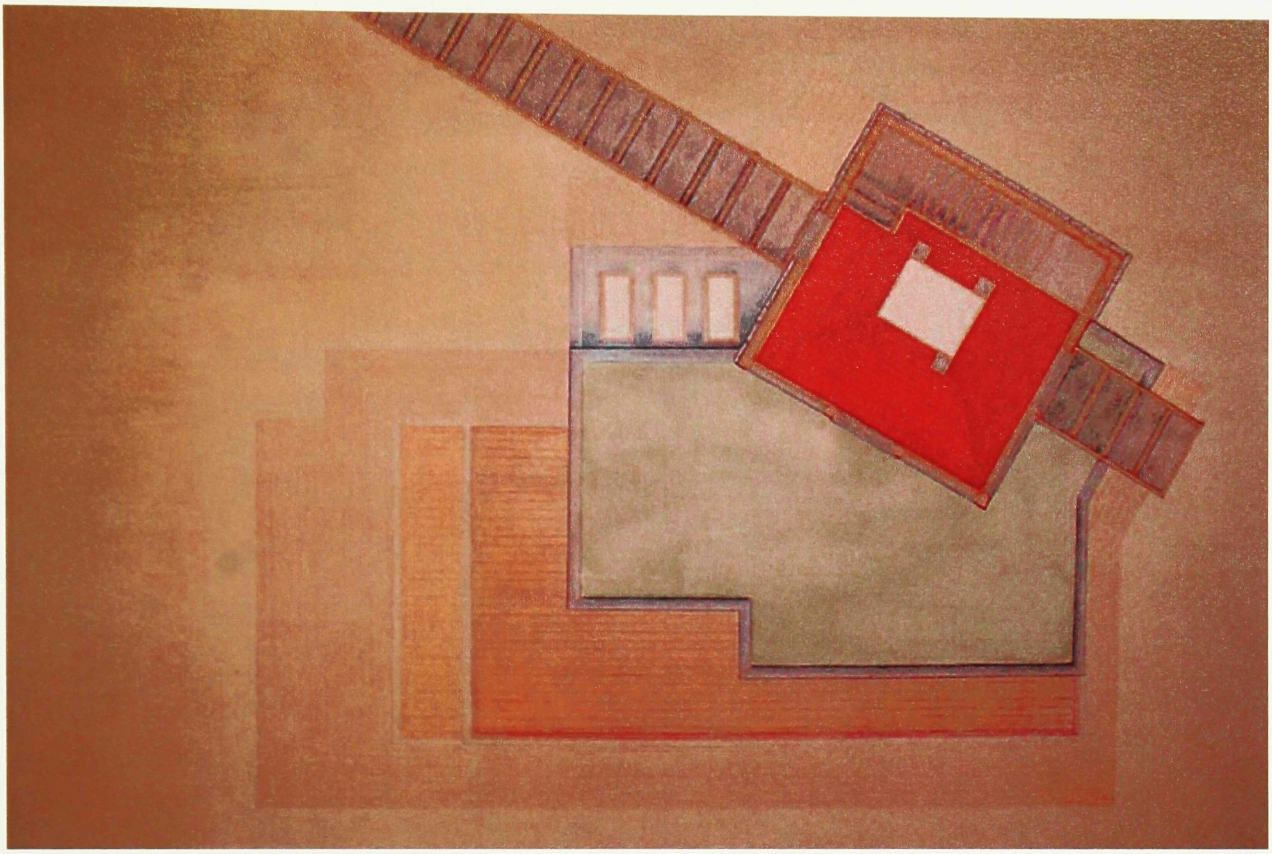

Figure 85 Plan: Tower Room Entry Level of Year Round Tree House Home

Phase I-IV: Year Round Tree House Home: Section and Details

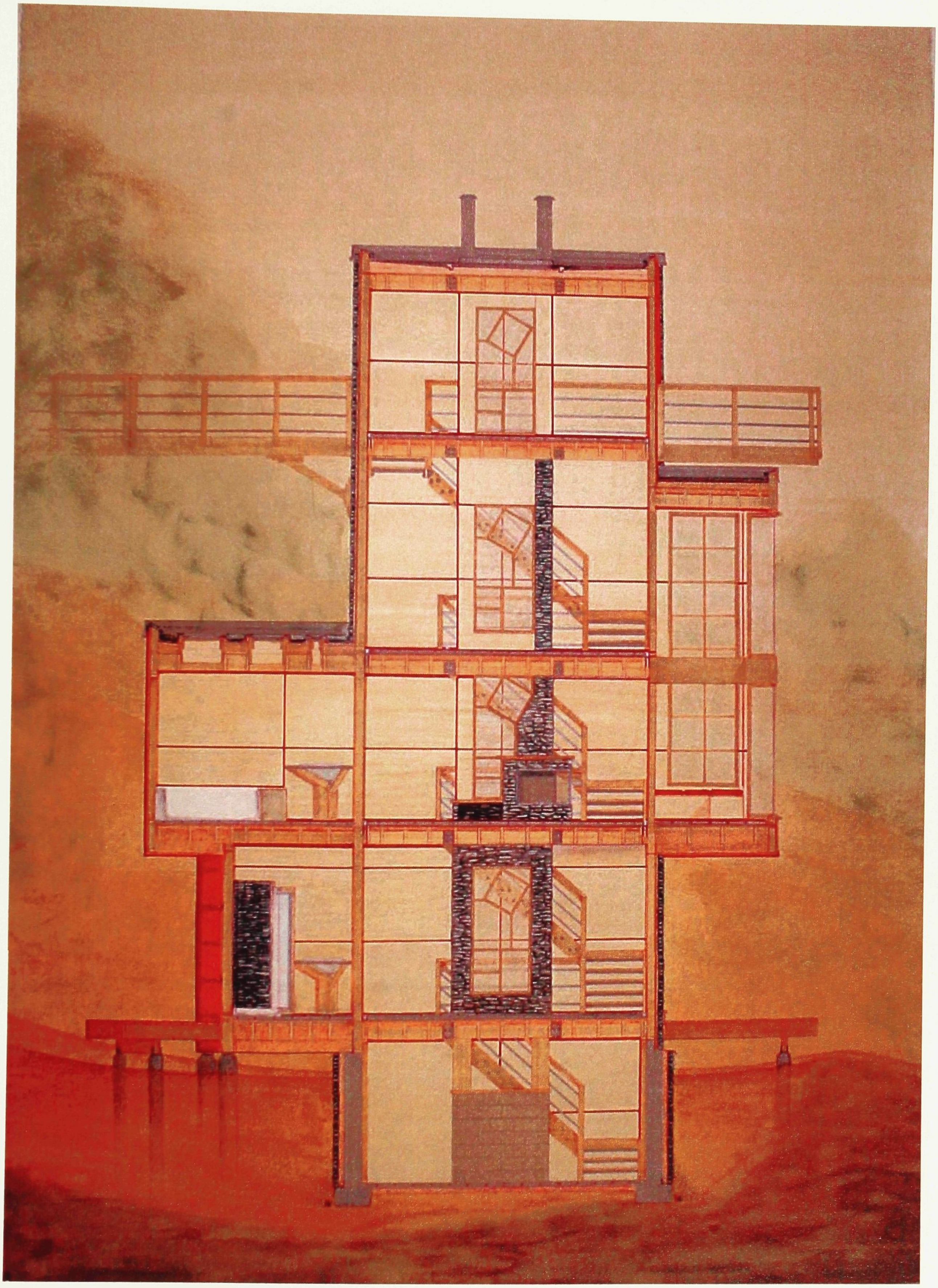

Figure 86 Section: Tower core areas of Year Round Tree House Home

Phase I-IV: Year Round Tree House Home: Section and Details (continued)

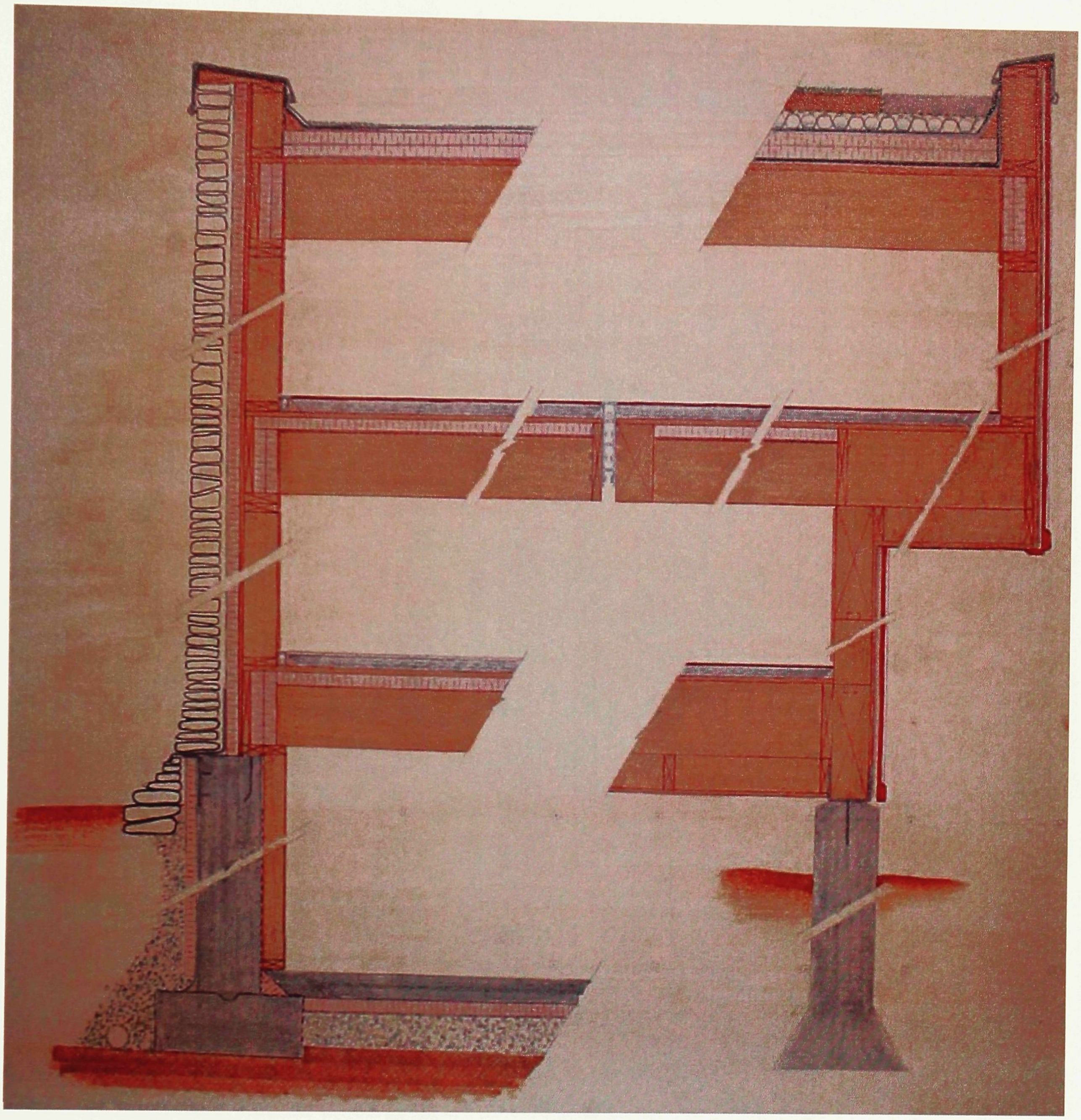

Figure 87 Detail: Construction of Foundation Footing and Sill, Upper Sills, Floors, Walls, Cantilever, Parapet, and Roof details.

Phase I-IV: Year Round Tree House Home: Section and Details (continued)

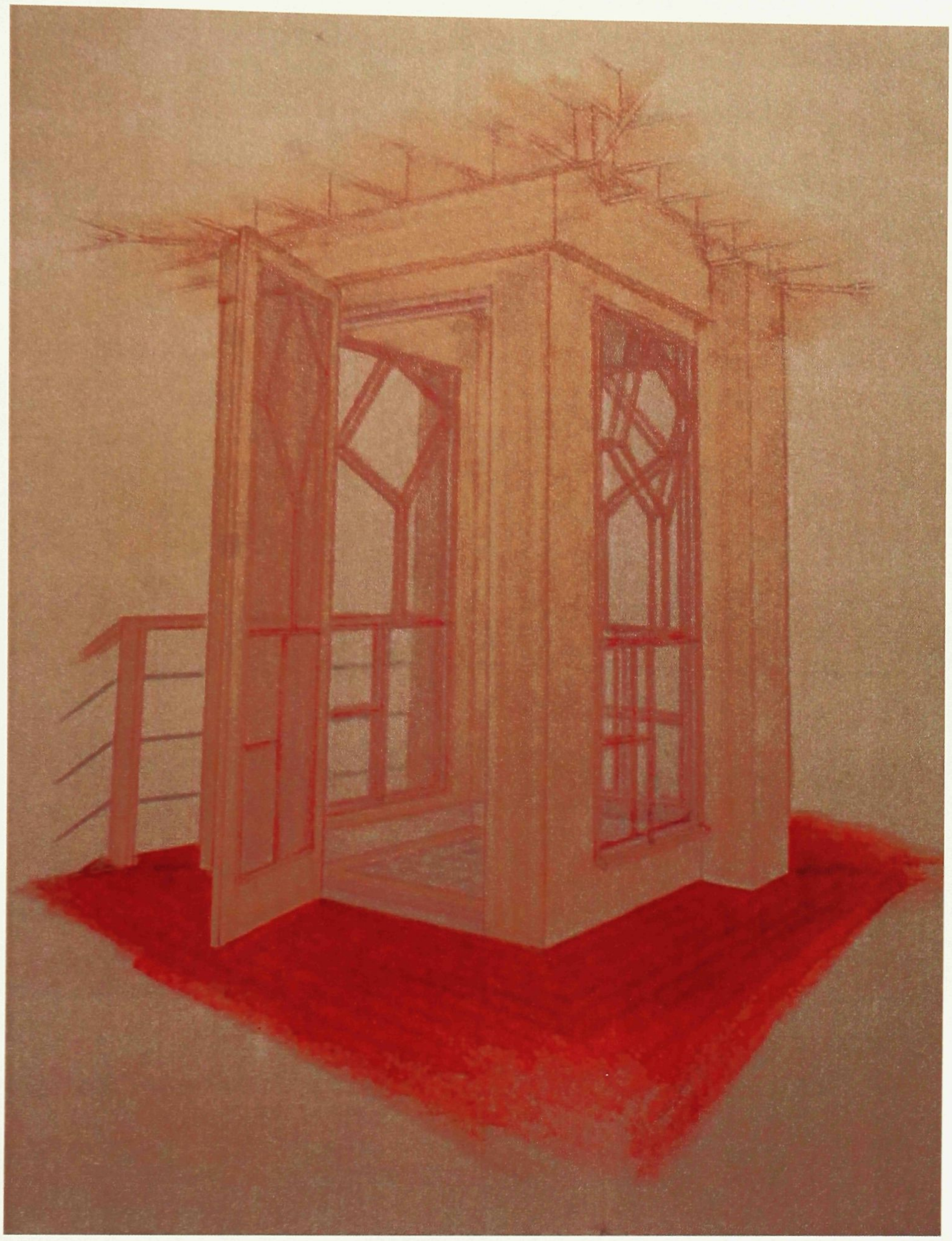

Figure 88 Elevator for Phase IV Long Term Care Plans (in existing light well)

Phase I-IV: Year Round Tree House Home: Section and Details (continued)

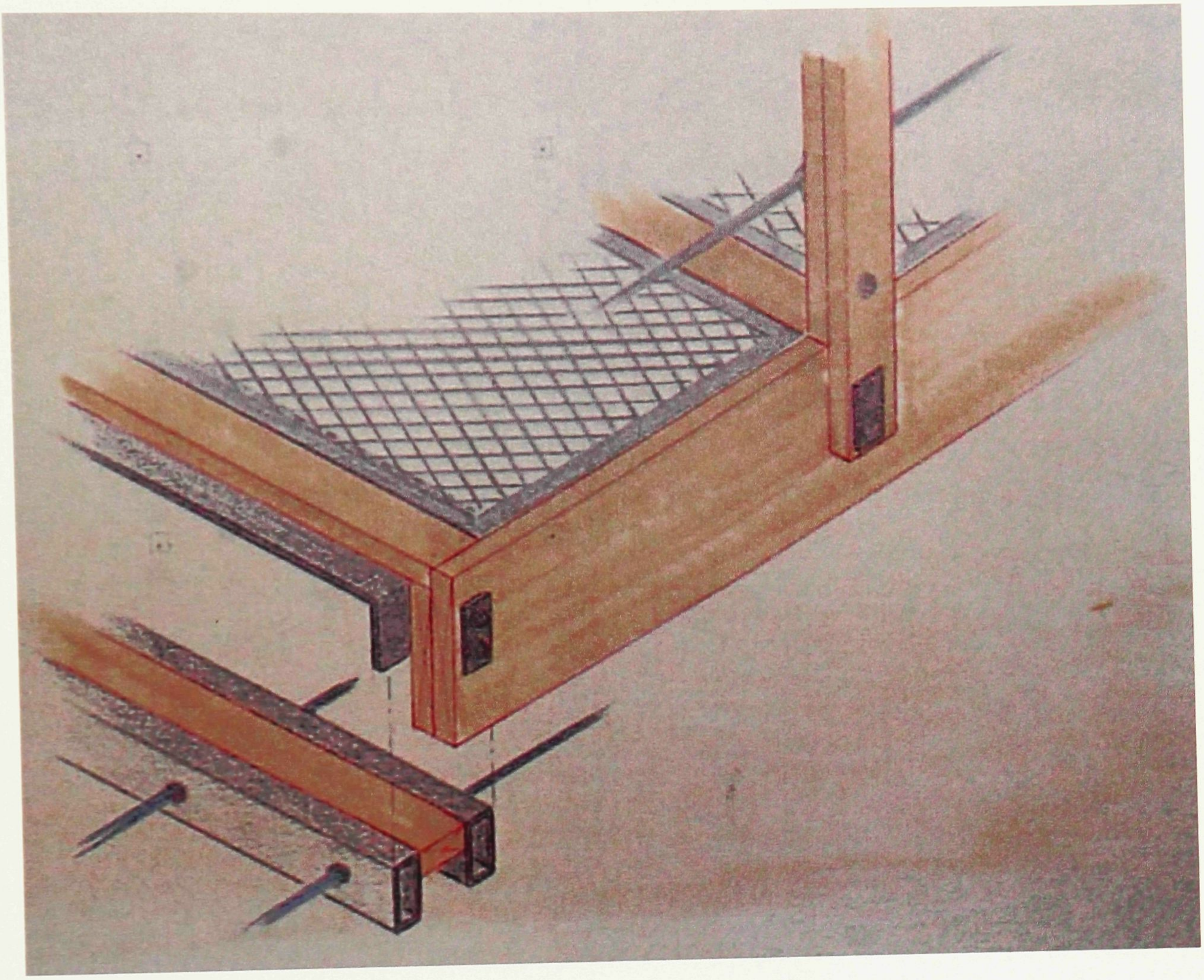

Figure 89 Suspension Bridge detail

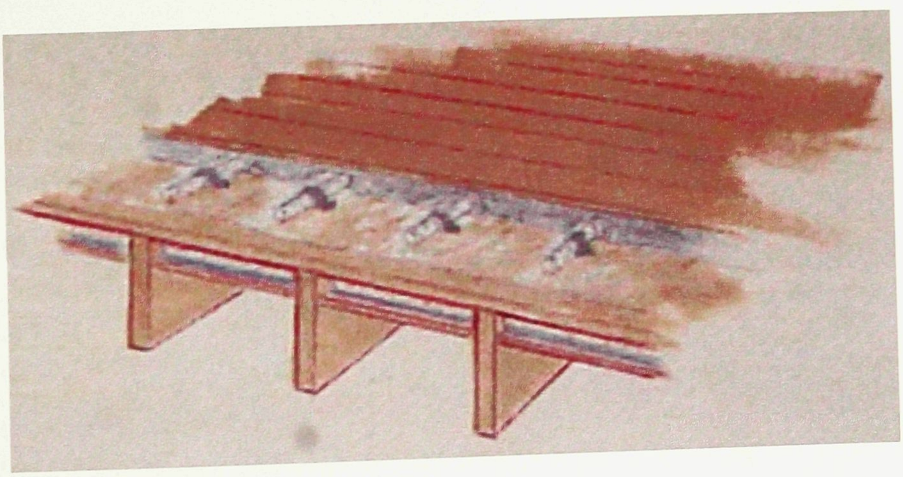

Figure 90 Radiant Floor Heating Coils and sub-floor insulation panels

Phase I-IV: Year Round Tree House Home: Section and Details (continued)

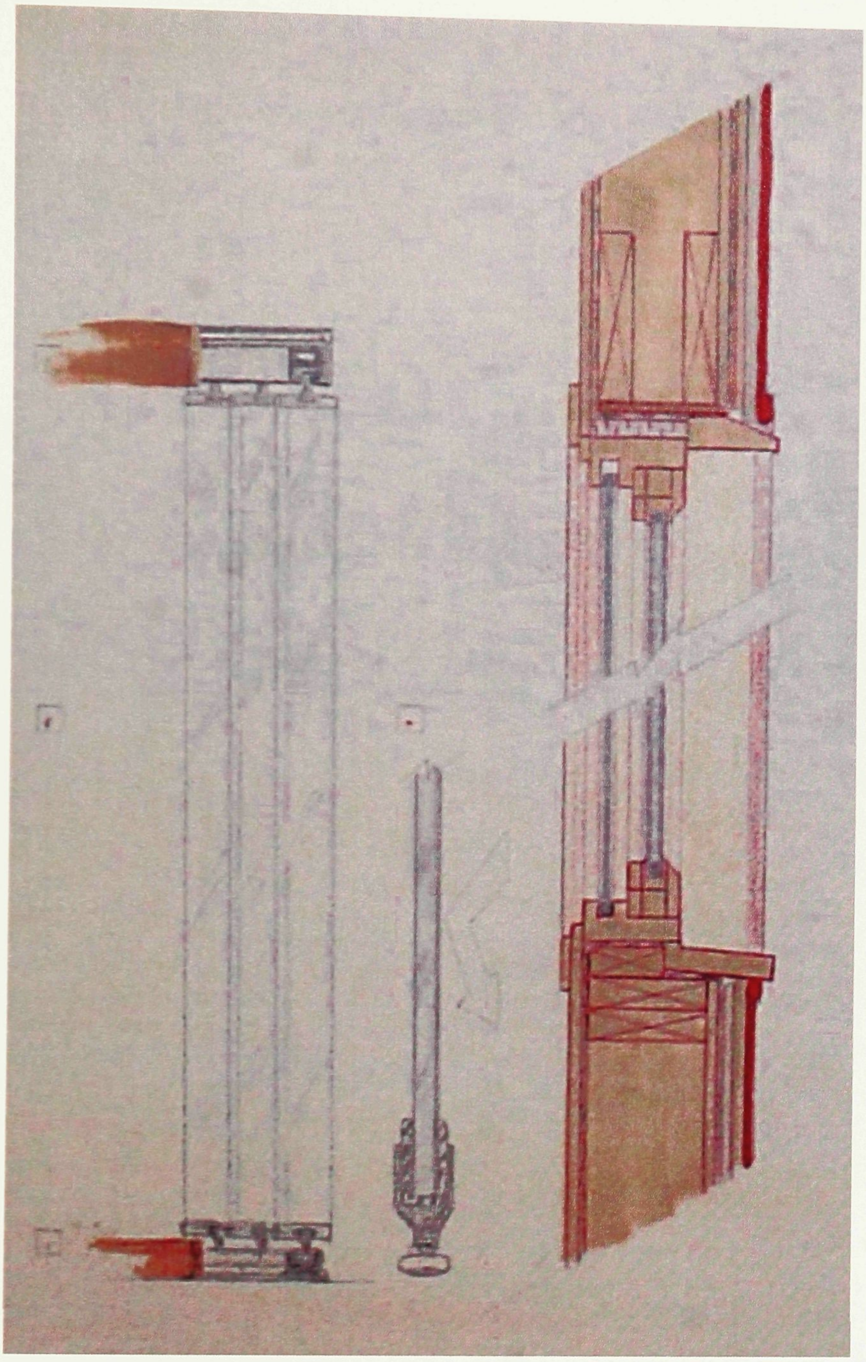

Figure 91 Solar Glazing System Details. Reflective film applied to third (reversible) pane at fixed and operable locations as well as on glazed vertical and horizontal blinds for heat gain/loss and glare control.

Phase I-IV: Year Round Tree House Home: Vignettes

Figure 92 Bridge approach raises up into, and through, the canopy

Figure 93 View through the threshold into the building and through to the Belvedere.

Phase I-IV: Year Round Tree House Home: Vignettes

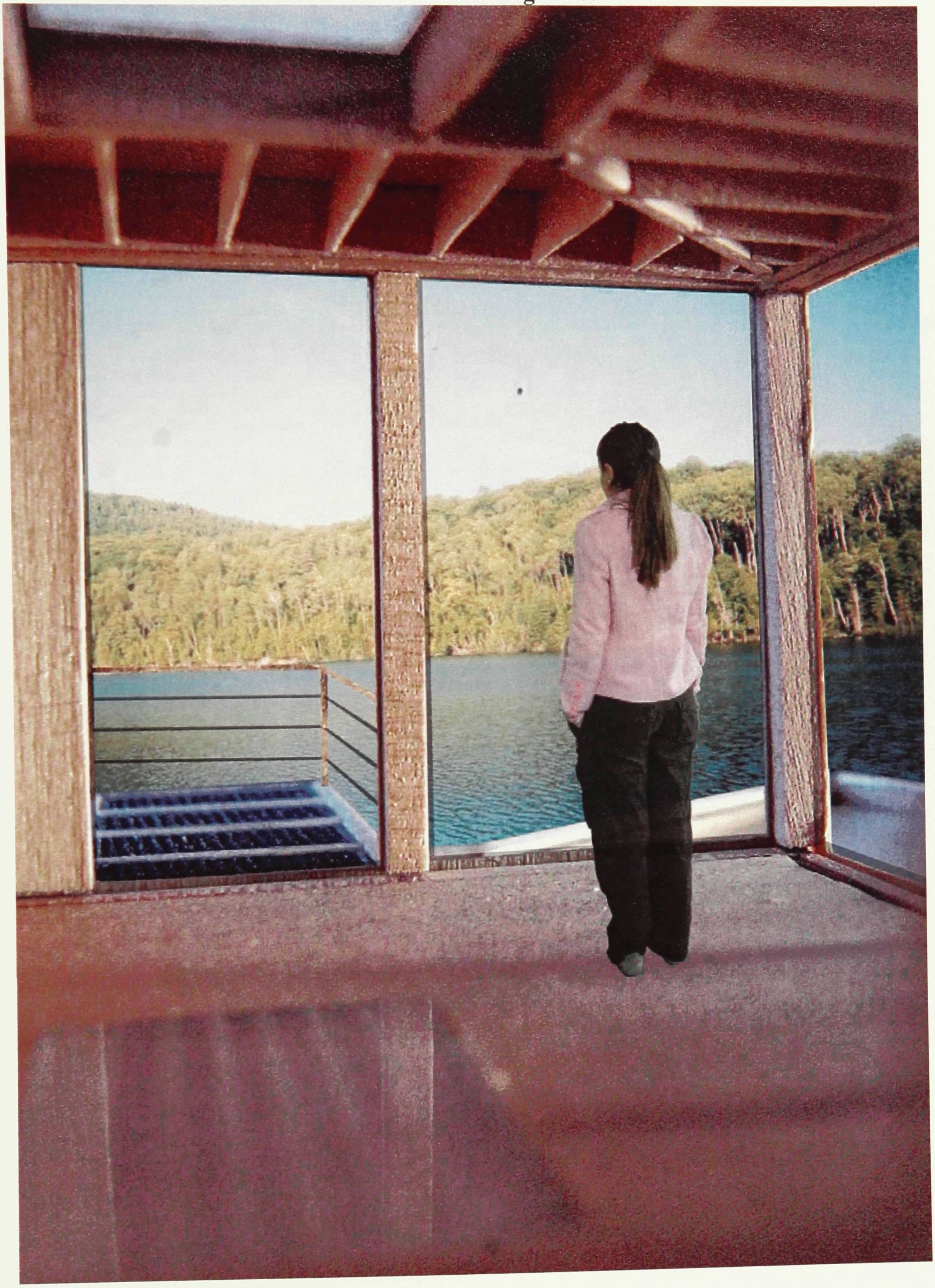

Figure 94 View from the Tower room entry.