

***Sustainable Architecture for the Urban Elderly:  
A Holistic Design Strategy***

***A Master's Degree Project by Bonnie Farmer***



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The University of Calgary  
Faculty of Environmental Design

The undersigned certify that they have read, and recommend to the Faculty of Environmental Design for acceptance, a Master's Degree Project entitled

*Sustainable Architecture for the Urban Elderly:  
A Holistic Design Strategy*

submitted by Bonnie Farmer in partial fulfillment of the requirements for the degree of Master of Environmental Design.

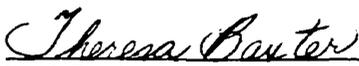
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***Abstract***

The goal of this Master's Degree Project is to provide a strategy for elderly housing that improves quality of life, both for the elderly and for the earth. This housing is defined as socially and environmentally sustainable. The project proposes that architecture designed to enhance and enable our experience of the natural environment enriches our sense of being in the world and is especially viable for the elderly living in an urban context. The following document presents a theoretical framework for sustainable design that incorporates both the author's own experience and current architectural theory. This framework is based on deep ecology, ecofeminism and the phenomenological approach of Juhani Pallasmaa. The relationship between humans and nature and the perception of architecture via the body emerge from the theory as fundamental concepts for an elderly housing strategy. To achieve sustainable elderly housing, the author proposes strategies for choice, home and community, and a vital human connection with nature. The practical guidelines for a sustainable architecture within the context of elderly design are presented and illustrated. The project emphasizes a balance in architectural practice between the theoretical and the utilitarian and through this approach a deeply thoughtful and practical design strategy emerges. In the final section, the author devises a design strategy that responds to elderly needs in an urban setting and to critical issues in environmental sustainability.

***Key Words***

sustainability, sustainable architecture, holistic, elderly, environment, deep ecology, ecofeminism, phenomenology, Juhani Pallasmaa, aging, xeriscape, nature, home, community, atrium, loggia, universal design

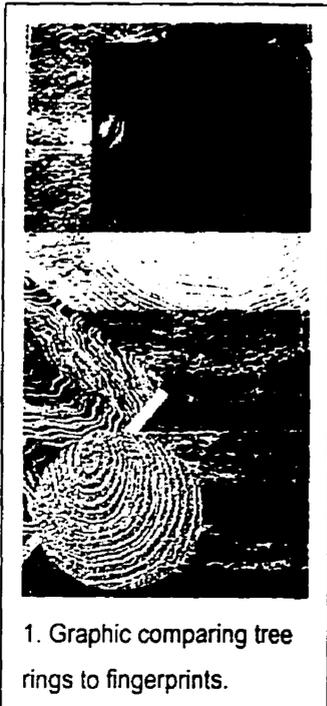
## A. Theoretical Framework

### I. Ecology and Nature

This project presents an architectural strategy for sustainable elderly housing that is founded on critical theory. The thesis is a blending of the factual, literary, theoretic, and personal. The first section, "Ecology and Nature," and the following section, "The body," outline the established literary, environmental and architectural theories that comprise this project's theoretical framework. In prelude, the first section begins with a personal exploration.

#### **Awareness of cycles and change: The connectedness of earth and body:**

Our world is in constant change. The cycle of birth and death, the forces of consumption and renewal, and the tides of growth and destruction, form a full and continuous sensation of motion, a constancy of diversity, a richness and multiplicity of experience. Even in its most still moments, the earth is teeming with life, moving in multiple paths, burning at its core while water endlessly transforms itself upon its surface. Cells pulse with internal processes; raw energy, made most tangible in the idea of quirks and quarks, appears and disappears in a predictable cycle of random motion. Our human bodies hum with myriad tides of internal cycles: the sleep cycle, digestion, the heartbeat and flow of blood, the breath filling and releasing the space within the chest, a reaching out and pushing away, the footfall, the outward motion and the constant inner movement even in stillness. Cycles appear in the internal dance of sways and twitches as our bodies adjust to gravity's relentless pull. The process of human aging embodies this natural force of constant change. The desire to respond to the forces of change with a careful and thoughtful shaping of the built environment, stems from a deep awareness



of these cycles, cycles in which the living pulse of the earth is inseparable from the living pulse of our bodies.

### **A personal approach: Memory and nature: A childhood in nature**

The awareness of cycles and the forces of constant change which link earth and body is deeply rooted in the memory of a childhood in nature. As a child, I would spend countless hours wandering in the tall prairie grasses amongst the cattle, climbing under the grey-weathered boards of the aging feedlots, and amongst the long columns of trees planted by my grandparents on our family farm. Listening for a gopher's shrill cry or the more chilling and magnificent call of the prairie hawk, or taking in the rich textures of every type of grass in varying shades of honey and burnt gold, my senses opened to the depth of experience, to a sense of the richness of the natural world. I was ripe for the discovery of each detail; my hands were eager to feel the shape of a knot in the wood or the faces of the tiny kittens, or the cold, delicate feet of a frog in my hands. My grandmother, taking me up on her lap with a tone of hushed delight, would point to the tiny nuthatch or chuckle in satisfaction at the relish with which the robin pulled his dinner from the grass. Growing up amongst the simple beauty of an Alberta grain farm, the reverence for these natural things was never in question. Surrounded by the mud and snow, the inviting puddles and the constant variety of shapes and smells of every plant, and inhaling deeply the winds, sunshine, snow and rain, and listening to the voice of breezes in the thick trees -- all these things became sacred. The foundation was laid, during the hours alone out-of-doors as a child, for a profound sense of connection with, and responsibility for, the natural environment.

In ninth grade biology class, a largely wordless film entitled Gaia, which depicted the raw forces and topography of the planet, its oceans, volcanoes and living things, allowed me to attach a named concept to the pervasive sense I had that all things are intimately connected and together

form one unified sense of being. The idea of the living planet, Gaia, held great significance as I escaped from daily life at boarding school to roam in the lush and ample forests on the campus lands and to feel again the rich textural and sonorous life teeming in the undergrowth. These most primal experiences from my youth form a basis for a profound connection with and desire to protect the natural environment. This sensibility is at the heart of sustainable design.

### **Human culture and nature: The age-old relationship**



The connection between humans and nature is an age-old and vital relationship. The words of Thoreau would ring with conviction in my ears as I emulated in my walks his retreat from society to the forest. From the primal need to retreat from human society to the depth of the natural world come the questions:

1. "What is that fundamental relationship with nature? How has it been expressed in history?" and
2. "How can we live in a way which acknowledges and respects the fundamental connection of humanity with the natural environment?"

From an architecture student's perspective, I now also ask:

3. **"How can we design the very shell within which humans live so that it will acknowledge and enhance the occupants' experience of their fundamental connection with the natural environment?"**

I see these questions as the basis for the sustainability concept in architecture. My direct and profoundly felt experiences of nature and the desire to understand and express these sublime moments evidence the deep questioning approach that ecological philosopher Arne Naess describes as deep ecology. A deep and thoughtful consideration of architecture and the possibility for its function as an enriching place of dwelling is the intent of this master's degree project. I conceive of the being of nature as that which connects us to the presence of things. Thoughtfully designed architecture

enables a deep and mindful way of dwelling.<sup>1</sup> This project proposes that an architecture designed to enhance and enable our experience of the natural environment will enrich our sense of being in the world. As I discuss further in this document, this architectural strategy is especially viable for the elderly living in an urban context.<sup>2</sup>

## Deep Ecology

Deep Ecology:  
Arne Naess & George  
Sessions:  
A fundamental respect  
for natural ecologies.

The following discussion of ecological theory provides the basis for a design strategy that both enhances the human experience and cares for the earth. In his introduction to Environmental Philosophy, Micheal E. Zimmerman describes the various theories in the environmental philosophy movement. He divides the movement into three related fields: environmental ethics, radical ecology, and anthropocentric reformism. Environmental ethics challenges anthropocentric norms and extends moral considerability to nonhumans.<sup>3</sup> Radical ecology includes deep ecology, ecofeminism, and social ecology, and proposes a revolution or a cultural paradigm shift to save the planet. Anthropocentric reformism is a well-known field which argues that nature has value for human ends (aesthetic, recreational, and for food and raw materials) but that humans should use nature more prudently to ensure its continued availability for future generations. These viewpoints are not mutually exclusive, but rather share a basic concern for, and valuation of, the natural environment. Both ecofeminism and the deep ecology approach will be especially useful as a theoretical foundation for this project.

Norwegian ecophilosopher Arne Naess, first in a 1972 paper presented in Bucharest<sup>4</sup> and then in a 1984 paper introducing the eight point platform, outlines the deep ecology approach. Naess defines deep ecology as "the ecology movement which questions deeper."<sup>5</sup> George Sessions, chair of the Department of Philosophy at Sierra College in Rocklin, California, and author of numerous essays about ecophilosophy and deep ecology, describes the basic principles of deep ecology as first devised by Arne Naess.

Sessions outlines the three identifying elements that most deep ecology theorists now associate with deep ecology. They are: the deep questioning process, the eight-point platform, and the need for humans to identify with nonhumans and the wild world.<sup>6</sup>

The first element, deep questioning, is the "necessity of 'questioning everything.'"<sup>7</sup> While the shallow environmental approach focuses on the technical aspects of environmental problems, deep ecology presents crucial non-technical environmental issues related to everyday life, and questions the presuppositions of the dominant economic approach in terms of values, philosophy and religion. Deep ecology is primarily concerned with a willingness to question openly and publicly the root values behind every

**The eight-point platform of Deep Ecology:**

1. "The well-being and flourishing of human and non-human life on Earth have value in themselves (synonyms: intrinsic value, inherent worth). These values are independent of the usefulness of the non-human world for human purposes.
2. Richness and diversity of life forms contribute to the realization of these values and are also values in themselves.
3. Humans have no right to reduce this richness and diversity except to satisfy vital needs.
4. The flourishing of human life and cultures is compatible with a substantially smaller human population. The flourishing of non-human life *requires* a smaller human population.
5. Present human interference with the non-human world is excessive, and the situation is rapidly worsening.
6. Policies must therefore be changed. These policies affect basic economic, technological, and ideological structures. The resulting state of affairs will be deeply different from the present.
7. The ideological change will be mainly that of appreciating life quality (dwelling in situations of inherent value) rather than adhering to an increasingly higher standard of living. There will be a profound awareness of the difference between bigness and greatness.
8. Those who subscribe to the foregoing points have an obligation directly or indirectly to try to implement the necessary changes."

**George Sessions and Arne Naess**

economic and political decision. This method of questioning, when applied to architecture, will aid the designer in developing an environmental approach to architecture that is both technically sustainable and deeply ecological.

One can construe an example of the application of deep ecology to architecture. An environmentally conscious architecture, for instance, involves careful materials selection that uses resources wisely. Naess describes the deep ecological approach of questioning the human use of resources. Rather than viewing resources as valuable only in their usefulness for humans, the architect can appreciate the inherent value of these resources in the ecosystem. All life forms have a right to resources and habitats, and no natural object has value only as a resource. The ecological architect would question the specific use of materials based on the eight-point platform. For example, she might ask: Does this use of a material satisfy vital needs? Or, Does this resource serve quality of life as opposed to serving a typical consumerist economic standard of living?

The eight-point platform,<sup>8</sup> agreed upon by Sessions and Naess, is the second fundamental element of deep ecology. The seventh point of this platform is especially relevant to this project. It addresses the need for ideological change in terms of life quality as opposed to an increasingly escalating standard of living. In the seventh point, Naess and Sessions define life quality as “dwelling in situations of inherent value,”<sup>9</sup> and this notion of dwelling is one of particular concern to architects. The way in which one dwells and the quality of one’s life is significantly defined by one’s environment. Architects have a crucial role in defining environments rich with inherent value and imbued with a sense of dwelling. Architecture, if designed thoughtfully to enhance a sense of dwelling in a place of value, will invoke a sense of connection with nature, and thus will increase quality of life. As emphasized throughout this paper, an improvement in life quality is vital to the design of elderly housing.

The obligation to research, design and implement changes in architectural practice is a serious one, and architects who subscribe to ecological principles should strive to actualize these principles in their work. Improving quality of life for humans as well as sustaining the earth’s ecology are important goals for the architectural profession. Rather than reducing population size,<sup>10</sup> architects concerned with conservation reduce the environmental impact of the population’s buildings. Naess explains the importance of a genuine commitment to caring for the earth. He writes, “Conservation strategies are more eagerly implemented by people who love what they are conserving, and who are convinced that what they love is intrinsically lovable.”<sup>11</sup> At first glance, architecture is a profession founded on the consumption of resources, industrial processes, and the destruction of natural environments for human urban development. The notion of preserving wilderness and free nature is incongruous with the practice of constructing cities and buildings. For those who are committed to conservation, however, architecture is a powerful means for change – both in the implementation of practical design strategies (for example, the careful selection of building materials and systems) and in

the deeper philosophical approach to design which enhances the housing of people by encouraging an interaction with the natural world. According to Naess, the practical and philosophical can be effectively combined in educating the public towards ecologically centered practices:

. . . environmental education campaigns can fortunately combine human-centered arguments with a practical environmental ethic based on either a deeper and more fundamental philosophic or religious perspective, and on a set of norms resting on intrinsic values. But the inherent strength of this overall position will be lost if those who work professionally on environmental problems do not freely give testimony to fundamental norms.<sup>12</sup>

A work of architecture is typically a human environment made to benefit humans and meet human needs. The design, construction, and habitation of this environment, however, can and should be founded on an environmental ethic that acknowledges the intrinsic value of the natural world.

The need for humans to connect with nature (defined as both non-humans and the wild world) is the third fundamental element of deep ecology. This thesis maintains, with Naess, that access to the wild world is the experience of ultimate intrinsic value. An urban experience will not replace the sense of profound inherent worth felt in the unspoiled wilderness.<sup>13</sup> The human need to connect with nature can, however, be partially fulfilled within an urban context through a thoughtful design of the human built environment. The challenge of this project is to acknowledge the deeply engrained societal patterns of urbanized living and housing and yet provide within this context an enrichment of the built environment and the lived experience via an architectural connection with the natural world.

### **The garden: An age-old relationship with nature**

An understanding of the relation of humanity with nature throughout history is a subject for an entire thesis, and this document can only touch upon

that profound relationship. In his text Interpreting Nature: Cultural Constructions of the Environment, I.G. Simmons, professor of Geography at the University of Durham, provides a broad cursory overview of nature as construed by various philosophers, scientists and artists. His observations on gardens and on architecture present the multiplicity of ways in which we alter our environment, and show that these alterations reflect our attitudes towards nature. He writes,

In pursuit of their two-fold purpose of beauty and productivity, gardeners effect a very intense transformation of their surroundings. The input of materials is very high: energy, fertilisers, biocides, machinery, domesticated plants are all used. This is paralleled by a very high cultural input in which the piece of ground is made over in the image which the gardener has acquired. Seen in this light, there seem to be two main kinds of garden, the first of which is the creation of some nature in what would otherwise be a totally built setting: no matter that the nature is as artificial as the rest of the place. Hence the Japanese garden no larger than a paving stone, the rooftop gardens and the window box. The second type is the manipulation of a less intensively used environment in order to demonstrate the appropriate values for the users' pleasure-times. The formal garden of the great houses of Europe (and its watered-down versions still present in suburbia and beyond) demonstrates cultural *mores*. . .<sup>14</sup>

This passage reveals the human desire embodied through gardening to reconcile the urban environment with nature, whether the garden signifies manipulation and domination of nature or an attempt to filter in a reminiscent trace of the natural world and its balance into built urbanity.

There are many primary sources in literature which shed light on this struggle to define humanity's role within nature's vast play, and conversely, nature's role within the urban landscape. A poem composed by the seventeenth-century poet Andrew Marvell describes the ultimate question of humanity's relationship with nature:



3. The wide sweet fields.

### THE MOWER AGAINST GARDENS

Luxurious<sup>15</sup> man, to bring his vice in use,  
Did after him the world seduce,  
And from the fields the flowers and plants allure,  
Where Nature was most plain and pure.  
He first enclosed within the gardens square  
A dead and standing pool of air,  
And a more luscious earth for them did knead,  
Which stupified them while it fed.  
The pink grew then as double as his mind;  
The nutriment did change the kind.  
With strange perfumes he did the roses taint;  
And flowers themselves were taught to paint.  
The tulip white did for complexion seek,  
And learned to interline its cheek;  
Its onion root they then so high did hold,  
That one was for a meadow sold:<sup>16</sup>  
Another world was searched through oceans new,  
To find the marvel of Peru;<sup>17</sup>  
And yet these rarities might be allowed  
To man, that sovereign thing and proud,  
Had he not dealt between the bark and tree,  
Forbidden mixtures there to see.  
No plant now knew the stock from which it came;  
He grafts upon the wild the tame,  
That the uncertain and adulterate fruit  
Might put the palate in dispute.  
His green seraglio has its eunuchs too,  
Lest any tyrant him outdo;  
And in the cherry he does Nature vex,  
To procreate without a sex.<sup>18</sup>  
'Tis all enforced, the fountain and the grot,  
While the sweet fields do lie forgot,  
Where willing Nature does to all dispense  
A wild and fragrant innocence;  
And fauns and fairies do the meadows till  
More by their presence than their skill.  
Their statues polished by some ancient hand,  
May to adorn the gardens stand;  
But, howsoe'er the figures do excel,  
The Gods themselves with us do dwell.<sup>19</sup>

The speaker in this poem, the mower, finds that the true spirit of nature lives in the wild sweet fields where he and his men work, not in the finely manicured walled gardens of the seventeenth-century city. Marvell presents the walled garden as a sexualized nature, a "plain and pure" natural world that is corrupted by the ravages of colonialism and the gross manipulation of natural species. The mower especially bemoans the empty artificiality of a constructed nature. The vital spirit of wild nature can only be wistfully represented in the marble statues which desperately invoke the memory of the free spirits of the wildland, and yet are poor substitute for the real wilderness.

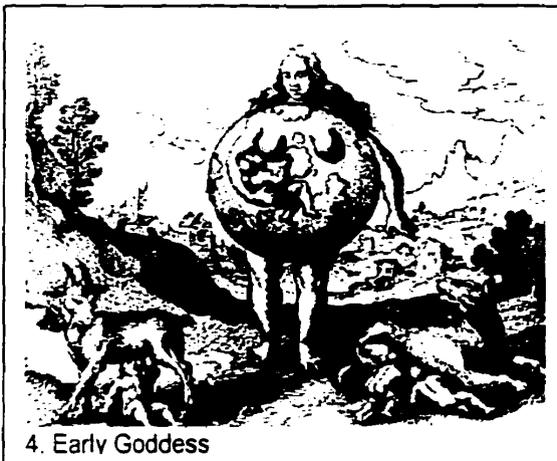
Marvell's critical presentation of the patriarchal forces of colonialism's rape of its conquered lands and especially his colourful rendering of the sexual domination of nature through grafting and breeding, as seen through the eyes of the simple English mower of the fields, presents an eerily prescient view of humanity and nature as we stand today on the verge of an era of Disney nature-parks and genetic engineering.

## II. The body

In this section, several philosophers contribute to the theoretical exploration of nature, the body, the city, technology and architecture. The project goal, to explore and define a sustainable architecture for the urban elderly, is furthered here by a firm grounding in ecofeminist principles. The phenomenological writing of architect Juhani Pallasmaa provides the final theoretical link with the ecofeminist body-nature connection, by contextualizing within an urban environment the sensory perceptual experience of architecture via the body.

### Women and nature: the roots of ecofeminism

The association between women and nature is evident in culture, language and history. Nature is often seen in history as an organic metaphor



4. Early Goddess

– the nurturing mother – or as a wild and uncontrollable female force of violence, storms and chaos. Environmental philosopher and feminist Carolyn Merchant identifies the rise of modern science as the “crucial period when our cosmos ceased to be viewed as an organism and became instead a machine.”<sup>20</sup> Merchant characterizes the human experience before industrialism as a daily, immediate, organic relation with the natural environment within close-knit, cooperative communities.

In the modern era, domination and mastery of nature prevails. The change from images of the earth as a living organism and nurturing mother to a disfunctioning mechanized object, disobedient female, monster or aberration that must be mastered and managed by science allows for a human ethic of consumption and aggressive attitudes which sanction destructive acts towards the earth.<sup>21</sup> The mechanical view of nature removes animistic and organic assumptions about the earth and cosmos and breaks matter into definable,

manipulatable and consumable parts such as atoms, light waves, and genes. Menchant explains, "Mechanistic assumptions about nature push us increasingly in the direction of artificial environments, mechanized control over more and more aspects of human life, and a loss of the quality of life itself."<sup>22</sup> To maintain quality of life, Menchant emphasizes the notion of holism in which a unity of whole and parts reciprocally influence and merge with each other:

The idea of cyclical processes, of the interconnectedness of all things, and the assumption that nature is active and alive are fundamental to the history of human thought. No element of an interlocking cycle can be removed without the collapse of the cycle. The parts themselves thus take their meaning from the whole. Each particular part is defined by and dependent on the total context.<sup>23</sup>

This holistic image of nature promotes a life in equilibrium with the environment. To embrace this holistic ethic, Menchant suggests that a social, economic, and political restructuring of priorities, including non-hierarchical forms of organization, recycling waste, simpler living, pollution reduction, labour intensive economic methods, and the distribution of resources based on the integration of human and natural systems, is needed. A similar restructuring of priorities towards a holistic ethic is also needed in architecture.

### **Nature and body: The ecofeminist connection**

Ecofeminism:  
Karren Warren:  
The female body and nature are historically consumed.

A holistic image of earth and body provides foundation for an architecture in equilibrium with nature. In contrast with, or perhaps existing parallel to, the modern experience of body as the technologized body, there is a primal, natural body connected profoundly with nature and its phenomenological impression. Simmons acknowledges this sense of connection as essential to an ecofeminist conception of nature:

At heart, . . . ecofeminism seems to be phenomenological, "fundamentally a feeling experienced by many women that



they are somehow intimately connected to and part of the earth."<sup>24</sup>

Phrases like "Mother Earth" and the "rape of the earth" gain new meaning as I study feminist theory, while at the same time a sense of the earth as body and a knowledge of the sacred body awakens in me as I study dance and native spirit-mask making and ritual. The ideals of ecofeminism, as I have come to understand them through my study of Environmental Design, prepare the way for my embracing of a phenomenological approach to architecture. These ecofeminist principles, which acknowledge the connection between earth and body, are summarized by Simmons as "holism, interdependence, equality, and process." Simmons writes,

Most of these are familiar from other contexts: holism, for example, from ecological science and the Gaia hypothesis, and interdependence from those ethical traditions which accord equal value to the human and non-human. Equality spurns the dualistic and hierarchical societies which are common and suggests that these are the most likely to follow paths leading to the degradation of nature. An emphasis upon process affirms that ends do not justify means and the quality of all relationships is an end in itself.<sup>25</sup>

In particular, the emphasis on process is a significant one for Western society, which could benefit from an embrace of the Buddhist notion of the path being more important than the destination. We live and do business within a product-oriented paradigm, rarely looking at the environmental costs of every action or product purchased.

Contemporary ecofeminists disapprove of excessive consumerism and the normative valuation of the product, and promote the well-being of natural systems and the essential human-to-nature relationship founded on a deep understanding of the body's relationship with the earth. Feminist philosopher Karen Warren defines ecofeminism as,

. . . the position that there are important connections – historical, experiential, symbolic, theoretical—between the domination of women and the domination of nature.<sup>26</sup>

This logic of domination justifies a subordination of nature for human consumption and control, as nature is valued as inferior to the human. An ecofeminist vision of architecture would oppose the subordination of nature in human design via an excessive consumerism of materials and resources. This architecture would also, in its form, choice of materials, orientation, shape, contour, and method of construction, express a holistic connectedness with nature. The body provides this vital connection between humans and nature in architecture.

Simmons provides a brief historical overview, with an acute criticism of international style ideals, which describes how architecture has typically and historically stood in relation with nature:

At first sight, architecture is the very antithesis of all that we have meant by environment since it is an attempt to control our surroundings totally and hence to replace what nature or the previous generation of humans provided: 'the built environment' is a phrase often used. It has not always been the case that structures ignored their surroundings: most low-technology building has to conform and adapt in terms of materials and orientation, for example, as well as to cultural *mores* and it has often been very successful in adapting to flood regimes or intense solar radiation or the need for nomadism, for example. . . . Architecture after the industrial revolution, however, positively celebrates its release from the forces of nature. The skyscraper building is the obvious example of this: it grows as if gravity itself were no longer important, and its rectangular lines are those of the draughtsman's instruments rather than those of the natural world. Naturally, there have been reactions to this: houses which grow over streams or incorporate trees, like some of Frank Lloyd Wright's buildings, as obvious samples, although they are not very numerous. . . . In other words, the construction made by architecture, both physical and symbolic, is that of the high-energy industrial world, which is the outcome of centuries of adherence to the idea that nature had to be overcome.<sup>27</sup>

A closer look at some of the exceptions in architectural history, such as the vernacular, indigenous, organic, or even arts and crafts architecture which Simmons alludes to, provides insight into the sort of architecture which would correspond with a holistic, interdependent notion of nature. Indian architect, Balkrishna Doshi, for example, employs sustainable design principles in his architecture. In addition to the "pursuit of architectural forms that evolve from climatic considerations," he uses bare brick and rough concrete which are a "viable vernacular for countries with simple building techniques and few resources."<sup>28</sup> His studio, Sangath, in Ahmedabad, India "encapsulates the essence of much traditional thinking about passive climatic control and the introduction of soft natural light: concerns which . . . create the building's form."<sup>29</sup> Additional precedents are discussed in the design strategy portion of this project. A comprehensive study of the disparate examples of sustainable architecture in architectural history and their significance in the definition of humanity's relation with nature presents an area for further research.

### **Defining sustainable architecture in a technologized world**

The technologization of our society is not something we can easily or enthusiastically shake off, as it shapes our bodies, thought patterns, means of communicating and relationships with each other and the world. The potential for technology, however, is great. Like many, I am occasionally consumed with a Luddite passion to flee to whatever remains of the wilderness and stay there, living in simple harmony; but I also see that within our current societal framework, the possibility for "progress" of a different kind exists. A new directive for research and development towards sustainable projects can redefine uses of technology from solely personal to environmental gain. Achievements such as the heat recovery ventilator, solar technologies, and vast fields of power-generating wind turbines are current examples. These technologies should be paired with an ethic of reduced consumption. Small

signs of the positive potential for human invention also present themselves in technologies developed for the third world. A wind-up powered radio and a solar water purification system are recent examples.

A consumer awareness of and demand for sustainable products is unquestionably needed if sustainable practices are to become widespread and sustainable methods and products are to be developed. The word "sustainability" is commonly understood as defined by the 1987 UN conference: to "meet present needs without compromising the ability of future generations to meet their needs." Webster's New Collegiate Dictionary's first four listings for "to sustain" are

1: to give support or relief to 2: to supply with sustenance: NOURISH 3: to keep up: PROLONG 4: to support the weight of: PROP.

There is in these definitions the idea of foundation, structural soundness (support), lasting through time (prolong), and the idea of care (nourish), and rescue (relief). Sustainability, then, is a rescuing of an endangered environment, a nourishing of the holistic conglomerate of Gaia/earth/life, a visionary approach to design which plans for creations to last and resists the transitory nature of a throwaway society, and a soundness that rings with integrity, safety, and strength. These fundamental concepts, paired with the deep ecology and ecofeminist ideologies I have surveyed thus far, can serve to redirect the uses of technology to meet a new consumer demand and to achieve a new architecture defined as "sustainable."

The cautionary ecofeminist skepticism that rampant free-market consumerism is not likely to exist alongside a conservationist approach remains valid; but innovations in technology and practice continue to provide hope for a more responsible use of technology. While the return to an agrarian way of life is one familiar proposal, a new age of visionaries formulate alternative modern paradisaical visions of spatially contained closed-loop

systems for aquaculture and hydroponics which could hypothetically produce abundant food while leaving more space for wilderness.<sup>30</sup>

Population control is a common solution to the resource and energy crisis. A limit on the net energy and resources consumed per family, however, would be a more appropriate censure than restricting the number of offspring per family, as consumptive patterns vary from individual to individual and especially from country to country. The need for limits to consumption demands a strategy for social restructuring and for town planning with an attention to net energy and resource consumption. Architects have an essential role to play in this environmentally sustainable revolution, and well-considered design and building practices must contribute to a sustainable society.

The design strategy portion of this paper selects a highly urbane site. To understand architecture, and to formulate how a sustainable architecture can exist within an urban context, this document examines the current urban (technologized) fabric of existence. It examines how the body perceives architecture, and the impact of architecture on our cities. It examines architecture in relation to our bodies and to our very existence.

### **The body technologized: The urban body**

The environments we create, whether it is garden, city, building, park, or the virtual space of the cyber-human, reveal our relation with nature -- be it



6.

one of domination or symbiosis -- and the extent to which we understand the impact of our creations. Like the doctor in Mary Shelley's Frankenstein, we create according to our vision and desires, piecing together our world like mad scientists, not entirely prepared for the responsible care of the creation we have engendered. I walk now with the urbanized body of the city, the sleek shine of lycra, the drive of electronic

music, cappuccino rush or sushi purity in my veins as another styrofoam cup glides effortlessly from my hands and the sleek body of car/machine/power is under my hands seeking out the curve of the road, my fingers flickering over keyboard to (((hug)))) in cyber-warmth a new friend across the continent from me, whom I have never seen, my fingers reaching out to touch the screen in a desire to sense the estranged body of the speaker whom I will never really perceive. The gridwork of my city, the patterns of my familiar routes mapped out in my body as a series of intricate sensation, as on auto-pilot my mind exits briefly and body-memory guides me home, through the wheels of the car – an extension of my urban body – I move in the dance of the technologized human. While I am lit with the electric glow of technologized experience, mind aflame with visions of the earth from space, and the topography of my planet stitched together from plane flights and travel documentaries, my body warns that the midnight flight from the oppressive buzz of the urban landscape to the rolling forests of Kananaskis country is as much the pleasure of hyperspeed along dark deserted roads as the later dance under the moon in the crisp night air. Even as I flee the city, I sing the body technologized.

Australian literary critic Elizabeth Grosz illustrates the technologized city/body as follows:

The implosion of space into time, the transmutation of distance into speed, the instantaneousness of communication, the collapsing of the workspace into the home computer system, will clearly have major effects on specifically sexual and racial bodies of the city's inhabitants as well as on the form and structure of the city.<sup>31</sup>

In this "mutually defining" interface, city and body

. . . produce each other as forms of the hyperreal, as modes of simulation which have overtaken and transformed whatever reality each may have had into the image of the other: the city is made and made over into the simulacrum of

the body, and the body . . . is transformed, "citified," urbanized as a distinctively metropolitan body.<sup>32</sup>



The contemporary feminist exploration of architecture and the urban landscape incorporates the definition of sexualized space and the symbiosis between the sexualized body and the spaces in which this body acts and responds. Grosz defines the human body as a "produced body"<sup>33</sup> which is structured and organized by social conscription via an "interface" with the city. The body shapes or causes the city and the city organizes familial, sexual and social relations and shapes patterns of travel, our posture, and our actions. Grosz speculates on the changing body of the future with the imminent advent of the cyborg, bionic, and computer prosthesis as the city spaces become more technologized.<sup>34</sup>

### **The body and architecture: a phenomenological ethic of design**

Juhani Pallasmaa:

The body is linked to architecture as primary perceiver / experiencer.

Finnish architect and philosopher, Juhani Pallasmaa places the body at the centre of experience, and he proclaims "a sensory architecture in opposition to the prevailing visual understanding of architecture."<sup>35</sup> Like Grosz, he illustrates the relation of body – city:

i confront the city with my body; my legs measure the length of the arcade and the width of the square; my gaze unconsciously projects my body onto the façade of the cathedral, where it roams over the mouldings and contours, sensing the size of recesses and projections; my body weight meets the mass of the cathedral door; and my hand grasps the door pull as I enter the dark void behind. I experience myself in the city, and the city exists through my embodied experience. The city and my body supplement and define each other.<sup>36</sup>

Pallasmaa, in a manner which rings true with my phenomenological experiences in the fields and forests of childhood, connects nature and architecture via the sensory body:

A walk through a forest is invigorating and healing due to the interaction of all sense modalities; Bachelard speaks of 'the polyphony of the senses'. The eye collaborates with the body and the other senses. One's sense of reality is strengthened and articulated by this interaction of the senses. Architecture is essentially an extension of nature into the man-made realm, providing the ground for perception and the horizon to experience and understand the world.

. . . Every touching experience of architecture is multi-sensory; qualities of matter, space and scale are measured equally by the eye, ear, nose, skin, tongue, skeleton and muscle. Architecture strengthens the existential experience, one's sense of being in the world, essentially giving rise to a strengthened experience of self.<sup>37</sup>

Pallasmaa illustrates how we experience architecture via a sensory and spiritual process, and more than any other theorist, most clearly captures the capacity for architecture to have an impact on those who experience it and, especially to articulate their relationship with the world:

. . . an architectural work generates an indivisible complex of impressions. An architectural work is not experienced as a collection of isolated visual pictures but in its full material and spiritual presence. A work of architecture incorporates both physical and mental structures.<sup>38</sup>



He continues,

. . . the art of architecture is engaged with metaphysical and existential questions concerning man's being in the world. The making of architecture calls for clear thinking, but it is a specific embodied mode of thought that takes place through the senses and the body, and through the specific medium of architecture.<sup>39</sup>

The embodied thought of architecture, and the embodied societal structures of town planning, shape our beings:

. . . Architecture is engaged with fundamental existential questions in its way of representing and structuring action and power, societal and cultural orders, interaction and separation, identity and memory. . . . We transport all the cities and towns that we have visited, all the places that we have recognised, into the incarnate memory of our body. Our domicile becomes integrated with our self-identity; it becomes part of our own body and being.<sup>40</sup>

These notions have profound relevance for the architect who wishes to explore the relationship between human and environment. A building, then, is a sensory experience, and a signifier of a society's understanding of the world. As much as the imperious sky scraper signifies our thought and is carried in incarnate memory, so does the humble and delicately crafted prairie house create a modality of being.

To shape this project's theoretical framework for sustainable elderly housing, there is then, this understanding of the embodied language of architecture and the full-bodied nature of sensory perception. There are also the ecofeminist ideals of holism, interdependence, equality and process, and the meaning of the word sustain -- to support, to nourish, to prolong -- that define a sustainable relationship with the environment. Once we have established this theoretical basis for sustainable design, what then, functionally, is sustainable architecture? The following section of this paper



defines socially and environmentally sustainable architecture for the urban elderly in terms of practical applications. Pallasmaa suggests a balance between the theoretical, phenomenological nature of the design and the practical realities. He maintains that the mystery of the design must be maintained even while utilitarian demands of functionalism are met:

Architecture cannot, however, become an instrument of mere functionality, bodily comfort and sensory pleasure without losing its existentially mediating task. A distinct sense of distance, resistance and tension has to be maintained in relation to programme, function and comfort. A piece of architecture should not become transparent in its utilitarian motive; architecture has to maintain its impenetrable secret and mystery in order to ignite the imagination and emotions.<sup>41</sup>

Sustainability in architecture, therefore, represents a union of the most practical and functional considerations with a heightened sensitivity to the bodily/sensory experiential journey and the ideological realities signified by each mysterious and imaginative living work of architecture.

## **B. Applications section**

### **I. Social Factors and Sustainability**

#### **Defining sustainability for the practical design of elderly housing**



This master's degree project proposes a strategy for elderly housing because sustainable architecture is particularly applicable to the elderly context. Many of the elderly experience a loss of mobility, health or independence which requires that they move from larger single family homes to dwellings of higher density. This change from the common modality of dwelling to smaller apartments, with shared amenities and communal spaces, provides a natural transition to a more sustainable way of living. Communal housing is often proposed as a more sustainable lifestyle, but finds general resistance in our independence-loving culture. The elderly, who often leave their homes out of necessity, have opportunity to discover the benefits of sharing a well-designed place of dwelling with others.

In addition, there are many elderly with reduced mobility who find it difficult or impossible to access areas of wilderness, to maintain a large garden, or to go walking in natural areas and public parks. The urban elderly have the clear advantage of access to services and community activities but often experience the disadvantages of reduced contact with the outdoors and nature. The urban elderly, therefore, will benefit greatly from architecture designed to enhance and enable a healing connection with the natural environment.

As they approach a time of transition in their lives, the elderly should have choices in housing. The conventional seniors' home is typically located in a quiet and remote suburb with limited access to services and public transportation. The housing is frequently equipped with long halls broken by



an even repetition of identical suites, and is often distinguished on the exterior by its institutional façade and the bland expanse of manicured lawn and shrubberies. Although these serviceable environments are home to many elderly, they indicate a momentous opportunity for innovation in elderly housing design that will greatly improve quality of life. The following section proposes strengthening elderly housing and examines such factors as an urban location, access to services, a sense of home and community, and a connection with nature as key strategies.

### **Definition of sustainable development in relation to the elderly**

The 1987 Brundtland report, Our Common Future (World Commission on Environment and Development), defines sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs.<sup>42</sup> This concept is similar to a principle in some North American aboriginal cultures that decisions be made “with seven future generations in mind.”<sup>43</sup> With this understanding that how we live in the present has a direct impact on how future generations will live, comes the need to examine and transform our present way of living in the world. Through careful examination, comes the ability to measure one’s way of living against the principles of sustainable development. J. Carew-Reid et al’s definition of a sustainable society enhances our understanding of the integral nature of sustainability:

Sustainable development means improving and maintaining the well-being of people and ecosystems . . . The human system is an integral part of the ecosystem. A society is sustainable only if both the human condition and the condition of the ecosystem are satisfactory or improving.<sup>44</sup>

Thus, we must examine our lives and institutions in terms of both socio-economic and environmental factors. To aid the analysis, Timothy J. F. Lash, from the Canadian office of the World Conservation Union in Montreal (IUCN),

alludes to the various connotations and subtleties of the word “sustainability” in common usage and provides this visionary definition:

[Sustainable development] no longer carries the risk of simply being taken and used as a rationale for consumer-driven business as usual. It means developing sustainability in environmental, social and economic terms together. It heralds significant changes in the life-style expectations and underlying values that are held by individuals and communities and that are expressed in institutions, from local to international levels.<sup>45</sup>

These “strengthened institutions” will include the “real integration of social and environmental goals and programmes.”<sup>46</sup> The focus of this document is intervention at the local level, specifically via the design of the built environment. The institution that I propose to strengthen through (environmental and social) sustainable development is the housing of our elderly population.

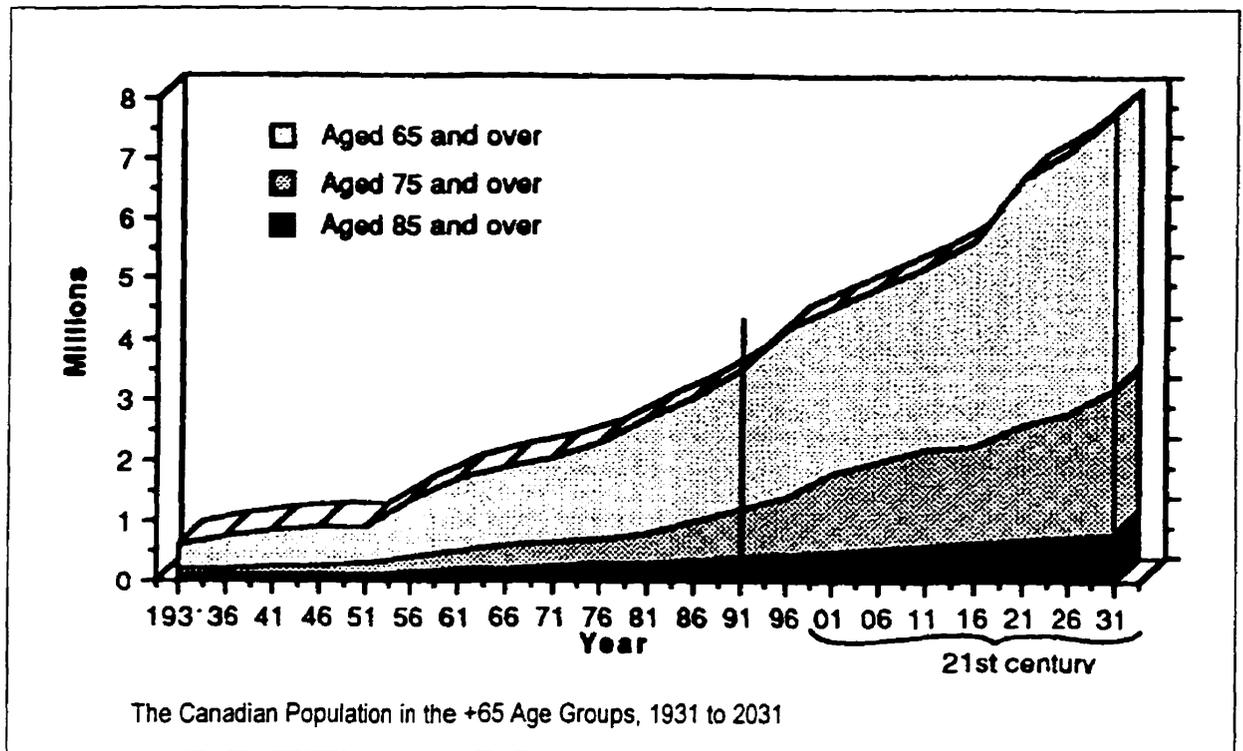
### **The elderly experience**

What is aging?

To successfully design for an aging population, one must question what it is to age, what are the characteristics, the losses, the benefits, the daily way of life, and the needs of the elderly.

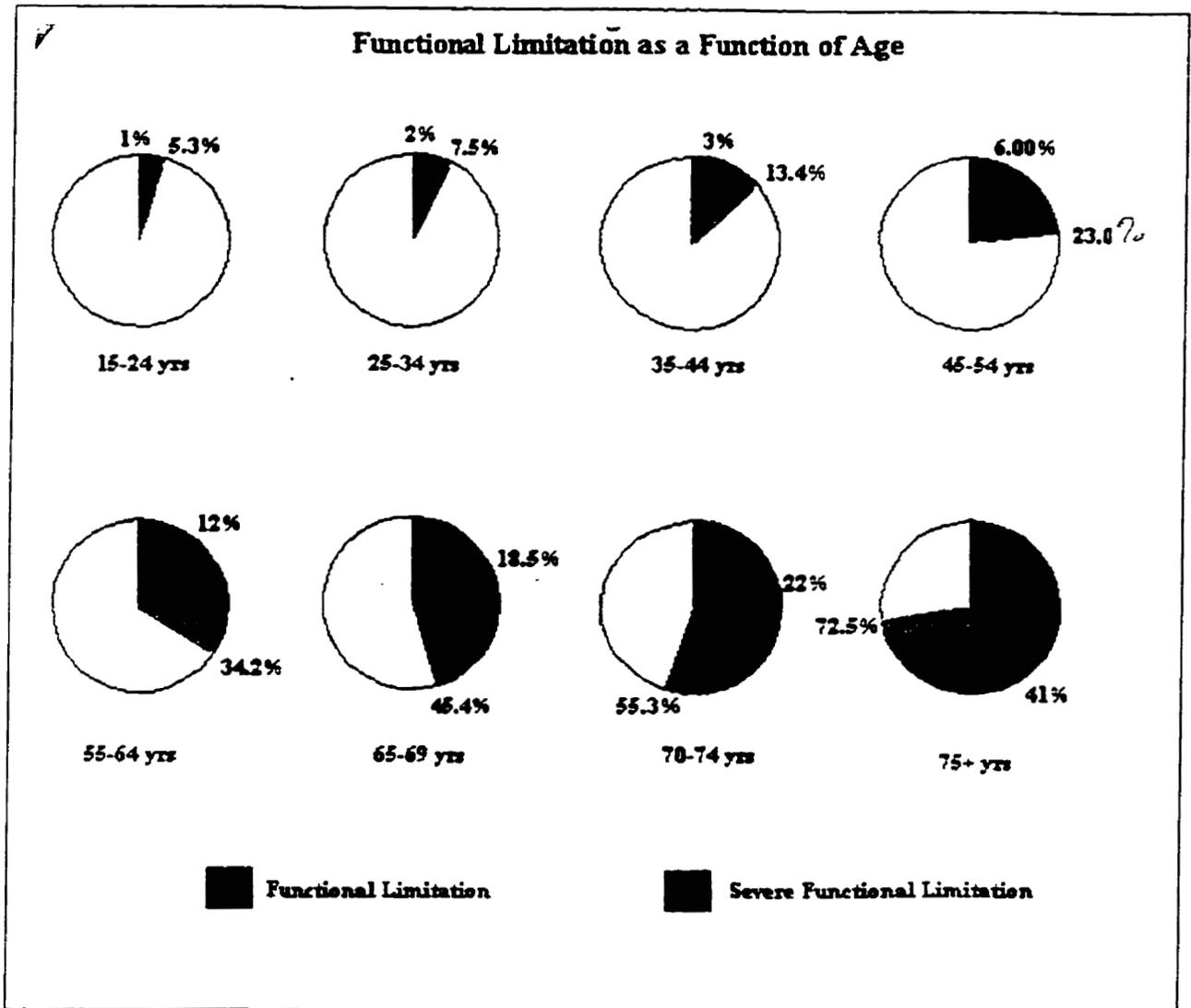
Demographic trends in aging

The number of aged in our population has been growing significantly over the years. The following table, compiled by Environmental Design student Merinda Conley from 1986 Statistics Canada figures, illustrates the graying of the Canadian baby boom generation (those born between 1946 and 1966).<sup>47</sup>

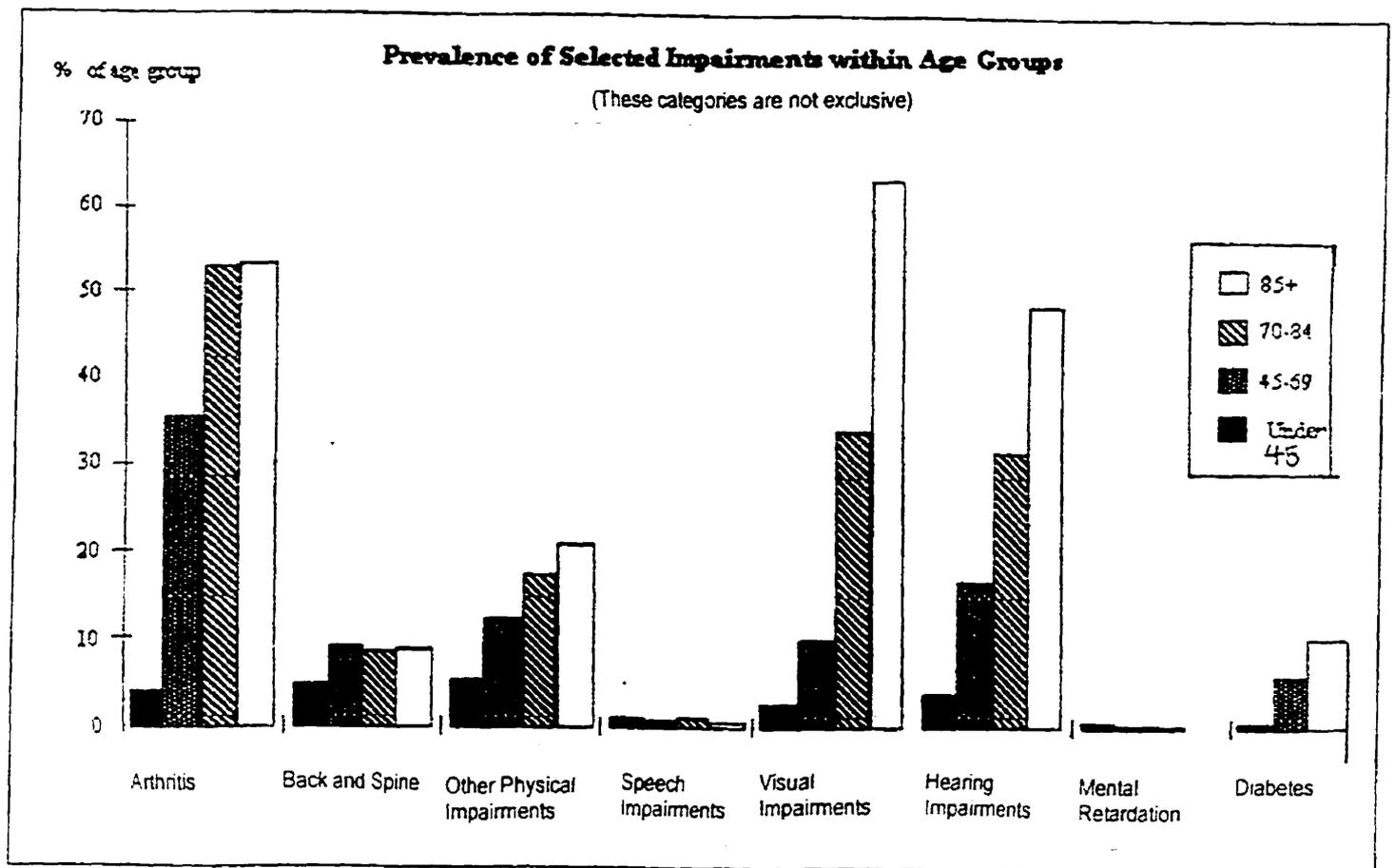


The allocation of resources and the thoughtful design of housing environments will contribute to the well being of this growing elderly population.

Gregg Vanderheiden of the Trace Research and Development Center, University of Wisconsin-Madison, also observes this growing elderly population as a demographic trend in America. As the number of elderly in the population increases, so do the number of individuals with disabilities and impairments. The table on the following page illustrates functional limitation as a function of age.<sup>48</sup>



The final table, shown on the next page, breaks down the disabilities and impairments into specific categories for each age group.<sup>49</sup>



For the elderly, there is a dramatic increase especially in arthritis, visual and hearing impediments. The severity of disability and degree of limitation for each category, however, can differ radically from individual to individual.

The director of DesignAge, Roger Coleman, however, emphasizes the dangers of associating age with disability. He emphasizes that many elderly are fit and active and that perceptions of the aging population need to change. Coleman notes:

... the disparity between theory and reality: between the official, or medical view of ageing and the way people feel

about themselves as they grow older; between the perception of age as a disabling affliction and the reality of age as a period of opportunity and achievement . . .

He proposes,

With the help of new models based on vitality, on activity and autonomy, we can begin to measure not the deficits of ageing, but the abilities and activities that can be sustained into old age . . . <sup>50</sup>

This attitude against ageism and for the promotion of the abilities and autonomy of the elderly should be embraced by those who design elderly housing. To understand elderly needs and design positive and empowering elderly housing, however, designers must also carefully examine the losses, challenges and life changes of the elderly.

Aging does encompass loss, and elderly housing with its capacity to improve quality of life can ease these losses. Some elderly may experience a number of possible losses. For example, the elderly can lose mobility, vision, hearing, independence, job, spouse, or aging friends who die or relocate. In addition, the elderly may experience a loss of ability to complete daily cooking, shopping, dressing and bathing, or they may lose home, possessions and community as they move from familiar surroundings to a new facility. Finally, some elderly lose connection with their families when these families move away or concentrate on raising younger generations.

Aging may also encompass a loss of value and respect within society. For this reason, Abu-Laban and McDaniel identify aging as a profoundly feminist issue. They propose that elders, and especially older women, are devalued in our society. For women in our society, beauty is associated with youth and is a factor in women's gaining respect and power. As women visibly age they experience a loss of social acceptance and worth:



Over time, one's appearance undergoes significant change and for aged women, particularly, these changes are subject

to social judgements in some cases and social sanctions in others.<sup>51</sup>

In addition to the loss of social power as beauty dwindles, women often experience dramatic loss in the aging process because they tend to outlive men. They tend to marry men older than they are and have a higher life expectancy.<sup>52</sup> Thus, women are more likely than men are to experience the death of a spouse. Abu-Laban and McDaniel state that in most populations, including the aging populations of North America, Europe and Japan, there are many more women than men, especially at the older ages. In Canada, for example, in 1986, there were twice as many women as men in the 85+ age group.

The death of a spouse often indicates both an emotional and economic loss. A widow may experience a reduced standard of living due to limitations in pension entitlements, grief causing susceptibility to physical and mental illness, and reduced ability to cope with daily activities without the help of their spouse. Poverty is also an important concern among many women in their older years. McDaniel tells us that:

Women comprise 60 percent of all poor people in Canada, 70 percent of all poor people over age 65, and 83 percent of all poor unattached over age 65.<sup>53</sup>

This combination of economic, health, and social factors will often contribute to an older woman's move to an institution. As this move becomes necessary in many women's lives, a strategy for maintaining their well being in a new environment and at a time of often overwhelming life changes is necessary. Under their heading, "Aging women and well-being," Abu-Laban and McDaniel suggest:

Well-being is known to be as closely related to independence and autonomy as it is to physical health. Lack of control over one's life is well known to have adverse effects on emotional

states, performance of tasks, subjective well-being, and on actual physiological indicators.<sup>54</sup>

Independence and autonomy are two important needs to consider in designing housing for the elderly. It is important for the elderly to maintain as much as possible a level of control over their lives and daily decisions. This sense of autonomy, control, and privacy contributes to an environment that is more like the residents' own home. For example, maintaining access as long as possible to household activities such as gardening, cooking, making tea, bathing and dressing can reinforce this sense of autonomy. Thus, the sense of a "home space" is essential in housing the elderly.

### **Understanding aging: Body and place: The construction of a "home space"**

In Resisting Institutionalization: Constructing Old Age and Negotiating Home, Pia C. Kontos proposes that a combination of biology, culture and the physical and social environments inform the experience of old age. She examines the construct of the aging body within its environment. This notion is in direct opposition to what Kontos calls the "decontextualization"<sup>55</sup> of the body, a process by which modern biomedicine severs biology from culture, positions the aged body in pathology, and renders aging a process only of anatomical decline. While gerontology incorporates cultural studies such as sociology, psychology, and demography into the study of the aged, Kontos proposes to take a step further by developing a contextualized perspective of aging in which place, biology and culture are studied together. In Kontos' model, the social and physical environment has direct impact upon the merged body-mind, the locus of unified biology and culture. Thus, the body cannot be separated from its environment but is always located in place. To better understand aging then, is to understand how biology, culture, and place inform each other.

Place is inextricably linked with the body. Kontos argues that “a dynamic relationship ensues between the body, meaning and place”<sup>56</sup> and uses the word “interface”<sup>57</sup> to describe this relationship. The contextualized body would include a complex and dynamic interaction of “biology, individual subjectivity, culturally infused expectations, and social and physical surroundings.”<sup>58</sup> Thus, the contextualized body implies a plurality of individual bodies and histories as opposed to a universal aging body. The aged individual is thus constituted through individual experiences. The account of the aging body is personal, subjective, plural as opposed to the logos of uniformity and the privileging of selected voices. Rather than a mute objective biological substrate, the body offers resistance to external superimposition of meaning and insists on its own meaning.

As an example of the body contextualized in place and thus infused with meaning, Kontos cites the experience of the tenants at the “Home Frontier” facility as they respond to physical decline by constructing a home community. This community is defined by “mutual support, reciprocal dependence, and boundless care.”<sup>59</sup> Through informal support networks, a social fabric of community forms in the institution which in turn helps the elderly to cope with physical decline.

Kontos explores the notion of “home space” as that which allows senior tenants to maintain independence, sustain a meaningful existence, and resist institutionalization. Place is a subjective territory, a “structure of feeling,” a source of emotional and experiential meaning. Kontos posits that the construction of a sense of place that is “home” via the experiential dimension is essential to a sense of personal identity for the institutionalized elderly. Home is the context for everyday life, and a place for the free exercise of control over one’s life, and thus a place for the sustenance of independence and identity. The home environment is constructed and negotiated by senior tenants as the domain of the individual, and as a place of choice. This construction of home and independent living allows senior tenants to cope with physical decline and incapacity.

In conclusion, Kontos states that “the place where the last stage of life is lived is prominent in how old age is experienced and interpreted.”<sup>60</sup> The place for aging therefore interfaces with the experience of aging. From the foundation of a body contextualized in place, architects will recognize the role of place in human experience. As they design elderly housing, architects must consider the context of the aging body as located in place and account for the experiential dimension of housing. The design of elderly housing, therefore, becomes the design of home: home as a place for aging, a place for everyday living, a place for being.

### **Elderly needs: Social factors in elderly housing**

As architects become aware of the demographics, the losses, the changes, and the needs of the aging population, they can better design appropriate housing for this portion of the population. The International Year of Older Persons, 1999, is designated as the year in which the situation of older persons, their lifelong development, and multi-generational relationships have primary focus in the international community.<sup>61</sup> This is an especially appropriate time, therefore, to examine the housing needs of the elderly and develop an architecture suited to these needs. Indeed, Timothy Lash cites “housing and living environment” as one of the vital sectors in which we can apply The United Nations Principles for Older Persons. These principles are independence, participation, care, self-fulfillment, and dignity.<sup>62</sup> An Ontario member of the Government of Canada National Advisory Council on Aging (NACA), Doug Rapelje, describes in the 1996 NACA newsletter the importance of well-designed housing in seniors' lives:

Housing is an important element in the maintenance of seniors' independence and well-being in the community. . . . Seniors' housing must be safe, affordable, accessible and adaptable, allowing maximum freedom and continuation of a person's lifestyle.<sup>63</sup>

The 1996 NACA newsletter identifies physiological, psychological, and social needs of the elderly as well as the various types of housing available to Canadian seniors. According to these guidelines, elderly housing should provide for occupant health, hygiene, nutrition, shelter and safety, should acknowledge user autonomy, choice, competence, privacy, and security, and should include space for visiting family or friends, recreation, leisure and intellectual pursuits.<sup>64</sup> In Housing an Aging Population, NACA also recommends affordability, accessibility, and security from the extremes of weather or from intrusion and attack.<sup>65</sup>

### **Elderly housing: types available**

The government of Canada publication, Housing an Aging Population: Guidelines for Development and Design, is an excellent beginning guide to understanding housing options available to seniors in Canada. According to this source, the elderly prefer to remain in their homes as long as possible and “age in place” with help from support services.<sup>66</sup> Other seniors live in Multi-unit buildings including apartments, townhouses, condominiums, co-operative housing, homesharing, or group homes. Finally, some seniors occupy nursing homes and other institutions. Tenure, whether one is renting or owning, is a defining feature of housing. In condominiums the resident owns a unit and has joint ownership of common areas. In cooperative housing, residents are members of a non-profit corporation and are entitled to a unit for a monthly occupancy charge. Equity-cooperatives allow their residents to make monthly payments to own their unit and may sell it with membership approval. Group homes are smaller houses in which several people have private bedrooms and share living spaces and the costs of managing the house. Hiring of staff for services may also be involved.

The types of support services available for seniors are also an important consideration in selecting housing types. Personal care provides assistance with bathing, dressing, eating and housecleaning while home care

involves medical care from a licensed care giver. Meals on wheels delivers two meals, one hot and one cold, to elderly living at home. For elderly who do not choose independent living in their own homes, there are several service packages available to seniors in different types of housing. Retirement homes are managed by a hired administrator and offer small apartments with communal dining and other facilities, and includes optional medical and personal care. Multilevel care facilities are complexes owned by private corporations or governments which contain shared dining facilities and other activities, and also offer a full range of living accommodations from completely independent apartments to chronic care.

Resident ownership of units gives the elderly a sense of independence and autonomy, and the hiring of management for these units by a resident board evokes an essential sense of control and self-worth. The provision of personal and medical care as well as dining, leisure, and other facilities promotes resident health and enhances a sense of community.

### **Elderly housing and human factors applications**

According to NACA's Housing an Aging Population,<sup>67</sup> the elderly have unique needs and capabilities which affect their housing. For example, older people are often affected by sensory and mobility limitations such as weakness, stiff joints, bad backs, tremors and the need for wheelchairs or walking aids. Remedies include reducing reflected sound by applying appropriate materials to wall, ceiling and floor surfaces, improving depth perception and reducing shadows by incorporating contrast and strong, well-diffused lighting, and allowing for audible conversations by arranging close groupings of furniture. The following section dedicated to universal design principles and "Appendix A: Practical applications of universal design" present further solutions for specific elderly needs.

## **Universal design: definition and principles**

Universal design<sup>68</sup> offers design solutions that respond to the greatest possible range of the population. Universal design solutions are intended to be marketable to a wide range of users. The goal is to design for all people within a community, including people with disabilities, children, seniors, the tall and short, and the strong and the weak. In addition, universal design includes consideration of a user's sensitivity to particular building and decorating materials and aids users in wayfinding. Although universal design applications may not accommodate users of every disability in every situation, the goal of universal design remains to meet a variety of user needs and to empower users.

The steps for architects using universal design are: identify the target market and their needs and wants, create a profile of the range of functioning within the target market, catalogue the design solutions and problems commonly encountered for this market group, and consider innovative solutions which include groups not represented within the target market. For example, when designing for seniors, the needs of children who may visit the seniors should also be considered.

Factors involved in universal design include vision, audition, stature (height, weight, seated or standing), dexterity, balance, and cognition. Visually, designers provide sufficient font sizes, colour contrast, directive information at decision-making locations, sufficient lighting levels, and minimal glare. To aid in audition, the designer provides visual information, access to assistive technology, and reduces visual distractions. In considering stature, designers provide clear space and easy reach and approach to switches, handles and mirrors. Designers also consider those with limited dexterity by limiting the fine motor movement and coordination levels required of users and by providing ample space for maneuvering assistive devices. To accommodate varying abilities to balance, walk, and control body movements designers provide handrails, rest areas, and ample space and floor coverings

as suitable for walking aids. They also minimize walking distances in circulation patterns, eliminate the need for bending over, limit the strength required to use the doors and other features of the space, and ensure that tasks can be performed with only one hand. Finally, to aid in cognition, designers ensure that information is clearly presented visually, audibly and in a tactile manner, and that the acoustics are appropriate for the intended use.

### **Case study: The move to congregate housing**



The following section provides valuable insight for architects and designers. The case study described below investigates thoroughly the elderly experience as they move to congregate housing. This exploration of the aging experience should be used as a guide to elder design.

In the 1998 *Journal of Aging Studies*, Heather Young publishes the article: "Moving to Congregate Housing: The Last Chosen Home" where she explores the experience of moving to congregate housing among a group of 21 elderly. The group ranges in age from 72 to 96 and 71% are female. She examines reasons for moving to congregate housing, criteria for selecting a new home, the process of making the move, fitting into a new environment, and adjusting to significant life changes.

#### *Characterising congregate housing as a positive environment*

Young notes a recent growth in congregate housing<sup>69</sup> facilities that "reflects the increased needs of aging and disabled populations who benefit from sheltered care environments yet wish to retain independence and freedom of choice."<sup>70</sup> For the most part, she characterises this move as a positive one. Young cites previous research which indicates that in

comparison with tenants who relocate to traditional housing, “those moving into congregate facilities show greater increases in morale, housing satisfaction, and social network.”<sup>71</sup> In addition, other researchers conclude that moving is a stimulus for psychosocial development amongst the elderly. New friendships, new environments, and new activities provide opportunities for development.

#### *The site*

Young’s approach is to describe the recounted experiences of elderly individuals as they move from traditional housing into a new wing of an existing retirement complex. Young’s site is a rental congregate housing community within an urban setting. The original 46 apartments are without kitchens and with few common spaces. The residents of the original apartments are characterized as having a lower socio-economic status and poorer functional and physical health than the newer residents moving to the complex have. The new facility, therefore, combines residents of varying health and economic status in one building, albeit in different wings. The expansion of the facility includes enlarged dining and activity areas, communal spaces scattered throughout, and a new wing of apartments. The 58 new apartments range from 550 – 800 feet and include 1 or 2 bedrooms, a full kitchen, a living room, and bathrooms with universal design features. Services include activities, three meals a day, and 24 – hour staffing. While residents are encouraged to be independent in the basic activities of daily living, provision is made for aging in place and increased needs over time.

#### *Home space*

The participants identify four critical elements of home.

1. The first, *interpersonal warmth* is defined as love, congeniality, or friendship and is characterized by being able to welcome someone into your own home space.
2. The second, *physical comfort*, is the response of furnishings and physical layout to resident needs and the personalization of the environment with possessions, pictures, music, and items of furniture.
3. The third element of home is the *investment of energy in the environment*, characterized as an active endeavor in which residents invest care and time in daily chores at home.
4. The fourth element of home is the notion of *freedom to be oneself* and includes an expectation for privacy and license. It is characterised by a sense of recognized boundary between the resident's home space and the outside world. The residential nature of the apartments in Young's study afforded privacy to the residents.<sup>72</sup>

#### *The move*

Young states that the central reason for moving is "the perception that the demands of the former environment exceeded the resources of the individual."<sup>73</sup> These demands include housework, gardening, decreased mobility within the neighborhood or house, lack of transportation, a catastrophic event such as death of a spouse, severe illness or accident, or family perception that the individual should not live alone because of health or safety. Young observed that the residents tend to select a facility according to location, services, financial arrangement, and the physical attractiveness of the building.<sup>74</sup>

#### *Getting settled*

Young notes that personalizing the physical environment with possessions affirms personal identity and connection. The reduced size of the

apartments in comparison with the residents' previous large suburban homes "posed the greatest challenge."<sup>75</sup> Small storage spaces, in another section of the building, would be a desirable addition for many residents because they can store special items that might clutter or crowd the small apartments.

The participants in Young's study adapted well to their new environments. They appreciated the ease of using the accessible showers as well as the choice to use a communal tub down the hall. With the help of the activity director, they learned about the services and amenities in the building and the greater community, including shopping, mail, laundry, social and recreational activities and the emergency call system. The retirement community represents a significant change in social and cultural environment for the new residents. For example, they tend to spend an average of two hours daily at shared meals. Young observes that, "As a solution to the population density, most residents respected the privacy of others when they retreated to their apartments, so that interaction took place primarily in public spaces or upon specific invitation."<sup>76</sup> This suggests a need for easy access to common spaces within an elderly housing facility, to encourage social interaction within communal areas, and privacy within the individual units.

#### *Adjusting to change and loss*

Young notes some attitudes of intolerance and ageism amongst over two thirds of the residents as well as feelings of ghettoization as they move to a seniors-only community:

Sixteen of the twenty-one participants focused their observations almost exclusively on the mental and physical impairment of others, even when the participants themselves had significant functional limitations. Many were unprepared for living among such a large group of older people and commented on the age segregation, regretting having lost the age heterogeneity of their former neighborhoods.<sup>77</sup>

Young notes that many of the participants were still struggling to face the realities of their own aging. The personal losses of the elderly participants include a change in role as hostess for large gatherings and overnight guests, giving up driving with a resultant reduced access to habitual places and events, a loss of physical mobility, an increase in regimentation and structure to daily life, and a change in social environment. Some residents adjusted well to the change, expressed tolerance, and discovered commonalities with other residents, which fostered a sense of social belonging. As residents achieve social integration, they begin to consider the facility a new home. In addition, while the elderly residents gave up many things in the move to congregate housing,

Many described this move as their last planned relocation and reported a feeling of great satisfaction in putting their affairs in order and tying up loose ends. There was reluctance to impose on others and bringing closure to the details of their lives reassured the participants that they were not leaving unwieldy disorder for their survivors to disentangle.<sup>78</sup>

Overall, Young reports a reconciliation with, and acceptance of, the current situation amongst the participants. While sacrifices were made, new opportunities and freedom from the demands of a larger home balance the losses. The majority of residents in Young's study expressed satisfaction with the move to congregate housing.<sup>79</sup>

#### *Aging in Place*

Finally, Young defines a need for the "identification of factors that extend the length of stay in less restrictive environments." She emphasizes that "the ability of older adults to remain in a setting is relevant from both adaptational and service delivery perspectives." With provisions for aging in place, therefore, congregate housing is a viable housing type for an aging population.

Young's observations of the elderly experience and recommendations for aging in place within elderly housing provide an essential basis for this projects' design strategy.

### **The elderly in their environment: Benefits of a connection with nature**



Timothy Lash suggests improving older people's situations via "access to and use of the natural environment" and "interactions with the non-human environment" as a possible "source of independence and dignity for older people."<sup>80</sup> These ideas are supported by a recent study in The Gerontologist.

In this article in The Gerontologist, April 1998, Jiska Cohen-Mansfield and Perla Werner publish the results of their research on the effects of an enhanced environment on the elderly. Their study refers to several researchers who identify the physical environment as a "silent partner" in caregiving, as it is of utmost importance in the health, functioning, and well-being of nursing home residents. The aim of the Cohen-Mansfield and Werner study was to "assess the effects of an enhanced environment . . . on the behavior and mood, as well as on the manifestation of pacing and wandering behaviors, of nursing home residents who pace frequently."<sup>81</sup> The goal was to provide visual, auditory, and olfactory stimuli which "maintain the connections of the residents with what is familiar to them while at the same time reducing the institutional aspects of the environments."<sup>82</sup>

The research team chose two types of enhanced environment for their study, a nature scene and a home and people scene. The nature scene included a bench in a hall way surrounded by artificial plants and trees, posters of forests and valleys, tape recordings of nature sounds such as birdsong, and a forest smell from an aroma diffuser machine.<sup>83</sup> The home scene included a bench in a hall surrounded by a family dinner scene poster,

artificial plants, Jewish and classical music, and citrus aroma. The team observed increased time spent in the enhanced corridors, more sitting, less trespassing and exit-seeking, and in the nature scene corridor, "a statistically significant increase in the level of the participants' pleasure . . . when compared to the no-scene situation."<sup>84</sup>

In addition to improving resident behavior and mood, staff members and relatives praised the change in environment. Cohen-Mansfield and Werner observe that "if the environment becomes a more pleasant place to work, staff members' feelings may ultimately affect the residents' care and well-being."<sup>85</sup> They conclude that:

. . . since even in our study (which intended to maximize the influence of the environment by implementing changes in as many sensory domains as possible) only modest effects were observed, it may be the case that future studies should concentrate on implementing additional changes, rather than assessing the effect of individual changes.<sup>86</sup>

For example, these changes could include daylighting, live plants and animals, fresh air, spatial variation, and experimentation with colour. This suggests a role for architects and interior designers to enhance environments for the elderly.

Although the Cohen-Mansfield and Werner study focused on changing the mood and behaviors of residents who pace, they are working from the standpoint that the physical environment effects the health, functioning and well-being of all residents. Their choice to investigate the improvement of environments by making them either more homelike or more reminiscent of the natural world, suggests to me that architects can improve elderly housing by enhancing these elements through design. This call for an enhanced connection with nature via architectural design is a key design strategy proposed in this paper.

## **II. Environmental Sustainability**

### **Environmentally sustainable applications for housing in the urban setting**

Environmental sustainability is a holistic ethic that promotes the protection of the earth and its ecosystems. The application of environmental sustainability to urban housing focuses on the design of buildings and communities that have a reduced negative impact upon the environment and human health and which allow for future generations' ability to meet their needs. The following paragraphs explore some of the more practical considerations in designing buildings and communities sustainably. These steps indicate a deep concern for the environment that we are responsible to protect, as well as a deep sense of the human need for integration with their natural community.

### **Sustainable community planning**

Sustainable planning addresses such issues as town planning for the better integration of work, home, and child rearing, the need to solve the commuter problem through better public transportation, the de-centralization of the work core, and the desire to maintain a network of green spaces. Sustainable communities are safe and unified with a sense of identity and character as an area. Architects can identify and apply the characteristics of a sustainable community when developing or selecting sites for elderly housing.

Debra-Lee Hamilton's Masters Degree Project defines organizing principles and design guidelines for a sustainable community.<sup>87</sup> The following discussion of sustainable planning is inspired, in part, by her project, as well as by class discussions of sustainable planning practices in The University of Calgary course, Environmental Design 609.

### *A sense of community*

Hamilton defines a successful community as one that involves member participation, responsibility, and respect for individuality. Community residents play an active role in social, political, physical, and economic decision-making.<sup>88</sup> A sustainable community is designed with a holistic environmental approach, and with attention to user health, safety, and quality of life. Its livable streets, affordable neighbourhoods, and safety for residents and businesses give the community a special character. Education about sustainability in urban, environmental and building science processes will be visible in the sustainable community.

### *Green spaces*

Sustainable planning includes the preservation of habitat and the provision of a strong connection with nature for urban residents. Planning strategies include clustering buildings to conserve open space, providing buffers between environmentally sensitive areas and the built environment, and linking open spaces to a greenspace system. This continuous system of natural greenspaces will be connected with a regional open space system linking sensitive lands and wetlands in a web of natural areas. The continuity of green corridors aids in pedestrian and wildlife movement. The interconnection of green spaces, as opposed to fragmenting natural areas into pockets, preserves animal and plant diversity and reduces edge conditions and their associated impacts. The impacts of edge conditions include increased solar radiation and wind, temperature and humidity changes, predation and parasitism, non-native competitive species, and noise, water and air pollution.<sup>89</sup>

Interpretive trails provide vital education about local ecology to residents. These trails encourage community interest in environmental

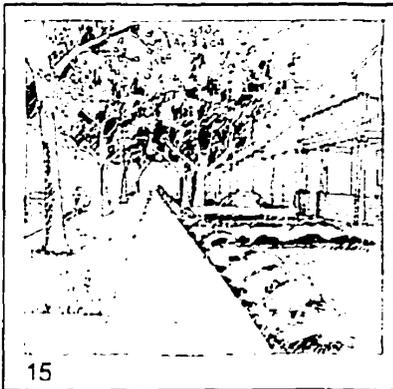
preservation and management, and are designed carefully so they do not interfere with the natural processes of wetlands, wildlife and plants.

An environmental impact assessment should accompany the proposal to build a sustainable community. Environmental impact assessments consider a variety of issues including impacts on soils, land forms, sensitive areas, ecosystems, habitats, species, wetlands, water table, hydrology and wildlife.

Finally, in a sustainable community, the maintenance of urban parks, open spaces, trails and community gardens should employ organic farming and gardening. These organic practices include the elimination of pesticides, herbicides and chemical fertilizers and employ companion planting, indigenous planting, biodiversity, and crop rotation principles.

#### *Organizing the neighbourhood*

The sustainable community mixes residential, recreational, and small-scale commercial and retail land uses. Within the community, planners make provisions for a diversity of housing type, size, affordability, tenure and potential for adaptability. This housing variety includes single family dwellings, multi-family apartments, town houses, co-housing and co-operatives. This diverse range of housing allows for residents to move to the community regardless of age, income, cultural or social background. These practices may require changes or exemptions from typical zoning laws.



The streets in the community are oriented east/west to allow for solar gains from south elevations, and houses are oriented toward the streets. Setbacks from the street are minimized, and generous boulevards are planted with deciduous trees to create more attractive streetscapes for pedestrians, provide a sense of intimacy and safety, provide a buffer between pedestrian and vehicular traffic and shelter buildings from excessive solar gains in summer.

The sustainably planned community is organized around a central hub, or “village commons” that is accessible within a five-minute (or 400 m) walk from “at least eighty percent of the residential units.”<sup>90</sup> The hub is a pedestrian-oriented central space that mixes transit facilities, open space, community market space, businesses for daily goods and services, and residential apartments. It is a meeting place for all ages and is historically, culturally, or architecturally significant. This community hub encourages community identity, responsibility, and small town atmosphere.

#### *Design guidelines*

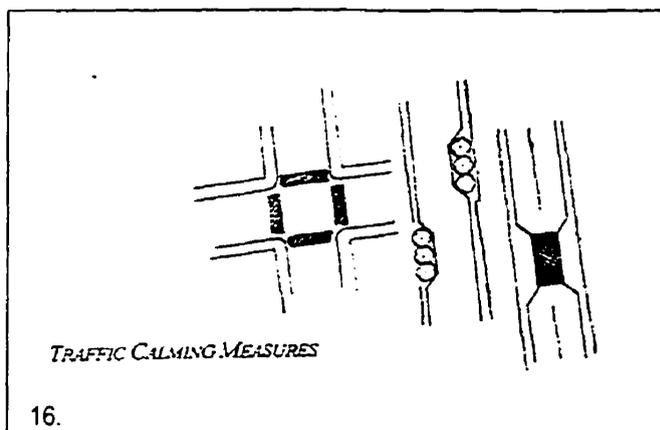
In the sustainable community, a sense of place, community identity and pride are encouraged through local and historical design elements, enabling views by restricting building heights to tree canopy height, and, to encourage safety, incorporating nighttime lighting, open vistas, and multiple pedestrian access routes.

#### *Transportation and circulation*

The most essential feature of sustainable transportation planning is designing for pedestrian traffic. Community planners design the street system for easy negotiation, wayfinding, safety, efficiency, and short, direct routes between destinations. Reducing traffic speeds make foot travel more appealing to residents and reduces traffic noise. Limiting vehicular entry

points to the community also reduces through traffic and high speed traffic. Hamilton suggests additional traffic-calming measures including,

. . . narrower roads, tighter corners, [the] use of different paving materials and textures at intersections and crosswalks, shorter blocks, and ‘pop-outs’ where the sidewalk is expanded at certain points in the street.<sup>91</sup>



For ease of vehicular and pedestrian traffic, road design will also incorporate space for temporary storage of snow when cleaning roads and sidewalks.

A walking path system linking the neighbourhood to other communities and to natural areas completes the pedestrian movement system. Community planners should also make provisions for other sustainable transportation modalities including bicycle and public transit facilities. These provisions include bike paths, on-road cycling lanes, bicycle racks at public facilities and shopping areas, a community shuttle (bus) from the more remote houses to the central hub, and commuter rail to other residential communities and the city centre.

#### *Waste management services*

A sustainable community fosters recycling and composting programs for its users. Community parks, gardens, and even local restaurants that produce organic wastes contribute to the composting program.

Innovations in wastewater treatment and the upgrading of municipal facilities to the highest standards and new technologies reduce the disruption of ecosystems downstream. For example, Dr. John Todd of the New Alchemy Institute is experimenting with a solar aquatics system for purifying sewage with aquatic plant and animal species.<sup>92</sup> Constructed wetlands also provide opportunity for the treatment of community wastewater.

#### *Buildings*

An important part of sustainable communities is sustainable building design. Sustainable building strategies include minimizing building footprint, using indigenous and recyclable materials from local suppliers, designing and specifying for energy conservation, and reducing, reusing and recycling

construction and demolition waste. These topics will be discussed in greater detail in the following sections.

### **Sustainability in the built environment**

Brenda and Robert Vale call sustainable architecture "Green Architecture" whose purpose they define as simply "the survival of the planet."<sup>93</sup> The goals of this new architecture are to protect the earth's atmosphere, water resources, natural resources, and fuels. Green architecture is founded on principles of sustainability which the Vales define as conserving energy, working with climate, minimizing new resources, respect for users (this includes toxicity and user health issues), respect for site, and holism.

The Vales also see food production as an integral portion of the sustainability equation as it "has an essential impact on the environment, and also of necessity impinges on architecture through the need to balance town and city with countryside"<sup>94</sup> Community gardens and greenhouse spaces can provide food production options for individuals with the desire to produce their own food. Some forms of sustainable architecture are entirely "off the grid" in a closed-loop system that produces energy and food and recycles all wastes on site. In the urban context, however, residents are usually part of a much larger system of food and energy production and waste handling. The challenge is to maintain the integrity of the closed loop ideal, even in the much larger system. While power generation from sustainable sources, environmentally responsible waste treatment, and farming practices that do not degrade the natural environment or human health are important global factors, the architect's more local role is of equal importance in creating a sustainable society.

Sustainable buildings should conserve water, reduce air pollution and fuel consumption, and use a minimal amount of raw materials and resources. Essential components of sustainable buildings include the specification of

recycled materials, reusing and recycling construction waste, and designing for reuse or recycling in the demolition phase of the building's lifecycle. Other key factors in sustainable architecture are the building's consumption of energy via lighting, electricity consumption, the use of alternative energy sources, and the design of buildings to encourage a sustainable lifestyle by incorporating public transportation, recycling, and composting facilities into the design plan.

### **Site selection and planning**

The resources on the site should be evaluated. Ideally the site will have clean air, water and soil, but site history should be investigated for agricultural, industrial or urban pollution. Testing may be necessary for the presence of hazards such as radon, or electromagnetic fields. For example, the Rocky Mountain Institute's Primer on Sustainable Building recommends that buildings be kept 100 yards away from "power transmission lines, electrical transformers, and radio, television or microwave installations."<sup>95</sup>

In a site analysis, the architect will determine access to sunlight for daylighting and solar power, availability of renewable power sources such as wind or geothermal as well as access to roads, pathways, public transportation, and community services such as schools, shops, fire station, airport and hospital. The architect will also gather information, with the help of specialists, to evaluate existing habitats, wildlife and plant species, location of wetlands on site, topography, geology, soil stability and percolation, hydrology and erosion control, and climate – which includes sun, wind, rain, and snow loads. Additional factors are potential for agricultural use, cultural, historical or archaeological significance, sense of place, views, surrounding urban context, and any existing buildings and the potential to reuse them or their salvaged materials. Zoning designations or future development plans for adjacent property should also be investigated as new developments can affect air and water quality, noise pollution, and access to transportation and solar gain.

Applications of the site analysis affect various aspects of the building, site, and construction process. For example, knowledge of the climate may lead to the capture and draining of rain and snow fall for site irrigation or as cistern water for showers and toilets. Careful analysis of plant life and the planning of construction vehicle access and materials staging and storage on site, enables protection and restoration of native plantings. Understanding the importance of ample green space may require reducing the building footprint and putting the parking underground. Studying local hydrology will reveal existing water circulation routes and indicate needs for rainwater to percolate through the groundcover. Understanding the cultural and historical context of the site allows architects to effectively integrate sustainable architecture, technologies, and site development strategies into existing communities. A thoughtful site analysis, therefore, is a fundamental concern in sustainable design, and will provide a sound basis for sustainable architecture.

### **Materials selection**

Sustainable building design largely involves site planning, materials selection, envelope design and configuration, and the careful specification of mechanical systems. "Appendix B: Criteria and methodology for materials selection" addresses materials selection by compiling the recommendations of key sources and examining the major considerations in establishing a methodology for determining such indicators as embodied energy and embodied pollution. There are many factors involved in materials selection and complex issues and processes surround the attachment of number valuations to building materials and systems.

#### *Embodied energy and embodied pollution*

Embodied energy can be defined as the net resources, expressed in Btu's, required to create resources for, acquire or harvest, process,

manufacture, transport, assemble, demolish and dispose of a given product or assembly. Values for the embodied energy of building materials sometimes include as a factor embodied pollution which is a value given to the pollutants of air or water, and human health risk (toxicity) produced in the acquisition, processing, manufacture, transport and assembly of a product. Values for embodied energy can include such indicators as transportation costs, recyclability, potential for reuse, ease of disassembly, and ability to biodegrade. Values for embodied pollution often refer to CO<sub>2</sub> or CFC's introduced into the atmosphere by a product and its acquisition, manufacture, application and transport, and thus refer to the product's contribution to ozone depletion and the accumulation of greenhouse gases. In addition, embodied pollution often includes reference to toxins released in landfill or VOC's (Volatile Organic Compounds) into the indoor air.

In a market of ever-widening building products and assemblies, architects and specifiers require the means to evaluate and select materials and their assembly. Current criteria for materials selection often include structural performance, aesthetic effect, the initial monetary cost, and for some projects durability or life-cycle monetary cost. Indicators such as embodied energy and embodied pollution can make environmentally responsible materials selection easier by presenting in a rational and numerical format the energy and environmental value associated with various materials. See Appendix B for a discussion of current values for materials selection. The table below summarises three materials reviewed in Appendix B.<sup>96</sup> Establishing a means of comparison for various materials and further, for various products on the market, allows for consumers of these materials and products to make responsible, environmentally friendly choices. Architects, as primary consumers of building products, have a significant responsibility to educate themselves and their clients about environmentally sustainable materials selection.

	<b>Wood</b>	<b>Brick</b>	<b>Concrete</b>
<b>Occurs naturally</b>	Y	Y	Y
<b>Renewable</b>	Y	N	N
<b>Use</b>	Structure, cladding, finishes	Cladding mostly (and some structural)	Structure, cladding, foundation, finishes
<b>Durability</b>	Decays without moisture protection	Low maintenance and long lasting	Long lasting
<b>Costly transport<sup>97</sup></b>	N	Y	Y
<b>Combustible</b>	Y	N	N
<b>Acquisition energy</b>	Moderate	High	High
<b>Acquisition pollutants</b>	Y	Y	Y
<b>Habitat loss</b>	Y	Y	Y
<b>Recyclable</b>	Y	Y	Y
<b>Reuseable</b>	Y	Y	Blocks and crush only
<b>Innovations to specify</b>	Sustainable forestry	Recycled content	Recycled content
<b>Locally available</b>	Y (Alberta)	Y (Alberta)	Y (Alberta)
<b>GJ/tonne (worldwide)<sup>98</sup></b>	0.1 – 5.0 Timber	2.0 – 7.0 Clay brick 0.8 – 1.2 Sand-lime	0.8 – 1.5 In situ 0.8 – 3.5 Blocks 1.5 – 8.0 Precast
<b>BTUs (U.S.A.)<sup>99</sup></b>	2500 Btu's	Not listed, but more similar to concrete.	10,000 Btu's
<b>Waste</b>	high	minimal	minimal
<b>Outgassing</b>	moderate	minimal	minimal
<b>R-value</b>	moderate	low	low

### **Building systems**

A site analysis provides information on the existing systems available for running water, power and sanitary waste management. The architect must integrate systems suitable for the site's climate, topography, and natural resources. Energy conservation and both human and ecosystem health are vital in the design of sustainable building systems.

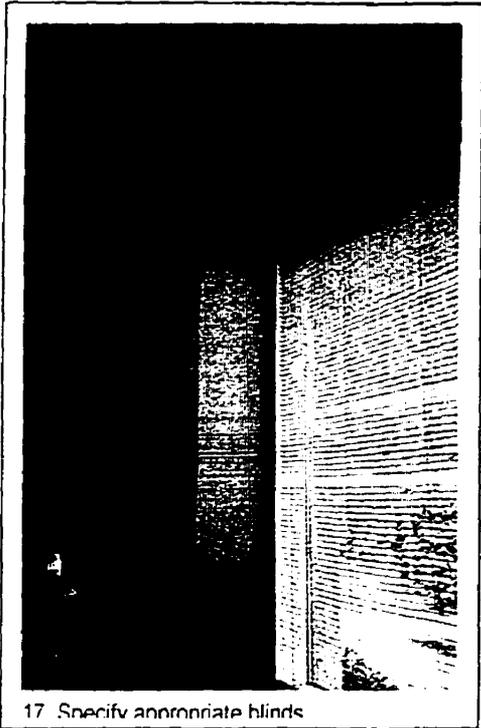
### *Energy conservation*

While energy conservation saves the environment by reducing pollution released in common energy production methods, conservation also saves money. The Rocky Mountain Institute reports the following figures for American energy expenditures: "More than 60% of all electricity used and more than 30% of all energy consumed in the United States is used in buildings."<sup>100</sup> Energy conservation depends largely upon building orientation, insulation and glazing, topics discussed in the next section, which are integrated with building systems to form the total energy conservation picture.

An important indicator of sustainability in the built environment is *operational energy* which Andrew St. John defines as the energy resources used to heat, cool, light, and run a buildings' various systems during occupation.<sup>101</sup> To reduce operational energy costs, architects can use passive solar, thermal mass, daylighting, shading devices, high-performance glazing, cross ventilation, energy efficient lighting (such as compact fluorescents with automatic controls), high R-value insulation, and heat recovery ventilation in their designs.

### *Daylighting*

Lighting buildings accounts for 20% of electricity consumption in the United States<sup>102</sup> and 16% of energy consumption in office buildings.<sup>103</sup> These numbers can be reduced by incorporating increased natural daylighting and more energy efficient artificial lighting into buildings. Both direct beam rays, known as sunlight, and diffuse sky radiation, known as skylight, provide daylighting in a building. To make the best use of daylight, and thus gain subsequent energy savings in artificial lighting costs, architects should take care to mitigate problems associated with windows that can result in higher energy costs for lighting, heating and cooling. Glare, which causes residents



to lower blinds when working, raises artificial lighting costs. Designers can specify appropriate blinds to reduce glare, reflect heat, and let in light. Windows, if not treated properly, can cause heat loss in winter and heat gain in summer. Architects should provide ample high-efficiency glazing for solar gains and daylight in winter but control glare and summer overheating at the building envelope by using a combination of awnings, deciduous tree-cover, blinds, or frosted glass, depending upon the individual application. Awnings block solar radiation during the summer but permit the lower-angle winter rays.

Daylighting is the preferred lighting for most people. Thomas Randall et al indicate the possible health benefits of daylighting. They tell us that, "The contact with changing natural light is physiologically, psychologically and architecturally important."<sup>104</sup> Daylighting changes in angle, direction, tone, and light quality according to the time of day. Lighting designers will consider daylight from all altitudes. Specialists measure daylighting according to the daylight factor, which is:

... the illuminance received at a point, indoors, from a sky of known or assumed luminance distribution, expressed as a percentage of the horizontal illuminance outdoors from an unobstructed hemisphere of the same sky; direct sunlight is excluded from both values of illuminance.<sup>105</sup>

Randall et al reference tables of recommended daylight factors for various building types, but above all they advise that daylight should be maximised to its fullest potential, provided that the architect resolves any problems with glare, solar gains, heat loss, or damage from ultra violet rays.

To maximise daylighting, the architect can increase glazing, use light paint colours on ceilings to increase reflectance, keep the ceiling uncluttered by massive lighting fixtures, and design building massing to benefit from the available daylight. A highly articulated building envelope with a greater total perimeter will provide more potential daylighting and natural ventilation. However, these benefits must be balanced against greater heat loss from the

increased surface area of the building envelope. Careful attention to the envelope's thermal adequacy and design of the heating system can reduce the costs of a more highly articulated building envelope. Reducing heat loss through windows at night is an essential strategy for cold climates. Special blinds, shutters, or high-efficiency glazing reduce nighttime heat losses.

Victorian schools and hospitals typically have high ceilings with windows which run right up to ceiling height. The architecture studios in the professional faculties building at The University of Calgary make use of this architectural device. Increasing the floor to ceiling height and the height of the windows lets significantly more light into the space. However, user needs for increased light in a space must be weighed carefully against increased costs for more building materials and energy to heat and cool.

The arrangement of spaces to benefit from available light levels is another important strategy. Activities which require high levels of lighting will benefit from a location nearer to the window, whereas storerooms, hallways, and less frequently used spaces require daylighting less urgently and are more suited to the interior of the building. Areas closer to a window are often much brighter than areas at a distance away from them. These areas next to the window may require solar control to ease glare and potential thermal discomfort from direct solar gains. Blinds that reduce glare, diffuse sunlight, and reflect heat, yet allow a percentage of daylight to enter, are commonly available.

Lighting designers should attend to light uniformity. In a space with windows on only one wall, the range of light levels between the front and back of the space may not be adequately uniform and the space will tend to look gloomy. Skylights, which receive more direct, bright light than windows (5000 lux for skylights versus 2000 lux for windows<sup>106</sup>), are one solution to lighting the space away from the building's perimeter. Skylights can be fitted with insulating shutters and triggered by heat sensors that close the shutters during cold nights to reduce heat loss.<sup>107</sup>

To bring daylight down to lower floors from the rooftop, Randall et al suggest that “atria with large glazed areas and few obstructions [are] not a problem but shafts are much less effective”<sup>108</sup> because much of the light is lost as it travels down the stack. Balconies, walkways, and large vegetation projecting into the atrium space obstruct a portion of the daylight from reaching the lower levels. Vegetation must be planned carefully and maintained. Slower growing and less bushy varieties are preferable for maximizing daylighting. There will be some argument that atria are “wasted” space in a building, if they are serving only to provide light. Atria spaces, therefore, should serve more than one function. This project proposes that in elderly housing the atria spaces can fulfill several programmatic functions. They act as vital common spaces and replace dark “space wasting” hallways by providing circulation space from suite to suite. The indoor atrium space becomes a vital place to exercise and experience plants life and a more open space in cold winter climates. To mitigate heat loss, cover the atria windows/skylights with automated insulating shutters at night.

#### *Passive solar*

While daylighting provides energy savings by reducing the need for artificial lighting, windows can also save energy by providing useful heat gains. Orienting the building and its fenestration towards the south, when possible, is essential for the greatest solar gains. Every building has some potential for energy savings from passive and/or active (photovoltaic cell) solar use. During the site analysis, sun path in the sky, angle of light, and obstructions to sunlight reaching the building should be observed. Passive solar strategies incorporate thermal mass, where appropriate, paired with windowed spaces. A brick wall, or another high-mass architectural feature, stores heat from direct sunlight during the day and releases the heat into the air space at night as the building cools. Another key strategy in passive solar designs is using a windowed space as a solar collector. Hot air that tends to collect at the top of

a windowed space can be ducted away (using fans and ducting) to cooler areas of the building, or can be exhausted outdoors in summer.

### *Artificial lighting*

To reduce the need for and the costs of artificial lighting, architects should employ a thoughtfully crafted daylighting scheme. During the day, any necessary artificial lights should complement the daylighting strategy. Designers should artfully craft transition zones between the day lit and artificially lit spaces. The lights in a room should be wired separately in banks so that areas away from the window can be lit separately from the spaces nearer the window, which may already have sufficient natural light.

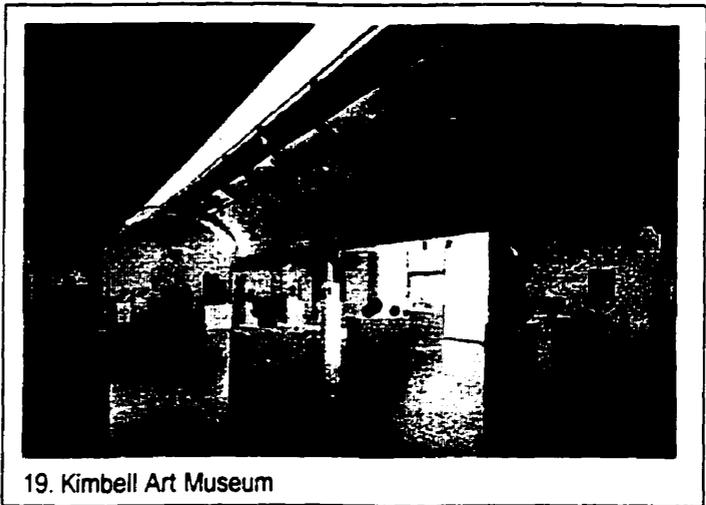
In addition to reducing the need for artificial lighting by maximizing daylighting, architects should also choose their lights according to energy consumption and light quality. Light quality includes brightness, spectral composition, warmth and light colour. To ensure that daylight and natural light mix successfully, architects consider the colour of the interior, the glazing, and the changing composition of the daylight as the sun moves across the sky. Many architects find that a warm but not too yellowish light also known as intermediate colour temperature or 3300-5300K mixes well with natural light.<sup>109</sup> In addition, concern with seasonal affective depression, thought to be a result of a lack of sunlight, is a concern for designers. Possible remedies include increased daylighting and using more “natural” or full-spectrum indoor light sources.



18. Compact Fluorescent

Efficiency in lighting is measured in terms of lumens per watt. In an installation, lighting designers try to maximize the “lux” or lumens per square metre. Designers concerned with sustainable building choose high-efficiency fittings appropriate to the application. Standard incandescent bulbs use only ten percent of their total electrical energy to emit light and use the other ninety percent to emit heat.<sup>110</sup> Energy efficient lamps create immediate energy savings in most building applications and can also save in cooling costs.

Compact fluorescent lamps, for example, use approximately one quarter the electricity of incandescent bulbs.<sup>111</sup> While they have a higher initial cost, compact fluorescents last up to ten times as long as typical incandescents, which saves in manufacturing energy and maintenance. When compared with a halogen torchiere, the compact fluorescent torchiere gives "as much light as a 300-watt halogen lamp while using one-sixth the electricity."<sup>112</sup> Michael Siminovitch, who leads a project for the compact fluorescent labs at Lawrence Berkeley Laboratory in Berkeley, California, encourages homeowners to replace high-use fixtures, such as porch and kitchen lights with compact fluorescents. He estimates that if American homeowners replaced "one-third of their light fixtures with compact fluorescents, they would halve the nation's annual lighting bill."<sup>113</sup>



To reduce glare from artificial lights, architects use diffusers, shades, or uplighting to provide a softer, more pleasing lighting level. However, in uplighting, a clean white ceiling surface only reflects 85% of the light down to the room and thus some efficiency is traded for the reduction in glare. The pleasant light quality from uplighting, especially when combined with a barrel-vaulted architectural detail, may be worth the expense in rooms often used by many people at night and which require pleasant lighting effects. Louis Kahn makes good use of lighting details in his Kimbell Art Museum.

The controls for lighting can make a big difference in energy costs. As mentioned earlier, zoning lights on separate switches for different areas of a room encourages residents to turn on the lights only in the necessary areas. Separately controlled task lighting over desks, bathroom and kitchen counters and dining tables encourages residents to use high levels of light only where needed and allows for general background lighting to be at lower levels (200 to 300 lux, for example<sup>114</sup>). User control of lighting level and direction is vital and switches should be easily accessible and simple to understand. Dimmable lights can help to ease glare and reduce energy consumption. Switches at the bedside are especially appropriate for elderly housing applications. Motion detectors with a set time delay can be employed in rooms such as public washrooms to save energy when the room is not occupied. While motion sensors have effective applications, especially in outdoor security lighting, the possible complexity of some technological solutions must be weighed carefully against the desire for simple solutions, low-maintenance devices, durability, and ease of use.

#### *Electrical Equipment and Appliances*

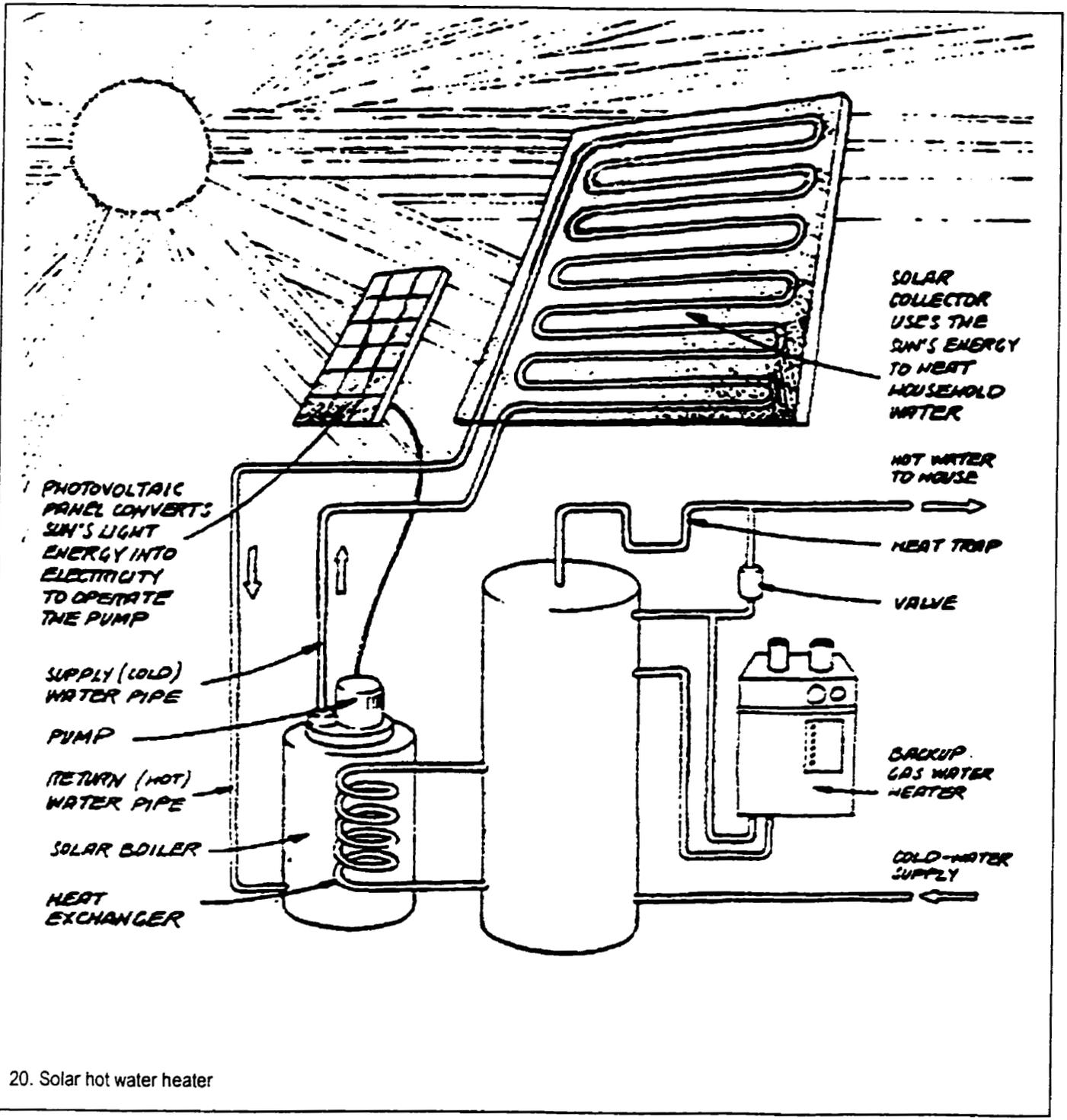
An essential part of sustainable building is the specification of high-efficiency models of appliances equipment. In comparison with top-loading washing machines, the front loading washing machine only uses half the hot water. Refrigerators with separate compressors for the freezer and refrigerator units also consume less energy.<sup>115</sup> The manufacturing energy and the environmental impact of appliance disposal are other important considerations. Specifying long-lasting, easy to repair, high-quality appliances will reduce the frequency of replacement. Architects must take on the responsibility of specifying appliances for their buildings, if they wish to practice sustainable architecture.

The selective use of appliances also saves energy. For example, the able-bodied and environmentally concerned residents of elderly housing may

wish to use clothes drying racks or clotheslines to dry their clothes outdoors during the warm season. In a dry climate, they can hang dry clothes during the winter months by selecting items to dry on a portable rack indoors. This practice saves energy by reducing the amount of mechanical clothes drying. Provision of space, racks, and mounting instructions for this energy conserving practice will encourage those elderly who wish to participate.

Another consideration for architects and residents is the emittance of electromagnetic fields that occur when a current runs through a wire or appliance. While research is inconclusive, EMF has been linked with cancer and miscarriages. As a precaution, Zeiher recommends locating building sites 100 yards from high-energy power lines and transformers, standing no closer than 3-5 feet from operating appliances, 2 feet from computer screens, and 3-10 feet from operating microwaves.<sup>116</sup>

Water heaters create a significant drain on energy costs in buildings. Replacing electric water heating with gas-powered heating cuts costs in half, but passive solar or cogeneration are better options, as they do not require fossil fuels. Cogeneration, usually only cost effective in large buildings, uses the transfer of waste heat from other building systems such as air-conditioning or refrigeration condensers. Passive solar hot water heaters are simple and efficient. A simple solar collector assembled from pipes of water in front of a dark surface creates a cycle of water heating. The sun heats the water in the collector and forces it out of the pipes and into the hot water tank, thus displacing colder water into the collector.



20. Solar hot water heater

Finally, energy conservation is easier if residents and commercial users have ways to monitor their energy use. Metering electricity consumption in a highly visible manner and setting goals for the reduction of electricity consumption help sustainable communities and individual residents achieve their objectives.

#### *Air supply and purification*

We define air supply in buildings in relation to heating, cooling, ventilation and filtration. To conserve energy and promote high standards of air quality, Randall et al recommend natural ventilation in lieu of air conditioning whenever possible. Natural ventilation is especially viable in the summer months. In the winter, heat recovery ventilators allow warm air leaving the building to pass around the cold air intake duct, thus bringing the cold air up to a higher temperature before it is heated by the furnace. Heat recovery saves on the expenditure of heating fuels and allows for better air quality because the cost of increasing air changes per hour is reduced. The building envelope, including passive solar spaces, should be designed to work in tandem with the mechanical and electrical systems.

In sustainable building design, architects and mechanical engineers should specify high-efficiency furnaces and mechanical systems. They should design systems to incorporate user control and thus allow for ample ventilation of the space for each user's comfort. Those who design elderly housing should be aware that the elderly often prefer temperatures slightly higher than average room temperatures.<sup>117</sup> In many rooms, a ceiling fan provides air movement in the summer that cools the body, and in winter, a reverse-running slow-speed setting on a ceiling fan will move warm air down from the ceiling so it does not escape through the ceiling. A better solution in large volume spaces such as atria is to duct the warm air at the top of the space down to the ground level with an electrical fan and duct system.

Indoor air quality is of vital importance to resident health and well being. The source of the air intake should be located on a windward side of the building away from areas of heavy traffic, loading zones, air exhausts from adjacent buildings, garbage storage and other pollutant sources. The air exhaust should be located on the opposite side of the building and downwind from the air intake. Air changes per hour should be set at levels greater than recommended levels. Air should be filtered at the intake with a combination of folded and charcoal bed filters, especially in urban areas where air pollution is significantly greater. High efficiency filters of 60% to 80%<sup>118</sup>, combined with a larger, more powerful blower, filter out the smaller airborne particles. The frequent maintenance of high efficiency filters is essential to indoor air quality.

Air pollution within the building should be controlled at the source. Bathrooms and kitchens should have quiet fans (at a remote location) that exhaust directly to the outside, and down wind from the building, if possible. These fans remove odours and excess humidity from cooking and bathing. They can be humidistat controlled. The odours from burning foods can be very toxic and should be vented at their source. The control of relative humidity levels and condensation is also vital as it discourages the growth of toxic species of moulds and mildew. To avoid moulds, maintenance staff should carefully monitor humidity levels in the indoor atria and should not overwater the indoor plants. The tiny (0.3 to 0.5 microns) dust particles blown into the air by conventional re-circulating vacuums are also a pollution source in buildings. Central vacuum systems that vent to the outdoors or HEPA filtered vacuums (such as Vacuflow or Nilfisk) provide a healthy alternative.

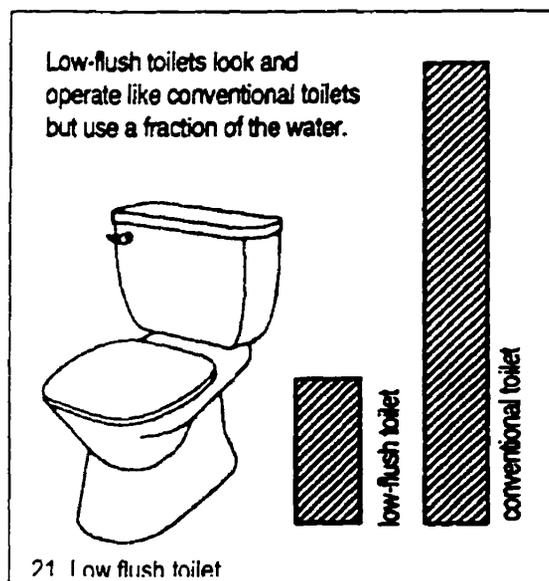
Photocopiers and laser printers (such as those in the nurses station or management office) also release numerous toxins and should be located in well-ventilated areas, preferably with their own exhaust hoods. Smoking is another pollutant source that merits careful attention. In apartment buildings, where units are located in close proximity allowing smoking in residents' private space, or in the public spaces, is not appropriate. To accommodate those residents who wish to smoke, the only appropriate solution is a separate

area that is completely contained by non-permeable materials and well ventilated with a *separate system* from the rest of the building's mechanical system. The location of the smoking room exhaust vent, and thus the location of the smoking room itself, is an essential consideration. The downwind side of the building, away from resident windows and air intakes, and on the rooftop will best encourage the polluted air to mix well with outdoor air and be dispersed. Especially in a residential building, where occupants spend most of their time, smoking should not be allowed in any part of the property, indoor or outdoor, other than in the specially designed room.

### *Noise pollution*

Architects prevent noise in the building from disrupting activities by employing acoustic barriers between units and acoustic ceilings or panels in areas with high reflectance surfaces. Other strategies include good window design and creating buffer zones between resident suites and noise sources such as mechanical rooms and elevators.

### *Water supply and purification*



To encourage water drinking and reduce potential dehydration, cold purified drinking water should be on supply at all times in individual units and communal spaces. Reverse osmosis filtration is one method used in Calgary for purifying drinking water.<sup>119</sup>

Water conservation is an essential principle in sustainable design. The installation of water meters provides financial incentives to conserve water. Green building designers use water-conserving appliances and fixtures, such as low flow faucets, low flush toilets, and the collection of rainwater for

irrigation of plants. Specifying European appliances may have a higher initial cost, but they provide long term savings for the environment. For example, European clothes washers use 86 litres of water, compared to the conventional 140 litres, and European dishwashers use 20 litres per cycle, compared to the conventional 60 litres.<sup>120</sup> For a single resident or couple, especially if many of their meals are eaten outside of their unit and thus the number of dishes per day is low, washing dishes by hand is a viable alternative that will save electricity and water. Water conserving showerheads aerate the water to reduce the volume of water consumed per minute from 20 litres to 8 litres.<sup>121</sup>

Finally, rainwater for irrigation should be collected from rooftops, filtered for large objects and particles, and stored in cisterns until a dry period.

#### *Human waste recycling and treatment*

Composting toilets and wetlands can provide alternative methods of sewage treatment in rural areas. In cities, sewage is usually piped away and treated. Systems are being extensively researched for the bio treatment of human sewage wastes in tanks of micro-organisms, snails and etc. but more research is needed before these systems are commonly adopted into apartment buildings.

A retirement facility can easily provide facilities for composting individual resident and cafeteria kitchen wastes for use in resident gardens and landscaping. Composting should be part of the resident program as well as the door to door "blue box" collection of recyclable materials, which resident managers can integrate into existing city recycling programs and services. The building and individual unit design should accommodate for the storage and pickup of garbage recycling. As discussed in a later section, architects also make provisions for construction, renovation and demolition waste reduction, reuse, and recycling.

## **Envelope design and configuration**

### *Durability*

As mentioned in the materials selection section, durability is an essential consideration in selecting building materials, components, and systems. Sustainable design specifies items which do not have to be replaced often, and which can be recycled or reused.

### *Thermal adequacy*

Air tightness is essential for mitigating heat loss in buildings by reducing infiltration and exfiltration rates. For healthy sustainable buildings, designers must pair increased air tightness with above-average air changes per hour, and thus bringing fresh air into the building often. For energy efficiency, a heat recovery ventilator will be a necessary part of the air handling system.

Insulation is also of utmost importance as it lowers winter heat losses and summer heat gains, thus reducing heating and cooling costs. The higher the r-value, or thermal resistance, the more effective the insulation as a thermal barrier.

In addition to their usefulness for daylighting, natural ventilation, and views, windows, doors and skylights form an essential part of the thermal envelope. Glazing is given R-values, which range from 1.83 for standard insulating glass to 4.5 or even 12 for superwindows.<sup>122</sup> These high efficiency windows are made with double or triple-paned glass, filled with argon, and painted with a low-emissivity coating. While superwindows provide dramatic energy savings, acoustic attenuation, and protection from UV rays, these features come at a higher initial cost of up to 50% more than standard windows.

Other applications also contribute to thermal performance. For example, shutters, curtains, or special blinds can reduce night-time heat losses. Vestibules and buffer spaces also reduce heat loss at the building envelope.

#### *Noise attenuation*

Buildings should be set back from the noisiest areas surrounding the site, with bedrooms farthest from the noise source. High-mass materials, airtightness and sound insulation attenuate outdoor and suite-to-suite noise.

#### *Building form and massing*

Building massing and groupings aid in wind attenuation. For example, maintaining heights of buildings at a fairly uniform level reduce winds. Creating outdoor courtyard spaces provides sheltered private areas for outdoor living. Architects must weigh the need for allowing as much daylight into as many rooms as possible with the important consideration that the more surface area of the building, the more heat loss from these surface areas.



22. Planted roof

#### *Roof system*

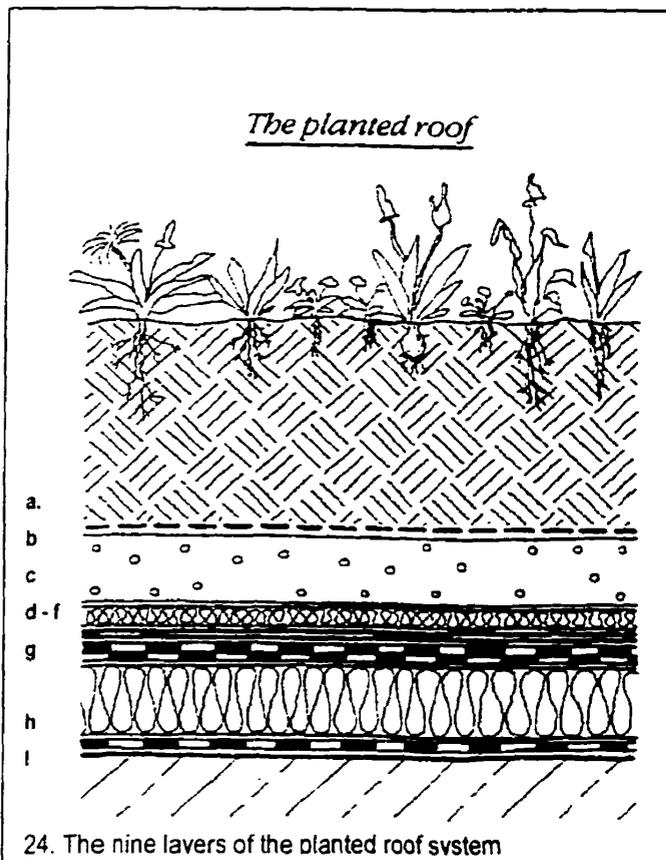
The planted roof is part of a sustainable architecture strategy to restore vegetation on the site that is displaced by the building footprint. This strategy is especially important in urban areas where roads, parking lots, and dense landscapes of rooftops often replace greenery. Using a flat roof system with rooftop gardens or a "living roof" system provides the replacement greenery. In Calgary's high-wind weather conditions, the living roof is usually a more viable option than rooftop resident gardening spaces, as gardening is more pleasant in more sheltered, ground-level spaces. Opportunities for small, rooftop patio garden spaces may be appropriate at level changes in the

building form where a building wall meets the roof and provides shelter from prevailing winds. The strongest and coldest prevailing winds in Calgary are from the north and northwest. If building massing descends towards the south, the south wall suites could have rooftop patio spaces nestled against that wall, with deciduous vegetation to screen the hot summer sun pouring from Calgary's famous blue skies.



Even the portions of the roof delegated to simple plantings as a cover crop, will benefit both building inhabitants and the environment. The Christian Science Monitor daily newspaper reports that the strategy of greening urban rooftops is currently underway as part of a national experiment in Chicago. Houston, Salt Lake City, Los Angeles, and Sacramento, California are also participating in the experiment but are choosing to use lighter colored roofing materials instead of gardens. According to a study at Lawrence Berkeley Laboratory in California, Sacramento buildings with lightly coloured roofs use 40 percent less energy from air conditioning than those with darker roofs. Chicago officials plan to plant gardens of prairie grasses, purple coneflowers and other plants on the tops of some public buildings to create prettier views, lower air pollution levels, reduce hot summer temperatures, and save on energy costs for air conditioning. The gardens' absorption of industrial emissions will be minimal, however, unless officials plant them on a majority of city rooftops. Using satellite photographs of the five cities in the experiment, NASA plans to measure the effects of the new roofing materials on "urban heat islands", a phenomenon in which city temperatures can rise six degrees higher than those in surrounding rural areas."<sup>123</sup>

The technical details in planting rooftop gardens and living roofs are important. Soil is heavy, especially when wet, and often requires stronger structures. A roof system with protective membrane must be carefully installed to avoid water damage. Brenda and Robert Vale describe the requirements for a dependable planted roof. They cite soil depth and subsequent structural loading as an important consideration. A normal garden with trees and plants is heavy and requires structures of unusual strength, as opposed to light-



weight roofing systems which incorporate slow-growing plant species and require little maintenance or structural changes. The Vales describe the nine essential layers of a planted roof system.<sup>124</sup>

**The nine layers:**

- a. **soil and planting**
- b. **filter layer** (prevents soil from blocking drainage)
- c. **drainage system** (prevents root rot) – or a water retention system depending on roof area and slope
- d. **protection layer**
- e. **separation layer** (for movement between layers)
- f. **root barrier**
- g. **waterproofing**
- h. **insulation** (rigid glass fibre or expanded polystyrene is able to withstand the weight of the soil)
- i. **vapour barrier** (bonded to the roof deck)

Roofing manufacturers offer roofing systems that are as easy for architects to specify as any other flat roof

system. For example, Soprema marketed their “Sopranature” rooftop vegetation system at the 1999 Alberta Association of Architects Banff Session trades exhibition. In their marketing material, Soprema announces that rooftop vegetation responds to a growing concern that buildings should address issues of environmental protection and improvement to quality of life. Soprema installs their “green roofs” in France and Canada and recommends them for a variety of building types, including “offices, hotels, hospitals, sports and leisure centers, and industrial and commercial buildings.”<sup>125</sup> They provide two types of roofs: The “Extensive” roofs feature a blend of low maintenance, annual, biennial and perennial self-generating ground covers, while the “Semi-intensive” roofs feature landscaped gardens of perennials, shrubs, and grass with an irrigation system that requires somewhat higher maintenance. They claim that Sopranature roofs contribute “little additional load on building structures” and use plants selected for extreme weather resistance. Their system can be applied to concrete, wood or steel roofs, whether flat or sloped up to 40%.

## **Landscape design**

Sustainable landscape design includes conserving and restoring elements of the natural environment – a variety of species of indigenous vegetation, for example, – conserving water, creating niche environments for a variety of indigenous animals, amphibians, birds and insects and minimizing chemical fertilizers and herbicides.

Carefully designed landscaping also takes into account environmental quality in terms of providing pleasurable sensory landscapes that incorporate air, light, water, sound, and texture. Shelterbelts and orientation of the building footprint should be incorporated into the design to temper the prevailing winter wind. Boulevards of deciduous trees shelter and shadow the southern elevations and outdoor patios, thus moderating hot summer temperatures and letting in light and heat in the winter. As discussed earlier, roof planting adds greenery to the site that the building footprint has displaced. Vegetation also can improve air quality on the site, and thoughtful landscaping provides welcome texture and beauty. Thomas Randall et al describe how highly planted zones have higher humidity, oxygen content, and fewer pollutants. They write about the benefits of plants:

In photosynthesis, plants absorb carbon dioxide and produce oxygen, and through transpiration they absorb water at the roots and release it into the air, principally at the leaves. Plants can . . . cleanse or filter the air when dust and pollutants adhere to their dry twigs or leaves (which are eventually washed by rain and impurities are deposited on the ground).<sup>126</sup>

Plants, however, are not a replacement for a good filtration system to remove outdoor pollutants from the incoming air, nor will they replace the need to monitor indoor air for acceptable humidity and air quality levels.

Plants have many benefits to people's lives and communities. An article in The Globe and Mail that reads "Love for plants rescues people and



25.

communities" explains the benefit of plants in human lives.<sup>127</sup> It describes the book, A Patch of Eden: America's Inner-City Gardeners (Chelsea Green Publishing, 1996), in which Patricia Hynes praises the act of gardening as it changes lives and neighborhoods. According to Hynes, gardens cultivate humanizing love in people and make cities livable. She describes the community gardens movement to rehabilitate inner city ghettos. Gardeners and community activists

transform desolate neighbourhoods by planting "small vegetable farms on vacant lots, tree and shrub nurseries, flowering gardens, herb gardens and safe playgrounds."<sup>128</sup> A counselor at the San Francisco County Jail set up a gardening education program for inmates. Graduates of the jail program grow organic greens for high-end restaurants, vegetables for soup kitchens for the homeless, and food for house-bound AIDS patients. By investing in feeding their communities, beautifying neighborhoods, or raising money by selling produce, gardens can contribute to residents' lives and their sense of community. Access to gardening space provides opportunities for personal and community growth and enjoyment.

Within the elderly community, designing the outdoor spaces for a variety of resident activities is of vital importance. For example, the outdoor environment can be enhanced for elderly enjoyment through the inclusion of accessible planting beds to garden in, furnished spaces with shelter from sun and wind for relaxing, reading, napping or dining, the provision of pathways for strolling, and the incorporation of fruit trees, baths and feeders for bird-watching or ponds and streams for fish-watching. An outdoor pet rabbit, sheltered in winter with an insulated hutch, provides further visual and tactile stimulus for the garden scene, and gives residents a sense of connection with the natural world. Thus, the outdoor landscape becomes a rich, lush, place of

activity, vibrancy and relaxation. It is designed both as a place for plants and animals and as a place for people. While it is not the vast and endlessly varied wilderness, the outdoor space brings humans in contact with sun, sky, wind, water, plants and animals which provide the vital sense of connection with the natural world.

As noted in the poem by Andrew Marvell, the backyard garden cannot be equated with the free fields of wild nature. However, landscaping practices can change significantly from the bland monoculture of the typical suburban lawn. Vast expanses of Kentucky bluegrass form a monotonous carpet over our cities. Kregg Fordyce, in his master's degree project, The Garden: Toward a Deep Architecture, mourns the culturally and aesthetically barren landscape of suburbia. He refers to the "lawning" of America, in which North America hosts a crop of 32 million acres of lawn. This number surpasses the more utilitarian crops such as corn, wheat, and tobacco.<sup>129</sup> Fordyce proposes that the lawn "is an entity that perpetuates our estrangement from nature, reinforcing the human apart from nature paradigm."<sup>130</sup> In contrast with the lawn, Fordyce proposes a "garden ethic" that "respects locality and promotes togetherness."<sup>131</sup>



A vital alternative to lawn-culture, the Xeriscape, or water-efficient, approach to landscaping is an increasingly well-known form of natural landscape design. Laura Zeiher writes, "Protection and restoration of native planting is the fundamental purpose of environmentally conscious design."<sup>132</sup> Xeriscaping employs site and climate-specific, drought-resistant vegetation such as "Jupiter's Beard" (*Centranthus ruber*), "Sunray" coreopsis (*Coreopsis graniflora*), catmint (*Nepeta*

*faassenii*), yarrow (*Achillea filipendulina*), meadowsage (*Salvia nemerosa*), or silver sage (*Artemesia*). Jim Knopf, author of The Xeriscape Flower Gardener (1991), explains:

The extraordinary savings in water alone are so significant, both to individuals and to municipalities trying to keep up with water demand, that water-wise landscaping is commanding increasing consideration as a relevant part of water supply planning. In addition, the potential saving in initial landscape construction, as well as in ongoing maintenance, is substantial.<sup>133</sup>

Knopf describes the fundamentals of Xeriscaping, some of which are common sense principles for good gardening. The principles of Xeriscaping include:

- Planning the landscape from the beginning,
- Planting appropriate grasses and creating areas of turf in manageable sizes,
- Using appropriate plants for the area and “zoning” these plants within the garden space according to how much water and sunlight they require,
- Improving the soil with organic matter such as manure and compost,
- Using mulches such as wood chips,
- Irrigating efficiently by watering close to the roots in the evening or early morning and refraining from over-watering,
- And finally, maintaining the Xeriscape garden by mowing, pruning, and fertilizing properly.

By choosing to landscape the property with drought resistant plants suited to the rainfall in the area, the building owner avoids the time and resource costs of fertilizing, mowing, spraying for weed control, and harvesting (cutting) a large crop of lawn grass that is usually thrown away.

### **Construction and Demolition**

During construction, care should be taken to protect existing vegetation and soils. For example, store the topsoil during construction and reuse it during landscaping. Protect the mature trees by erecting a fence around its drip line to protect the full extent of the tree's roots.

The architect can ensure the recycling of construction waste by specifying a requirement for the (on-site) source separation and the subsequent recycling of commercially viable construction waste materials. During demolition, materials should be source separated and recycled, if possible. Another option for both construction and demolition wastes is to source separate and landfill the waste in designated areas, because this will aid in the future landfill mining of raw materials. Architects can also specify contacts and procedures for the resale of demolished building elements such as plumbing fixtures, cabinetry, doors and windows, hardwood flooring, and architectural detailing. Several factors influence the diversion of materials from landfills. For example, the reuse and recycling of materials depends upon local markets for recycled goods and the prices of new materials, local landfill material bans and tipping fees, area recycling policies, the architect's specifications, a willingness in the workforce to reduce waste, on-site enforcement, and extra time scheduled to allow for the careful source separation of wastes when dismantling or constructing a building.<sup>134</sup>

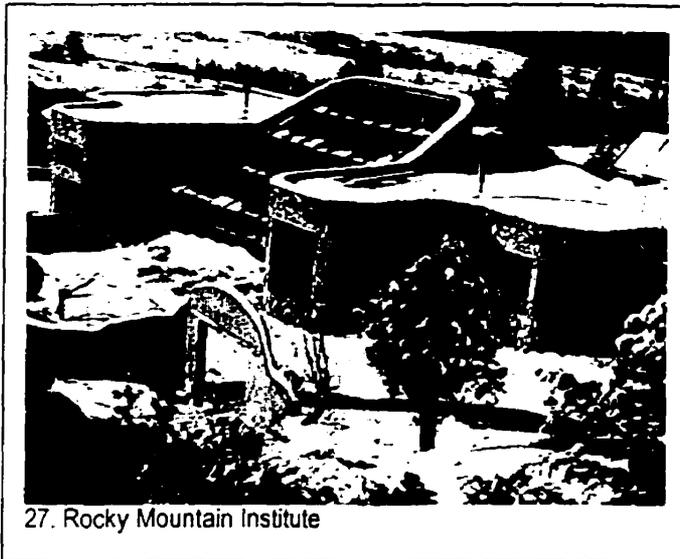
The protection of workers from potentially toxic materials and installation or removal processes is another essential issue in construction and demolition. For example, lead coatings and asbestos removal require specialty equipment and procedures.

## **C. The design strategy: a site-specific outline for applying sustainable principles to elderly housing**

### **I. Precedents**

#### **Sustainable building precedents**

The highest requirements for energy efficiency can be achieved, even in the coldest climate, with careful attention to sustainable design principles. For example, the Rocky Mountain Institute, Colorado, is one of the most energy efficient buildings in the world and requires virtually no conventional heating despite winter temperatures of as low as minus 40 degrees Celsius.<sup>135</sup>



The Institute is partially buried in the earth and has large expanses of south-facing windows for daylighting and solar gain.

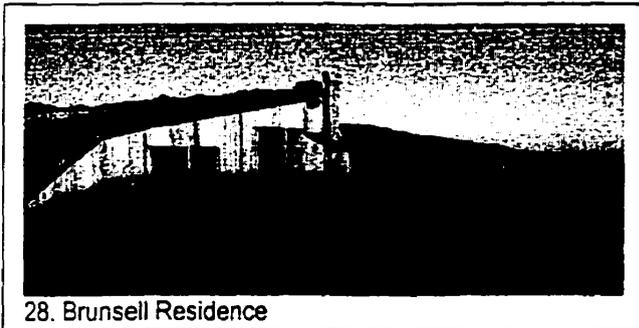
The Rocky Mountain Institute includes the use of indigenous materials which need not be transported long distances to the site, and the minimization of materials which require intensive energy use to manufacture. These are important considerations in maintaining a sense of integration with the local climate, resources, geology, materials and economy. In this way,

vernacular architectures are encouraged, as building types develop according to regional and climatological factors.

## Precedents that indicate a connection with nature

### *Planted Roof space and natural aesthetic*

Michael Crosbie, author of Green Architecture: A Guide to Sustainable Design, describes the Brunsell Residence in Raleigh, North Carolina which uses indigenous plants and natural materials, and incorporates



solar space and water heating, natural ventilation, natural lighting, and a radiant floor backup system.

"The meadow displaced by the building footprint has been replaced in the form of an earth-covered roof."<sup>136</sup>

The home emerged from the architect's desire for change; it was his personal search for "a desperately needed ethic between our expanding populace and

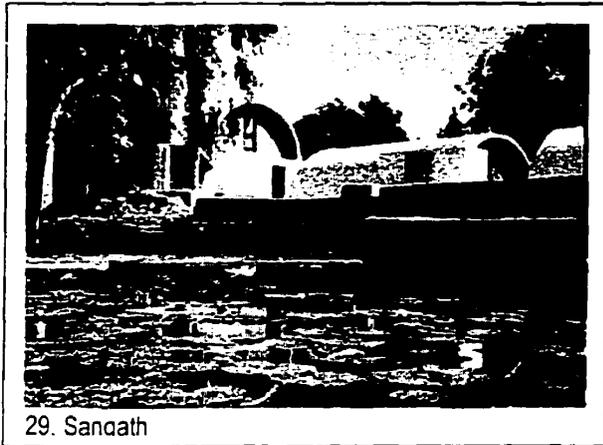
ever-diminishing natural resources" which inspired this building's conception.

While the plan of the Brunsell Residence indicates a high surface area to volume contained and thus higher material consumption, potential heat losses, and energy and labour to build, the partial submersion of the building into the earth and the roofing over with earth and plants may help to mitigate some of these concerns (such as heat loss and local availability of materials). A closer study of the methods of construction would be necessary to fully evaluate this example. While this building does not present a fully realized ideal of sustainability, it does make an important contribution to the sustainable theory of design in that it illustrates a thoughtful selection of materials, a relationship with its site, attention to natural landscaping, the use of alternative methods of space and water heating (solar), natural lighting and most importantly the desire for change expressed by the architect. Certainly, the Brunsell Residence is an example of compromise, between the clients desire for two separate wings and a unified eating and living area (thus giving inspiration for the shape of the floor plan) and the sustainable principles which

the architect is attempting to apply throughout the building. The primary inspiration that this architectural example provides for this MDP is the artful incorporation of the planted roofing system and natural wood siding into the landscape. It presents a blending of building with site that is truly admirable.

#### *Indigenous materials*

As discussed in an earlier section, Balkrishna Doshi's studio, Sangath, west of Ahmedabad, India, uses indigenous materials and methods of construction, and responds to the local climate. The studio



29. Sangath

represents Doshi's attempt to integrate aspects of Western modernism with indigenous Indian traditions. Doshi intended that the Kahn and Corbusier inspired forms of the building's elevation blend with the rolling contours of the local landscape. Sangath's system of tile roofing insulates the interior from the heat and the white polished surfaces reflect the sun's rays. The construction methods are suited to the manual labour that is plentiful in India. The Kahn-inspired high barrel vaults are

flooded with natural daylighting. Doshi's studio is both the exquisite poetic vision of a master architect and a carefully crafted response to climate, regional materials and local working methods by a Western-trained architect who feels a deep connection to and understanding of his home country. This knowledge of and deep connection to both the poetic tradition of great architecture and to the locality within which one builds is vital to a sensitive architecture with a profound sense of place.



30. Maybeck trellis

#### *Integration of greenery into the façade: layering and transparencies*

Bernard Maybeck's First Church of Christ Scientist, Berkeley, California, incorporates walkways and borders accented by wisteria-laden trellises. This 1912 church was Maybeck's masterwork and received the

Gold Medal of the American Institute of Architects. Maybeck believed in a simple use of raw materials, "the same on the inside as on the outside without sham or hypocrisy."<sup>137</sup> The design is remarkable in its stunning use of simple, natural materials and the sense of entry that is imbued with the grace of natural plantings integrated fully with the architecture. This integration of greenery into the façade and the long approach under vines demonstrates innovative landscaping within an urban setting. Also remarkable, is the church's sense of home, medieval quality, comfort, and tradition blended with the use of natural materials typical in the arts and crafts.



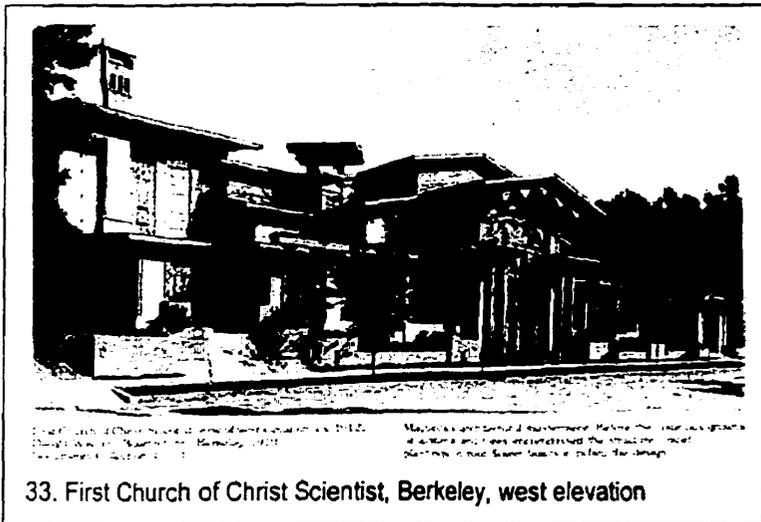
31. West isle



32. Fireplace room

Maybeck layers transparencies, plays with the gentle flow of light through art glass and abundant vegetation, and shapes the gradations from planters to trellis to each gentle step of the low-lying roof. His entry condition is an immensely satisfying romantic wander between street and building as

the two colonnades supporting branch-laden trellises intersect before the main



33. First Church of Christ Scientist, Berkeley, west elevation

entry's peak. The layering of elements continues inside with the profusion of glass panels of industrial sash glazing and the movable screens opening into the worship space. The rich textures of living plants, rough wood, form cast concrete, crude asbestos board, and the massive fireplace, combine with fanciful Gothic tracery, painted decoration in primary colours, and the delicate organic forms of branches and flowers painted on the cast concrete surface of the reader's desk,

bring the wandering viewer into a synesthesia of delight and pleasure, while

spiritually grounded by the firm and honest rock of an exposed concrete slab-on-grade.

*Daylighting and the California arts and crafts*

Maybeck's church is built in the tradition of the American Arts and Crafts movement, as made popular on the West Coast. This movement is known for its simple values, an honesty of materials, an idealization of the primitive and rustic, an appreciation of nature's commodity and simplicity, an honest expression in form, a native functionalism and a relation of the dwelling to its natural setting. The ideals pursued by the arts and crafts movement are those of nature and home unified and strengthened through architecture. These values are embodied by various stylistic features of American Arts and Crafts architecture, including "overhanging eaves, verandahs, climbing plants, . . . rusticated chimneys, . . . bare beams, 'humble' materials and fireplaces in

the hallway . . ."138 The valuing of home and nature, as expressed by Arts and Crafts precedents, is cohesive with the goals of socially and environmentally sustainable architecture.

Julia Morgan, one of Maybeck's students, also designed buildings in the California Arts and Crafts movement



34. Asilomar



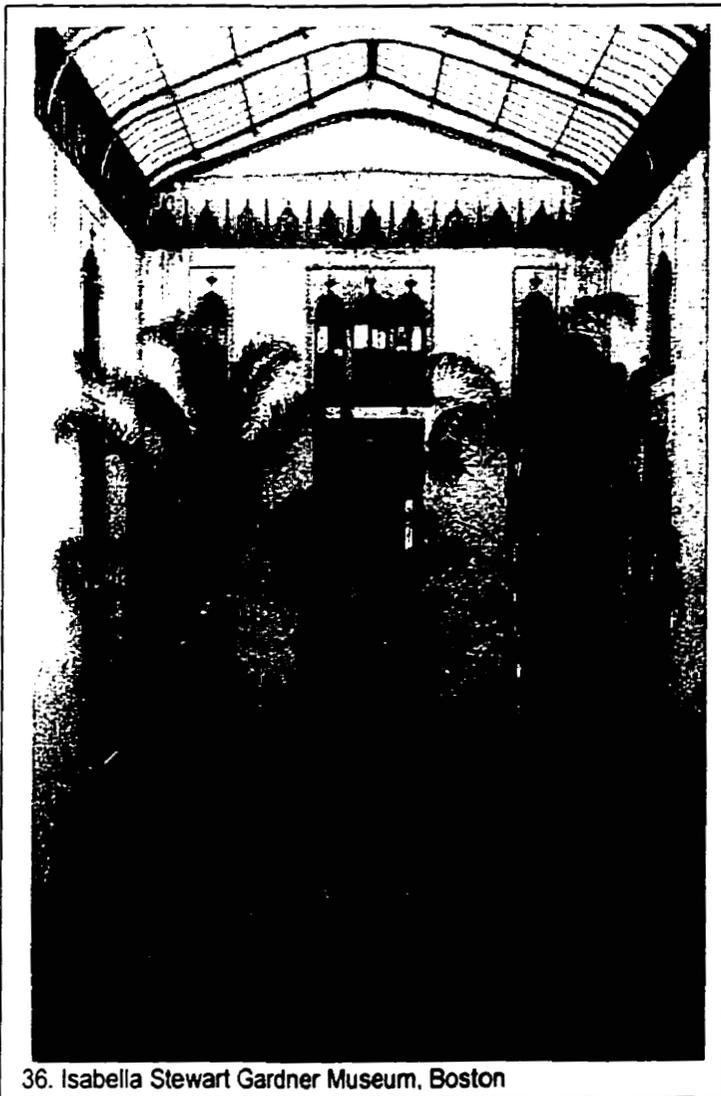
35. Asilomar, interior

style. While Morgan's buildings range from the opulent Hearst Castle to storyland cartoon-painted cottages, her YWCA conference center, Asilomar, has the elegant grace and natural aesthetic of a crafts building at harmony with nature. Morgan had a deep response to nature and the local environment expressed in her sense of materiality and incorporation of ample daylighting. The open and inspiring central auditorium at Asilomar is nestled into the cedar and Monterey pine forest, and is constructed with local redwoods and stone. The auditorium space is naturally lit from French doors and clerestory

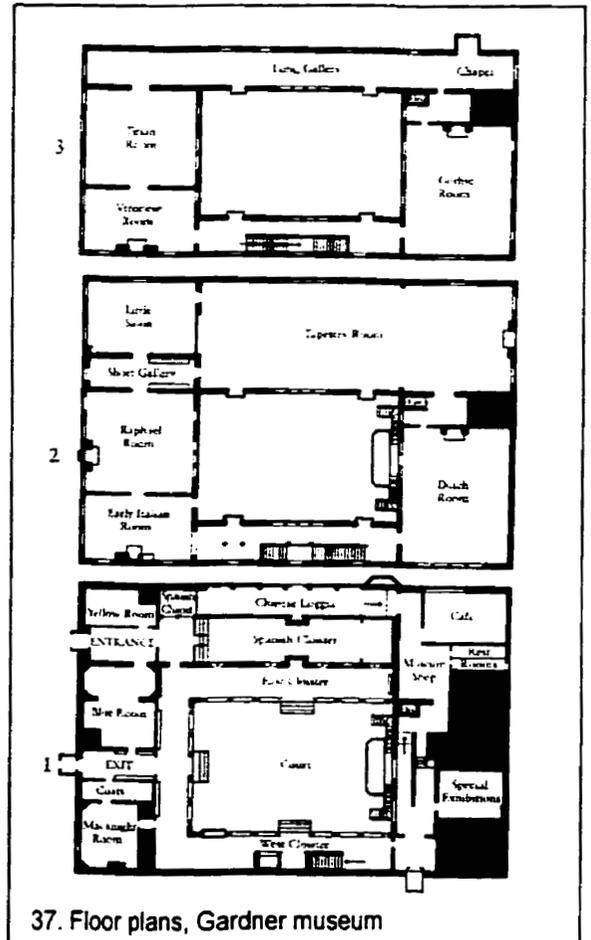
windows. The building's economy of structure and ornament, bare beams emphasizing visible structure, and the humble raw materials are typical of Arts and Crafts building. They provide an inspiring precedent for the design of an environmentally sustainable building which promotes a profound connection with the natural environment.

*Central atria with loggia*

More than any other building, the Isabella Stewart Gardner Museum in Boston, Massachusetts provides the primary inspiration for this project. Its central courtyard with loggia provides a meeting place for the gathering of



36. Isabella Stewart Gardner Museum, Boston



37. Floor plans, Gardner museum

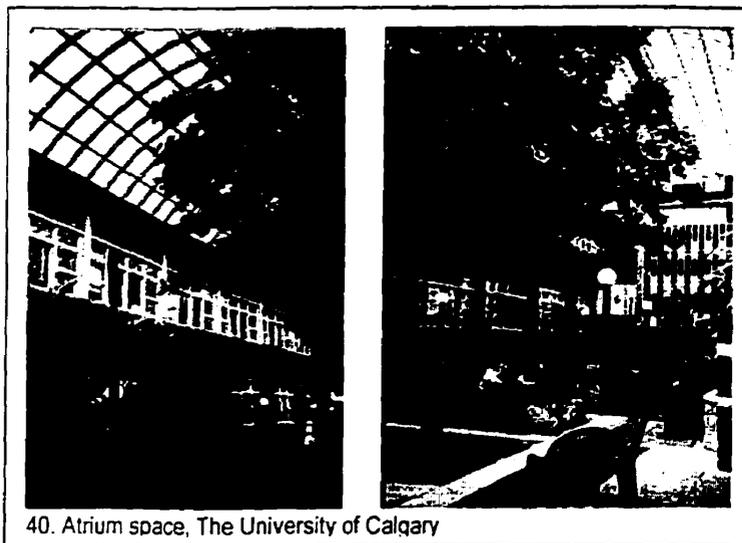
building residents as well as an indoor, natural area that brings a sense of nature, openness and light into the heart of the building. The

museum guidebook notes that more than any single work of art, the experience of the courtyard is what endures in the hearts and minds of visitors.<sup>139</sup> This interior courtyard atria fosters both a sense of community and a respect for the beauty of the natural world.



Elderly housing would greatly benefit from the incorporation of atria spaces like the one at the Gardner Museum. For example, the Gardner atrium courtyard is surrounded on three sides by a gracefully arched loggia. This configuration is an ideal solution to circulation requirements in elderly housing. The loggia will allow for a transition space between the private realm of individual units and the public realm of the courtyard gathering space. The more sheltered and confined space of the loggia is

like the traditional home verandah where one could sit in a quiet, protected area and watch the world go by. Benches and chairs in this space looking out into the courtyard promote the friendly habitation of the circulation spaces and a sense of neighborliness. In contrast with the typical long institutional hallway, the loggia segments the circulation route into short, daylight, inhabitable stretches that are a delight to inhabit.



40. Atrium space, The University of Calgary

Another example of an indoor atrium space is in the Administration building at The University of Calgary. It is a favourite gathering place for students who favour its relaxing atmosphere, places to sit and talk or read, ample natural light and pleasant variety of texture and plant life. The rooms on floors above have windows looking out into the atrium and thus benefit from the natural light and pleasant views into the courtyard greenery. At both the University of Calgary and the Gardner Museum, the greenery is not

allowed to take over the space, so daylighting reaches the lower floors.

### *The outdoor room*

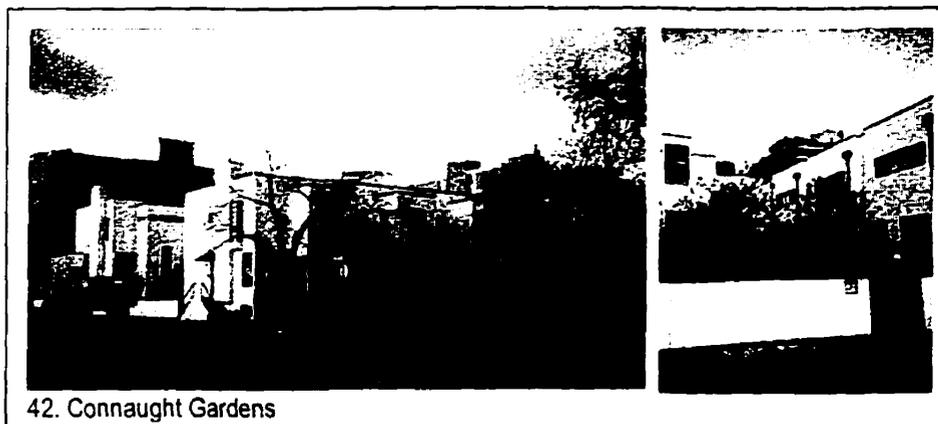


41. The outdoor room

Another architectural element that provides a useful precedent for sustainable housing design is the outdoor room. Natural Home magazine presents the outdoor room concept in residential design. An outdoor space is furnished with outdoor furniture, partially enclosed, sheltered and planted to create a space that is both indoors and outdoors, both home space and nature space. As an extension of the indoor environment, the outdoor room provides all the benefits of the home: shelter, privacy and relaxation in combination with the fresh air, rich textures, birdsong sunlight and breezes of the outdoor world.

### *Outdoor courtyards and residential scale*

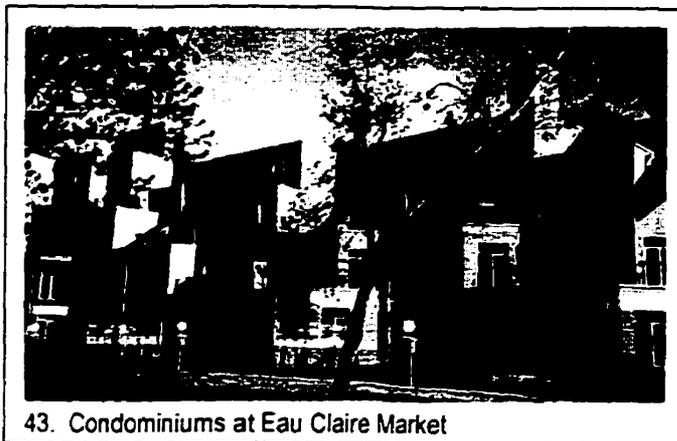
Examining prototypes of successful Calgary residential scale housing, Jeremy Sturgess's housing projects come to mind. His Connaught Gardens is an urban housing strategy, designed to cluster private units around a central outdoor court. It gives a sense of both autonomy and community. The units receive ample light and the west-facing courtyard blooms with flowers and



42. Connaught Gardens

trees, bringing a bit of the natural world to the residents' doorsteps.

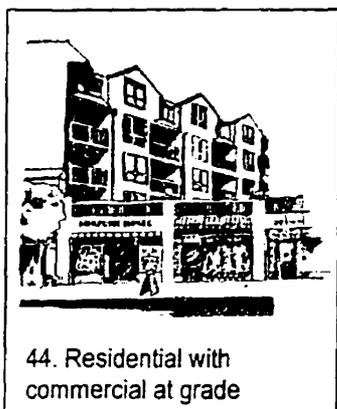
*Stepping the building massing down*



43. Condominiums at Eau Claire Market

By stepping the building massing down towards the street façade and the south, pedestrians have a more pleasant street environment, and residents benefit from a southerly orientation for yards, gardens, passive solar gain and daylit indoor spaces. A precedent for this type of form in residential apartments is the brick condominiums newly constructed at Eau Claire market. They blend stucco and brick to imitate a Calgary historic vernacular at a lower cost. Stepping back the massing allows for wind-sheltered and sun-exposed decks, roof gardens and patios.

**Precedents which indicate social connections**



44. Residential with commercial at grade

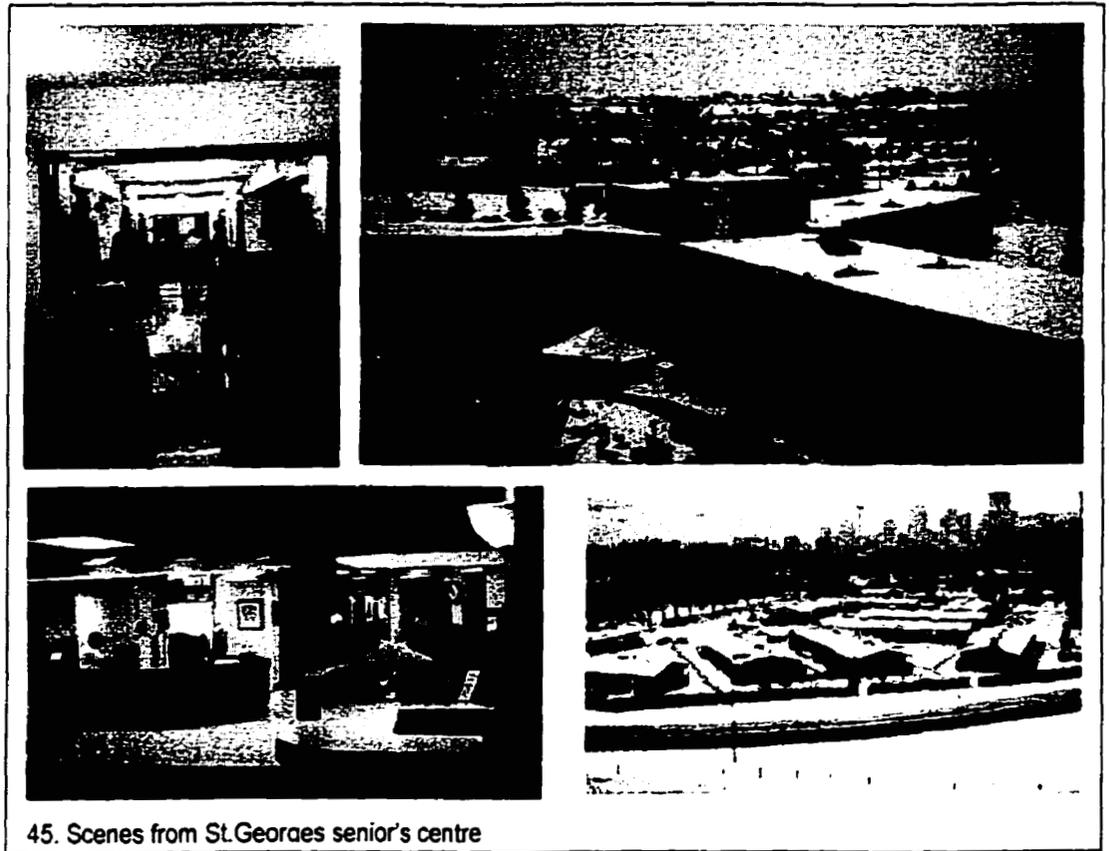
*Hillhurst / Sunnyside guidelines for a sense of community*

The Hillhurst / Sunnyside Area Redevelopment Plan provides examples of an architectural language meant to maintain a sense of community. The plan suggests such devices as corner treatment with a design element for corner lots, mixing retail and residential uses, building height guidelines based on solar angles, suggestions for building form, width, materials, roof slopes and cornice lines, glazed lobbies, pedestrian

environments, and parking solutions. Heartland, a local café, is an example of the historic brick storefront building encouraged for emulation by the community plan in order to evoke local flavour.

*Elderly housing precedents*

Prominent architectural periodicals review a number of elderly housing projects. For comparison, St. George's seniors' centre in Calgary has several institutional characteristics such as long hallways, bland façade and remote location. The provision of choice for the elderly in selecting housing is essential, especially at a time when their lives are becoming more limited.



45. Scenes from St. George's senior's centre

## II. Client

### **Definition of client: Assisted living and diversity**

For the purposes of this project, I have defined the client base as those primarily needing “assisted living,” a type of elderly housing which provides private furnished quarters for those seniors who “can no longer remain independent, but [are] not in need of intensive nursing care.”<sup>140</sup> In addition, I intend to allow for a purposeful mixing on one site seniors who have varying levels of need for care. The younger or more active seniors will share common spaces with the less mobile and will enrich and diversify the environment with their activities. In addition to adding vitality through diversity, I have chosen a less homogenous setting in terms of age and ability to allow for aging in place. For example, a senior in an apartment with a small garden may, as rooms become available, switch to smaller quarters that require less maintenance while remaining on the same site. This resident may also choose to increase assistance with daily tasks as necessary over time.

The Contact Agency and Resources for the Elderly (C.A.R.E.) shares my goal in the development of elderly housing which would delay or eliminate the need for the frail aged to be institutionalized. Pia Kontos summarizes the program:

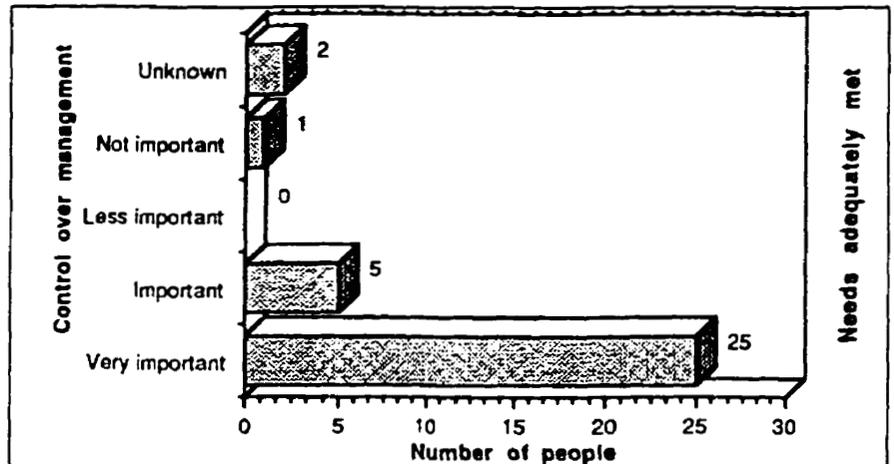
C.A.R.E. coordinates the delivery of a wide range of services which allow elderly people with different levels of competence and capacities for independent living to remain in community settings. Seniors are able to remain in community settings by progressively receiving greater input of service support as they become more vulnerable.<sup>141</sup>

Finally, the surrounding Sunnyside community provides further diversity of age, race and income level and ensures that the elderly are not ghettoized but a vital part of a vibrant community. An on-site after school

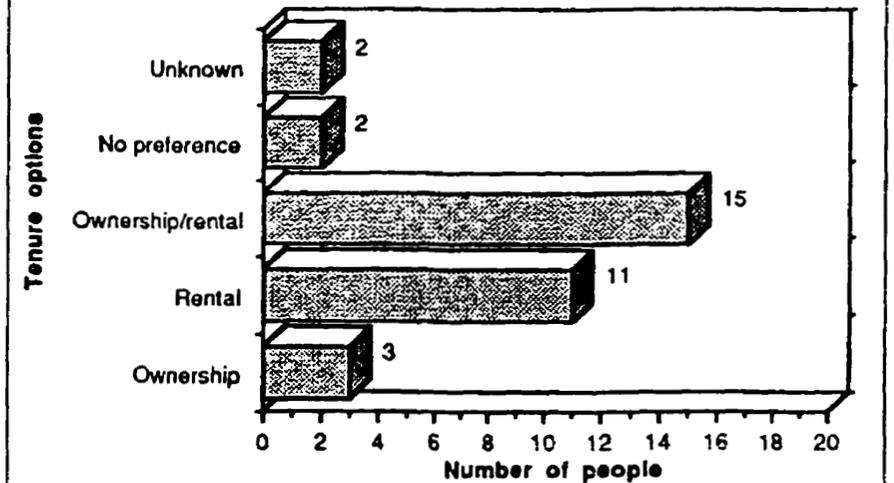
program or daycare can accommodate the wishes of some elderly to maintain contact with or observe youth in the community.

### Management and tenancy

The management will differ from a regular apartment. The ownership will be cooperative with both rental and owned units. A resident board collectively hires a management group. This is typical of many facilities available today and reflects the desires of a group of Calgary seniors polled by environmental design student Merinda Conley. The following tables from Conley's survey indicate that seniors prefer a blend of rental and ownership tenure and strongly prefer to have control over building management:



46. Seniors prefer control over management



47. Seniors prefer rental and ownership combination

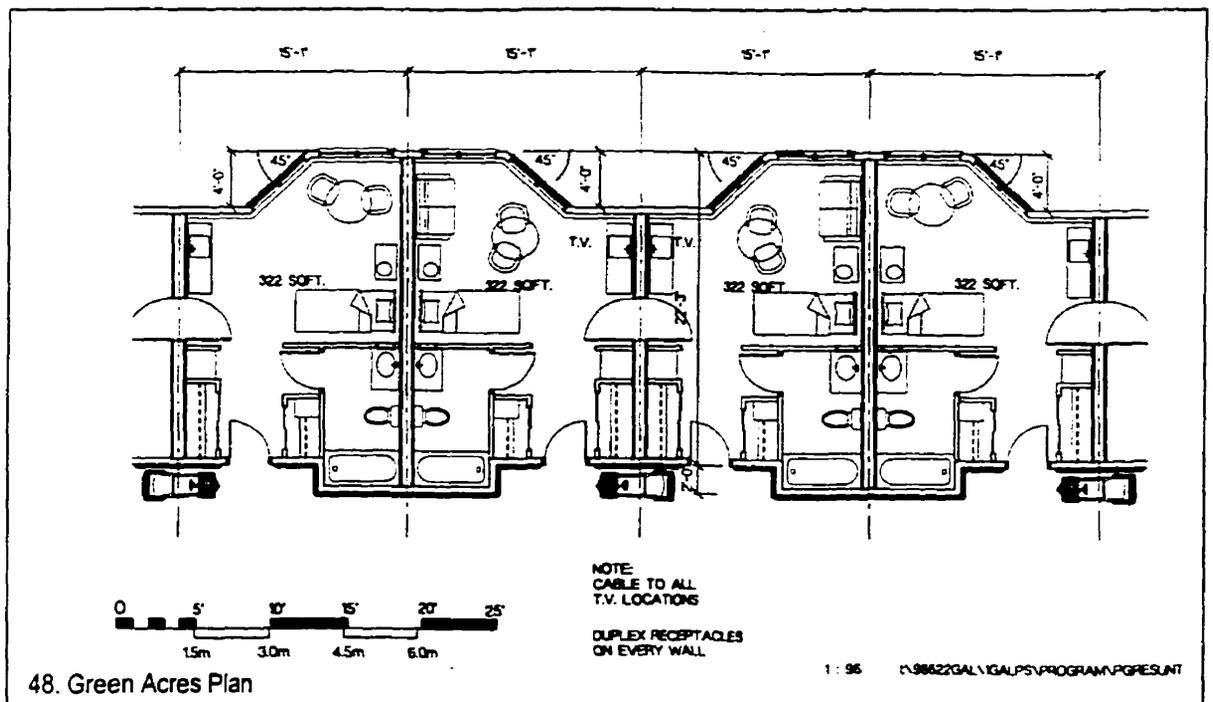
### III. Program

#### A Program based on elderly needs, neighborhood, and community

This section provides an outline of an architectural program that is suited to urban elderly housing. The program is part of the project design strategy and makes reference to the project site. Section "IV. Site" addresses the site in further detail. As is typical in an architectural program, the types of spaces and their function are discussed. The program outline also refers to a sample unit floor plan from a Lethbridge elderly housing centre.

#### *The Green Acres program*

The following floor plan from Green Acres Foundation Architectural Program for the New Green Acres Lodge by the Lethbridge firm Alvin Reinhard Fritz Architect shows two types of suites, adjoining or single studio. The Green Acres program also includes single rooms with bathrooms and no kitchens.



48. Green Acres Plan

Modifications to the Green Acres program for this paper's design strategy include designating universal design showers as the standard in most suites with keyed access to a private soaking tub room, and adding to the choice of suite designs. This project's design strategy also proposes incorporating universal design principles such as wheel chair turning radius into all suites and furniture layouts. Finally, in comparison with the Green Acres model, this design strategy increases access to the natural world from many suites via private patios overlooking the outdoor gardens, indoor atria access, or small private garden spaces looking out over the planted roofscape.

#### *Program outline*

The following program is proposed as an element of the design strategy for sustainable elderly housing.

- Units

On the lower floor some private rooms with bathroom only, Primarily bachelor/studio suites throughout all floors, Some couples suites will be available on the second floor. The upper floors will incorporate some two bedroom apartments as well as a small number of more full-sized apartments. However, there will be a careful mixing of types of suites on each floor.

- Common spaces

Common spaces will be provided as an integral part of the design strategy. The indoor atria lounges, around which the residential units cluster provide the primary common areas. In addition, the outdoor courtyard, public lobby area, television room and resident café provide other communal spaces.

- Quiet room/Spiritual space

This room is intended to provide quiet and solace for residents. A strict no noise policy, acoustic insulation, and intimate spaces designed for

one person to sit and contemplate are advised. Texture, materials and light quality should evoke a connection with nature.

- **Library/Resource centre**

This space provides access to computers, the internet, email, as well as books, magazines, and information on services and programs.

- **Exercise room/gym**

To promote fitness, strengthening and activity. Daylighting and operable windows enhance the pleasant use of this space.

- **Therapy rooms**

Rooms available for physical or other types of therapy.

- **Restaurant/café**

One kitchen serves both a public café space that is available for seniors to drop in, and a private seniors-only dining area which provides meals for those residents requiring assisted living and which has access to a private deck in the west garden area.

- **Greenhouse space**

Ideal for growing fresh greens year round, this space has planting beds for the residents as well as the café staff.

- **Daycare/after school program**

A space is designed to accommodate children. An after school story-time or crafts program provides solutions for working mothers and involves elderly residents with local children. This strategy provides resistance to elderly ghettoization.

- **Public Washrooms**

Washrooms for seniors and their guests when using communal areas as well as a set of public washrooms for the café patrons.

- **Laundry**

A fully equipped laundry room with an attendant and washing service available. This room could be located on the (east) commercial façade, and the resident board may choose to open this facility or the clothes washing service to the public during limited hours.

- **Nurses Quarters**

These apartments house on-call resident nurses.

- **Nursing Station**

This is a space for keeping files on record, storing supplies, and a monitoring station.

- **Music Room**

An acoustically insulated space for practicing instruments or listening to music.

- **TV Room**

An enclosed space that residents can book for special events or watching favorite shows together.

- **Guest and resident parking**

Underground heated parking is well ventilated with a separate mechanical system. Access is from the east side of the site. Directly across the street from the access door to the parking, an alleyway mirrors the visual break in the streetscape.

- Handi-bus, taxi, or private car drop-off/sheltered waiting area

This space is proximal to the lobby (access is from 9<sup>th</sup> Street on the east side of the site).

- Reception/Entry/Lobby

The lobby is a warm and welcoming space, is furnished comfortably, and could be located on the south-east corner of the site, across from Heartland café. This area of the site is the most public and is highly visible to the heaviest flows of pedestrian and vehicular traffic.

- Access to outdoor spaces

Balconies, garden plots, roof garden patios, and fenced or screened ground level sun porches provide outdoor space for individual residents.

- Outdoor central court

Enclosed by the building walls on three sides and bounded by a low barrier and landscaping to the west, this highly secure, safe, serene and protected outdoor space is the ideal space for residents to enjoy the outdoors. The resident café deck looks over this area.

- Guest rooms

Residents can book these rooms with bathrooms for visiting guests.

- Bathing room

This bathtub room allows residents (whose rooms are equipped with showers only) to book soaking time in a private, universal design tub. The meditative quality of bathing is enhanced in this room by natural materials, rich textures, and daylight streaming through glass block.

- **Security station**

As part of the reception area, this station allows for easy views of the public entry as well as security camera views of vulnerable areas.

- **Storage spaces**

Essential storage space with priority for residents living in the smallest units.

## IV. Site

### Selection of Site

The Government of Canada “Housing an Aging Population” recommends guidelines for locating a site for elderly housing. The suggestions include locating housing near shopping, recreation, services and other people, and ensuring that each community has enough housing to support its elderly population without overly concentrating seniors’ facilities in any one area.<sup>142</sup>

In her masters degree project, An Interactive Design Approach to Housing for the Elderly, Merinda Conley interviews and surveys a group of the Calgary elderly using a Codesign approach to determine the features of her elderly housing design. This Codesign process includes site selection. Conley analyzes eight sites in terms of location, size and context and chooses two with opposing characteristics for her elderly participants to evaluate. The first, in Lincoln Park, is more isolated in a quiet residential location and is near other senior housing developments. The second site, in Marda Loop, is “more centralized, exposed to a main community street, and close to amenities within the community’s business district.”<sup>143</sup> Conley identifies user needs in terms of “site location, amenities, privacy, safety, and perceptual qualities.” She asks the participants of her study to visit the two sites, to observe “movement and circulation, time and season, the number of people around, the mood of the place, the light, orientation and views, as well as the sounds textures and smells,”<sup>144</sup> and then to consider their user needs and vote on which site is most appropriate for these needs.

The participants chose the Marda Loop site as more favourable for their needs. While the Lincoln Park site is larger, in a newer neighborhood, and near parks, educational and medical facilities, the elderly group felt that the site’s isolated location, inadequate transportation, limited amenities, and

traffic noise made it undesirable. In contrast, the participants found that the Marda Loop site is centrally located, more secure with a higher level street lighting, is accessible by bus service, has amenities and services within walking distance, and while smaller, has mature trees and views that make this setting more attractive. Although the elderly participants were concerned about high levels of traffic noise and pollution on 33<sup>rd</sup> Avenue, they were confident that landscaping and building orientation would provide adequate remedy.

The site I am recommending, 1020 9<sup>th</sup> Street NW, for the development of elderly housing provides all the benefits of the Marda Loop site and more. It is centrally located in the Hillhurst/Sunnyside area with ample street lighting, mature trees, and beautiful views of downtown and vibrant community atmosphere. Transportation is a key benefit of the site as light rail transit, community shuttle, and buses are all available within one block of the site. Amenities and services are abundant in the area including a major grocery store within one block that provides home delivery. Landscaping and building orientation will remedy noise from the C-train.

## **Site Analysis**

### *An urban niche*

Robert Ian Stirling's masters degree project analyzes 1020 9<sup>th</sup> Street SW as an ideal setting for a communal housing project. He defines the district of Sunnyside as a unique urban niche within Calgary.<sup>145</sup> Various elements such as roads, rails and geographic features form edge conditions that define a niche community which in turn "def(ies) strict zoning protocol."<sup>146</sup> The Sunnyside district is one of the city's oldest residential neighborhoods brimming with local flavour, diversity and difference. As Stirling notes, it houses "one of the city's few and longest established housing co-operatives"<sup>147</sup> in the Northeast corner of the neighborhood. The area's

diversity of residents – young, old, transient, permanent, representing racial and cultural diversity, living in single-family dwellings and apartments – as well as a strong sense of community are Sunnyside's most remarkable features. It is recognized a rare gem within the city.

#### *History and cultural context*

The site, 1020 9<sup>th</sup> Street NW is located in Sunnyside, one of the oldest residential neighborhoods in Calgary. This is a vibrant community of mixed income levels, races and ages. There are abundant shops, a large grocery store, a seniors association, and quiet residential streets. Proximity to community activity and bustle are essential factors in site selection. The Sunnyside light rail transit and community shuttle stop adjacent to the site providing easy access via public transit to amenities throughout the city. Heartland, a gift shop and café specializing in healthy homestyle cooking, is a community favorite and a historic site. Pedestrians in the community often stop at Heartland on their way to the train in the mornings to pick up a coffee and muffin. Significant buildings in the area are the historic Heartland café, a large brick apartment complex bordering Memorial Drive and 10<sup>th</sup> Street, The Plaza historic theatre, and the Pointe.

#### *Geography and forces*



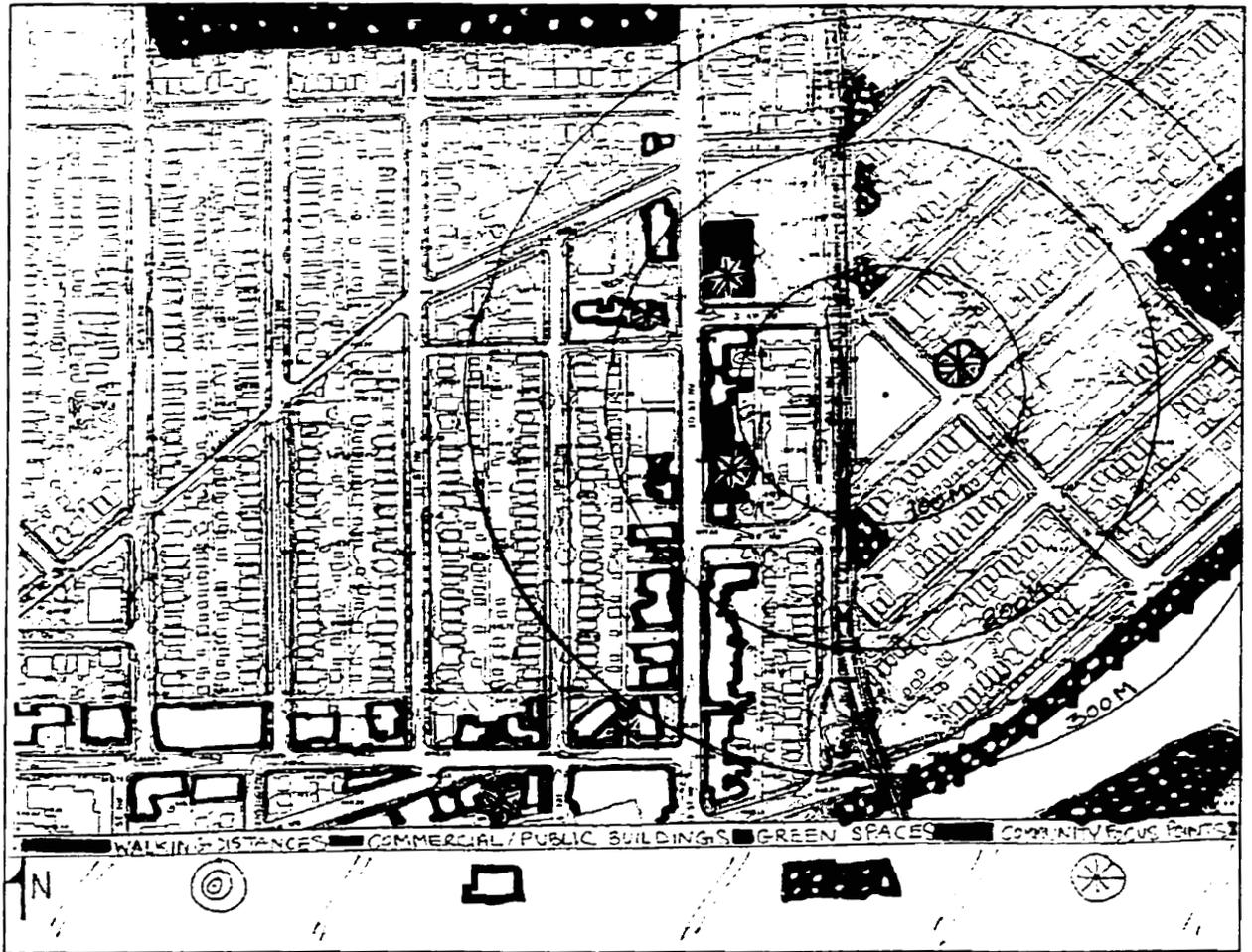
At 1020 9<sup>th</sup> Street NW, a number of forces converge: Two grid patterns meet at a 45° angle, the C-train tracks tear a rift in the urban fabric at the converging point of the two grids along the west boundary of the site. The west edge is the hypotenuse of the triangular site, and at either end of this edge are two major crossing points funneling traffic over the tracks between the Sunnyside residential area and the busy 10<sup>th</sup> Street commercial area. Of the two crossings directly proximal to the site, the south along 2<sup>nd</sup> Avenue sees both vehicular and pedestrian movement while the north at the

end of 3<sup>rd</sup> Avenue serves pedestrians only as they enter and leave the Sunnyside C-train station. Stirling describes the site's crucial location as a "gateway . . . between the denser urban fabric of the Tenth Street retail area to the West and the neighborhood's more open residential grid to the East."<sup>148</sup> The gateway construct is an essential element of this project's site as it will place the elderly in an essential position of balance between the vibrant and active commercial life and the quiet tree-lined streets of residential neighborhoods. In this gateway location, the elderly will be neither isolated nor overwhelmed, but located in a position of ultimate poised balance.

#### *Views and vistas*

A larger view of the extended site area reveals powerful geographical features and views shaping the site context. Along the east and north boundaries, the Sunnyside escarpment forms a bowl-shaped border belt cradling the residential area nestled on the ancient river bed below. The Bow River, accompanied by the river-park pathways and Memorial Drive that follow its path, bound the south side of the greater site area. To the west, the vibrant commercial culture bustles on 10<sup>th</sup> Street and Kensington Road. Views to the west encompass a quaint brick church and the distant mountains, to the northwest Riley park, and to the south a vivid view of the downtown cityscape as frequently photographed with the Bow River in the foreground.

### Greenspaces, walking distances, and community focal points



A number of green areas are within three to four hundred metres from the site including Riley park, the Bow river, the Sunnyside elementary school playground, and small landscaped green spaces alongside the C-train tracks. In addition, most streets in the area have boulevards of mature trees. Community focus points include the Heartland café within 100 metres, as well as, within 200 metres, the local grocery store, a picturesque old church, and the public seating area outside a group of 10<sup>th</sup> Street retail shops. The historic plaza theatre is within 400 metres from the site. Shops, cafés and restaurants are plentiful along 10<sup>th</sup> Street and Kensington road. Many are within a 400 metre walking distance.

## **Site Planning: The elderly in the urban fabric**

### *Items to minimize*

#### **Traffic**

Traffic in the area is slow moving residential traffic. The private outdoor space will be sheltered from car traffic by the building.

#### **Noise**

Primary noise is from the C-train. Measures to remedy noise include a landscaped sound barrier, material mass, air-tightness and sound insulation.

#### **Air pollutants**

Proximity to downtown and location in a geographical low area suggests higher levels of air pollution from vehicular traffic than in outlying areas. Air filtration is advisable.

#### **Crime**

Panhandlers and the homeless are occasionally attracted to the area from downtown. The lively streets and visible presence of bicycle police deter criminal activity. Security cameras, motion sensor outdoor lighting and secure windows are common precautions against crime. Door access cards for residents, an alarm system, and a door person to monitor entry can also be installed. Separating outdoor space from public access by a low barrier and landscaping maintains the friendly residential character while deterring non-residents from entry.

### *Items to enhance*

#### Community living and shared responsibility

Residents participate in community recycling programs and designate the commercial space in their building for services which benefit their needs and the needs of the community.

#### Neighborhood

The Sunnyside neighborhood is vibrant and colourful. This elderly housing strategy proposes to contribute to the community spirit by providing a café as a meeting point for neighbors and by maintaining the building and the beautiful grounds.

#### Access to transportation

Public pathways, rail transit, buses, and shuttle are available. A waiting area is included in the program to facilitate access to the handibus, taxis, and other private transportation.

#### Zoning and parking

The highest multifamily density currently in the area is RM – 5 Medium Density Dwellings of up to four stories. For this type of mixed use project a proposal for permitted or discretionary uses would be submitted to the approving authority. In the area, there are currently properties that have been redesignated to C – 1 Local Commercial District for permitted or discretionary uses. Mixed use commercial and residential spaces are more

likely to be approved in an older area such as Sunnyside.<sup>149</sup> To accommodate the amount of parking needed for visitors and a higher density of housing, underground parking will be provided. This will allow for the maintenance of green space above ground and will ease the building's impact on the surrounding community.

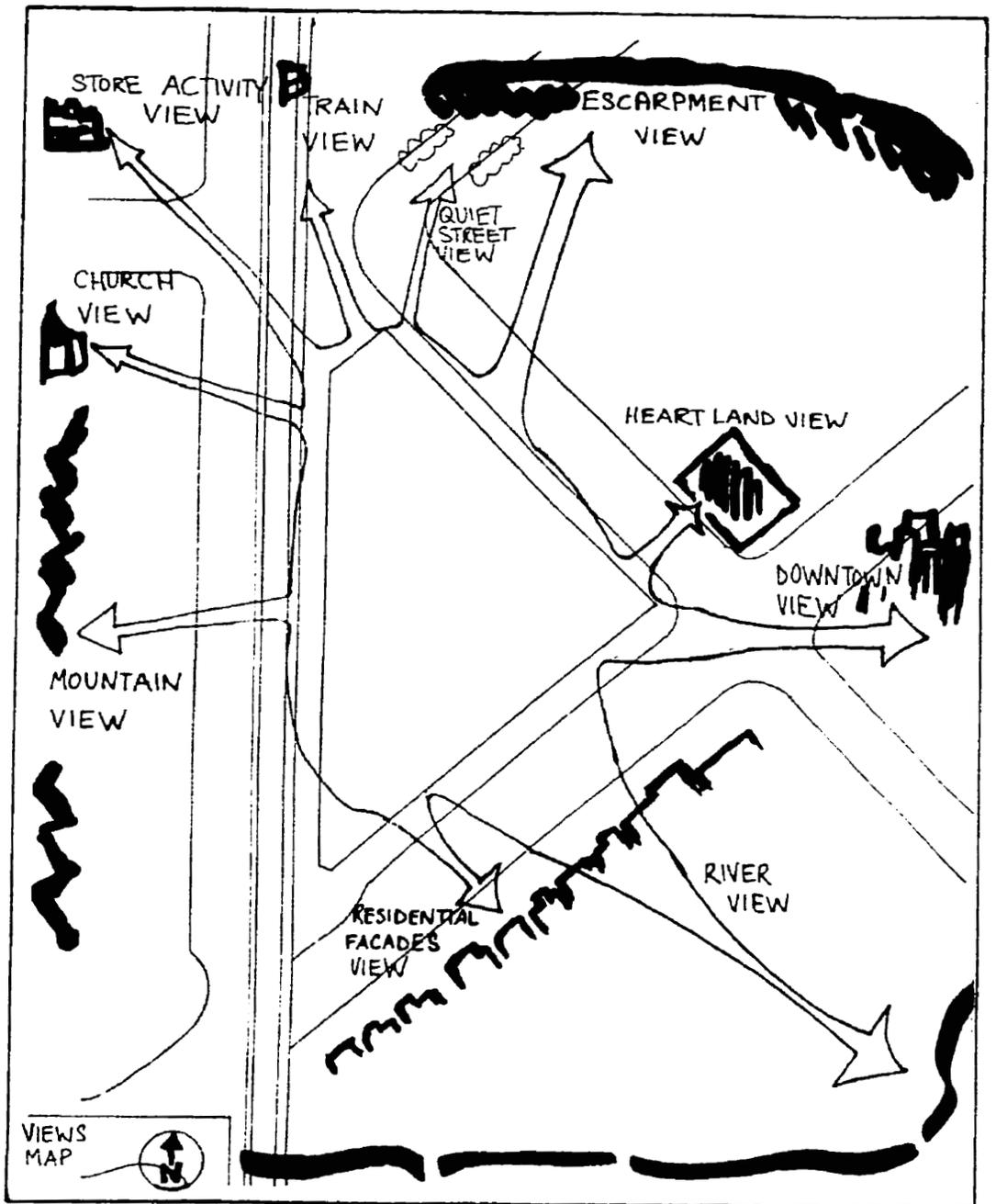
#### Environmental impact assessment of the development

Many projects undergo an environmental impact assessment. The project architects should consider the impact the project will have on the surrounding environment and devise steps to mitigate the impact of the building. Planting drought-resistant indigenous vegetation, collecting rainwater for on-site irrigation, creating habitat niches, integrating a planted roof system and purifying greywater are common suggestions to mitigate the environmental impact of a building or development. These strategies promote a sustainable urban ecology. Planning the project through all its stages is vital.

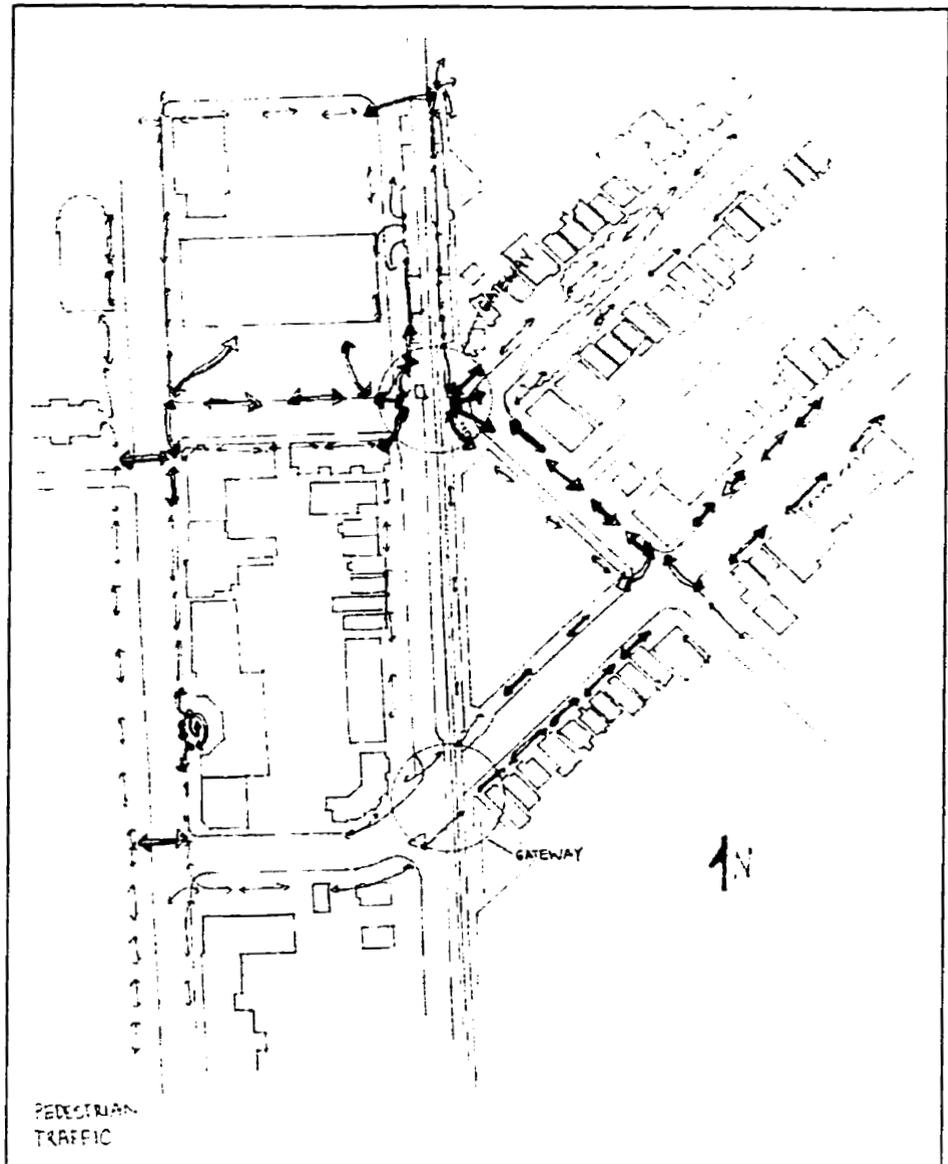
#### Views and vistas

The highest (northern) portion of the building anticipates downtown (south) and historic church (west) views. The public café looks out onto the busy train station (to the north) and down the quiet tree-lined street (to the east). The lower residential façade on the south side meets the quiet faces of the houses across the street. The lobby and entry look out (east) at the historic façade of Heartland café, bustling with friendly community activity. The stepping down of the building massing toward the south facilitates downtown views from sheltered rooftop patios as well as solar gains. The map on the following page shows important views on site.

Views map

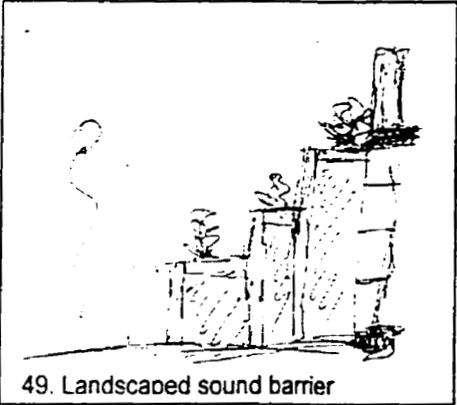
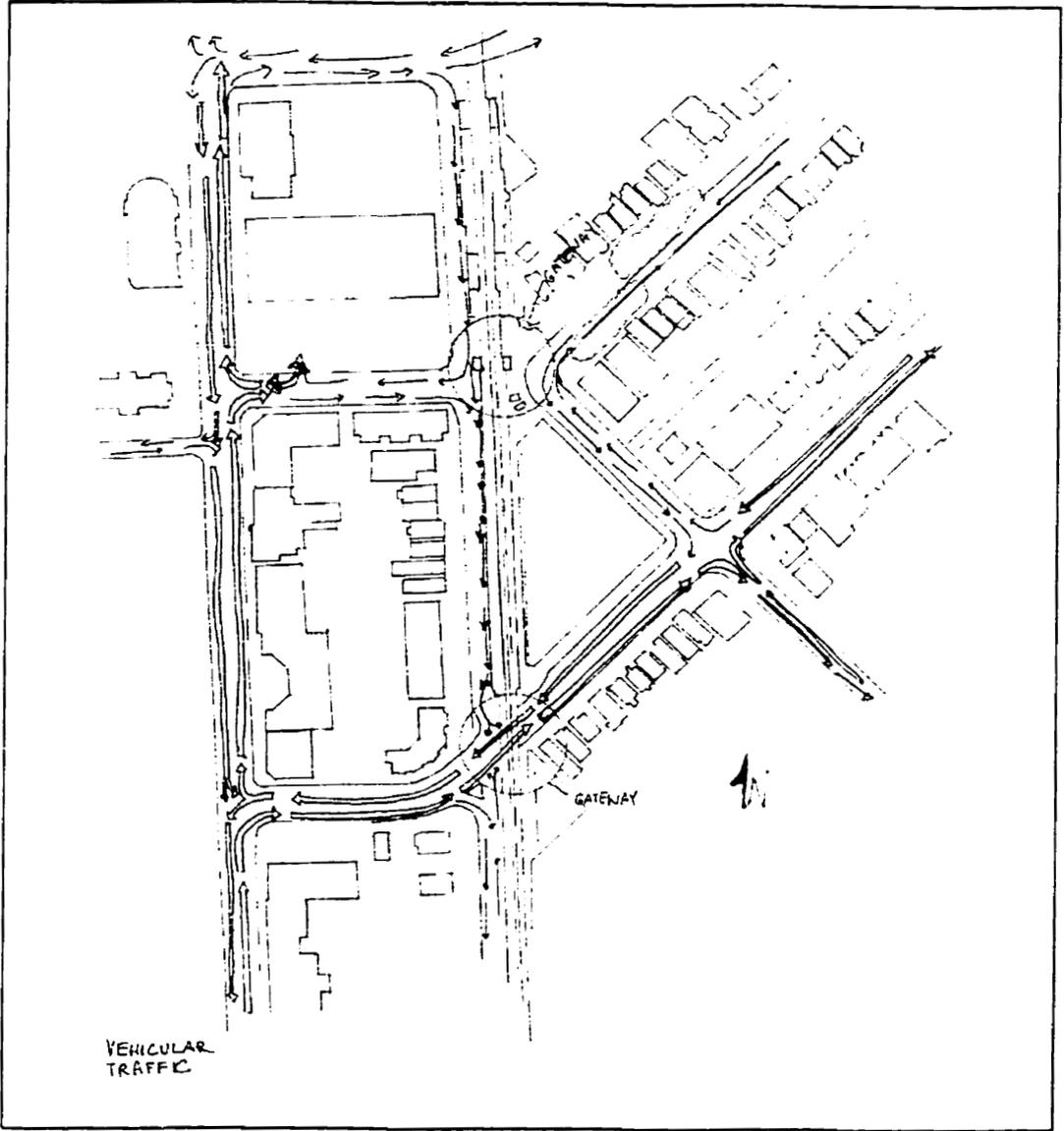


## Pedestrian and vehicular movement systems



The pedestrian movement around the site flows through two major gateways at the north and south corners of the site. Traffic is heaviest at the pedestrian-only gateway which cross the tracks at the northern edge of the site. Residents cross here to shop at the Safeway or to access the C-train. The heavy foot traffic to and from the Safeway and Heartland country store make the eastern street bordering the site an ideal location for further small

scale first floor retail spaces. For example, a public café at the Northern gateway would attract pedestrians passing by this corner of the site.

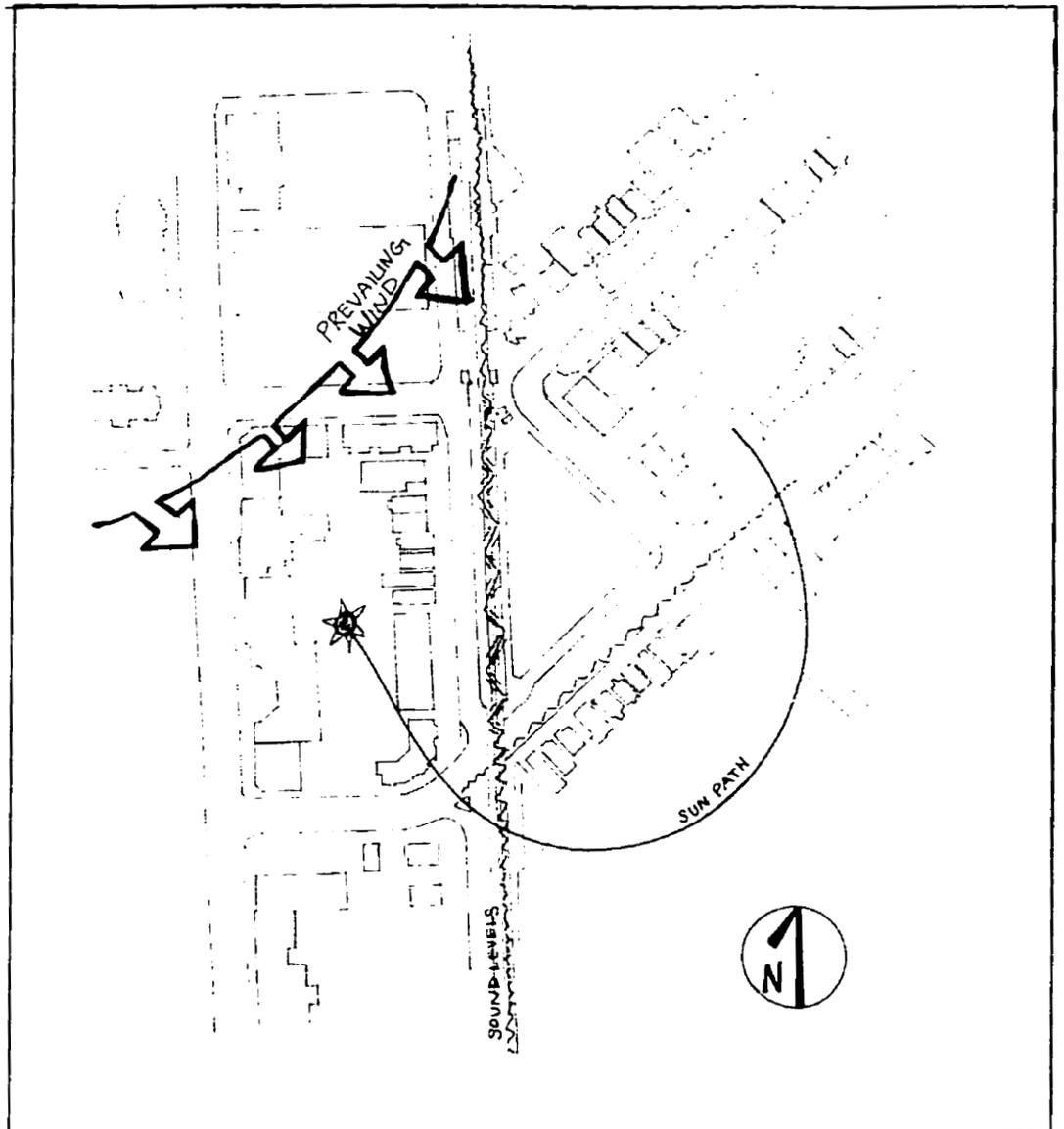


49. Landscaped sound barrier

Traffic around the site is slow-moving and light on all sides, although slightly heavier on the south border. The most disruptive vehicular traffic is the C-train passing on the West side of the site. Although the noise from Calgary's Light Rail Transit system is mild, the architect can improve the quiet residential quality of this site by pulling the building massing back from the C-train side of the site and by incorporating appropriate noise and vibration attenuation measures. A landscaped wall

of planting beds will provide an attractive and sound-attenuating alternative to the current fencing. The building setback from the western edge will create a pleasantly-lit greenspace ideal for evening and afternoon use.

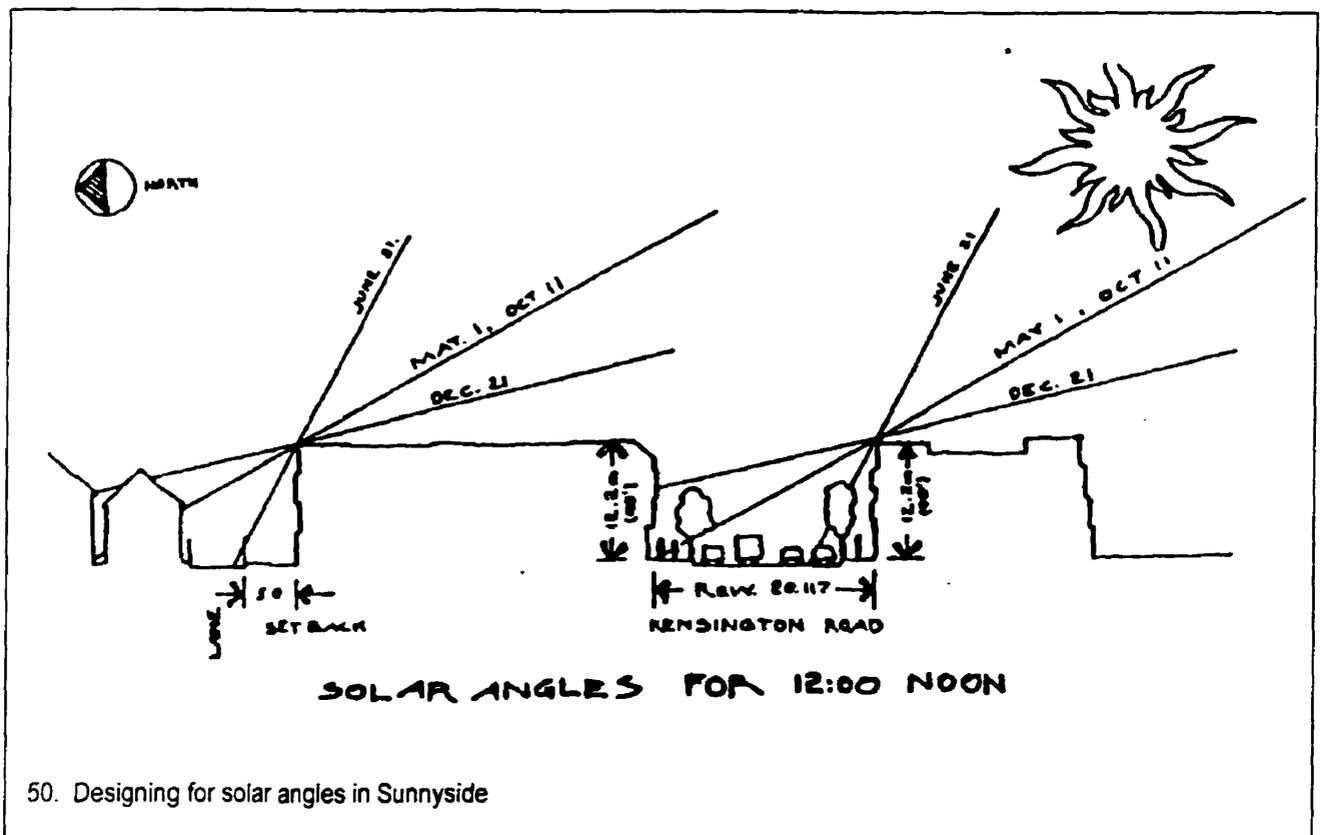
Responding to climate: solar orientation and wind shelter



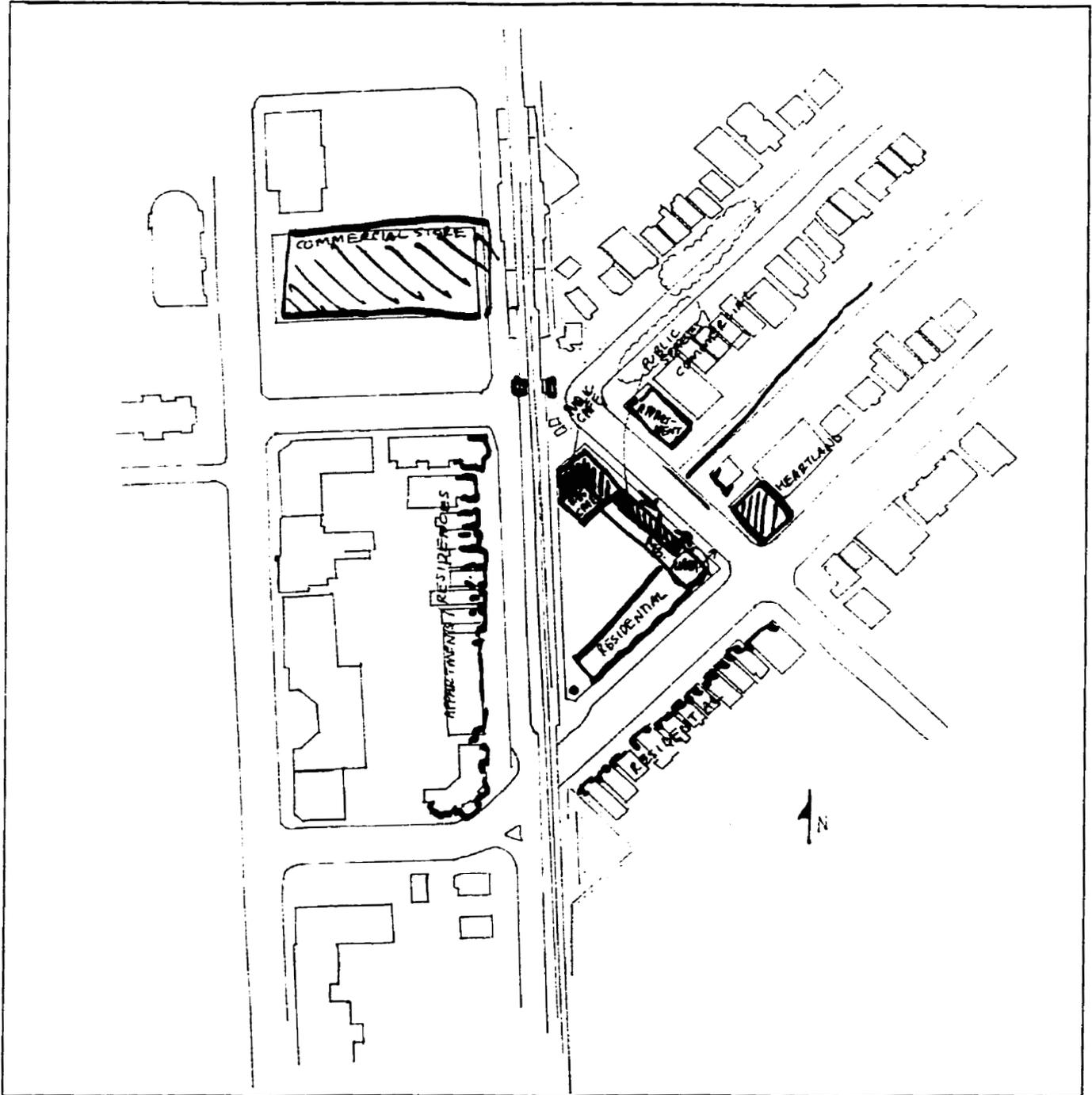
The sun arcing across the site suggests southern and eastern orientations for the building facades to take advantage of solar gains and maintain the current streetscape. Stepping the building massing down

towards the south will shelter the outdoor spaces from prevailing north-west winds and provide ample sun for roof-top patios and plantings. By keeping the building massing low on the southern end and opening the built form to the western side of the side, the architect creates a sheltered outdoor courtyard space bordered by the building on three sides. This landscaped space will receive ample sun, especially in the later hours.

According to the City of Calgary Department of Planning, there is an existing height limit of 12.2 metres along Kensington Road and 10<sup>th</sup> Street which will be maintained throughout the area in future projects. The low heights allow more sunlight to reach pedestrian spaces at street level and residential buildings across the street.



Conceptual site layout and features



The above layout (see previous page) allows for a somewhat private outdoor space sheltered from heavy traffic and opening out to pleasant western sun. Against the south wall in the northern half of the private greenspace is an ideal location for the resident café deck space and for the small green house space because this side of the building will receive ample sunshine. The low-height residential wing on the south side of the site faces the residential facades to the north and continues the residential streetscape. A vital precaution against EMF radiation is to pull this residential section back from the south-west corner of the site as there is a power supply box located there. Three meters set back from this box is advisable, and the indoor space most proximal to the box should not be bedrooms. Because this space receives direct south and west light, a greenhouse area could easily be located in the site's south-west corner. The east (10<sup>th</sup>) street faces onto Heartland café, the entrance to an alley, and the side of an apartment block. This (east) façade also receives the heaviest foot traffic and is therefore most suited to ground floor commercial space.

## **V. Architectural elements**

### **The Design Problem:**

The following directive is essential: To design elderly housing which promotes a sense of connection with nature rather than separation/alienation from it and thus will enrich the human experience through dwelling. In addition, architectural solutions must foster a sense of community and home space and facilitate choice in housing.

### **Architectural idea/methods/partis for realizing a connection with nature:**

The following architectural ideas provide inspiration for the design of elderly housing that provides a connection to nature: Meshing, transparencies, framing views, permeability, bringing the outdoor in and the indoor out, and easy access to the outdoors provide the architectural concepts.

### **Architectural elements that provide a connection with nature:**

Methods for connection with nature and enhancing the sensory experience include providing places designed for specific outdoor activities such as: places to sit and contemplate, reading or writing at outdoor tables, watching birds, eating on a patio, gardening in raised beds, walking on pathways looking at plants, fish, water, children playing, reclining in nature: places for reclining in nature: the hammock/ deck recliner, sheltered outdoor spaces for sitting in warm, wind-free, diffused light situations.

Applications outdoors include: patio gardens, second floor sheltered sun decks, planting beds, bird feeders and baths, fruit trees, living roof with

rabbit hutch, Xeriscaping, and a residential, human-centered sense of scale and proportion.

Indoor architectural methods for connecting with nature include: operable windows, patio/deck/balcony/sheltered outdoor court access from individual suites, indoor atria with surrounding loggia, skylight penetrations, spaces for indoor fish tank, bird cage, plants, flowers, and a small greenhouse accessible for residents and kitchen staff use.

**Architectural elements that facilitate choice and diversity in housing:**

A variety of suite types and sizes are integrated into the design strategy to provide choice. The combination of various suites allows for residents of varying health, age ranges (within a bracket of 55 to 125), ability, and economic status. The range of suites and care services available is also a provision for aging in place to accommodate increased needs over time – from independent to assisted living. In addition, many other choices are available within this housing design strategy. For example, residents can choose to eat in an en-suite kitchenette, dine in the resident café, order a meal delivery service, have groceries delivered from the grocery next door, or access one of many nearby restaurants and delis. Individual control over heating and cooling, operable windows, and a variety of indoor and outdoor public spaces also provides an essential element of choice in this design strategy.

**Architectural elements that facilitate home and community:**

The central indoor atria space provides a key communal area, and the surrounding loggia provides the transition space between the public atria and the private units. Like the neighborhood front porch, the loggia is a boundary

between the outside world and the private, autonomous home space of the residential units.

In addition to the strong sense of community within the elderly housing itself, connection with the community at large is essential. The vibrant Sunnyside community with its ample pedestrian traffic supports design strategies such as the public café adjacent to the C-train station. The café will draw pedestrians of all ages to the north-west corner of the site and therefore will encourage vibrant public interaction, ensure quality food choices for the residents, and enhance the integration of the elderly housing project into the existing urban fabric. The proximity to transportation, services, and public activity all contribute to a strong community atmosphere and resist ghettoization.

The east façade (along 9<sup>th</sup> Street) on the ground floor is commercial/public access space. The reception/lobby/entry to the facility is on the southeast corner followed by the parking garage entry. A series of public access shop fronts follow and culminate in the café at the northeast corner of the site. The shop fronts encompass such specialty services as a laundry service, physical therapy for the elderly, an after-school story and craft program for children, and other services that would benefit the residents but also serve a public clientele. These commercial spaces will provide valuable resources to other elderly living in the area, or as in the case of the children's after school program, they provide essential links with younger generations in the community. The primary intention of these commercial spaces is that they provide essential services to the residents. These services will also extend to a certain portion of the larger community, as long as resident needs continue to be met. Opportunity for resident-run businesses or a forum for selling resident crafts, quilts, plants or produce is another intention of this commercial streetscape. The commercial streetscape provides an essential connection with the vibrant Sunnyside community.

## **Conclusion**

Within a technologized world, there is still a deep desire for an experience enriched by a connection to nature. Our desire to sustain the earth and its systems is within our grasp if we pursue a heartfelt ethic of sustainable architecture. At the base of this architecture lies an ethic of responsibility. The interrelation of ecofeminism, deep ecology, and a phenomenological design approach are cohesive with my personal beliefs and experiences. These theories form the theoretical basis for an application of sustainable principles in architecture. To achieve social and environmental sustainability in elderly housing, the built environment is designed to allow for choice and aging in place, to define home space, to strengthen communities, to protect the earth and its ecosystems, and to establish through architectural design, the connection between humans and nature. The application of current technologies, combined with an awareness of energy use and alternative design concepts from passive solar and daylighting to indigenous planting, can change the face of architecture. The technologized building and the corresponding urban technologized body, if designed thoughtfully, can still function in connection with nature and in sustenance with the earth and human communities. It is within such a building, infused with a profound sense of place, that the elderly can be humanely and sustainably housed. The elderly will then dwell in a deeply relevant architecture that resounds in the body with connection to the earth from which it came.

## **Limitations**

This project presents a design strategy for the *urban* elderly. The rural elderly experience is beyond the context of this report.

In addition, the intention of this project is to present a design strategy and not a fully realised, drawn up, and detailed architectural design project. Rather than producing a single designed building, this project provides a strategy for sustainable elderly housing comprised of designing a program, selecting and analyzing an appropriate urban site, and delineating architectural elements to meet project goals.

## **Methodology**

The methodology for this project includes -- researching and formulating a theoretical framework, investigating the experience of aging and the needs of the elderly, defining sustainability in elderly housing, determining the primary components of an environmentally sustainable architecture, examining precedents, defining the project client, and developing a design strategy for improving elderly housing.

## **Addendum**

The following minor revisions to this document provide further clarification to readers.

This project presents the role of the architect as a "reactor" -- an agent responsible for anticipating and responding to *user* needs, as well as to specific client requests. As a design strategy specific to the urban elderly, this project examines the needs of the primary user, the elderly, and responds to their needs. This project examines the elderly experience as they find it necessary or desirable to move to congregate housing, and devises solutions

to better accommodate their needs – whether it be by designating a vibrant urban site, by providing for a diversity of suites to accommodate those with various ages and abilities, by allowing for choice in the type of housing available, or by designing atria spaces which can function as common areas, circulation spaces, as well as places for making a sensory connection with natural plants, light, and materials.

As this project was conceived, the precedents searched out and contemplated, and the architectural elements designated, the process was imbued with a deep phenomenological consideration. This approach involved an imaginative immersion in the physical experience of the site context and the architectural elements – a constant consciousness that the elements in the design strategy are meant to be experienced, breathed, felt, soaked in, and embraced by the body. Deep ecology and ecofeminism provide an understanding of our fundamental relationship with nature and contribute valuable inspiration and justification for an urban architecture that strives to acknowledge and respect this human to nature relationship. It is the urbanity of the site, with its absolutely vital social context for the elderly resident, which provides the challenge for the design strategy: how to live with respect and reverence for nature within a city environment. Thus, the theoretical framework for this project inspires and determines the choices made in the design strategy.

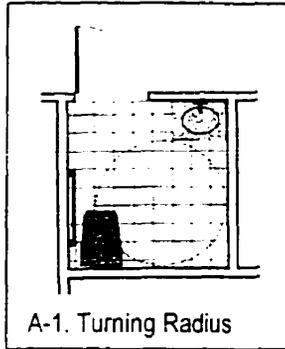
Both individual architects and those responsible for government housing projects should make use of the ideas in this Masters Degree Project and can benefit from examining closely both the needs of the urban elderly and the deep ecological need for environmentally sustainable housing designs. This project has proposed that responsibility to the environment necessitates both minimising our impact on the earth's natural systems (through responsible materials specification and waste management, for example), and just as importantly, revering a vital human connection with nature. Even as we take care to specify responsible choices in materials selection, energy conservation and waste management, and even while we

consider deeply the impact of our designs on the earth, we must also remember that the materials, spaces, light, air quality, footfall, sight of greenery and every sensory element of a design has profound impact upon our bodies, our experience and the quality of our lives.

We are responsible to both humans and the earth. In the International Year of Older Persons (1999), the need for innovative housing for the elderly is coming into public awareness and a desire for change is evident. The term “Sustainability” is used frequently in business and the increased awareness of environmental issues in both business and public life indicates that the socio-political context is evolving. The ideas expressed in this paper are immensely relevant in and can be imminently realised in current architectural projects for the elderly. It is my hope that architects will be inspired to provide choice in urban elderly housing – a choice to live in a responsible relationship with the earth, a choice to live in a vibrant community with access to services, a choice to live in close contact with the natural beauty of the outdoor environment, and a choice to experience daily a thoughtful and enriching architectural design.

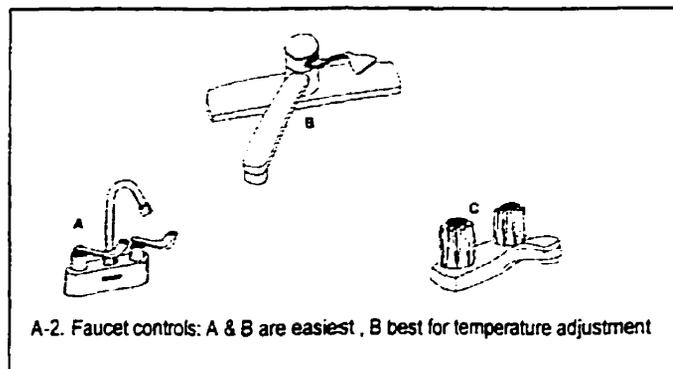
## Appendix A: Practical applications of universal design:

This appendix provides illustration of how universal design concepts are implemented in the design of spaces and objects.



### Bathrooms

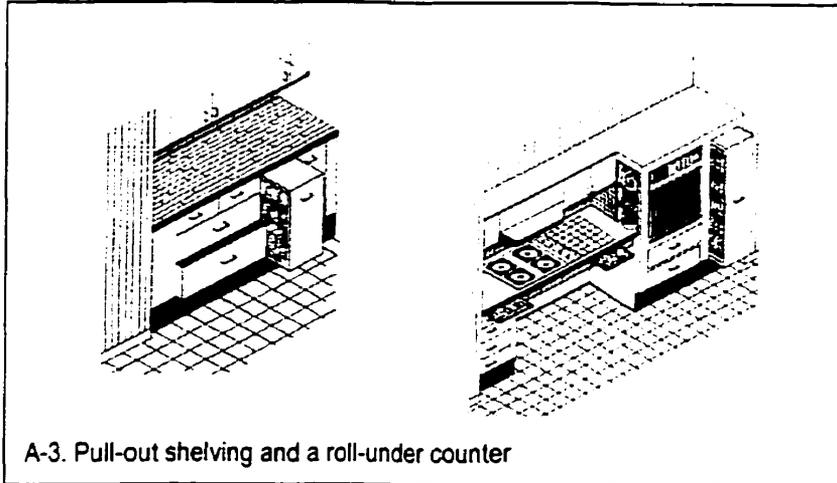
- Mirrors in washrooms are just above the sink and tall enough so that tall, short and seated users all have access.
- Reinforced studs allow for the securing of grab bars.
- Provide ample turning radius for wheelchairs.
- For public washrooms, eliminate awkward double doors (and unhygienic door handles), and yet maintain privacy, by turning the entry pathway.
- Soap, towels, sink controls, and waste-bin are proximal to each other and within easy reach.
- Counter levels are accessible for seated individuals.
- Provide places to set down items at counter level to eliminate bending.
- Use single lever controls (item B, below) at the sink and shower.



- Bath or shower controls are placed in easy reach from both inside and outside the tub or shower stream to eliminate bending and stretching.
- Shower stalls and bathtubs are installed without curbs to eliminate stepping over or up and down. Bathtubs have doors to facilitate wheel chair access and eliminate climbing over the tub edge.

### Kitchens

- Single lever control at the sink allows for easy one-handed operation.
- Roll out shelving is a comfortable means of access to supplies.



- Counter levels are accessible for seated individuals.
- Self-storing cabinet doors fold and slide back to provide knee space for wheelchair users.
- Adaptable counter tops and closet rods are placed on adjustable supports.
- Switches for the exhaust fan and stove controls are located at counter height.

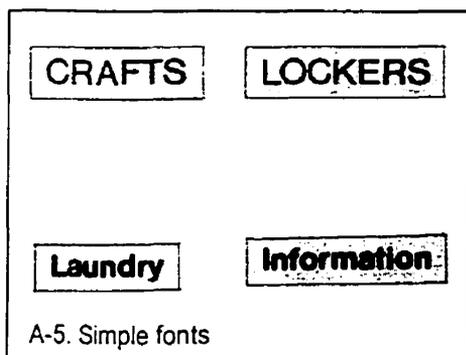


### Elevators

Use simple and clear methods of presenting information such as pictorial, verbal and tactile signals. For example, large contrasting type, easy to press buttons, Braille, and a slow-acting automatic door that is not dangerous to frail occupants are essential in elevators.

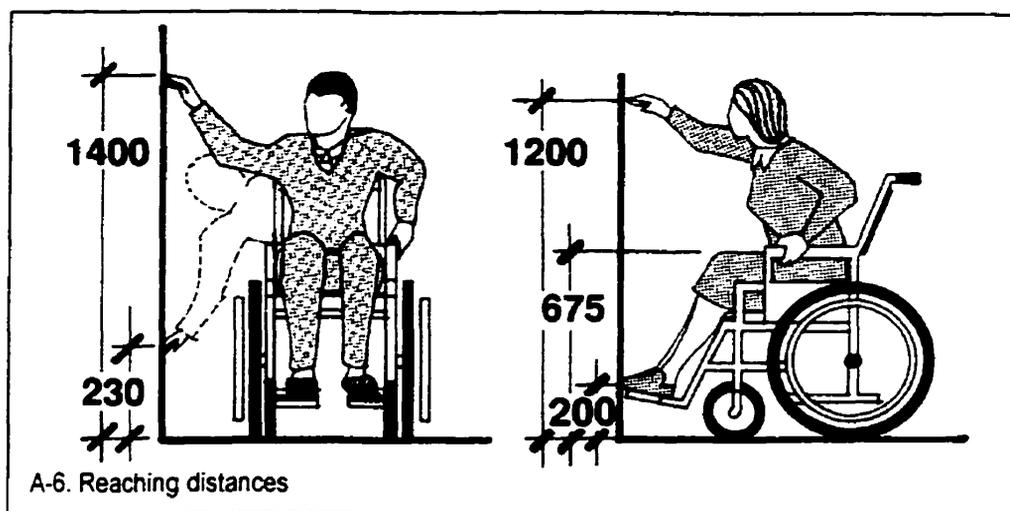
### Circulation and mobility

Universal design incorporates design for easy wheel chair mobility including appropriate door and hallway width, cupboard and countertop



heights, turning radius, and ramps. It provides access to all parts of the home from a wheel chair. In addition, a visually readable environment is essential. For example, the design should provide contrast on stairs, curbsides and other level changes, and distinguishing walls from floors. Safety is also a significant priority in universal design. This includes minimizing hazards and errors and providing warnings.

*Easy access*



Access includes clear circulation patterns, ease in wayfinding, comfortable reaches to components for seated and standing users, wide doors, no steps, hallways and floor plans that accommodate wheelchairs and other assistive devices. In addition, wall switches, handles, temperature controls, drawers, and storage space should be within reach and all rooms should provide ample turning radius. Grab bar reinforcing should be built in. The light switches should be designed lower and electrical receptacles raised to 15 – 18” from the floor. Switches for opening doors and turning on lights can also use sound or motion activated sensors. Manual controls should be touch-sensitive.

### *Windows and doors*

Windows and doors should have easily operable lever handles. These handles must be within reach from a seated posture and easy to operate for seniors with arthritic hands. The doors must not be too heavy for those with minimal strength.

### *Outdoors*

Important outdoor features include the provision of curb cuts, no steps, an environment which promotes a variety of outdoor activities, and gardening beds at waist height and some with knee spaces for seated gardeners. In addition, the surfacing of outdoor walkways should accommodate wheelchairs and other assistive devices.

### *Indoor environment*

- Indoor temperatures are maintained at a minimum of 22 degrees C°. Seniors will often prefer a warmer environment. Adjustable thermostats are available in each suite.
- Clean, filtered air with at least 30% fresh air is essential.
- Chilled and filtered drinking water is available in each unit and all common areas. Drinking water supply and filtration system are carefully maintained and monitored.
- High temperature limit control on water faucets prevents hot water temperatures from exceeding 48 degrees C°.
- High quality lighting provides ample daylight, warm tones, well lit spaces free of shadows or glare, and night-lights activated by motion sensors.
- The non-glare, non-slip floor finishes are contrasting for stairs and level changes.
- Appropriate wall finishes minimise abrasions and falls.

- Furniture in furnished suites is designed for those elderly with reduced physical strength.
- Suites are finished with individual controls for temperature, lighting, and window operation.
- Sound insulation provides a barrier between units.
- For privacy, include lockable rooms and storage units.
- Monitoring systems in halls and communal spaces contribute to security and safety.
- Emergency call systems provide access to facility staff.
- Hardware for the physically challenged (handrails at two different heights, for example) are also included.
- Finally, well designed elderly housing includes a choice of housing type. For example, provide choices for a private room, studio apartment, or shared two bedroom apartments occupied with a friend or spouse.

## **Appendix B: Criteria and methodology for materials selection**

### *Information search for materials selection data*

A number of sources discuss sustainable building practices and materials selection, including those sources available through an internet search. The most significant finding of the internet search was the American Institute of Architects (AIA) Environmental Building News reports on concrete and insulation materials, 1995. While these reports were comprehensive, they did not discuss methodology except to note that their figures came from a variety of sources using different assumptions. Several books provide information on materials selection, including The Sourcebook for Sustainable Design, Boston Society of Architects, 1992 in which the AIA editor, Andrew St. John, provides no quantified data but an excellent summary of materials profiles. Laura Zeiher, in The Ecology of Architecture, 1996, cites data from the AIA Environmental Resource Guide and basic principles from Your Natural Home by Martinelli and Bierman-Lytle. Thomas Randall, in Environmental Design, 1996, writes a chapter on materials that contains some charts with quantifiable data. His focus is on the United Kingdom. Towards a Sustainable Architecture, 1996, is also a United Kingdom-based book discussing sustainable design, but it discusses materials selection only briefly. It provides interesting insight into the EC eco-labelling scheme. The most significant source for materials selection data is a major report by the American Institute of Architects, The AIA Environmental Resource Guide (ERG), 1996. Important features of the ERG include the following: it is a text commonly referred to in other sources, it provides a detailed methodology, and it examines both qualitative and quantitative data. One problem with this guide is that the comparison of embodied energy units between the various material reports is difficult. Another limitation is that the ERG does not compare

specific products or various building assemblies, it analyses simple building materials only.

#### *Criteria for building materials*

The following summary compiles a list of criteria from the above sources. These materials selection criteria aid in the evaluation of embodied energy and pollution for the production, use and disposal of building materials.

##### More easily quantifiable:

- Transportation costs.
- Space occupied in landfill.
- Pollution/ leachate/ offgassing produced. [Including CO<sub>2</sub> emissions, volatile organic compounds, CFC's]
- Durability over time.
- Level of waste generation. [The quantity of the material used versus discarded during construction.]
- Groundwater pollution.
- Use of toxic chemicals in any stage of the life cycle.
- Release of VOC's into indoor air.
- Percentage content of recycled post-consumer and post-industrial materials.

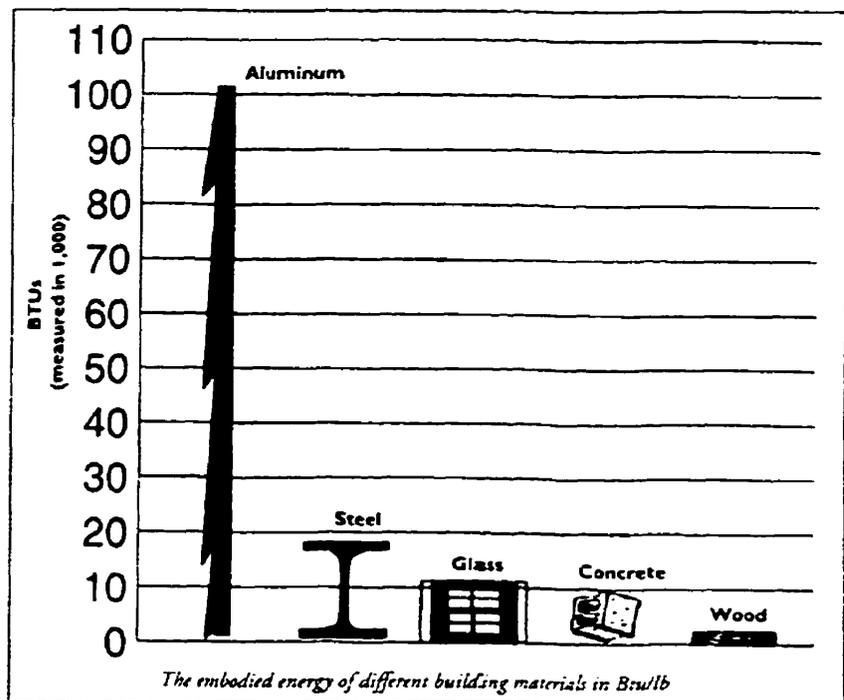
##### Less easily quantifiable:

- Support of local industries. [Locally produced and manufactured products.]
- Mass production of a material for energy efficiency.
- Habitat destruction or replenishment.
- Human health impact. [Including risk to installers, factory workers, miners, and building occupants.]
- Recyclability.
- Ease of demolition and source separation.
- Potential for reuse.

- Design using the modular units of product manufacture.

#### Quantitative values

A number of sources list quantitative values for building materials. For example, Ray Cole, professor of architectural research at the University of Vancouver, British Columbia, makes a table of the environmental properties of building materials and established a Building Environmental Performance and Evaluation Criteria, or BEPAC for assigning values to building materials and systems. This section reviews a number of tables from various sources that depict the embodied energy and pollution values of various materials. The following comparison of tables indicates the type of quantitative data typically available:



*Reprinted from A Primer on Sustainable Building, Rocky Mountain Institute, 1995.*

**B-1: This is the tell-all table.** The oversimplified version that tells architects the basics of embodied energy without reference to transportation or region.

**Table 6.2 Broad comparative energy requirements of building materials**

<i>Material</i>	<i>Primary energy requirement (GJ/tonne)</i>		
	<i>Worldwide<sup>20</sup></i>	<i>UK<sup>21</sup></i>	<i>UK<sup>22</sup></i>
<i>Very-high-energy</i>			
Aluminium	200–250		97
Plastics	50–100		162
Copper	100 +		54
Stainless steel	100 +	75 <sup>a</sup>	
<i>High-energy</i>			
Steel	30–60	50	48
Lead, zinc	25 +		
Glass	12–25		33
Cement	5–8		8
Plasterboard	8–10		3
<i>Medium-energy</i>			
Lime	3–5		
Clay bricks and tiles	2–7	2	3
Gypsum plaster	1–4		
Concrete:			
In situ	0.8–1.5		1.2
Blocks	0.8–3.5		
Precast	1.5–8		
Sand–lime bricks	0.8–1.2		
Timber	0.1–5		0.7 <sup>b</sup>
<i>Low-energy</i>			
Sand, aggregate	<0.5		0.1
Flyash, volcanic ash	<0.5		
Soil	<0.5		

<sup>a</sup>More complete data is available in the reference cited.

<sup>b</sup>Local air dried.

**B-2: This table uses GigaJoules of energy to indicate embodied energy for a few more materials.** It compares the UK region with worldwide figures.

It is important to note that these tables have limited value without the additional consideration of qualitative data.

Upon closer examination, the assignment of quantitative values to building materials is complex, and the many variables make comparison difficult. Some researchers find it necessary to incorporate qualitative as well as quantitative data into their findings. The examination of a moderate

number of sources to compare embodied energy values, reveals a need for further expert research, especially because the calculation of embodied energy for materials is often a factor of region. One can anticipate that more countries and organizations will produce embodied energy data in the future.

#### *Qualitative values*

There are qualitative analyses provided for a large number of building materials. The AIA's ERG and Andrew St. John each provide a qualitative analysis of such materials as concrete, masonry, wood, plastics, insulation, moisture protection, doors and windows, gypsum board, acoustical tile, resilient flooring, wood paneling and flooring, ceramic tile, carpet, paints and stains, adhesives and finishes, wallpaper, mechanical systems, electrical systems, and construction and demolition wastes. Distinguished author, Andrew St. John, AIA editor, chooses to represent embodied energy and pollution indicators via written description rather than by a numerical indicator. He decides to present qualitative data because, in the complex process of materials selection, there are too many variables to represent accurately with a simple numerical value. For example, the architect's choice to use brick is a factor of intended lifespan of the building, need for durability, proximity to a local source of raw materials and to the manufacturing area, suitability of the assembly for climate, aesthetic and cultural associations, and the energy required and pollutants generated during mining, manufacture, transport, and assembly. Associating a single value to brick which makes it better or worse than another material is unrealistic because of the number of variables and especially because indicators such as embodied energy vary so greatly with factors of local industries, economy, and proximity of resources to the site. Thus, for the architect and specifier, materials selection becomes more than a brief scan down a chart of numerical values, but a lifelong process of research into the local economies and practices of resource collection, manufacturing, construction, recycling, demolition and landfill industries.

While his work is comprehensive, Andrew St. John did not provide a detailed methodology with his report. Because the ERG provides a detailed methodology, this section focuses on ERG methods. Clearly, a guide to materials selection is most relevant if it includes a discussion of methodology. The comparisons between materials are more relevant when the criteria for the analysis are carefully explained.

*The Environmental Resource Guide (ERG) methodology*

The American Institute of Architects' Environmental Resource Guide (ERG) is the current definitive study on the environmental impact of building materials. While the ERG discusses many of the contributing factors which can act as indicators in establishing the environmental impact of materials choices in building construction, it is significant to note that they are reluctant to designate *quantitative* ratings for any indicator other than the embodied energy value.<sup>150</sup>

The ERG provides a life cycle analysis of 28 categories of building materials. They identify materials selection factors for the architectural profession, which include "cost, aesthetics, availability, durability, maintenance, manufacturer's reputation, customer needs and preferences, and code compliance" (ERG Methodology, p.1). The ERG also identifies environmental considerations as a factor in materials selection. Environmental considerations include: site selection and planning, land-use planning, energy use and conservation, waste management, materials selection, building design, construction, operation, renovation, and demolition. The ERG follows methodology guidelines from SETAC (Society for Environmental Toxicology and Chemistry) and the United States government EPA (Environmental Protection Agency). This recommended methodology includes a Life-Cycle Assessment (LCA) framework.

### *The life cycle assessment framework*

The life cycle assessment framework is usually comprised of the examination of a product from raw material acquisition and processing (including manufacture, fabrication, construction, use and maintenance) to final recovery, reuse, recycling or disposal, and can also include transportation and the use of packaging. The following diagram illustrates the life cycle framework:



Material acquisition and preparation → Manufacturing and fabrication



→ Construction, use and maintenance → Reuse, recycling, or disposal

There are four components of a life cycle assessment:

- First, *goal setting*, is a component comprised of defining study objectives.
- The second component, *inventory*, is comprised of the accumulation of quantitative data for energy and raw material inputs and waste outputs including air pollution, effluents, and solid waste at each stage of the life cycle.
- Thirdly, the *impact assessment* component evaluates the ecological and human health impacts of energy, resource and waste factors.
- The fourth component, *improvement assessment*, outlines opportunities for prevention or reduction of environmental burden.

## Using LCA to evaluate materials

Life cycle assessment is an important methodology for materials selection. As companies and industries see advantages in “green marketing,” interest in life cycle assessments is growing and life cycle assessment is being used to document claims of one product being superior over another. An interest in LCA is also developing in several countries to analyze and acquire data for environmental labeling programs. For example, the European Community (EC) has enacted by its council an eco-labelling policy to be enacted by the eco-labelling boards of separate Member States (in Directive 94/2/EEC). The system is meant to present all the environmental information systematically and grade the products in order to help consumers make environmentally sound choices. At present the scheme is voluntary although plans exist to expand the program in the future. The EC’s move to adopt eco-labelling indicates their desire to reduce pollution at its source, encourage better management of raw resources, to move towards the “polluter pays” principle, and to encourage the development of future policies towards clean products. The UK Eco-labelling board (established in 1992) has been working to develop assessment criteria based on the LCA model.



**B-3: The EC Eco-label logo for use on approved products**

**Table 25.1 Building products in non EC eco-labelling schemes**

Scheme	Building product category
Blue Angel (Germany)	Materials made from waste paper Materials made from recycled glass Materials made from recycled gypsum Low-pollutant varnishes Asbestos-free floor coverings Paints low in lead and chromates Low-formaldehyde wooden products
Environmental Choice  (Canada)	Insulation from recycled wood-based cellulose Heat recovery ventilators Products from recycled plastic Water-based paints
Ecomark (Japan)	Thermal insulation Cement containing 50% blastfurnace slag

Source: BRE Information Paper 1P 11/93

#### **B-4: Building products in other eco-labelling schemes.**

##### *Criticisms of LCA*

There are several criticisms of life cycle assessment methodology.

- For example, different interests could interpret the studies to support their own claims.
- The design of the studies could significantly influence outcome. For example, either side of several common debates can be argued and supported using LCA methodology, such as cloth versus disposable diapers, paper versus plastic bags, and paper versus Styrofoam food containers.
- Another criticism is lack of consistency. The ISO (International Standards Association) had a forum to develop consistency among LCA activities.

- Finally, many claim that LCA is too costly to do well. There is, however, a growing recognition that a streamlined, simplified approach of the LCA concept can still be useful. SETAC and EPA developed a comprehensive methodology for *inventory*, but they are still working on methodology for *impact assessment*, which is greatly needed. ASTM (American Society of Testing and Materials) is working on methodology for *improvement assessment*.

#### *ERG modifications of LCA methodology*

The ERG modifies typical LCA methodology to adapt it to their purposes. For example, the ERG analysis differs from a typical product LCA in that it includes qualitative and quantitative information, and addresses generic materials versus specific products. Typically, LCA methodology is applied to product research (such as the paper versus plastic grocery bag debate or the cloth versus disposable diaper choice). The subject of the ERG study, building materials, is different from the study of other products for several reasons.

- Firstly, building materials are part of assemblies and structures.
- Secondly, the disposal stage for building materials is far in the future. Recycling technology for these materials and assemblies may significantly develop by the time the building is demolished, deconstructed, or source separated for recycling.
- Thirdly, the location of the building is an essential factor in the assessment. Transportation costs and local economies will have significant impact on the analysis.
- Finally, the environmental profile of a material depends on how it is used in the building. For example, plastic products may be necessary in some climates for vapour barriers, yet may be inappropriate as cladding where ultraviolet rays can degrade the materials and require frequent replacement.

The ERG further modified the LCA methodology by including stakeholders and peer review in the research process. Environmentalists and manufacturers were encouraged to contribute.

Another modification is that the ERG thoroughly developed the "materials use stage" of the report. They include in this stage an evaluation of

- building performance characteristics (thermal performance, lighting load, and indoor air quality),
- local and global availability of materials (transportation factors and depletion of global resources),
- and concepts of useful life and durability. To illustrate how useful life and durability are important, one should multiply the embodied energy of a given material by the number of times a material needs to be replaced. Thus, for units of measure, one would use btu's per square foot per year of useful life as opposed to btu's per square foot.

Finally, the AIA needed to streamline the methodology for the ERG because of the cost of research. They justified this measure by stating that what architects need most is general information about building materials from which they can make an intelligent choice as opposed the academic's requirement for quantified data.

#### *Successes and limitations of ERG methodology*

The AIA's methodology for the ERG was particularly successful because it incorporated both quantitative and qualitative information and because they were careful to modify the typical LCA to meet the specific requirements of their topic of study (building materials). However, the ERG has limitations as well. There is a clear need for continued further research in quantitative data collection, to be used in conjunction with the qualitative data. For example, the embodied energy figures cited in the ERG are given in a variety of incompatible units that make comparison difficult. Often,

Btu's/pound are used, but in other instances Btu's per brick, unit, board, or foot are used.

Another limitation of the ERG study is that their focus is on *building materials* only, which is only one part of sustainable design. For example, sustainable building design also involves site planning, materials selection, envelope design and configuration, building orientation and daylighting, and the careful specification of mechanical systems. In its discussion of methodology, the ERG acknowledges that factors at other levels influence building decisions and materials selection such as: treaties on global environmental issues, manufacturer's selections of chemical constituents for a product, federal standards and regulations, public and private labeling and certification programs, state laws, local zoning ordinances, industry association standards, community development projects, and the force of public opinion. (Methodology, p,1).

*Analysis of selected materials for residential-scale construction: Wood, Concrete, Brick*

This section evaluates three common residential materials as summarized from both the ERG materials reports and Andrew St. John's guidelines. The ERG produces materials reports highlight sheets to summarize the information for each specific material. These highlight sheets are divided into the four priority areas of the material's analysis: waste generation, natural resource depletion, energy consumption, and indoor air quality. In the longer reports that follow the highlights, the ERG addresses in detail the following factors: environmental impact, design considerations, construction issues, building use and operation, inputs and outputs, current regulations, perspectives from the industry and environmental groups, and reference lists. Andrew St. John addresses material uses, composition, properties, substitutes, resource consumption, transportation costs, recycling potential, and climatic considerations.

## WOOD

Uses: Wood is most commonly used for small scale or residential structures in cladding, finishes and as structural members. Glue lamination, or heavy timbers in truss application are used in large structures such as churches and warehouses.

Composed of: Wood is a naturally occurring material and is considered a renewable resource.

Properties: Wood has small scale load-bearing capacity ideal for residential construction. (Concrete masonry or steel framing are preferable at larger scales). Wood is durable if protected from moisture damage, is transportable, and is a combustible material.

Substitutes: There are many substitutes for wood as a cladding and finish material.

Resource consumption: Wood consumes forests, rainforests, or old growth forests and creates other environmental concerns including "soil erosion, pollutant runoff, and habitat loss from logging operations, as well as air and water pollution due to lumber production."<sup>151</sup>

Transportation costs: Costs depend upon proximity to forests. The hauling of logs and timbers can be costly.

Recycling potential: High quality beams, posts, trusses, and millwork are in demand for reuse. Markets for wood waste include chips for oriented strand board (OSB), paper pulp, roofing materials, landscaping mulch, landfill cover, animal bedding, compost, and firewood. Demolition and disposal: requires some energy to separate and remove metal fasteners from high quality re-useable lumber. Wood chippers and grinders will grind the nails, staples and fasteners in wood, which can then be removed magnetically, if necessary for the end application.

Climatic considerations: Wood, a forestry product farmed from living trees, is a carbon compound, and thus part of the carbon cycle. Carbon is stored in plant tissue and returned to the atmosphere when the plant decays or burns.

With the clearcutting of forests and increased combustion of various fuels, more carbon is discharged into the atmosphere. Increased atmospheric carbon is associated with the greenhouse effect and global warming.

Advice for architects and specifiers:

- Wood is ideal as structural members for small scale and residential construction as well as for highly visible building elements where its natural beauty, texture and grain can be appreciated by building occupants.
- Wood holds a significant cultural and emotional position in human cultures throughout the world.
- While wood is a renewable resource, the proper management of forests and harvesting of timber is essential for a sustainable supply. Therefore, use locally and sustainably harvested materials. Sustainable forestry includes selective harvesting, replanting harvested trees with trees of equal value, and the preservation of old-growth timber.
- Avoid tropical hardwoods because their harvest depletes the rainforests in such countries as Central and South America and the South Pacific.
- Prohibit toxic or unapproved resins and glues used in manufactured wood products. Exposure to wood constituents, as with cedar, may produce symptoms in sensitive individuals.
- Design shapes and lengths according to plywood and lumber dimensions and framing layouts to minimize cutoffs. Design with a general efficiency of details to reduce construction waste.

## CONCRETE

Uses: Concrete's uses are as foundation, structure, cladding, and finishes.

Composed of: Concrete is stone, sand, cement, and water. All are naturally occurring materials but are non-renewable resources.

Properties: Concrete has high and calculable strength, moldability, transportability, and is fire proof. It also acts as thermal mass to mitigate short term temperature swings.

**Substitutes:** There are many substitutes for concrete and concrete products as a cladding and finish material.

**Resource consumption:** The mining and production of cement and aggregate involve energy intensive processes. The form work often involves a wasteful use of wood, and the steel reinforcing increases embodied energy values.

**Transportation costs:** Concrete is a heavy material. The transport of bulk material to batching plants is costly.

**Recycling potential:** Concrete demolition and disposal requires significant energy to demolish with explosives or mechanical chisels and then crush the concrete into aggregate-sized pieces suitable for recycling. The recycled aggregate is of a quality suited for road-bed fill or asphalt paving. In the recycling process, steel reinforcing is extracted with magnets and reused. Architects can specify concrete blocks for some applications which contain aggregate replacements such as wood chips or other recycled materials.

**Climatic considerations:** In a northern climate, avoid surface deterioration from the freeze thaw cycle by removing air voids via a chemical entraining process during batching. Avoid thermal cracking in climates with wide temperature variations by specifying frequent expansion joints for large expanses of concrete. Concrete exposed to road salts, as in parking garages, must be coated or sealed or the reinforcing steel will corrode.

**Advice for architects and specifiers:**

- Concrete is suitable for a structure intended to last a long time.
- Consult with a formwork contractor to develop repetitive shapes, the reuse of forms, the use of modules in plywood dimensions to minimize cutoffs, and a general efficiency of details to reduce construction waste.
- Use locally mined and produced materials.
- Prohibit toxic or unapproved additives to the concrete.

## BRICK

Uses: Brick can be used for structure at a small scale, and as cladding or finishes. It is most commonly used today as cladding.

Composed of: Historically brick is composed of local clay and sun dried or fired in kilns. Modern bricks are fired at up to 2500 °C. They are composed of naturally occurring materials but are non-renewable resources.

Properties: Bricks have loadbearing capacity at a small scale. (Concrete masonry or steel framing are preferable at larger scales.) Bricks are durable, transportable, fire proof and modular with small unit size. They also act as thermal mass to mitigate short-term temperature swings.

Substitutes: There are many substitutes for brick as a cladding and finish material.

Resource consumption: The mining and production of cement for mortar involves energy intensive processes, soil erosion, pollutant runoff, habitat loss and water pollution. When architects specify this durable building material they reduce the consumption of replacement materials.

Transportation costs: The transport of bulk materials can be costly.

Recycling potential: The demolition and disposal of brick buildings requires significant energy to either separate and clean the used bricks by hand or to demolish with explosives or mechanical chisels and then separate and crush the bricks into aggregate-sized pieces suitable for recycling. Recycled brick pieces are crushed for landscaping purposes and whole used bricks are often in demand for reuse because of their historic character. In addition, new masonry products are available which contain recycled materials such as petroleum-contaminated soils, fly-ash from incinerators or sewage sludge.

Climatic considerations: In a northern climate, brick is usually employed as a veneer in combination with insulative, structural, and vapour barrier materials. Avoid deterioration of veneers from the freeze thaw cycle and water damage to the wall components by providing weep holes for drainage.

Advice for architects and specifiers:

- Bricks are ideal for small scale construction because they are flexible in design and use simple construction methods that require no forms.
- Brick is suitable for a structure intended to last a long time.
- Brick holds a significant emotional position in many cultures.
- Use locally mined and produced materials.
- Prohibit toxic or unapproved additives.

#### *Sustaining human health via materials selection*

Architects should make a conscious effort to reduce occupant exposure to environmental pollutants and contaminants. The elderly or future generations may have less resistance to the effects of pollutants, and thus toxicity of materials is a vital consideration in materials selection.

#### *Sustainable materials selection in the building industry: barriers and mitigation*

##### Barriers

- The primary barrier against sustainable practice in the building industry is the need for further research and quantification of data for the embodied energy of materials. In addition, embodied energy needs to be defined for building assemblies and components as well as for materials. There are other barriers such as a difficulty in establishing and enforcing standards, a reluctance to assign responsibility for making and enforcing changes, a difficulty in quantifying embodied energy in comparable units, and a problem with the number of variables involved which makes it is easy to alter results.

- Another barrier is a lack of public awareness of and demand for sustainable products, and a lack of public outcry against waste, pollution, and environmental costs.
- In many cases, relevant data is not available from product manufacturers and materials suppliers.
- Also, few policies are in place to promote green materials and sustainable design.
- An additional barrier is an aesthetic of universality or “International Style” that does not take into account regional typologies and climate.
- A final barrier is a limited perception of architects’ role. Architects need to broaden their definition of architectural practice to include the sustainable use of resources in their building designs and in the selection of building materials and technology. As important components of materials analysis, embodied energy and embodied pollution should form the basis of an architect’s materials selection. As indicated by the ERG, architects need to weigh both quantitative and qualitative information in their materials choices. The role of the architect is an important one. Architects are vital to the building industry because they are trained to make complex, and demanding decisions in which they must assess and weigh a combination of factors. They must choose materials based on their suitability as a combination within an assembly while weighing the many other factors involved, including embodied energy and pollution. Architects must educate themselves to be better qualified to make environmentally responsible materials selections and should keep abreast of current research.

#### **Mitigating these barriers**

- Sustainable design is linked with social and economic sustainability. Andrew St. John writes that “A cornerstone of sustainable development policy is the principle of community and regional economic control. The

aim is to retain as many resources as possible within the community, to spur economic growth and increase community well being."<sup>152</sup> Perhaps the increasing trend towards regional (provincial) thinking in Canada can be seen in a positive light from the perspective of building sustainably (using local resources and materials).

- There are indicators that attitudes are changing towards the more environmentally conscious. For example, eco-labelling is beginning, sustainable housing campaigns such as R2000 are emerging, and even the production and consumption of organic food is becoming more fashionable.
- A viable strategy to implement embodied energy and pollution indicators is public education via high visibility projects. In this way architects can raise public awareness of possibilities for sustainable construction. The R2000 program is one example of a high visibility program.
- Consumer demand will initiate the process of sustainability and advertising campaigns such as eco-labelling will both respond to and generate this demand.
- To implement the knowledge gained from these indicators, consumers must make changes in their personal habits including selective purchasing, investigative consumerism, reuse of materials, recycling more, using less fossil fuels, and using public transit.
- A greater demand for and awareness of green materials is clearly necessary amongst the architecture profession and the public. Building codes, incentives, policies and penalties must be initiated to enforce sustainable materials acquisition, use and disposal.
- At all stages, especially the materials acquisition, manufacturing, packaging and transportation stages of a material's life cycle, codes and penalties must enforce the recording and publishing of energy and pollution data for provision to consumers and architects. A standard method of quantifying and presenting the data must be established by a regulatory body.

- Governing bodies can implement policies and incentive programs to promote green materials and sustainable design. These policies must encourage sustainable practices at the materials acquisition stage. For example, governing bodies can enforce sustainable forestry practices and provide incentive programs for builders who use sustainably forested. In addition, city utilities can make energy and water savings appealing to the pocketbook and encourage long term thinking. Incentives at the recycling stage are another possibility.
- A solution or response to “International Style” barrier would be the expression of local identity in building design including the use of local materials and responsiveness to climate in site orientation, envelope, and landscape design. The expression of local identity can break through public apathy and foster an attitude of interest in local buildings and their upkeep. Neighborhoods will then receive better care and maintenance. The regional aesthetic for each area would be built upon that region’s materials, resources, climatic conditions and economies.
- Another solution is that architects should, on an individual basis, make their clients aware of the total cost of building, including the environmental and energy costs. Education programs for architects, perhaps as a requirement enforced by their certifying body, will provide information and contacts for the implementation of sustainable practices.
- Clearly, environmental responsibility is an important factor demanding careful consideration in the selection of materials and assemblies. Further studies, more detailed and more quantifiable in similar units, will be useful in these decisions, but even today, by careful examination of the ERG and available studies, architects have enough information to make informed and more environmentally conscious decisions.

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## Endnotes

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- <sup>1</sup> This sentence, and the idea of a profound and thoughtful architecture that is about dwelling in the world, springs from the teachings of John Brown, professor of Architecture at the University of Calgary, and his exploration of Heideggerian philosophy.
- <sup>2</sup> See section B. Applications
- <sup>3</sup> Zimmerman, p.3.
- <sup>4</sup> In his short paper, "The Shallow and the Deep, Long-Range Ecology Movements," presented to the 1972 Third World Futures conference in Bucharest, Arne Naess coined the term "deep ecology." George Sessions in Zimmerman, p. 127.
- <sup>5</sup> Arne Naess, "The Deep Ecological Movement: Some Philosophical Aspects" in Zimmerman, p. 203.
- <sup>6</sup> George Sessions, "Part II, Deep Ecology, Introduction," in Zimmerman, p.173.
- <sup>7</sup> Naess, "The Deep Ecological Movement," in Zimmerman, p. 203.
- <sup>8</sup> The eight-point platform, co-authored by Sessions and Naess, and quoted in full in the left margin of this document, is from Naess, p. 196 – 7.
- <sup>9</sup> Ibid, p. 197.
- <sup>10</sup> Point four in the Deep Ecology platform suggests reducing the size of the human population.
- <sup>11</sup> Ibid, p. 196.
- <sup>12</sup> Ibid.
- <sup>13</sup> A positive aspect of urban living is that it can conserve wilderness areas by concentrating human populations in limited areas.
- <sup>14</sup> I. G. Simmons, p. 114.
- <sup>15</sup> Lecherous.
- <sup>16</sup> A reference to the tulip mania in Holland in the 1630's.
- <sup>17</sup> *Mirabilia Peruviana*, a species of flower.
- <sup>18</sup> Macdonald, as quoted in Witherspoon and Warnke's *Seventeenth Century Prose and Poetry*, explains these lines as a reference to the propagation of cherries through grafting. p. 968.
- <sup>19</sup> Andrew Marvell, "The Mower Against Gardens," with footnotes cited above from within the poem, in Witherspoon and Warnke's *Seventeenth Century Prose and Poetry*, p. 968.
- <sup>20</sup> Carolyn Menchant, *The Death of Nature*, in Environmental Philosophy. Ed. Zimmerman, p.278.
- <sup>21</sup> Ibid p.280.
- <sup>22</sup> Ibid, p.286.
- <sup>23</sup> Ibid, p.287.

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- <sup>24</sup> Simmons, p. 145.
- <sup>25</sup> Ibid.
- <sup>26</sup> Karen Warren. *"The Power and Promise of Ecological Feminism,"* p. 267.
- <sup>27</sup> Simmons, p.115.
- <sup>28</sup> Witold Rybczynski. *"The Last Outpost,"* p. 36.
- <sup>29</sup> Dan Cruickshank. *"Variations and Traditions,"* p. 58.
- <sup>30</sup> Travis Colley, Bonnie Farmer, Gordon Home, Ernest McCrank and Lee Prevost, *Design Options for Greenview Aquafarm*, A project for EVDS 702, Resource Centre, Faculty of Environmental Design, The University of Calgary. December 1998.
- <sup>31</sup> Elizabeth Grosz. *"Bodies-Cities,"* p. 251.
- <sup>32</sup> Ibid, p. 242.
- <sup>33</sup> Ibid, p. 244.
- <sup>34</sup> Ibid. p. 252.
- <sup>35</sup> Juhani Pallasmaa. *The Eyes of the Skin*, p. 26.
- <sup>36</sup> Ibid.
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- <sup>38</sup> Ibid, p. 30.
- <sup>39</sup> Ibid, p. 31.
- <sup>40</sup> Ibid, p. 50.
- <sup>41</sup> Ibid, p. 43-44.
- <sup>42</sup> Timothy J.F. Lash. *Sustainable Development and a Society for all Ages: An Environmental Perspective*. No. 2 & 3. Department of Economic and Social Affairs of the United Nations Secretariat. New York, 1997, p. 19.
- <sup>43</sup> Timothy J.F. Lash. *Sustainable Development and a Society for all Ages: An Environmental Perspective*. No. 2 & 3. Department of Economic and Social Affairs of the United Nations Secretariat. New York, 1997, p. 19.
- <sup>44</sup> J. Carew-Reid et al. *Strategies for National Sustainable Development*. London: Earthscan Publications, 1994. As quoted in Timothy J.F. Lash. *Sustainable Development and a Society for all Ages: An Environmental Perspective*. No. 2 & 3. Department of Economic and Social Affairs of the United Nations Secretariat. New York, 1997, p.18.
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- <sup>46</sup> Ibid, p.21.
- <sup>47</sup> Merinda Conley, *An Interactive Design Approach to Housing for the Elderly*, A Master's Degree Project, Faculty of Environmental Design, The University of Calgary, 1991, p. 12.

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- <sup>48</sup> Gregg C. Vanderheiden, *Thirty Something (Million): Should they be Exceptions?* Trace Research and Development Center, Waisman Center and Department of Industrial Engineering, University of Wisconsin-Madison, [www.trace.wisc.edu/docs/30\\_something](http://www.trace.wisc.edu/docs/30_something), p. 7.
- <sup>49</sup> Ibid, p. 6.
- <sup>50</sup> Roger Coleman, *Breaking the Age Barrier*, text of speech delivered at the Royal Society of Arts, London, as part of the Design Council's Design in Education Week, [www.designage.rsa.ac.uk/publications](http://www.designage.rsa.ac.uk/publications), p. 3.
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- <sup>52</sup> Ibid, p. 100.
- <sup>53</sup> Ibid, p. 101.
- <sup>54</sup> Ibid, p. 105.
- <sup>55</sup> Pia C. Kontos. "Resisting Institutionalization: Constructing Old Age and Negotiating Home." *Journal of Aging Studies*, Vol. 12, No. 2, 1998, p. 169.
- <sup>56</sup> Pia C. Kontos. "Resisting Institutionalization: Constructing Old Age and Negotiating Home." *Journal of Aging Studies*, Vol. 12, No. 2, 1998, p. 181.
- <sup>57</sup> Ibid, p. 171.
- <sup>58</sup> Ibid.
- <sup>59</sup> Ibid, p.181.
- <sup>60</sup> Ibid.
- <sup>61</sup> Ibid, p.18.
- <sup>62</sup> Timothy J.F. Lash. *Sustainable Development and a Society for all Ages: An Environmental Perspective*. No. 2 & 3. Department of Economic and Social Affairs of the United Nations Secretariat. New York, 1997, p.20. Lash cites housing and living environment amongst health and nutrition, family, education and the media, employment and income security.
- <sup>63</sup> Doug Rapelje, "A Choice of Housing Lifestyle" in *Expression: Newsletter of the National Advisory Council on Aging*. 1996, vol.10, no. 4. Government of Canada National Advisory Council on Aging, p.1.
- <sup>64</sup> Rapelje, p.2.
- <sup>65</sup> Government of Canada, *Housing an Aging Population: Guidelines for Development and Design*, National Advisory Council on Aging, 2<sup>nd</sup> edition, Ottawa, Ontario, 1992, p. 8.
- <sup>66</sup> Government of Canada, *Housing an Aging Population: Guidelines for Development and Design*, National Advisory Council on Aging, 2<sup>nd</sup> edition, Ottawa, Ontario, 1992, p.2.
- <sup>67</sup> Government of Canada, *Housing an Aging Population: Guidelines for Development and Design*, National Advisory Council on Aging, 2<sup>nd</sup> edition, Ottawa, Ontario, 1992, p.6-7.

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<sup>68</sup> This section refers to information from Gail Finkel, instructor, *Universal Design: Collected Notes from Block III, EVDS 683.46*, March 1-5, 1999.

<sup>69</sup> Congregate housing and assisted living are understood to be approximately synonymous terms for elderly housing which provide a sheltered care environment but retain choice and independent living whenever possible.

<sup>70</sup> Heather M. Young, "Moving to Congregate Housing: The Last Chosen Home," In Journal of Aging Studies, Volume 12, Number 2, 1998, p. 149.

<sup>71</sup> Young refers here to Lawton, M. P. , and J. Cohen. 1974. "The Generality of Housing Impact on the Well-being of Older People." *Journal of Gerontology* 20(2): 194-204, and Lawton, M. P. 1976. "The Relative Impact of Congregate and Traditional Housing on Elderly Tenants." *The Gerontologist* 16(3): 237-42.

<sup>72</sup> Young, p. 156.

<sup>73</sup> Ibid, p. 155.

<sup>74</sup> Ibid, p. 156.

<sup>75</sup> Ibid, p. 158.

<sup>76</sup> Ibid, p. 159.

<sup>77</sup> Ibid.

<sup>78</sup> Ibid, p. 161.

<sup>79</sup> Ibid, p. 162.

<sup>80</sup> Lash, p. 22.

<sup>81</sup> Jiska Cohen-Mansfield and Perla Werner, "The Effects of an Enhanced Environment on Nursing Home Residents Who Pace," *The Gerontologist*, v. 38, n.2 April 1998. p. 199.

<sup>82</sup> Ibid, p. 202.

<sup>83</sup> The author of this masters degree project does not recommend the indiscriminate use of an aroma diffuser machine in housing due to potential problems with indoor air quality such as the release into the air of possible Volatile Organic Compounds in the perfumed additives, a risk of spreading bacteria if the machine is not properly maintained, and the possibility that increased humidity in the air released by the machine could lead to condensation and moulds in the building.

<sup>84</sup> Ibid, p. 205.

<sup>85</sup> Ibid, p. 207.

<sup>86</sup> Ibid.

<sup>87</sup> Debra-Lee Hamilton, Design Guidelines for an Ecological, Sustainable Community, A Master's Degree Project in the Faculty of Environmental Design, The University of Calgary, 1996.

<sup>88</sup> Ibid, p. 32.

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- <sup>89</sup> Ibid, p. 50.
- <sup>90</sup> Ibid, p.35.
- <sup>91</sup> Ibid, p. 39.
- <sup>92</sup> Ibid, p.44.
- <sup>93</sup> Brenda and Robert Vale. *Green Architecture*, p. 13.
- <sup>94</sup> Ibid, p. 62.
- <sup>95</sup> Laura Zeiher, *The Ecology of Architecture*, New York: Watson-Guptill, 1996, p.104.
- <sup>96</sup> Site variables will impact many of the comparison figures, and therefore care must be taken when referring to and interpreting this data.
- <sup>97</sup> In Alberta, the clay for brick and concrete is abundant while forestry products are available at a greater distance. Location of the site in relation to materials is a factor as well as material weight.
- <sup>98</sup> These figures are from The Rocky Mountain Institute's Primer on Sustainable Building, 1995, cited in Ibid, p. 125.
- <sup>99</sup> Thomas Randall et all, *Environmental Design: An Introduction for Architects and Engineers*, p. 71.
- <sup>100</sup> Laura Zeiher, *The Ecology of Architecture*, New York: Watson-Guptill, 1996, p. 106.
- <sup>101</sup> Andrew St. John, AIA editor. *The Sourcebook for Sustainable Design: A Guide to Environmentally Responsible Building Materials and Processes*. Boston, MA: Architects for Social Responsibility. Boston Society of Architects, 1992, p. 1.4.
- <sup>102</sup> Laura Zeiher, p. 112.
- <sup>103</sup> Thomas Randall et all, p. 97.
- <sup>104</sup> Thomas Randall et all, p. 97.
- <sup>105</sup> Ibid.
- <sup>106</sup> Ibid, p. 101.
- <sup>107</sup> Ibid, p. 102.
- <sup>108</sup> Ibid, p. 103.
- <sup>109</sup> Ibid, p. 105.
- <sup>110</sup> Zeiher, p.112.
- <sup>111</sup> Ibid, p. 113.
- <sup>112</sup> Laurent Belsie, "Want to Save Energy? Say Goodbye to Your Halogen Lamp," in *The Christian Science Monitor*, Tuesday, April 1, 1997, p.12.
- <sup>113</sup> Ibid.
- <sup>114</sup> Randall, p. 109.
- <sup>115</sup> Debra-Lee Hamilton, p. 48.
- <sup>116</sup> Laura Zeiher, p. 116.

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- <sup>117</sup> A preference for higher temperatures may be due to low metabolism and low activity levels.
- <sup>118</sup> Tang Lee, "Indoor Building Systems and Indoor Air Quality," in *Sustainable Building Symposium*, Conference Booklet, May 1999, p. 7.3.
- <sup>119</sup> Personal communication, *Community Natural Foods*, Calgary, Alberta, Canada.
- <sup>120</sup> Debra-Lee Hamilton, p. 45.
- <sup>121</sup> Ibid, p. 46.
- <sup>122</sup> Laura Zeiher, p. 109.
- <sup>123</sup> Laura Gatland, "Chicago rooftops: from gravel and tar to greenery," *The Christian Science Monitor*, Thursday, April 15, 1999, p.2.
- <sup>124</sup> Brenda and Robert Vale, *Green Architecture*, London: Thames and Hudson, 1991, p. 148.
- <sup>125</sup> Soprema, *Sopranature: Nature rules the roof!*, marketing materials.
- <sup>126</sup> Thomas Randall et all, p.143.
- <sup>127</sup> Des Kennedy, "Love for plants rescues people and communities" in *The Globe and Mail*, Saturday, February 13, 1999, p. D9.
- <sup>128</sup> Ibid.
- <sup>129</sup> Kregg Fordyce, *The Garden: Toward a Deep Architecture*, Masters Degree Project, Faculty of Environmental Design, The University of Calgary, 1999, p. 16.
- <sup>130</sup> Ibid, p.18.
- <sup>131</sup> Ibid, p.19.
- <sup>132</sup> Laura Zeiher, *The Ecology of Architecture*, New York: Watson-Guptill, 1996, p. 105.
- <sup>133</sup> Jim Knopf. "Xeriscape: It's a Natural" in *Natural Home*, May/June 1999, p. 30.
- <sup>134</sup> *The Construction, Renovation and Demolition Resource / Waste Management Workshop, Student's Manual*, prepared by dEsign consultants in cooperation with The Environmental Management Institute for Alberta Environmental Protection, Municipal Program Branch, January 1999, II.1.5., p. 2.
- <sup>135</sup> Ibid, p. 34.
- <sup>136</sup> Micheal Crosbie. *Green Architecture: A Guide to Sustainable Design*, p. 54.
- <sup>137</sup> Kenneth H. Cardwell, *Bernard Maybeck: Artisan, Architect, Artist*. Santa Barbara: Peregrine Smith, 1977. p. 122.
- <sup>138</sup> William J. R. Curtis, *Modern Architecture Since 1900*, Third edition, New Jersey: Prentice Hall, 1996, p. 94.
- <sup>139</sup> Hilliard T. Goldfarb, *The Isabella Stewart Gardener Museum*, Yale UP, 1995, p.42.
- <sup>140</sup> Rapelje, p.4.
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<sup>142</sup> Government of Canada, *Housing an Aging Population: Guidelines for Development and Design*, 2<sup>nd</sup> edition, Ottawa, Ontario, National Advisory Council on Aging, 1992, p. 6.

<sup>143</sup> Merinda Conley, *An Interactive Design Approach to Housing for the Elderly*, p. 25-26.

<sup>144</sup> Ibid, p. 44.

<sup>145</sup> Robert Ian Stirling, *Image and Essence: An Architectural Design for a Collaborative Community in Calgary*, A Masters Degree Project, University of Calgary, Faculty of Environmental Design, 1993, p. 15.

<sup>146</sup> Ibid, p. 16.

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<sup>148</sup> Ibid.

<sup>149</sup> Personal communication, The City of Calgary Planning and Building Department.

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<sup>151</sup> ERG, material report, wood framing, p. 1.

<sup>152</sup> Andrew St. John, AIA editor. *The Sourcebook for Sustainable Design: A Guide to Environmentally Responsible Building Materials and Processes*. Boston, MA: Architects for Social Responsibility. Boston Society of Architects, 1992, p. 1.2.