Thinking Inside-Out:

An Inter-Disciplinary Approach for Sustainable Building Design

by

Jasbir S. Bhamra

A Practicum submitted to the Faculty of Graduate Studies of

The University of Manitoba

in partial fulfilment of the requirements of the degree of

MASTER OF INTERIOR DESIGN

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Abstract

This project delivers a sustainable solution for the design of a student design centre in Winnipeg- primarily intended for imparting knowledge about sustainable means in building design. In doing so an emphasis is laid on a holistic process of design involving considerations from various disciplines as facilitated through varied experiences of the team involved in the project with backgrounds in interior design, architecture, and city planning. Professionals from such varied backgrounds provide views and suggestions for a comprehensive assimilation of ideas to develop the program for the centre. The project asserts on the issue of spreading knowledge of sustainability among the users and to aid in this process, the interior design is conceived and is expressive of Gibson's affordance theory. Production of interior spaces informs the envelope of the building by making environmental sustainability a primary concern. The LEED™[1] rating system is used as means to guide the design process and to promote sustainable ideas.

Keywords: Inter-disciplinary, Integrated Design Process, Sustainable Environment, Interior Design, Affordance Theory

[1] LEED™ – Leadership in Energy and Environmental Design

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Chapter One: Introduction

Sustainable development has become one of the most important concerns in the twenty first century. Growing concerns over the availability of natural resources are evidence enough to indicate the impact of human beings on nature. It therefore becomes important that concerns over the abuse of natural resources be handled responsibly in the future. This is critical when compared with the expanding capitalist economy that defies nature (Jucker, 2002). Indeed, the advancements have created a dependency on economies that social identities and behaviors are consequently finding way towards unsustainable culture. In addition, lack awareness about a sustainable approach among people adds to the issue of increased exploitation of natural resources.

Design is a powerful tool and can act as a harbinger of movements that can promote accordance with nature. The investigation and analysis to undertake this project, within the context of interior design and architecture, leads to key issues that any design needs to progress with, to be a successful proponent of sustainability. Thus, a possibility of creating an environmentally sustainable space, which aids in educating the users about green design, is explored through this project.

The project is termed Student Design Centre (SDC) proposed in downtown Winnipeg and is aimed as a facility for students, university faculty and design professionals to provide design advisory resources to groups, individuals, City Council and various organizations. The facility will involve students in real

projects and at the same time enhance the importance of design in the community. With the increasing importance of sustainable issues this facility will provide opportunities to spread knowledge among the building users, about sustainability in the building industry.

The literature review in chapter two investigates and analyses firstly; the existing trends and practices in the professions of interior design and architecture, and secondly; a lack of awareness about the topic of sustainability in the public at large. In due recognition of a lack of coordination among various disciplines - namely interior design, architecture, landscape architecture and city planning involved in the construction of buildings the author has attempted a holistic approach to arrive at a sustainable solution in the design of the SDC. This approach is intended to unify various disciplines from the conceptual stages of design development. The author believes that this addresses the needs and questions of key disciplines involved in the process and result in an effective, efficient and expressive design vocabulary, and establish an understanding of the space. The issue of unawareness about sustainability among the public is handled by implying Gibson's affordance theory[2] in the design of spaces so that the experience in a space becomes educational for the users.

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[2] see para.2, pg.68

Case studies provide strategic information by considering some of the primary concerns discussed in the literature review and help establish precedents in terms of the design considerations for SDC .

1.2 Research Problem and Objectives

The project brings forward questions pertinent to its goal and scope. The research questions investigated through the project are:

- How can design of interior spaces aide in sustainable design of a building?
- What role can interior design play in increasing awareness about sustainable design?
- How can an interdisciplinary approach effectively lead to more sustainable solutions?

1.3 Research Strategy

The design of the facility is conceived through the application of a research plan, which includes literature review, case studies and application of information to address relevant concerns. The literature review consists of different themes leading to the project goals of understanding:

1. Sustainability as a rising concern;
2. Importance of education to bring help create public awareness among the public; and
3. Integration of disciplines: Interior design and others.

The literature review provides a foundation that would inform design ideas so that the project conveys the intended purpose of presenting sustainability as a viable and appropriate option for buildings to the users. The study of relevant precedents based on the concepts of sustainability helps to identify and analyze strategies for development of respective projects that help in informing the design process to arrive at a sustainable solution for the proposed facility. The program of the facility has been defined through an analysis of responses to a questionnaire prepared to inform the development of the facility in Winnipeg.

Chapter Two: Literary Investigation and Analysis

The topic of sustainability is defined as meeting the needs of the present without compromising the ability of future generations to meet their needs (Kibert, 2005, p. 33). This implies a greater responsibility for present generation towards nature and its resources. Unfortunately, a large proportion of the population is unaware of the effects of their behaviours that cause harm to nature (Jucker, 2002, p.261). This section investigates pertinent topics of sustainability, education and practice in the profession of building design and construction for the development of the facility and validates the need for developing such a facility for greater understanding of sustainable ideas among people. The need for sustainable development is discussed with statistical facts and qualitative arguments justify its importance.

2.1 Sustainability as a Rising Concern

An increase in the consumption of natural resources and increasing adverse environmental impact is realized through energy consumption patterns until recently that have impacted the environment to a drastic extent (Jucker, 2002, p.19-26). Chambers argue that future generations might not have sufficient resources left for meeting their demands and that human behaviour has put nature on a risk of extinction (Chambers, Simmons & Wackernagel, 2000). Jucker explains that the biosphere is a thermodynamically closed and non-materially-growing system, which establishes the fact that there are definable, scientifically-verifiable limits to our endeavours on Earth (Jucker,

2002, p.42). This raises the importance of sustainable issues and necessitates the evaluation of human actions and their impacts on nature. Dürr (2000) explains that this is a concern that humanity has to address as we have to look after sustainability ourselves, because nature would not force us (Jucker, 2002, p.5). In the given context a unique vocabulary is emerging to describe and highlight concepts related to sustainability and global environmental changes (Kibert, 2005, p.3). Kibert explains that terms such as *Factor 4* and *Factor 10*, *ecological footprint, ecological rucksack, biomimicry, the Natural Step, eco-efficiency, ecological economics, biophilia* and the *Precautionary Principle* describe the overarching philosophical and scientific concepts that apply to a paradigm shift toward sustainability. (Kibert, 2005, p.3)

The building sector has a tremendous negative impact on the environment (USGBC, 2001,p.1), which raises concern over the way buildings are designed, used and maintained and raises the importance of sustainable means to address the same.

2.1.1 Sustainability and its significance in regard to buildings.

Our actions as humans have greatly affected our immediate environment and indeed, as discussed, they have been consequential in affecting the environment on a global scale. Due to the adversities caused in the present times, sustainability as a topic under consideration for maintenance of the environment and one that aids in ensuring resource management, have gained

importance. According to the Brundtland Report[3] sustainable development in terms of continuity and maintenance of resources is defined as:

> Sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs. (Williamson, Radford & Bennetts, 2003, p.4)

Within the carrying capacity of resources in context of an ecosystem, this and other definitions consider sustainability to be an avenue that maintains and possibly improves the quality of life with due respect to existing resources. With people spending eighty percent to ninety percent of their time in the buildings[4] it becomes a prime concern that interior design should address resource maintenance. Consequently, designers are faced with the challenges to improve the quality of life through design.

In broader terms, the design of interiors should assess available resources along with creating buildings with low environmental impact. Thus, buildings should be conceived as viably sustainable in terms of materials and space; where designers should have the responsibility to skilfully manage available resources in design. Realizing the importance of sustainability, the significance for achieving an optimal level of end result, is further endorsed by

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[3] Williamson, Radford & Bennetts, 2003, p.4
[4] USGBC, 2001, p.215

various rating systems that have been developed to evaluate sustainable design in different regions in general. These systems understandably address the issue of management of resources and their skilful applications. LEED (Leadership in Energy and Environmental Design), BREEAM (Building Research Establishment Environmental Assessment Method), Association HQE (Association pour la Haute Qualite Environnementale des bâtiments) and so on rate buildings based on environmental criteria. About the rating systems Gissen states:

> In broader terms to a large extent they define sustainable design as the one that uses renewable sources to generate energy; that uses passive techniques for ventilation and illumination; that incorporates, maintains and recycles greenery, water, and waste; that advances the use of environmentally conscious construction techniques; and that fosters a livable and viable urbanism. (Gissen, 2003, p.16)

Quantification of environmental concerns through rating systems brings forward the notion of understanding design approaches and provides a way to comprehend sustainability in building design. Environmental agencies have progressed with research into sustainable strategies in recognition of the depleting natural resources and provide data and resources as information for sustainable development. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has actively supported research for

decades[5]. Today, twenty percent of its US$ 3,200,000 research budget is dedicated to energy conservation[6]. Fifteen percent supports environmentally safe materials such as replacement refrigerants[7]. Likewise, ASHRAE continues to offer educational programs related to sustainability such as its professional development seminar on "Building Retrofit for Energy Efficiency"[8]. With most of the research and focus upon sustainability by various organizations it is to be understood that green design as an alternative term for sustainable development in building design is gaining importance with every passing day. However, it is not yet a part of mainstream design profession. It could very well be assumed that measures and evaluations facilitated through the advancing research confirm that a movement to bring green design into mainstream is on its way. Manasc and Mahaffy (2002) argue that:

> Green design will still be "new" for the next 5-10years- and then it will become increasingly mainstream until, by about the year 2020, it will be fully integrated into the practice of design and construction. (p.43)

With due diligence towards the environment, design professions are realizing the importance of sustainable design mainly in the sector of energy consumption as it remains the single most important green building issue, not only because of its environmental impacts, but also because of the probability of

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[5] Hayter, Torcellini & Judkoff, 2000, p.3
[6] ibid.
[7] ibid.
[8] ibid.

significantly higher future energy costs (Kibert, 2005, p.181).The following section discusses energy consumption in the buildings and the importance of addressing this concern through adopting sustainable design.

2.1.2 Energy use in buildings.

Buildings as long lasting products of society have a significant impact on global resources. Energy use in buildings may be defined as the non-renewable energy used in construction, heating, cooling, humidification, dehumidification, ventilation, illumination and operation of buildings, along with other applications. Buildings account for almost one third of Canada's annual, non-renewable energy consumption and greenhouse gas (GHG) emissions (Kesik, 2002, p.28). Their continually increasing impact on the environment makes the assurance of a sustained future even more challenging. Consequently, sustainability has become a core issue for design of buildings as more and more resources are being harnessed for energy production in buildings. Jones (1997) quite understandingly, points out that there is little scientific doubt that human activity is responsible for global warming and that buildings are a major contribution (Edwards, 1998, p.xiii). The Department of Energy (DOE) in the United States brought forward statistics that speak of the impacts of buildings on the environment (USGBC, 2001) as summarised below:

- Buildings in United States consume more than 30 % of total energy and 60 % of electricity annually.
- Five billion gallons of potable water are used to flush toilets daily.

- A typical North American commercial construction project generates up to 2.5 pounds of solid waste per square foot of floor space.
- Buildings are a major source of the pollutants that cause urban air quality problems and contribute to climate change.
- Buildings are accountable for-
  - 49 % of Sulphur dioxide emissions.
  - 25 % of Nitrous oxide emissions.
  - 10 % of particulate emissions.
  - 35 % of Carbon dioxide emissions.

With rising demand for efficient use of energy, alternatives have been explored to establish an optimal use of the same. Statistical figures in the media that project the used natural resources against the available ones keep reminding us of the impact that humans have had on nature. The habits that people have adopted over time have abused the natural environment to such an extent, that the present generation is realizing it through unusual or unnatural changes in the environment. Rise in global temperatures, melting ice, polluted cities and many other examples provide evidence of human habitual interventions. Wackernagel (1997) explains that:

> These trends indicate a decline in the quantity and productivity of nature's assets or, in the language of Ecological Economists, the depletion of "natural capital". (p.6)

At the same time, the growing population's demand for natural resources is increasing manifolds. In the wake of increasing energy demands sustainability gains importance as it heralds practices and processes that work in harmony with objectives of meeting energy needs. When measured, the use of energy in buildings provides a broader picture to establish a case for sustainable intervention in the building design. The following breakdown (Figure 1) of energy use by economic sector, establishes the energy use by various departments in a typical commercial building's recurring energy needs.

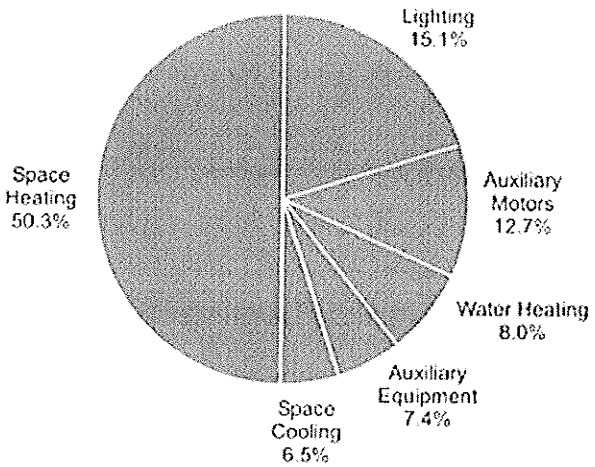

Figure 1. Breakdown of Commercial End Use Energy
[From Report to Parliament on the Administration and Enforcement of the Energy Efficiency Act, 1994-1995, Natural Resources Canada, Ottawa, 1995]

A comparison of the old with new stock of buildings in terms of energy use as described through the chart below (Figure 2) establishes that the potential for energy efficiency improvement is significant in new commercial buildings as compared to the ones in the past. It clearly shows a reduction in the energy use with the exception of cooling loads and energy use for equipments.

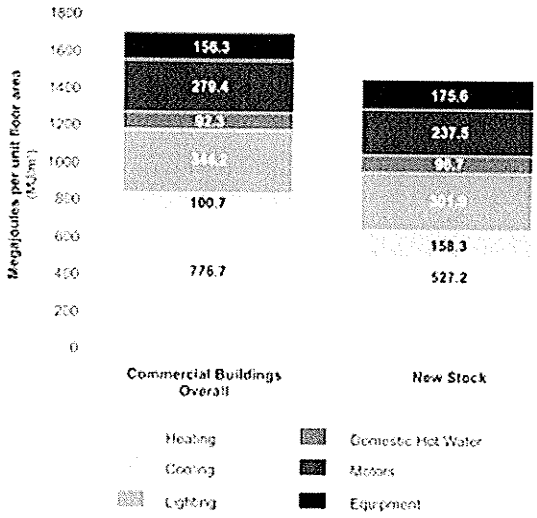

Figure 2. Commercial Sector Energy Usage: Overall Versus New Stock
[From Report to Parliament on the Administration and Enforcement of the Energy Efficiency Act, 1994-1995, Natural Resources Canada, Ottawa, 1995]

In due regard to the energy needs as depicted by the studies it becomes apparent that passive design as part of a building's architecture and interior design is an integrated consideration so that more renewable sources of energy namely sun, wind and water are used intelligently in given conditions. This approach acknowledges depleting natural resources and also provides an incentive for faster payback time. The LEED™ rating system supports incorporating energy conscious decisions by providing cash flow analysis of projects certified under four categories of certification namely certified, silver, gold and platinum (Figure 3).

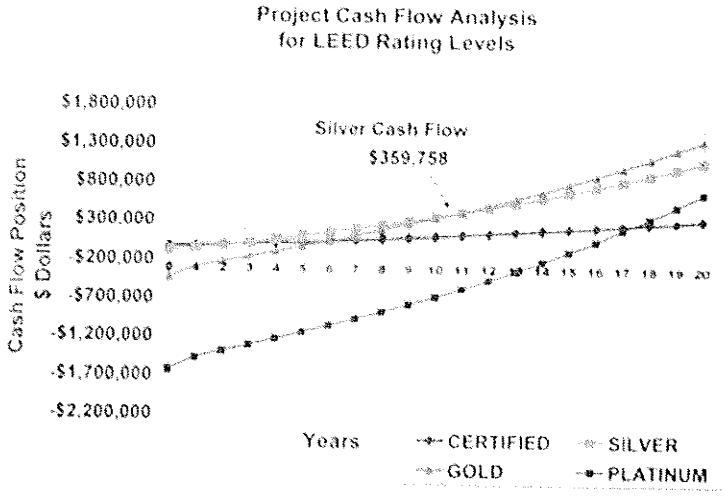

Figure 3. Project Cash Flow Analysis for LEED Rating Levels
[From Kibert, 2005, p.129]

A spreadsheet tool used during green building charrettes by DPR Construction, Inc., a commercial construction company based in the U.S, helps to provide rapid assessment of cost and benefits of various green building options, as well as the overall cost/benefits for various levels of LEED™ certification. It can easily be understood that the higher rating has a steeper payback line, though the initial first or construction cost is comparably high. Thus, a need for making future developments more sustainable and environmentally friendly proves economically viable in the long run.

2.1.3 Need for sustainable development.

Scientific advancements have brought about a large change in the society wherein the life styles of people have been affected dramatically and adhere to more comfort and sophistication in their day to day life. For example the invention of central cooling in 1928 changed how commercial buildings were

cooled (Pauken, 1999, p.42). Air-conditioning for comfort became increasingly popular prompting a change in the architecture of buildings. There was no longer a need to design buildings with thermal comfort as a criteria because mechanical systems could make any building comfortable (Hayter et. al, 2000, p.2). Similarly other developments have made the use of buildings simpler and easier for people, while the impact that is being made on the environment through their use is not realized. There are consequences in terms of green house gas emissions, carbon release in the environment, increased energy consumption and others due to the equipment use in the buildings that make lives easier in buildings and which makes it necessary to claim that in the scope of all things a price is being paid to validate the current unsustainable lifestyle and which is happening with a harm caused to the nature. Buildings originally designed to operate on passive solar principles without air conditioning now have air conditioning installed, not because they didn't operate effectively, but because the preferences of the occupants have changed[9]. Apart from this Williamson, Radford & Bennetts (2003) say that an issue for concern is the rights of future generations to seek a quality of life higher than ours and at the same time it is stated that these concerns do not explicitly address how in practice we might tackle making sustainable architecture[10]. Evernden (1993) asserts that:

> The world constructed through science is a series of tested hypotheses. It is this 'world of guesses' that we are asked to adopt in preference to our

[9] Willimanson, Radford & Bennetts, 2003, p. 53
[10] ibid.

own experience of the world. And we have. (p.53)

His assertion proves to be right to a great extent and is supported by the social construct of behaviours and lifestyles of the present times. Existing behaviours as a consequence of adoption of tested hypotheses that has led to the production of consumer goods and equipments have led us to create limits and boundaries in our thoughts, denying the sustainable options as supported by experiences. Therefore, unsustainable culture dominates and rules over bringing any change to existing trends and hence makes it difficult for making a transition towards sustainable social behaviours. Fundamental changes in human attitudes and behaviour are required to move towards the goal of sustainability (UNESCO, 1997,p.1). Brundtland (1987) has wisely stated:

> The concept of sustainable development does imply limits - not absolute limits but limitations imposed by the present state of technology and social organization on environmental resources and by the ability of the biosphere to absorb the effects of human activity. (Building Momentum-Sustainable Development in Canada, para.1)

Kesik narrows this down into the topic of architecture and implies that sustainability is not an architectural problem specifically, but rather a global cultural problem to which architecture may contribute valuable solutions (Kesik, 2002, p.28). A new developmental concept present factors under consideration for the buildings to be designed with a view towards sustainability. Bourdeau

(1999, p.358) explains that the key elements in various sustainable construction definitions are:

- reducing the use of energy sources and depletion of mineral resources;
- conserving natural areas and bio-diversity;
- maintaining the quality of the built environment; and
- management of healthy indoor environments.

Further Vanegas (1996) illustrate the acceptance and broadening of factors in the construction of buildings that will be considered in the near future towards recognition of environmental concerns as presented in Figure 4.

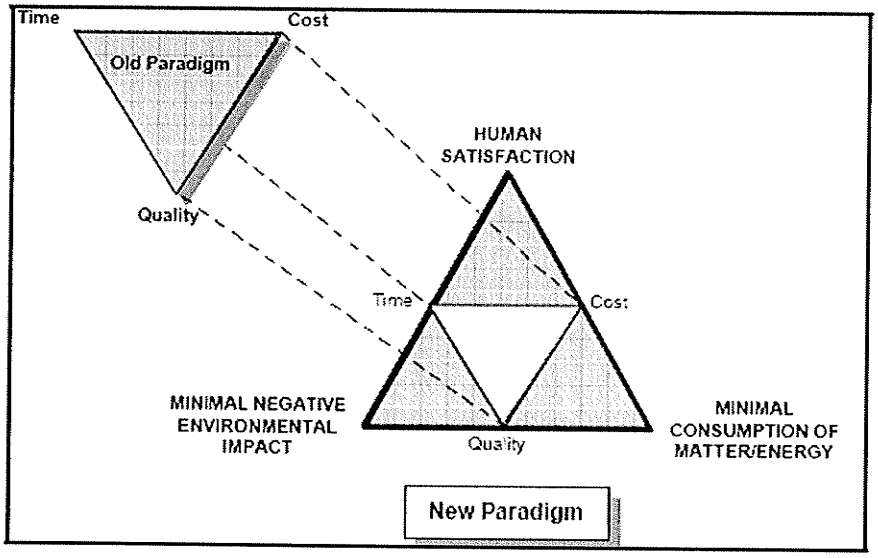

Figure 4. The new paradigm in global context
[From Vanegas et al, 1996, p.9]

Within this view it is necessary to realize that sustainability in the near future is looking over important factors beyond environmental concerns and is beneficial for the society as a whole. Communities can adopt sustainable development as a strategy for well-being. As more and more neighborhoods, villages, cities and regions are using sustainable development as a guiding principle not only for near-term goals, but also for long-term benefits. For example the U.S. Department of Energy[11] claims that sustainable projects:

- Strengthen the local economy;
- Improve and protect the quality of the environment; and
- Enhance the quality of life and the well-being of all of the people in the community.

Further the U.S. Green Building Council[12] asserts, that green buildings can:

- reduce the negative environmental impact;
- reduce operating cost;
- enhance building marketability;
- increase occupant productivity; and
- contribute to a more sustainable community.

With the understanding of all the positive aspects as an effect of sustainable design it becomes clear that sustainable design initiates healthier environment and promises a better future. Building design based on a response

[11] Smart Communities Network, see reference
[12] (USGBC, 2001, p.1)

to the environmental factors is a significant issue within this context. The ambience of interior spaces as part of the design of buildings further impart a greater role on the issue of adopting sustainable means in interior design. As discussed earlier, it becomes clear that the innovation in design lies in skilful use of the limited resources. Specifically, the design of buildings and interior spaces gain importance under these considerations.

For bringing forward the concept of sustainability a thought process is to be generated among the people to bring about a change in the social behaviours that respond to environmental concerns. Kofi Annan, Secretary General of the United Nations (2001) states:

> In the past we could afford a long gestation period before undertaking major environmental policy initiatives. Today the time for well-planned transition to a sustainable system is running out. We may be moving in the right direction, but we are moving too slowly. We are failing in our responsibility to future generations and even the present one. (cited in Manasc & Mahaffy, 2001, p.8)

Within this construct of circumstances, where the depletion of natural resources cause concerns for future sustenance, sustainability offers opportunities that consider development with due respect to energy efficiency and establishes itself as a prime need of the time.

2.1.4 Summary

We have come to a realization of our endeavours in the 21st century, when the replenishing capacity of the earth is outweighed by the adversity that we have already caused. While the design community is becoming aware of the rising demands for environmentally conscious design, it is understandable that construction of buildings is being addressed more carefully in the design process as various organizations have initiated efforts for environmentally conscious design. This is also realised through establishing guidelines for sustainable developments for example the LEED™ rating system, as developed by the U.S Green Building Council. Kibert explains that sustainable construction may one day become so commonplace that its unique, distinguishing terminology may be unnecessary (2005, p.21). Adoption of sustainable means to reduce the impacts on the environment will help in building a better future. Educating the people about the adopted means and methods play an important role to generate knowledge and resources and increases an understanding of the environment. .

2.2 Importance of Education to Bring About Change

Acquired behaviors in the society have established themselves deep into a social thought construct. This has led to many false assumptions among people that are unsustainable. Lack of knowledge about sustainability and other ecological concerns, fail to warn people about their activities and assumptions. Therefore, it is necessary that people be made aware of the ecological impact

occurring as a direct consequence of their habits. Knowledge is a powerful mode to affect decision-making, and therefore should be endorsed to spread an understanding of sustainability. Unless people are made aware of the results of their actions it will be difficult to invoke ecological consciousness. Cortese (1999) argues that our current level of thinking remains a significant obstacle to the promise of a just and sustainable future. It refers to the statement of Einstein who observed that the significant problems we face cannot be solved at the same level of thinking we were at when we created them[13]. Therefore a change in the mindset is necessary. Cortese (1999, p.6) provides an argument that our behaviours characterize our current mindset by the beliefs that:

- humans are both separate from and the dominant species of nature;
- that resources are free and inexhaustible;
- that technological fixes are available to solve most problems; that nature
- has an infinite capacity to assimilate human waste; and
- that material acquisition and accumulation is the most important determinant of success.

Involvement of a knowledge base for bringing change in the existing mindset of society is significant as it provides a backbone for supporting progress. Nathan and Taylor (2003, p.2) see education as one of the main ways of achieving sustainable development or at least of reducing environmental degradation by creating a knowledge base in the society. Lewis generally

[13] Cortese,1999, p.6

concedes that if environmental quality is to be achieved, public reeducation[sic] to new sustainable design options is essential (Lewis, 1996, p.195). At the same time it also becomes necessary that appropriate message regarding sustainability is conveyed. Education for sustainability, being an imminent concern in the society should also pertinently address issues that a society faces to solve as Williamson et al (2003) state that:

> The imprecision and uncertainty surrounding sustainability and the means for its achievement make knowledge, how it is used, and how relevance and ignorance are dealt with, all particularly important. (p.67)

At the same time Fien observes that education for sustainability is generally regarded as learning how to make decisions and taking action that considers the long term future of the environment, the economy and social justice of communities (Fien, 2002). Initiatives like the C-2000, LEED™, One–Tonne Challenge and others have been effective to take general understandings about sustainability beyond the simple blue-box recycling. The results of which are evident wherein people have become more knowledgeable and understanding towards their environment and the ecological impacts their behaviors create. Catalli and Drake (2002) state:

> Increased demand for improved sustainability in design and construction stems from a variety of factors, the most important being the need to alleviate the strain on our environment and resources. Other influences include increased public and client awareness of environmental issues.

> With increased knowledge about what can be done, buildings are being judged for environmental performance as much as for aesthetics and functionality. Knowledge about environmental issues on the part of manufacturers, suppliers, and designers has improved tremendously, bringing green technologies and green buildings into the mainstream. (p.23)

Incorporation of green design in the mainstream design process will aid in building an environmental ethic among designers, leading them to make sound environmental decisions. Green design leads to newer ideas exemplifying sustainability, and helps to raise awareness among people in the context of buildings. Therefore, in the scope of this project it becomes necessary that the design of the facility portray and exhibit features that are pertinent to sustainable concepts in building design by making the facility an educational tool. CEEE[14] as a case study provides information about exemplification of the building as an educational tool through its form and functions.

2.3 Integrating Disciplines: Interior Design and Others

Various disciplines are involved in conceiving a building, varying from designers to consulting experts. A collective effort of all the disciplines aids in realising a successful end-result. This section discusses the current trends in the professional practices of interior design and architecture in specific and

[14] see pg.45

identifies the need for a holistic approach involving interior design and various other disciplines in the design of buildings.

2.3.1 Current practice.

Canadian architects Manasc and Mahaffy, in their publication Agora Borealis mention that architects and engineers, have made tighter and tighter boundaries around the disciplines involved in putting a building together (Manasc & Mahaffy, 2002, p.27). This clearly indicates the specialisation of various disciplines involved in designing a building making a customary practice to address project issues through specialised scope of work that might not be in direct consultation with each other. Acknowledging a gap between the disciplines of architecture and interior design Hildebrandt (2004) explains that:

> Traditionally, the disciplines of architecture and interior design view themselves as distinctive and singular; being both boundary-tied by professional legislation as well as seeing themselves as offering specialized service roles. (para. 3)

The specialisation and matter of expertise lead to distinctive and separate approaches towards a single end result of designing a building. In the process, lack of proper communication and professional ethical dilemmas can lead to unsound decisions affecting the end product. In terms of sustainability, major environmental impacts could be overlooked due to the distinctiveness of disciplines. A greater emphasis placed on the ethical responsibilities on

practitioners with licensures and registrations, further adds to the boundary-concepts, as Cuff (2000) explains that:

> Because professional practice encompasses socially significant acts, practitioners bear an ethical responsibility not only to the client, but to the public at large, a responsibility which other occupations are spared... professional duties are ambiguous; the artist cannot be obligated to make something beautiful. There is an inherent assumption, therefore, that professional expertise is at least to some degree technically defined. (p.32)

Considering design practice as a responsible and distinctive act, specialisation and matter of identity could easily be understood, in its existing realm of conduct. Practitioners being cognizant of their roles tend to approach problems within their so called scope of services. At the same time Hildebrandt (2004) says that new problems require new approaches for creative solutions (para. 3). To achieve sustainability in building design is challenging, and it can be assumed that there is a need for innovative approaches and a unification of different disciplines for a holistic approach towards concerted action for sustainable futures. The holistic approach is thought of as a resolution that binds different disciplines in entirety to conceive an effective end-result.

2.3.2 Need for a holistic approach for design solutions.

The usual disciplinary trend provides little opportunity for a holistic development, wherein the issues in any one of the disciplines could hardly be addressed through others. For example some elements of structural design, such as placement of the column grid, might hinder design aspects for other interior developments. In such a situation it becomes clear that an understanding and an approach that integrates various disciplines is important.. Robert Jones (1997) argues that the creation of a new generation of low-energy and environmentally benign buildings requires teamwork between professionals (cited in Edwards, 1998, p.xiii). Over two decades ago, in reflecting on changing professional practice, Schön (1982) argued:

> At any given time in the life of a profession, certain ways of framing problems and roles come into good currency... When a practitioner becomes aware of his frames, he also becomes aware of the possibility of alternative ways of framing the realities of his practice... Frame awareness tends to entrain awareness of dilemmas. (p.103)

In the present context, growing environmental concerns offer a framework, which to a great extent express the need to define the realities of each profession. The C-2000 Program for Advanced Commercial Buildings, launched in 1993 by Natural Resources Canada's CANMET Energy Technology

Centre, initiated an attention to sustainability in Canada. The program ensured that:

1) Buildings chosen for the program must be designed to consume less than half the benchmark energy standard; and
2) Must promise minimal environmental impact, excellent indoor environment, adaptability, long lasting components and ease of maintenance.

In the program's first two years, six pilot projects met or exceeded the energy targets and the best of these pilots succeeded, not by incorporating next generation systems, but through the synergy of fully integrated design teams (Manasc & Mahaffy, 2002, p. 38-40). C-2000's Integrated Design Process (IDP)[15] contributes largely to developing a model of holistic development. The IDP follows a detailed pattern; all the building design disciplines, plus the owner or owner's representatives, take part in a series of facilitated workshops leading to the completed design of the new project. The workshop teams are supplemented by technology specialists, according to the specifics of the design, to ensure that the team has all the information required to make the best decisions. It is an essential concept to involve expertise from various disciplines from the outset of a project to better understand their integration and foresee the end-result. Towards achieving a sustainable end-result integration is deemed as

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[15] The Buildings Group: Integrated Design Process, see reference

a necessary expertise from the maximum number of disciplines. Hildebrandt (2004) explains:

> What should be clear (and is to a small number of professionals, academics, and journalists) is there is a new set of circumstances in contemporary society that demands a shift in thinking. (para. 3)

Sustainability, as a social movement in the profession needs newer approaches and shifts in traditional thought processes. Lewis expresses his opinion and difference from the traditional thought of being tied by professional boundaries and points out that integrating knowledge from natural and cultural resource inventories is a task that requires an interdisciplinary effort (Lewis, 1996, p.192). As awareness of global concerns increase it becomes apparent that designers can no longer rely merely on environmental specialists or indeed establish criteria to slow down natural resource exploitation and need to think more holistically along the process of design. The NCARB[16]'s report on sustainable design explains:

> The separate disciplines should work together to understand the relationship of their endeavours to the success of the entire project, they should also try to understand how the project's success is dependent upon the success of larger ecological, social and economic systems. (Kulman & Schurke, 2001, p4)

[16] National Council of Architectural Registration Boards (NCARB)

Because the implications of a design intervention affect communal and environmental concerns, sustainable design expands the responsibility of building industry to address long term consequential issues beyond the immediate client concerns. It is to be understood for the design profession that a greater responsible role is imminent.

2.3.3 Summary

In chapter two it is discussed that the notion of sustainable development as the touchstone of environmental education helps in understanding sustainability and at the same time provides opportunity to raise awareness about the environmental impact by human activities. A coordinated effort involving various disciplines further enhances understanding among them and achieves better performance of a building as an end-result. With rising concerns over depleting natural resources, and environmental impacts it is necessary that people be made aware of the situation. At the heart of this interpretation of sustainability lie the notion of a meaningful relationship with nature and which helps define people's attitudes towards the environment. Apart from this an integration of various disciplines that are involved in conceiving a building helps understand the process holistically for the participants. Therefore, the current boundaries of various disciplines have to allow for sharing and for active participation with other disciplines to realise a successful and sustainable end-result. The LEED™ rating system helps to achieve a coordinated effort among all the disciplines that are involved in the process of design. The system is also

used to evaluate and form guidelines for the selection of precedent studies. Having the processes, methods and other aspects of a building's function clear and readable for the users helps build up knowledge about green buildings. Exemplification of knowledge and different ideas about sustainable design in the building will make it effective for the users to understand a practical application and at the same time understand their responsibilities.

Chapter Three: Case studies

Based on the information gathered through pertinent literature as discussed in chapter two, and primarily guided by the LEED™ rating system for development of buildings, the following criteria help in selecting precedents that form case studies for design of the SDC:

1) Functional intent of the project; and

2) Strategies employed for the development

The precedents address various environmental concerns as part of the literature research. The case studies considered for the project are Smith Carter –SC3, Winnipeg, Manitoba and Center for Energy and Environmental Education at the University of Northern Iowa. These do not describe the program of the facility of this project to an extent as extensively as they provide the information and details as sources of sustainable developments. Indeed, explorations of sustainable ideas in the respective designs are relevant to their development, varying from the parameters of site selection, occupant health, material selection and others. Various parameters being assessed through the case studies are best described through the LEED™ rating system, currently the predominant building assessment standard in North America and, arguably, in the world for sustainable building design (Kibert, 2005, p.71).The categories under the LEED™ rating system[17] (Table 1) provide guidelines for assessment of design

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[17] LEED™ rating system project checklist is in Appendix F.

features. Various features of the case studies are looked upon through these categories to inform the development of the proposed facility.

Table 1- LEED™ rating system categories

LEED™ Rating System Categories	Credits Points
1. Sustainable sites	14
2. Water Efficiency	5
3. Energy efficiency	17
4. Materials and Resources	13
5. Indoor Environmental Quality	15
6. Innovation and Design Process	5

The case studies are further assessed through an inspection into various spaces in the projects and more specifically with a query to understand the formulation of such spaces with due regard to energy savings. The design of interior spaces gets affected due to the design of envelope and vice-versa. This is highly realised through the case studies and therefore a synchronized development with due consideration to all the disciplines simultaneously in the development is analysed.

3.1 Smith Carter - SC3, Winnipeg, Manitoba[18]

Location: Winnipeg, Manitoba
Type: Office Building
Area: 4600 sq. m

3.1.1 Overview.

The office building of Smith Carter, a leading architecture and design firm in Winnipeg provides an opportunity for understanding a sustainable approach for building construction in the local climate. The building includes office spaces, studio areas, meeting areas, break out spaces and a gymnasium and incorporates the latest green design features and is being projected as a gold rated building according to the LEED™ rating system. Further, a holistic process integrating different disciplines in the design process for the construction of the building and its interiors, provide information and inspiration to realise the goals of this project. Incorporation of LEED™ rating system strategies in the design and implementation in building construction makes it an important case study wherein a practical application exemplifies the strategies. The building is designed to respond to the environmental factors pertinent to the site. A flexible interior design of space responds to the design of the envelope of the building. Careful consideration in the material selection enhances its performance as a green building.

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[18] Linley, R., Principal, Smith Carter, Winnipeg, Manitoba. Interview with the author, 01/18/05.

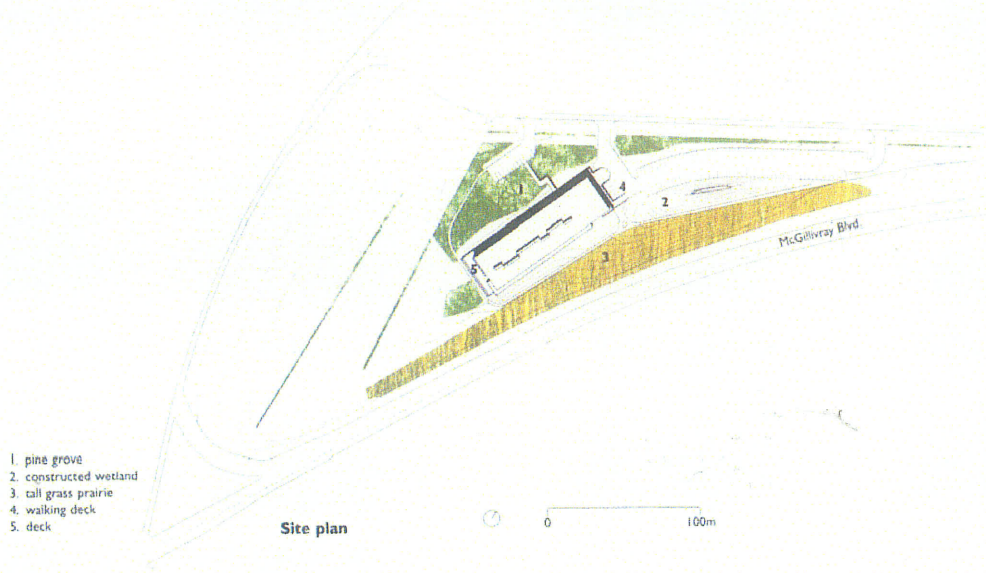

Figure 5. Site plan of SC3 office
[From Enns, 2004, p.36]

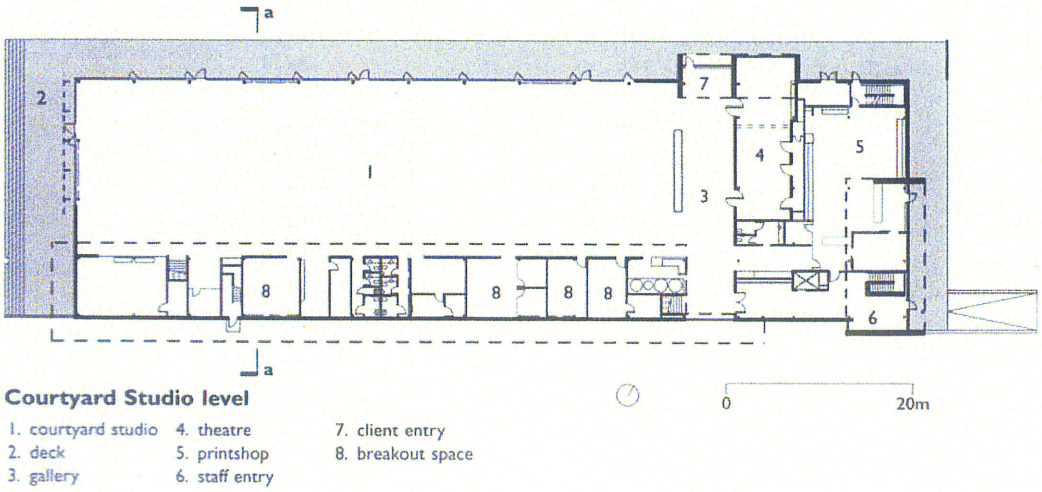

Figure 6. First floor plan- SC3 Office
[From Enns, 2004, p.36]

3.1.2 *Focus on energy.*

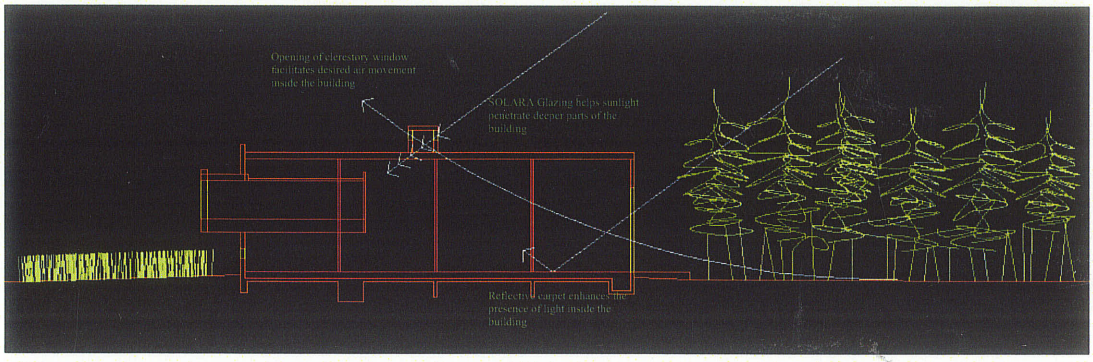

Figure 7. Sectional analysis- SC3 Office
[From the Author]

The building is designed as a linear rectangular frame encompassing an interior environment. Existing forest of spruce trees on the north-west side and native prairie grass on the south-east side surround the building. Major sustainable design considerations for the building helped achieve an optimal standard in interior environment leading towards energy savings. A collective approach to involve various disciplines from the beginning of the project gave impetus to the fact that representatives from every discipline had the opportunity to understand the objectives of moves of others according to their respective disciplines. Rick Linley[19] , one of the principals of Smith Carter and also involved in the design of this building says that, "all the people involved in the project were present in the project meetings right from the beginning." An effort to emphasise the importance of an integrated response for a solution is evident in

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[19] Linley, R., Principal, Smith Carter, Winnipeg, Manitoba. Interview with the author, 01/18/05.

the design consideration for the office. Some of the design considerations in the design of the office are categorised under the LEED™ rating system categories:

Sustainable sites

- Native prairie grass on the south-east side of the building helps maintain soil erosion, requires minimal maintenance and at the same time is self sustaining.
- The site is minimally disturbed, and retains the existing spruce trees.
- In-house bicycle storage and staff showers encourage occupants to use bicycle for transportation.

Water efficiency

- Water efficient fixtures in the washrooms reduce potable water usage.
- Dual flush toilets, waterless urinals, low-flow fixtures are powered by a battery that is recharged by the flowing water.
- Storm water is retained in an on-site pond reducing the storm-water run-off from the site.

Energy and atmosphere

- Use of geothermal energy helps reduce the heating load of the building.

Materials and resources

- Carpeting designed with embedded reflective material to reflect light in the office providing enough daylight inside the building to save energy on lighting cost.

- Steel construction makes the building completely recyclable, and endures in the long run.
- Material application of 90% recycled steel and local and rapidly renewable materials like sunflower seed board and strawboard, indicates a commitment for environmentally friendly material selection.
- Ramming of earth for flooring is done with crushed concrete from other sites, and therefore encourages resource reuse.

Indoor environmental quality

- Flexible office stations encourage collaborative and adaptable working environments.
- Light sensors on the exterior of windows control the shades and blinds.
- Raised flooring incorporating air distribution system helps in distributing fresh air throughout the building.
- Individual control for furniture, lights and indoor environmental quality provides freedom to the occupants to control their surroundings.
- CO_2 monitoring system inside the building helps maintain the indoor air quality.
- Recycling at individual workstations is encouraged.

Innovation in design

- Open clerestory windows in the centre along the cross section of the building allows for flexible cross ventilation throughout the occupied spaces of the building.

- Glazing for solar panels with the high efficiency polycrystalline solar cells aid in increasing the daylight inside the building.
- Moisture sensors on the roof, integrated with the building management system, close the windows automatically when there is a possibility of rain.
- Modular frame construction of the building helps to makes it easier to reassemble the building after deconstruction.

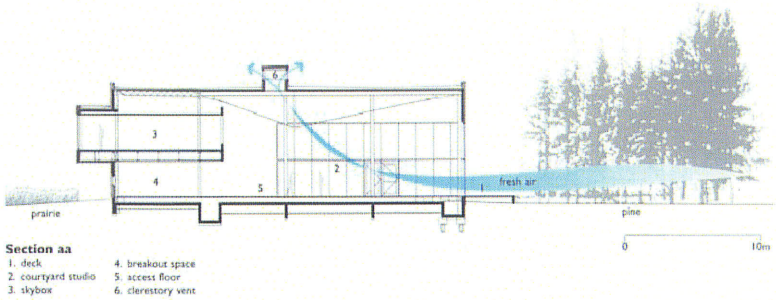

Figure 8. Section – SC3 office
[From Enns, 2004, p.38]

3.1.3 Summary

Investigation of Smith Carter's office building provides an opportunity to assess the implications of sustainable means for building construction in Winnipeg's climate. The response of one discipline to the other has led to an effective end result wherein the interior design, architecture, landscape architecture, mechanical design and so on participated in the design process from the beginning of the project. The workspaces provide greater flexibility in terms of controlling spaces as well as the environment. Adoption of LEED™

rating system as a guideline for the project provides information for implementing the same for a design solution. Energy efficiency in the office exceed the Model National Energy Code by 55% and saving the firm $36,000 in the 2005 in operating costs[20].

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[20] Outside the Box Awards

3.2 Centre for Energy and Environmental Education, University of Northern Iowa, Cedar Falls, Iowa[21]

Location: University of Northern Iowa, Cedar Falls, Iowa
Type: University classrooms, laboratories and offices
Area: Building- 2600 sq. m

3.2.1 Overview.

Centre for Energy and Environmental Education (CEEE) at the University of Northern Iowa is a resource centre for developing and disseminating educational research knowledge on energy and the environment. Its mission is to:

- Nurture an environmental ethic and develop environmental literacy in children and adults.
- Provide in-service training site for professionals and academicians in these fields.
- Contribute to the educational mission by demonstrating this ethic and associated environmental design principles through the building.
- Make the building a tool for teachers to use in curriculum development, used in the centre for students.

The building includes a reception/exhibit area, an auditorium, indoor and outdoor classrooms, labs, a curriculum resource centre, study areas, offices and meeting areas. Design development of the centre is done with a pre design

[21] Kulman & Schurke, 2001

comparison of a climate-rejecting base model design (Figure. 10) with a climate responsive design (Figure. 11). This consideration provides an opportunity to understand the development of the envelope of the building. The design simulations conducted to assess the effects of various natural parameters on the form and function of the building support a climate-responsive envelope. In these considerations the interior and the exterior spaces are developed simultaneously by focussing on a holistic approach for building design involving a collective effort from contributing disciplines.

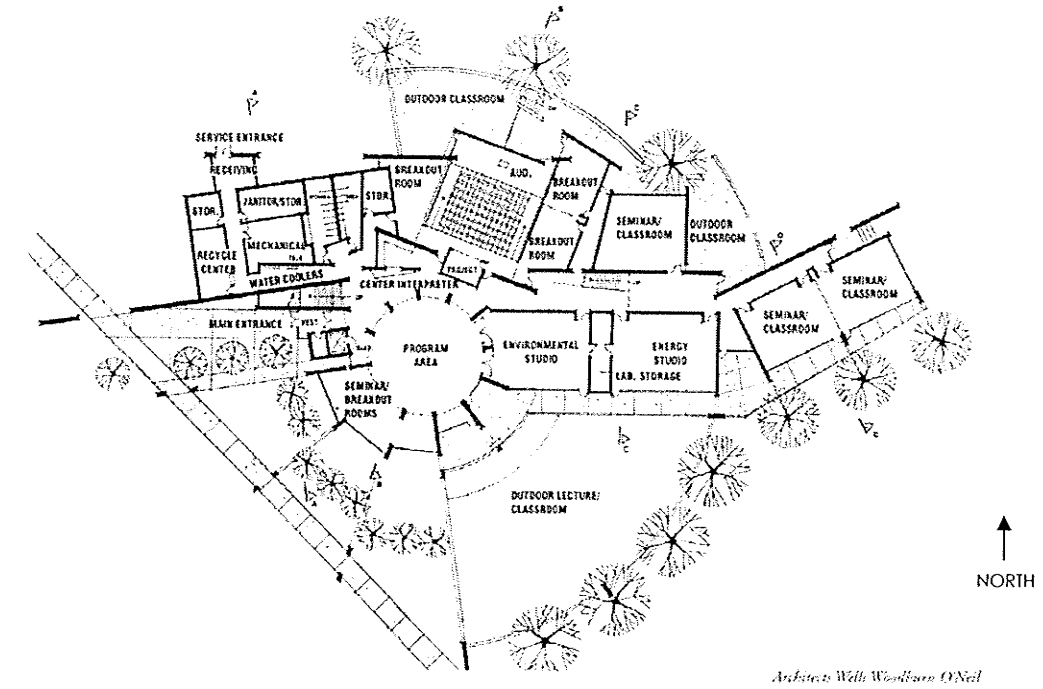

Figure 9. First floor plan-CEEE
[From Kulman & Schurke, 2001,p.28]

3.2.2 Focus on energy.

The most important aspect of the design was considered in developing the shape of the building. The reference case for the facility was a square plan

(Figure 10) that had no special elements and was not open to the climate. After a careful analysis of the square plan, a contrary approach established the first schematic design that was shaped to receive light and heat from the sun (Figure.11). The unique form of the building takes shape by responding to the environment as dictated by the site and directions.

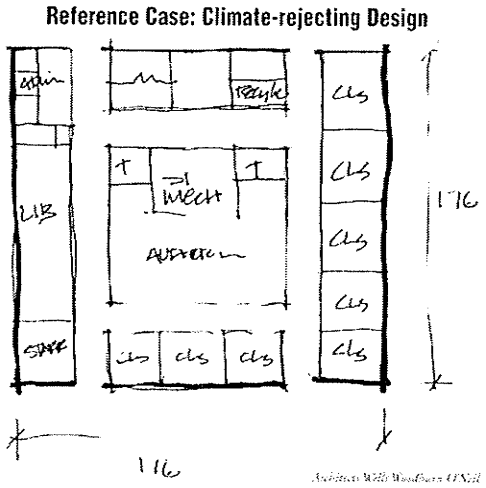

Figure 10. Schematic plan, reference case- CEEE
[From Kulman & Schurke, 2001, p.31]

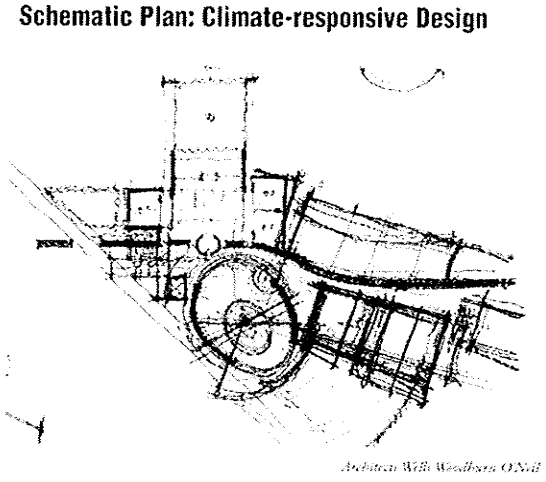

Figure 11. Schematic plan, climate responsive design - CEEE
[From Kulman & Schurke, 2001, p.31]

Thermal simulations and large-scale physical daylighting models were invaluable for evaluating and modifying alternatives throughout the design process. At the end of schematic design, energy consumption results were compared with the reference case and proved energy savings, as shown in Figure 12.

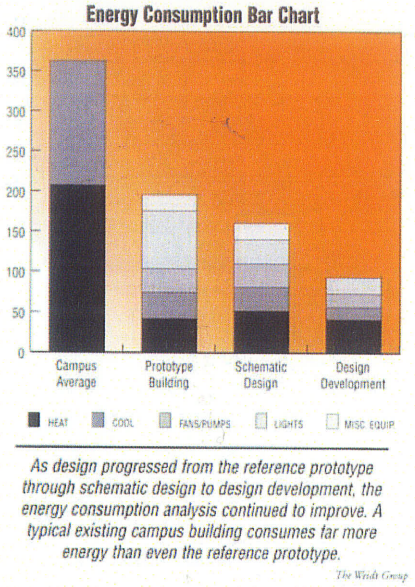

Figure 12. Energy consumption bar chart
[From Kulman & Schurke, 2001, p.29]

The basic considerations for the development of the form of the building included:

- The building is elongated on the east-west axis, with most of the glazing to the south and minimal glazing to the north.
- The structure designed as 1-1/2 stories to reduce the envelope area and footings. It is limited to 1-1/2 stories to maintain its low, horizontal relationship with the prairies landscape.

Apart from this, considerations in the design are categorised under the LEED™ rating system:

Sustainable sites

- The building makes strong spatial connections to site features, inviting students and faculty to the outdoor classroom and study areas.

Water efficiency

- The prairie landscape, with its low irrigation needs, reduces water consumption, and the limited paved areas minimize the need for storm-water management.

Energy and atmosphere

- A central corridor lined with thermal mass allows passive solar heating.
- Occupancy sensors respond to variations in occupancy and saves energy accordingly.
- Window overhangs protect the corridor against unwanted solar gain.

Material and resources

- Limestone used for the central mass wall is a local product.
- Recycled-content materials are used for some of the insulation, carpeting and wallboard.

Indoor environmental quality

- Indirect lighting provides equivalent visual performance as direct lighting but at lower foot-candle levels.
- Indoor environmental quality is enhanced with daylight and natural ventilation

Innovation in design

- Embodied energy, environmental impact, indoor air quality and building energy are highly considered in the selection of materials.
- Custom monitoring in the building regarding its energy-conserving features become tools for teaching the users about sustainable ideas.

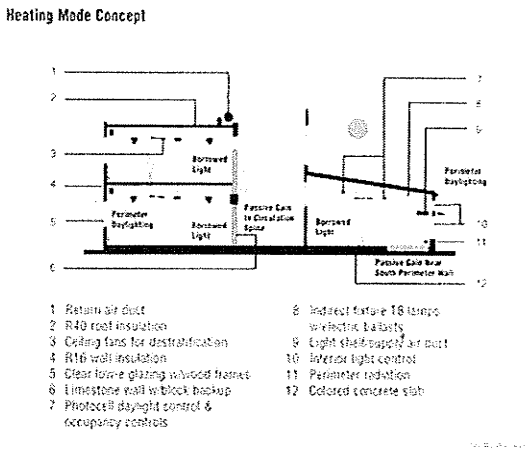

Figure 13. Section, Heating Mode Concept- CEEE
[From Kulman & Schurke, 2001, p.30]

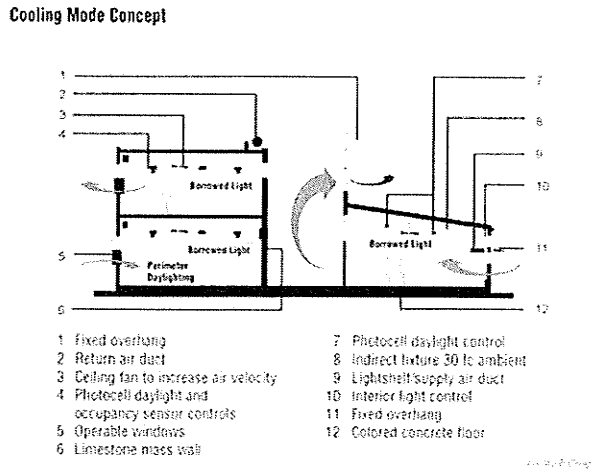

Figure 14. Section, Cooling Mode Concept- CEEE
[From Kulman & Schurke, 2001, p.30]

3.2.3 Summary.

The ability to simulate, model and quantify design alternatives and components helps to distinguish between high and low-value alternatives. The focus on energy led to a variety of benefits through adoption of simulation media. The reduced embodied and operational energy results in fewer pollutants and carbon dioxide emissions entering the environment. The client's estimated energy cost-savings are more than 50 percent per year over an efficient standard[22]. The energy-conserving features and accompanying custom monitoring become teaching tools by being an informative interface for the users in the building and aid in the intentions of spreading knowledge about the building's functions as a sustainable solution.

3.3 Summary of Case Studies – Informing Design

The strategies employed in the two case studies provide opportunities and consideration to comprehend design considerations encompassing the natural elements so that environmental impact through building use is minimized. This is further enhanced by relating respective designs to the LEED™ rating system that incorporates various design strategies for achieving efficiency and increasing environmental responsiveness. All the necessary measures and steps taken during the design process highlight the need for reducing energy use in the buildings, especially in the use of simulation media for CEEE as it predicts a combined effect of different strategies even before the building is

[22] NCARB, 2001, p.35

made. Apart from considering the passive design strategies the case studies address the need to conserve resources and their skilful application in the design of buildings. The case studies inform the progress of the SDC in the following:

- Site selection;
- Building form;
- Interior design;
- Spatial relationships;
- Strategic passive design; and
- Design process.

Chapter Four: Project Overview and Contextual Analysis

4.1 Project Overview

The Winnipeg Design Centre (WDC), as part of a collaborative approach between the Faculty of Architecture at the University of Manitoba and the Winnipeg City Council[23], is a proposed development in downtown Winnipeg. The centre provides opportunities towards achieving the goals of this practicum project in terms of establishing an educational outreach for the community in Winnipeg and therefore, a possibility of WDC becoming an educational outreach for the Winnipeg community is explored. Public interfacing with an educational outreach is highlighted through SDC because of an active public involvement proposed for WDC. WDC aims to[24]:

- Provide design advisory resources to groups and individuals,
- Provide design advice to the City Council,
- Involve students in real projects,
- Hold design workshops in city neighbourhoods; and
- Enhance the importance of design in the community.

Being a studio workplace for students, an institution for professors and professionals, and a public space to educate, the centre is proposed to become a hub of activities in which active participation of users occur where each group

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[23] Witty, D. (2004). Dean, Faculty of Architecture, University of Manitoba. Interview with the author 06/16/04.

[24] Blake, S. (April 2004). Associate Professor, Department of City Plannning, Faculty of Architecture, University of Manitoba. Interview with the author 04/27/04.

has a specific role pertinent to sharing and contributing knowledge to the society. WDC thus provides ample opportunity to generate awareness for sustainability in buildings among its users.

Based on the purpose of attaining the goals of SDC the program and requirements are acquired from WDC and modified based on responses to a questionnaire[25] specifically prepared to address the concerned issues pertaining to SDC. Though the collaboration is looking for an existing interior space to establish the facility, I have proposed a new building with its design based on an exploration of sustainability. This has allowed me to incorporate various features in the design of the building that relate and respond to environmental factors to achieve an optimum level of sustainability through the design and to use them as a part of the education in the centre. The case study analysis (chapter three) provides key principles to inform the design development of SDC on the lines of sustainability.

4.1.1 Project programme.

The programme for WDC is to be proposed with various stakeholders[26] inputs for the requirements. The programme compiled for SDC corresponds to this by involving representation of various stakeholders in developing the program for the project. This is done through a collective consideration of views, using an open-ended questionnaire, of a group of people from varying

[25] see Appendix A
[26] para.1,p.53

professional backgrounds namely interior design, architecture, landscape architecture and city planning[27]. The questionnaire was developed in four categories as mentioned in Table 2 (p.52) and comprises of varied intentions to gather concerns and recommendation for SDC that are specifically intended for Winnipeg. Figure 15 represents the flow of processes to arrive at the programme for the SDC[28].

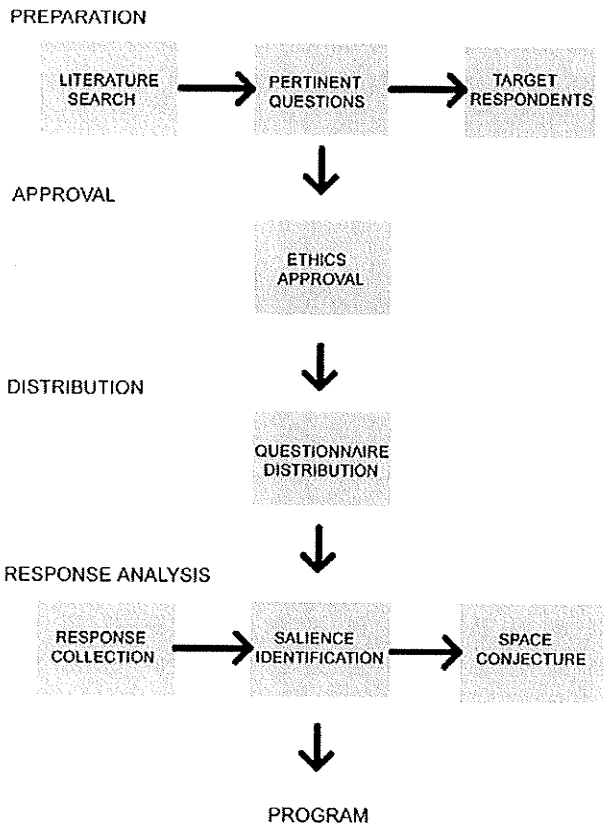

Figure 15. Process flow in program development
[From the author]

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[27] see Appendix C for list of respondents
[28] see Appendix D for project introduction to respondents

Table 2- Four categories of the questionnaire/intentions

Question Categories	Intentions
Issues	Primarily intended to acquire concerns in the built environment pertaining to sustainability
Services	To comprehend various services that the SDC could possibly offer through its functioning in the Exchange District of Winnipeg, and relate it towards the program of the facility
People	To know various groups of people who could access the centre and avail its services
Results	To comprehend the effect of establishing a facility like SDC in Winnipeg and how it can relate to the issue of sustainability

The replies to the questions address program development and design of the facility and assess the scope of the project. The responses to the questions are presented in Appendix B. In addition, the case studies address some of the key features for the development of various spatial functions.

Responses to the open-ended questions provide insight into various spatial and functional considerations to develop the centre and therefore address the requirements and needs for its functioning. This is achieved through identification of salience in the answers. A salience refers to the importance of an issue in people's minds (Sommer & Sommer, 2002, p.137). Table 3 describes various identifications through the responses. The salient categories refer to a conjecture towards defining the spatial and functional aspects of the centre and

therefore the categories broadly classify intended spaces for the centre and indeed a comprehension of the programme for the facility.

Table 3- Salience identification based on questionnaire response

Salience Identified	Conjectured Spaces and Components
Knowledge resource / Information dissemination	Library, Audio/Visual interface
Projects on display	Exhibition / Gallery area
Design recommendations	Interaction area, Studio area
Design Research	Studio area
Community involvement (visible and active engagement)	Public spaces and transparency
Revenue generation	Café / Renting spaces for display, workshops (Flexible space)
Continuing education	Classroom(s)

Following the conjecture for formulating various spaces and functions in the facility, importance is given to realising the form of the building that responds to:

1. An effective functioning of various spaces collectively; and

2. Addressing various environmental factors affecting the building form.

Conjectured spaces are categorised under public and private spaces in order to keep the functions broadly under respective precincts of public and private. To reduce the building footprint on the site, spaces are identified for being accommodated on the first and second floor of the building. Considering the pedestrian movement and access to the centre in the area the first floor is conceived as a public space; while studio spaces and adjoining other related

spaces to the studio are more orientated towards accommodating students and their work in the centre and involve least public participation or activity; therefore it is primarily a private space. This analysis leads to formulating the first floor as a public space while the second floor is considered as a private space for the centre.

Based on the occupancy as required for the WDC, approximate occupancy levels for major areas are identified in the first and second floor of SDC and are listed in Table 4. A detailed representation of functions in the spaces and relation to other spaces on the respective first and second floor is in appendix D. Relations of various areas on each floor are shown in Figure 16 and 17.

Table 4- Major spaces on the first and second floor and approximate areas

Space Identified	Approximate area	Remarks
Exhibition Area	110 sq.m	Exhibition, Presentations
Library	130 sq. m	Study, Resource
Cafe	165 sq. m	Revenue generation, Informal gatherings
Interaction Area	65 sq. m	Discussions
Studio	90 sq. m	Work area for students
Break Out Area	70 sq. m	Group work and discussions
Review Area	40 sq. m	Design work review, critique
Classroom	75 sq. m	Knowledge sharing

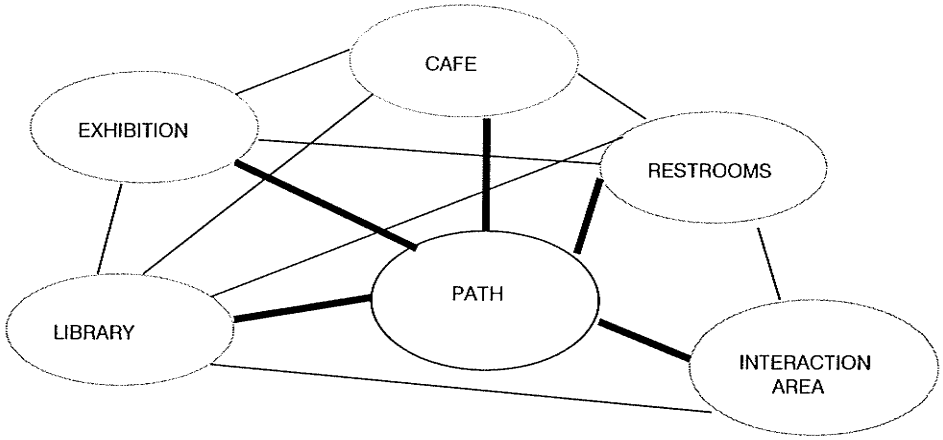


Figure 16. Diagrammatic representation of relationships of various spaces on the first floor
[From the author]

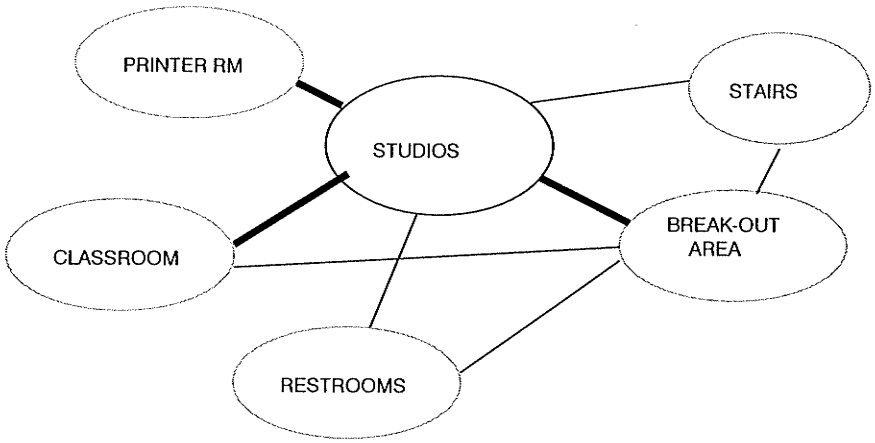


Figure 17. Diagrammatic representation of relationships of various spaces on the second floor
[From the author]

After identifying the relations of various spaces on each floor a schematic design based on the four directions; movement of sun, prevailing wind patterns,

water flow in the area provides a massing (Figure 18) that depict a combination of various spaces on the first and second floor for the proposed facility that addresses the functionality and form for the same.

4.2 Local Context: Winnipeg

Various parameters govern the development of the centre in the confines of the City of Winnipeg. Climate, site location, design guidelines and others affect the decisions for the proposed facility. The following section discusses some of the features under consideration for the design of the proposed facility upon selection of a suitable site.

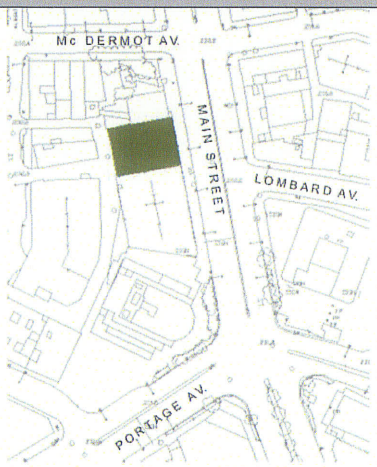
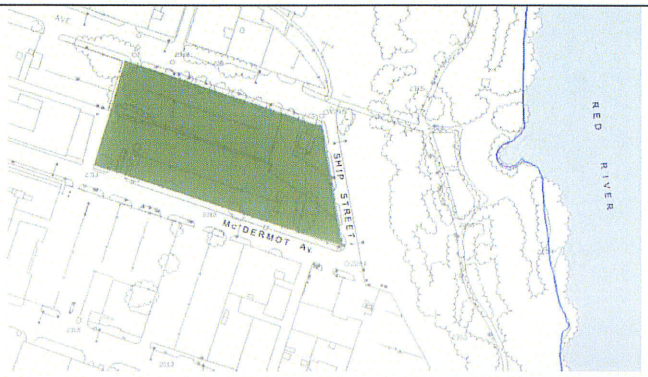
4.2.1 Site selection.

The initial factors for the selection of a site for SDC follow criteria based on the factors of choosing a building for WDC. With the intention of having the centre in the downtown core, the following features were considered for establishing the facility:

1. Proximity to City Council offices.
2. Close to transit routes.
3. Close to offices in the downtown.
4. Pedestrian access.

This led to the selection of possible options for a project site as presented in Table 5.

Table 5- Possible site options for developing the SDC

Site	Layout	Features
1		Main Street Plot Size : 6762 sf Open to three sides Current Use : Vacant Opposite Millennium Centre
2		Intersection of Notre Dame Avenue and Garry Street Plot Size: 29, 348 sf Open on all sides Current use : Parking Lot
3		Intersection of McDermot Avenue and Ship Street Plot Size: 73,915 sf Open on all sides Current use : Parking Lot

The factors leading to selection of the possible sites were condensed to choose a final site and site 3 was selected for the project. Apart from meeting

the above-mentioned criteria it provides additional features worth consideration in developing and meeting project goals. Site 3:

- Provides ample open space for the confluence of natural elements and their best use for a suitable sustainable solution.
- Has proximity to the Forks- a public gathering attracts a pedestrian population into the site.
- Most of the new building projects in the area are residential condominiums along with street level retail spaces, and are planned to achieve sustainability (Figure 18), therefore the growing impetus of green buildings is realized in the area.

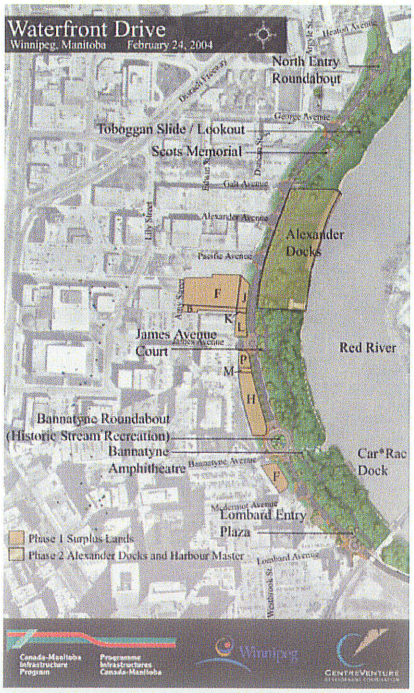


Figure 18. Impending developments along the waterfront drive and next to the project site

[From Russell, M.G., President, McGowan Russell, Winnipeg, Manitoba. personal communication, September 25, 2004.]

The chosen site also aids in the efforts of Exchange District strategic action plan developed by the Exchange Partnership[29] in1996 by considering the improvement of exchange through:

1) Incorporating an artist's quarter;

2) Improving access to the river bank;

3) Supporting a civic campus in the Exchange; and

4) Improving linkages among exchange, downtown and the Forks.

With a large number of people accessing the region due to its proximity to public spaces, major transit routes and landmarks in Winnipeg, SDC in the chosen site is perceived as a model of sustainable design with an opportunity to spread knowledge about sustainability in the community and enhance the character of the city. It can be foreseen that the development of SDC, knowledge about sustainable design can reach a wide range of people in Winnipeg.

63

[29] Exchange Partnership, September 1996. see reference

4.2.1 Site analysis.



Figure 19- Site Location

[From Planning Property and Development Department, City of Winnipeg, October 2004 with modifications by the author]

Climatic Data (Canadian Climate Normals)

Latitude: 49.55° N

Longitude: 97^0 13' W

Elevation: 238.7 m

Table 6- Average Climatic conditions in Winnipeg
[From: Canadian Climate Normals]

Temperature: Temperature:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Average (°C)	-17.8	-13.6	-6.1	4	12	17	19.5	18.5	12.3	5.3	-5.3	-14.4	2.6
Rainfall (mm)	0.2	2.5	7.5	21.5	58	89.5	70.6	75.1	51.9	31	6.1	1.6	415.6
Snowfall (cm)	23.1	14.2	15.8	10.1	0.8	0	0	0	0.4	5	21.4	19.8	110.6
Precipitation (mm)	19.7	14.9	21.5	31.9	58.8	89.5	70.6	75.1	52.3	36	25	18.5	513.7
Average Snow Depth (cm)	18	20	13	3	0	0	0	0	0	0	5	10	6
Speed (km/h)	17.1	16.7	17.7	18.4	17.9	16.4	14.6	14.9	17.1	18	17.4	17.1	16.9
Most Frequent Direction	S	S	S	S	S	S	S	S	S	S	S	S	S

Solar Movement

- Average Photoperiod: 16hrs in Summer; 8 hrs in Winters
- Solar Noon Sun Angle on the Summer Solstice (in June): 63.5°;
- Solar Noon Sun Angle on the Winter Solstice (in December): 16.5°
- Solar Noon Azimuth: 180°

Wind Direction

- The prevailing wind is towards the south and the secondary winds are from the southwest.
- In summer strong winds from the southeast through south wind directions accelerate between the tall buildings south of Portage and Main.
- Near the Richardson Building winter peak gusts are predicted to reach approximately 80 km/h once per month.
- During the summer months, the existing densely planted deciduous trees create a wind environment enjoyable to pedestrians.

Water Flow

- The stormwater flows from the west end of the site towards the east end, establishing an inclination of the site towards east.

Data acquired from Environment Canada is charted in Table 6 and highlights various climatic aspects of Winnipeg. Following the site analysis, and schematic design approach as discussed in the spatial blocking, design development for the SDC is conceived and is discussed in the following section.

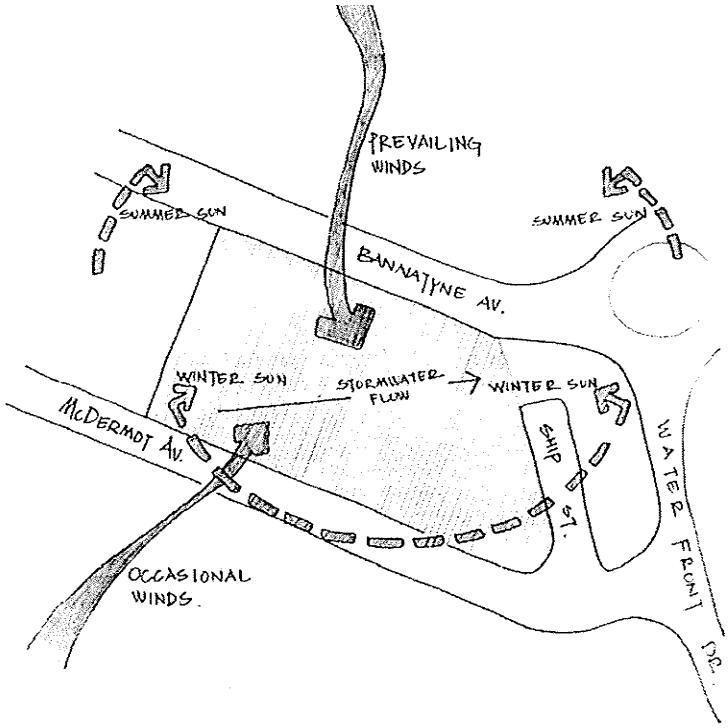


Figure 20. Schematic drawing of site analysis
[From the author]

Chapter Five: Design Approach

5.1 Holistic Approach

A holistic approach emphasises the issue of designing with due consideration to the interior and exterior spaces together to respond to environmental concerns by involving various disciplines in design development, as every aspect of the development defines the final outcome. Jack Robertson points out:

> You can't design a spare-part without understanding what the machine should look like, and you can't conceptualise the overall machine if you can't design a spare part. (Correa, 1999, p.7)

With a view towards the end product as a collective whole, conceptualisation of designing smaller or larger parts of a building with due consideration to each other, imparts the wisdom of conceiving the interior design and other aspects of a building design as related and dependent on one another for a holistic development. Design of a wall on the south side of the building will be dependent on the location of sun, direction of wind, the effects of the same in the adjacent interior spaces and so on and so forth. Similarly, other considerations are dependent and related to each other. The whole development is conceived as a unitary process involving the concerned disciplines in simultaneity.

5.2 Designing for Education

The way humans perceive a building and surrounding environment is a primary consideration in formulating a strategy for the design of the facility. The intention of spreading knowledge about sustainability being the primary focus, initiates the concept of making the building readable to the human psyche. Mayerovitch explains that we look at buildings to recognize whether it can serve our physical needs and whether we can enjoy what it offers, and to achieve this understanding we are blessed with a highly sophisticated set of faculties, namely our senses, our reasoning and our emotions (Mayerovitch, 1996, p.18-21). Formulation of design ideas for presenting knowledge about the centre considers that a greater understanding of design is manifested through the visual, emotional and physical senses.

Gibson's affordance theory considers that we perceive in order to operate on the environment and that perception is designed for action. He terms the perceivable possibilities for action as affordances (Ware, 2000, p.22). The design of any space is conceived as a set of affordances for the users to understand and act upon the information the space provides. The interior spaces are designed in simultaneous consideration for the architecture, therefore the design of spaces, services and components collectively affords users to understand the concept of sustainability in buildings.

According to Norman (1990) psychologists believe that people function through their use of two kinds of knowledge: 'knowledge of' and 'knowledge

how'. He suggests that 'knowledge of' is declarative and includes knowledge of facts and rules, and that this knowledge is easy to write down and to teach, while 'knowledge how' is procedural and enables a person to perform and that this knowledge is difficult or impossible to write down and difficult to teach (Norman, 1990, p.57-8). Most of the knowledge about sustainability in buildings is based on facts and rules and depends vastly on the design and spatial functions of spaces as the building is designed in congruence to respond to natural elements as manifested through the spaces inside. This makes sustainability easy to portray to the users for understanding.

5.3 Design Strategy

Implying the affordance theory, the spaces in the interiors are configured into three categories to afford understanding for the users:

1) Design;

2) Services; and

3) Components.

A design strategy is established through the design of a space, the services rendered in it, and the components or the objects and materials associated with the space.

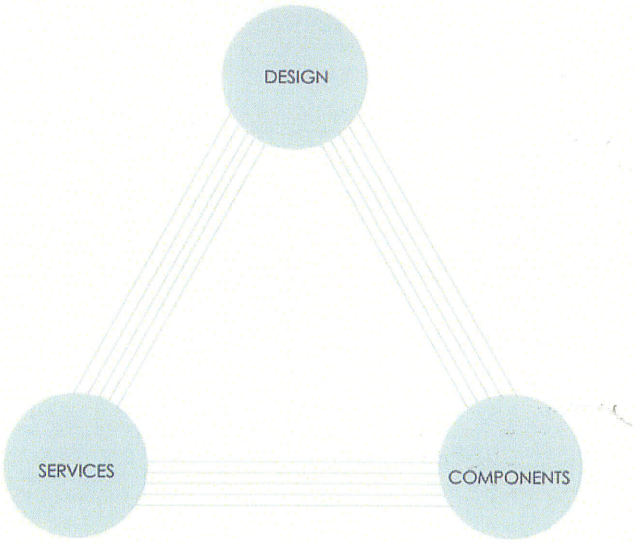


Figure 21. Design strategy- concept and approach
[From the author]

This is best described through Figure 21 that summarizes the entire design strategy, wherein the categories of design, services and components are connected through sustainable design approach to facilitate understanding for sustainability. Knowledge of sustainability as an affordance of this configuration of the three distinct categories facilitates the approach for conceiving the interior design of the spaces in the building. For example, the exhibition space (Figure - -) is designed as a flexible space to display exhibits carrying information pertaining to sustainable issues and at the same time the space gets converted so that workshops, charrettes and other discussion forums could be held as and when needed. The scope of events that can happen in this space can be categorized under the three categories as following:

1) Design: Orientation, Functional feasibility, Form generation, Relation to adjacent spaces
2) Services: Design workshops, Discussion forums, Exhibitions
3) Components: Material application, exhibits, objects

Hence, combinations of various spheres of consideration lead to a continuum of ideas that affords an understanding about sustainability and raise awareness among its users. Importance is given to incorporate various sustainable strategies to facilitate energy savings and reduce environmental impact as followed through the LEED™ rating system categories.

The design concept is developed out of the programming for the project. A conceptual model in Figure 22 describes the approach for a design solution. Blocking of identified private and public spaces is done so that the first floor remains a public space by being open to the public while the studio and work spaces being more private areas for the students remain on the second floor,

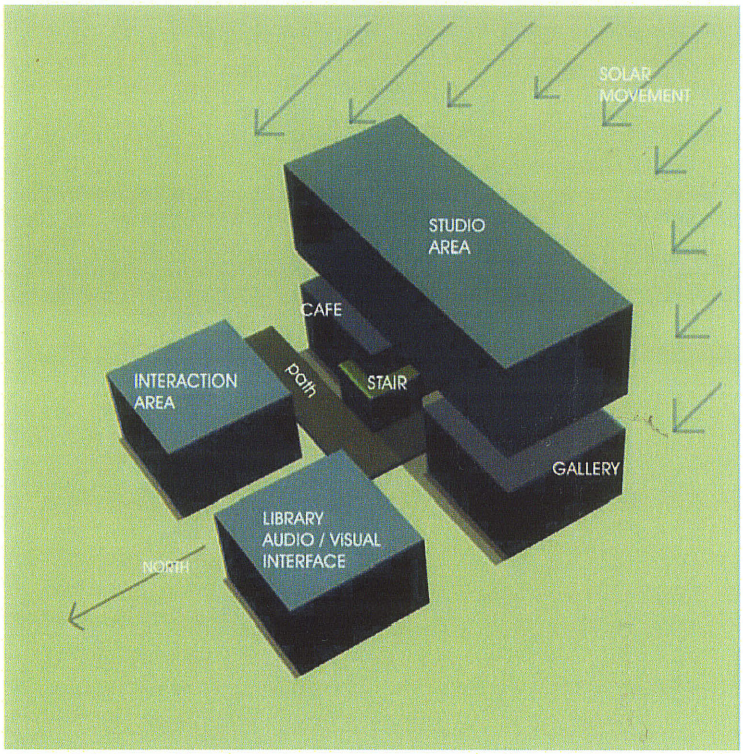


Figure 22. Blocking of various spaces for the centre.
[From the author]

Presence of a consistent level of intensity of light from the north aids in the allocation of Library with audio and visual interface area on that side. The gallery on the south-west side involves a flexible space for various functions and flexible openings on the west allow natural light in the space. The south façade prominently involves the presence of varying level of sunlight over its surface, and therefore the envelope on this side is conceived as a surface to tap into solar energy. Provision of solar panels on the south side generates energy for the facility. The east side has openings allowing light inside the building and providing a view towards the scenic Stephen Juba Park and the nearby Red river. The studio space on the second floor maximizes the south facade area

along with the facade area in the first floor to install the solar panels in continuity. This configuration gives a basic blocking of various spatial needs and is informed by various disciplines in simultaneous considerations.

5.4 Facility Design

The incorporation of principles, guidelines, theory and the requirements prescribed by the programming help establish a strategic combination of various functional aspects of the centre into a formidable practical design that respects sustainability. The design is facilitated through acknowledging the four directions and presence of the natural elements with respect to them.

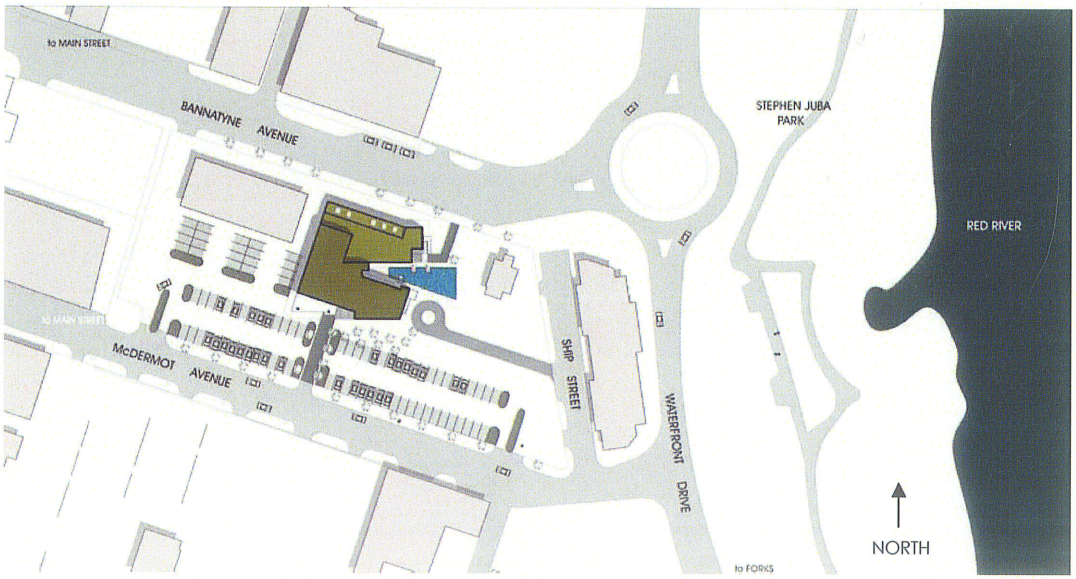


Figure 23. Site plan- SDC
[From the author]

The entrance to the facility is from both the McDermot avenue and the Bannatyne avenue (Figure 23) and is kept pedestrian through the centre which gives a strong directional flow into and out of the centre and respects the grid

pattern of urban design guidelines[30] with the pathway from McDermot avenue being perpendicular to the avenue and the path from the Bannatyne avenue being parallel to the grid directions. A separate entrance to the site from McDermot avenue for the vehicles lead to the parking lot proposed for the facility and apparently for a housing facility recommended as a future development in the site on the west end.

First Floor

The entrance to the centre from the south west end is connected to the entrance at the east end by a primary path inside the centre (Figure 24). The path is designed so that the users are made aware of the directions with respect to their positions inside. This helps in affordance of orientation in a space, and hence establishes a connection between the design and directions. Most of the functions in the facility branch out of the main path. The circulation pattern as facilitated by the path is shown in Figure 25.

[30] Caldwell, L., Senior Urban Designer, City of Winnipeg, Winnipeg, Manitoba. personal communication, April 25, 2005



Figure 24. First floor plan- SDC
[From the author]

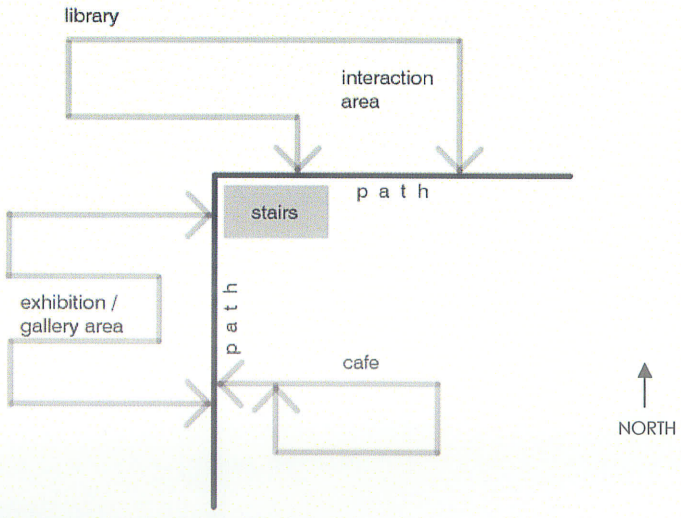


Figure 25. Circulation flow in different areas of SDC on the main floor
[From. the author]

On entering the facility from the south, the vision is led to the reception desk of the library at the end of the path. The view from the east end entrance leads the user to the wall behind the exhibition area that has pertinent information of events and activities in the centre. The flooring and arrangement of the furniture responds to the movement of sun from east to west and the envelope is designed to facilitate natural light into the building as conceptualised through basic blocking of spaces for the building. Exterior surfaces are also proposed to be used as billboards during night time for revenue generation. To ensure fresh air intake from the north side due the prevailing winds a band of operable openings at a height of 750 mm from the ground are designed that can be closed or opened to manage the airflow inside the centre (Figure 26).

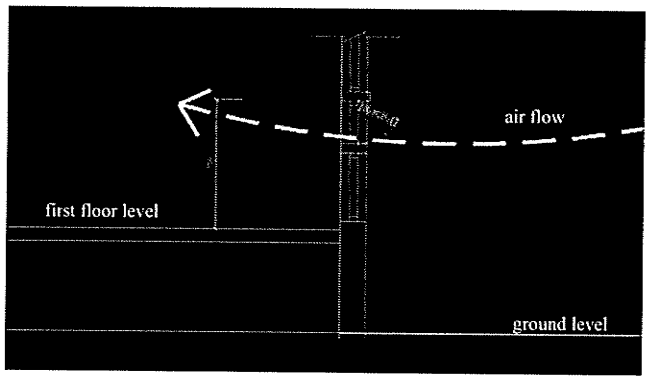


Figure 26. Openings on the north side allow fresh air movement in the interiors [From the author]

Raised flooring system ensures that fresh air is released at the floor level and used air leaves above the habitable space (Figure 27). Photo sensors in the

building adjust the lighting levels in the interiors of the building by responding to changing levels of natural light.

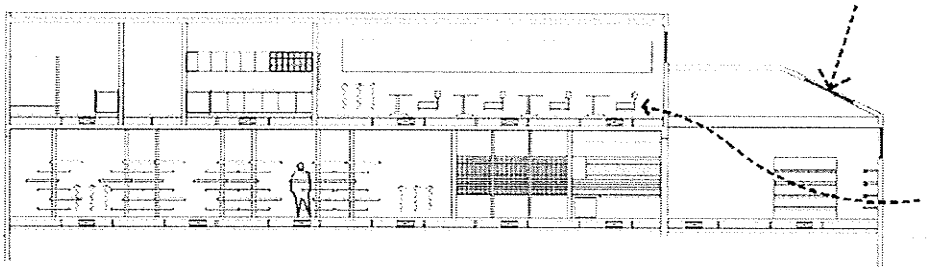


Figure 27. Cross-section across the north-south axis shows access flooring. [From the author]

Library & Interaction Area

The library (Figure 28) is conceived as a knowledge resource and is coupled with the interaction area. The shelving aisles along the wall and in the centre with carrels in between create a space for concentration and study. The artificial lighting over the carrels along with the ambient natural and constant north light enhances the study spaces. Space for a librarian is allocated next to the library. In the interaction area the clients interact with the students and others in the facility and discuss design considerations and are helped with specific concerns. The building design of the facility itself acts as a model to define certain strategies of sustainable building design.

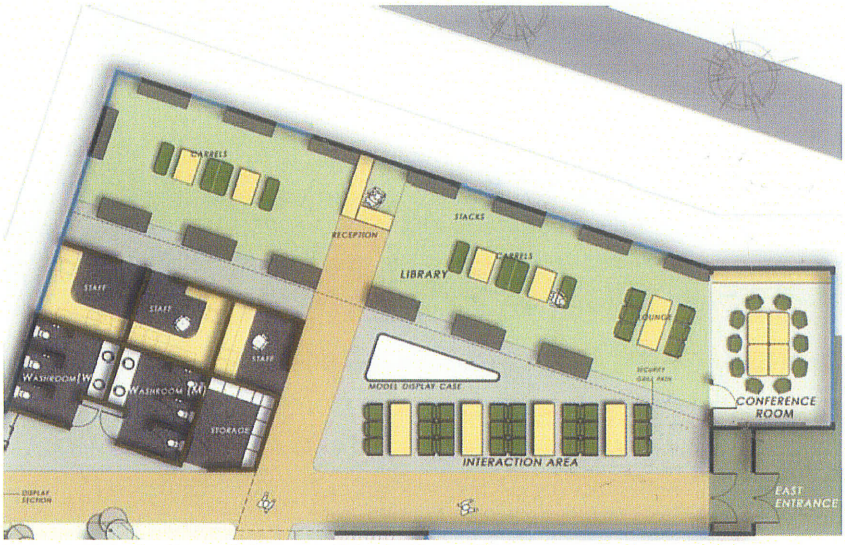


Figure 28. Library and Interaction Area on the first floor
[From the author]

Exhibition Area

The exhibition area (Figure 29) is designed as a flexible space to display exhibits carrying information pertaining to sustainable issues and at the same time it gets converted to space that can hold workshops, charrettes and other discussion forums as and when needed. The circular display-units provide surfaces for displaying while when stacked they form a working surface as a table for holding other functions in the space.

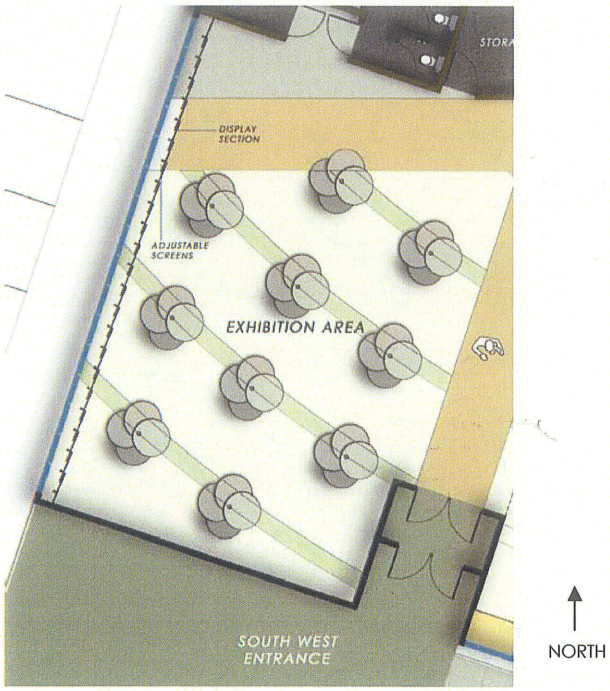


Figure 29. Exhibition Area on the first floor
[From the author]

Café

The café is primarily intended to generate revenue for the functioning of the centre, as the location of the centre provide ample opportunity to attract office going population in the area. Apart from this, proximity to the Forks may encourage more people to come to the SDC as a destination. The café would serve beverages and snacks.

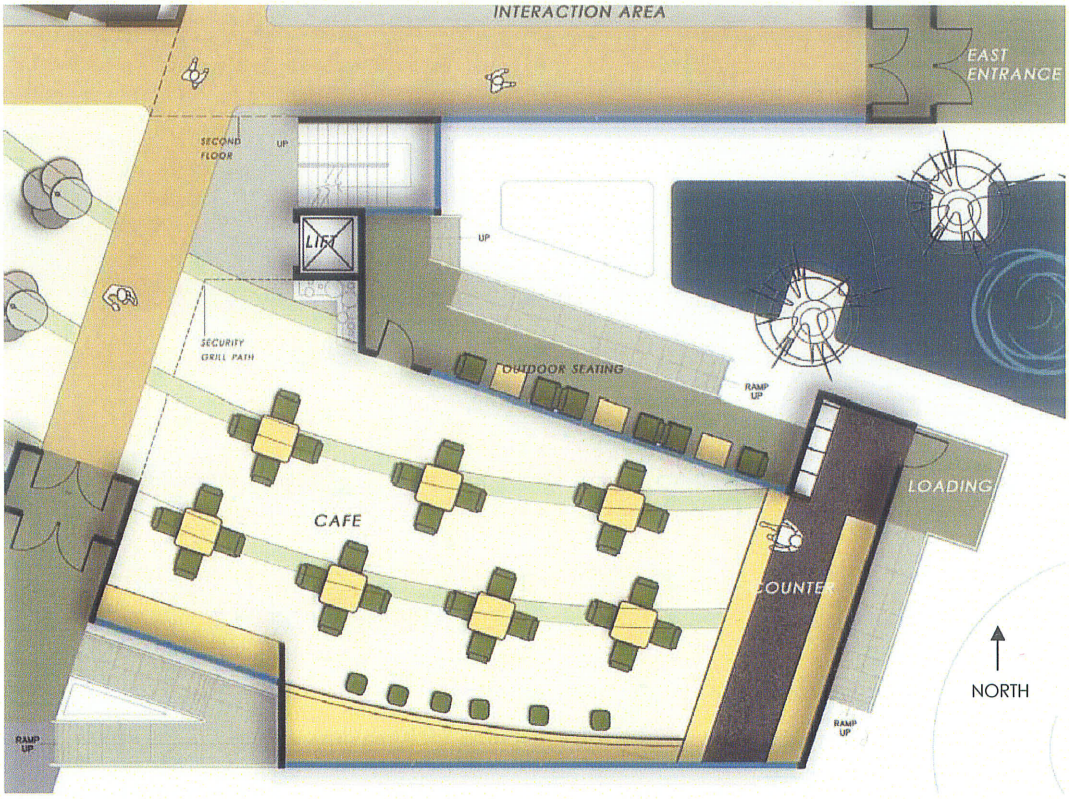


Figure 30. Cafe on the first floor
[From the author]

Second Floor

The circulation pattern for the second floor is determined by accommodating various spaces as per the requirement. Figure 31 describes the relation of various spaces as per the flow of circulation. The flooring pattern is intentional and depicts the solar movement along the day. The furniture is arranged accordingly (Figure 32).

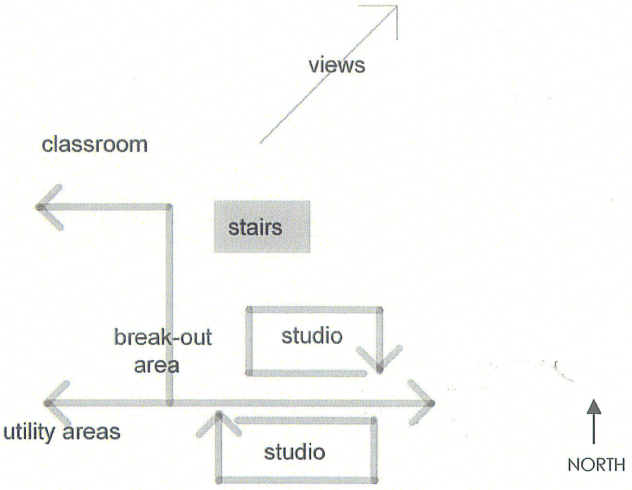


Figure 31. Circulation flow in different areas of SDC on the second floor
[From the author]

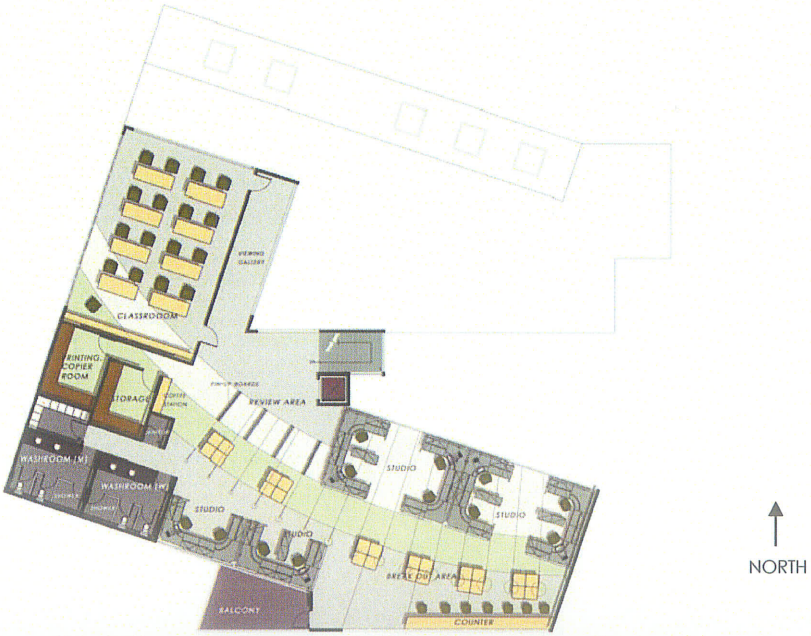


Figure 32. Second floor plan- SDC
[From the author]

Studio

Work areas for students are designed in the form of office workstations with accessibility to computers and drafting boards at the same time. A strong intentional design involving the furniture set up, flooring and lighting design set up affords the users to understand the movement of sun along the south façade of the building. The external wall along the studio spaces features photovoltaic cells and therefore a correlation of solar movement and presence of the cells could be understood. The studio spaces are coupled with other spaces such as the review areas and break out areas.

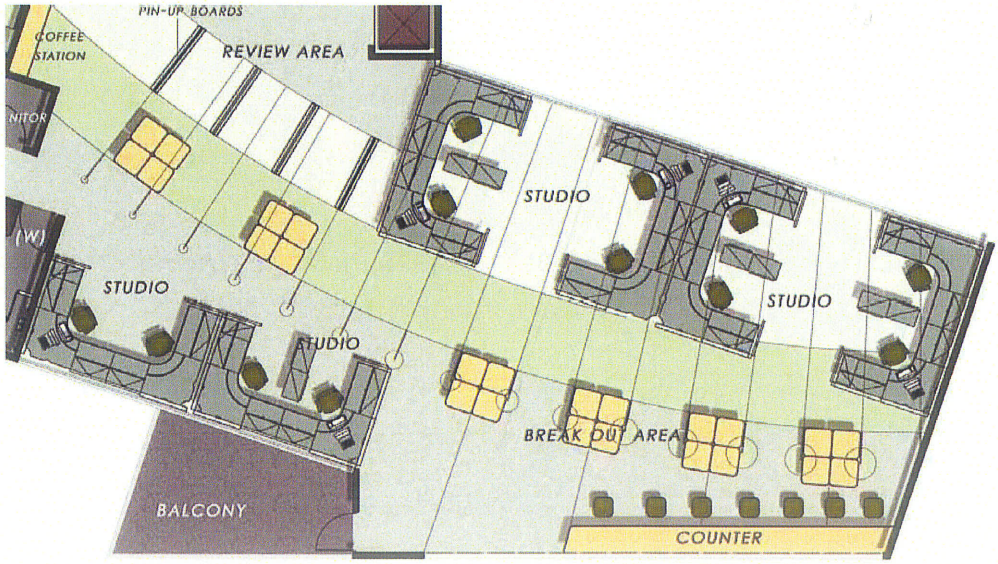


Figure 33. Studio space on the Second floor plan
[From the author]

Break out area

The break out area serves the purpose of having students work on projects in a collaborative manner. It is accommodated along with laptop plug in desktop for flexibility of work schedules. It is designed adjacent to the studio spaces for having an easy access for the students.

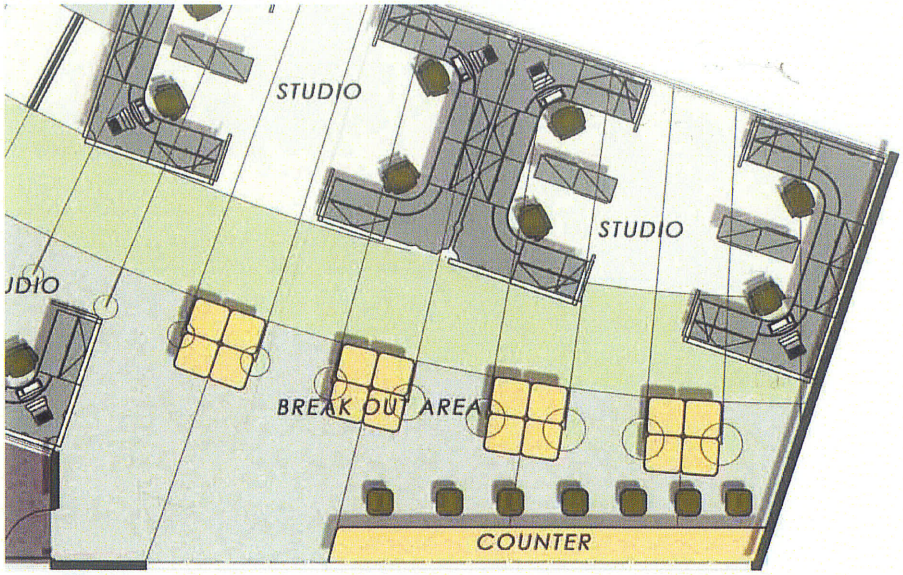


Figure 34. Break out area on the second floor
[From the author]

Review area

Review area is designed as a space where the reviews of student designs in front of a jury can take place. Pin up boards in the area are to be used for review sessions. In other times the space could be used for exhibiting student projects.

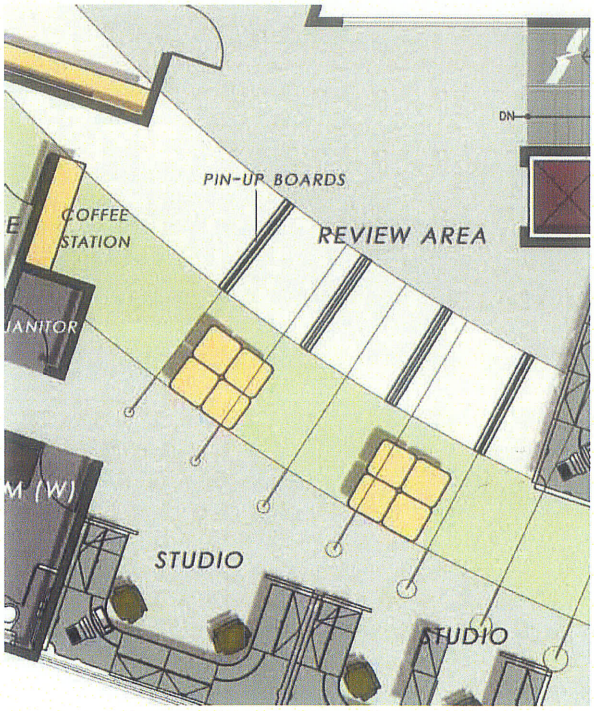


Figure 35. Review area on the second floor
[From the author]

Chapter Six: Conclusion and Recommendations

Through this project the author dealt with various dimensions of sustainability ranging from energy savings to environmental impacts. Vanegas's model[31] of including human satisfaction, minimal consumption of matter and energy; and minimal negative environmental impact to the parameters of time, cost and quality for the design and construction of building have been instrumental in the development of the design. Inclusion of LEED™ rating system criteria facilitates various sustainable strategies for the design development. In the given context of Winnipeg, various guidelines to formulate the concepts and define design strategies have been explored so that the development of the project follows the urban design guidelines. The purpose of meeting the educational goal through the design of interior spaces has been handled through availing the sensory responses of the human psyche by applying Gibson's affordance theory. In the process of conceiving the interior design of the facility coordination and consideration of various disciplines and realms proved instrumental. Inputs on the project from the committee members at successive stages of the project maintained a holistic approach for various design considerations. Formulation of the envelope of the building had to rely on the activities in the spaces and at the same time depended on the orientation of the building with respect to the four directions. Envelope of the building is designed strategically and defies usual rectangular footprints on the site.

[31] see pg. 22

For the purpose of this practicum project the committee provided varied inputs to develop the centre holistically, but for the project to realize its true potential a greater involvement of expert group of people is necessary. In addition, coordination of various disciplines in terms of responding to the set of questions also supports a collective approach. The application of Gibson's theoretical approach of affordances makes assumptions on the part of the users to understand spaces, and consequently the topic of sustainability.

The application of simulation media as discussed in the study of CEEE[32] is very important to foresee the effects of design ideas through study models and simulation software programming. Having access to such a facility for the design could have proved beneficial to integrate the concepts for a much improved and enhanced sustainable design for the facility.

The author believes that interior design is necessary for prior consideration wherein an "inside-out" approach reciprocates with "outside-in" thought process in building design resulting in effective sustainable solutions. Through prior consideration of the interior spaces the envelope of a building can be designed to respond to the environmental factors accordingly. Gibson's affordance theory provides insight into formulating concepts for design development and the proposed facility incorporates the ideas of incorporating design features according to the services and functions in various spaces of the building. Sustainability definitely requires various disciplines to make a

[32] see pg. 45

concerted effort for a successful end-result. For the purpose of this project inputs from professionals and committee members inform a holistic development as dictated by the design process during the design of SDC. The investigation of case studies and literature review supports a need for the same.

Consequently, if the SDC is proposed and developed in the Exchange District, the author believes the centre will contribute to the City Council's efforts of making the Exchange District a lively, sustainable place. The development of the waterfront drive will provide added benefits of easy access to the centre and help raise awareness among people to a larger extent.

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Appendix A - Questionnaire

Issues

o What do you feel are the primary issues of sustainability in the built environment that people should be made aware of? (eg. Indoor environmental quality, energy performance, materials and resources etc.)

o Are there any steps being taken currently to address these issues? If yes, please explain. If not, why not?

Services

o What services do you feel the Student Design Centre should offer to the community? (eg. design, consultancy etc.)

People

o Who do you think would use the services provided in the centre? (e.g. general public, design professionals, builders, schools etc.)

Results

o What do you think would be the benefits of having a design centre in Winnipeg?

o Please provide any additional comments that you think will make the Student Design Centre a success.

Appendix B - Questionnaire Response

Questions>	What do you feel are the primary issues of sustainability in the built environment that people should be made aware of? (e.g. Indoor environmental quality, energy performance, materials and resources etc.)	Are there any steps being taken currently to address these issues? If yes, please explain. If not, why not?
Issues	- Energy performance - Recycling - Indoor air quality - Environmentally safe construction practice guide lines - Increased density -reducing the length of services -making services more efficient - Support public transit - Reducing on-going operating costs - Pedestrianization of streets - Making a more desirable downtown - Engaging safe streets - Waste management - Happiness of the occupants - Balance environmental responsibility - Balance resource efficiency - Balance community development - Balance economics of building construction - Conservation of water & materials - Ecological wellbeing - Political empowerment - Economic security - Social engagement - Cultural acceptance - What we consume and what we can save, immediately and in long term	-Government of Canada provides some information and incentive programs to educate general public but it is not quite effective yet - Creation of Centre Venture Downtown Development Agency responsible to facilitate / stimulate downtown development while also providing them with tools such as funding for grants / low Interest loans, surplus vacant city owned properties, etc. - Looking to Improve transit service to the downtown - LEED™ Certification process, a standard for sustainability has been established but it is voluntary - These issues are being addressed by international treatises such as the Kyoto Accord, and by several national organizations such as the U.S. Environmental Protection Agency, the United States and Canada Green Building Councils, Natural Resources

		Canada - People trust those responsible for creating their built environment to take it (energy performance & IEQ) into consideration. -LEED and Sustainability has reached the professionals and government organizations in the form of lectures, built projects and conferences but the general public still has little understanding (other than blue box recycling) of what the concepts are. I think that it has not reached the masses because most of the current organizations are not for profit and have very little funds to educate. -The "One Tonne Challenge" is raising awareness.
Question>	What services do you feel the Student Design Centre should offer to the community? (e.g. design, consultancy etc.)	
Services	- Basic rules and guide lines for energy savings and design criteria for improving the indoor air quality and construction materials and procedures - Design Research supporting disadvantaged Communities as well as the existing private Business (design) community. - Research In Integrated design (Planning / L.A. / Arch / Interior Design) solutions - Research / design recommendations for Urban Design Guidelines and Standards - Demonstration projects - Forums for new design ideas - Collecting and making Information accessible to designers, builders and others - Critiques of designs and design practices In Winnipeg - helping communities define design issues	

	- The Design Centre should **NOT** offer design and consultancy services - Offer facilities for testing, research, meetings, workshops, and education for the purposes of collecting and disseminating information on sustainable design. It could explore and test sustainable design strategies in laboratory or research settings - A place for engagement that increases the residents empowerment in sustainable issues and design - A working model of how sustainability could work in the form of the centre. A gallery of projects around the world. Lecture space and yes a design centre that could house designers that are willing to help with sustainable projects for the general public - In exchange for the opportunity for real-world experience and locally relevant studio projects the centre could provide project development services at no cost
Question>	Who do you think would use the services provided in the centre? (e.g. general public, design professionals, builders, schools etc.)
People	- General public - Design professionals - Builders - Schools - Disadvantaged communities - Existing planning - Design community - City - Outreach to secondary schools - Those areas that are not In conflict / do not compete with the private sector - Politicians - Landowners - Resident's associations - academia (student and staff) - government, and pre-post-secondary school programs - Local designers - Facility managers - Two core constituencies - the students and the public (the public will wear many hats) - Everybody, it should create no barriers - Non-profit organizations
Questions>	What do you think would be the benefits of having a design centre in / Please provide any additional comments that you think will

	Winnipeg ?	make the Student Design Centre a success.
Results	- Public resource centre - Centralize the environmental protection - Strengthens the ties with the community - Increased Research and Outreach capacity - Improved relations / partnership with gov't and the private sector. - Improved understanding by students of gov't / private sector - More students / Improved vibrancy within the downtown - Foster Innovative Ideas about design in Winnipeg's context - By exposing people to new Ideas, concepts and solution, raise the bar on design. - Make design Ideas, language and concepts accessible - Help people think about the problems of their community from a design perspective - Dissemination of information on sustainable design, and the ability to research and test theories in a local setting - Visibility and active engagement within the community are critical - A means to showcase what Winnipeg can achieve and a way to educate everybody on the concepts - It could be a institution that gives back to the community in exchange for a more relevant educational experience	- Operating hours and personalized service - Library area for reading materials for the public - Off-hour continuing education programs for the public, gov't and private sector practitioners - Have links to professional design and building associations as sponsors, mentors, source of projects - The Design Centre may want to try to generate revenue by operating as a work supply office for design firms that need help with projects - Creativity must be harnessed into a format that is useful to those the centre intends to work with. Otherwise the relationship is one-way with the centre benefiting from enriched educational experiences and those providing the experience with nothing useful.

Appendix C- Respondents to the Questionnaire

Andrew Brimble

Project Architect,

L M Architectural Group,

500- 136 Market Avenue,

Winnipeg, MB.

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Downtown Planning Co-ordinator
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Michael Robertson

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Prairie Architect,

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Winnipeg, MB.

Robert Winslow

L M Architectural Group,

500- 136 Market Avenue,

Winnipeg, MB.

Ted Mc Lachlan

Associate Professor

Landscape Architecture,

Faculty of Architecture,

University of Manitoba,
Winnipeg, MB

Tijen Roshko
Senior Interior Designer,
Environmental Space Planning
500- 136 Market Avenue,
Winnipeg, MB.

Appendix D – Project Introduction to Respondents

Please allow me to introduce myself. I am a graduate student of the Department of Interior Design's Masters Degree Program at the University of Manitoba. As part of the requirements for the Master's Program, I am undertaking a thesis project called 'Thinking Inside Out: An Interdisciplinary Approach for Sustainable Building Design'. The project will culminate in a proposal for a Student Design Centre in the Exchange District of Winnipeg. The purpose is to educate the public about sustainable design. It will attempt to achieve the following goals:

a) To serve as a design centre for the community by offering classrooms, meeting rooms, resources and exhibition space.

b) To integrate the university experience with the community.

c) To integrate the design of the building and its interiors in an attempt to support and explore sustainable design practice at many scales.

d) To communicate, promote and support sustainable practice in building design.

In preparation for the design of the facility I am asking for your response towards a questionnaire having four different categories.

Appendix E – Spatial programme and relationships

Space:

Exhibition Area (First Floor)

Approximate Area:
110 sq. m

Occupancy:
25-30 people

Activities:

Exhibitions
Charrettes
Classes
Presentation
Guest Speakers

Critical Factors:

Flexibility
Transparency
Meeting codes
Barrier free access
Views
Durable material selection

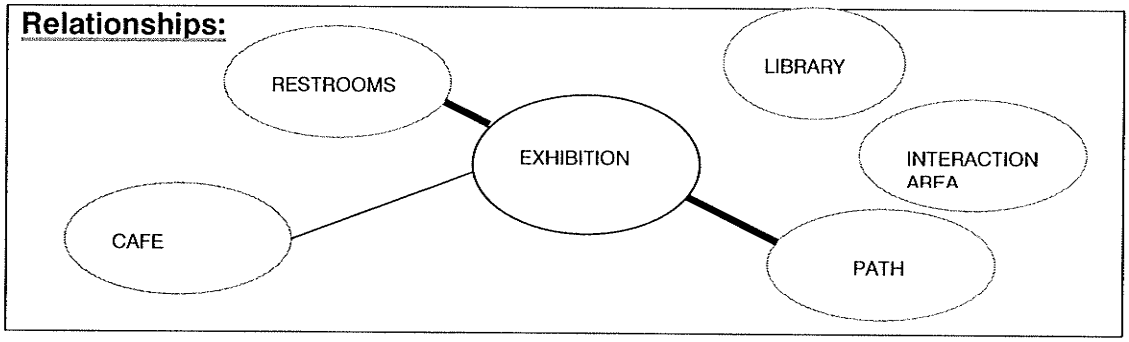
Equipments:

Custom designed exhibition
Custom designed screens
Chalkboard Wall
Light/ AV Controls

Functions:

-Exhibitions of various products, services available pertaining to sustainability
-Design charrettes involving professionals
-Formal and informal presentations for groups
-Should function as a display area for both students and professionals

Relationships:



Space:

Library (First Floor)

Approximate Area:
130 sq. m

Occupancy:
8-10 people

Activities:

Reading

Critical Factors:

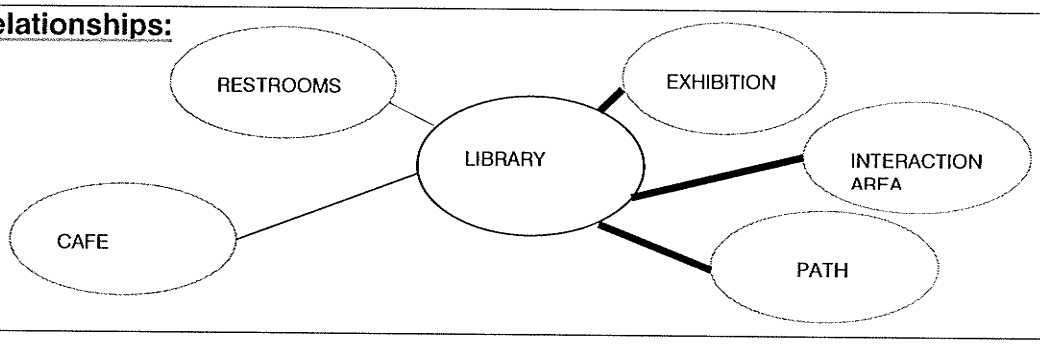
Concentration
Silence
Meeting the codes
Barrier free access

Equipments:

Book Shelves
Carrels
Window Screens
Flexible partitions

Functions:

Relationships:



Space:

Café (First Floor)

Approximate Area:
165 sq. m

Occupancy:
12-14 people

Activities:

Serving
Eating
Discussions

Critical Factors:

Openness
Flexibility
Views
Meeting the codes
Barrier free access

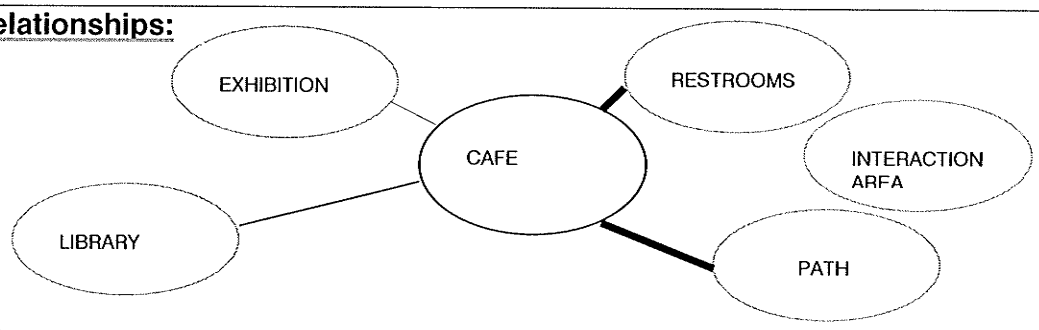
Equipments:

Tables
Chairs
Serving Counters
Lights
Trash-bins
Music

Functions:

-Informal gathering of groups/ individuals

Relationships:



Space:

Interaction Area (First Floor)

Approximate Area:
65 sq. m

Occupancy:
8-10 people

Activities:

Serving
Eating
Discussions

Critical Factors:

Proximity to knowledge resources
Views
Meeting the codes
Barrier free access

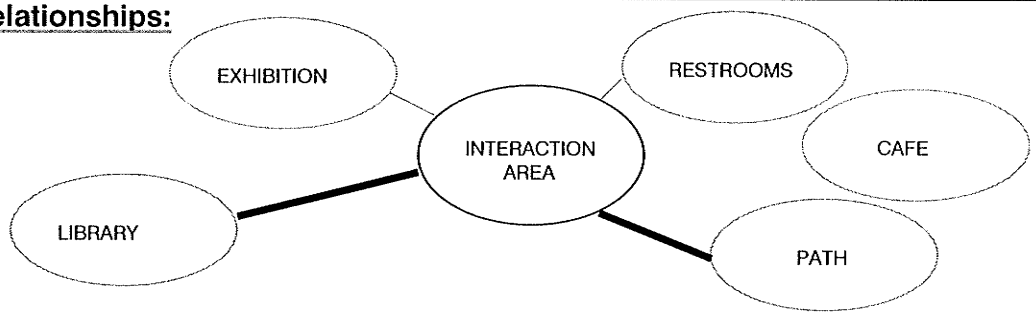
Equipments:

Tables
Seating

Functions:

-Discussions on various client needs

Relationships:



Space:

Studios - Work Space for Students (Second Floor)

Approximate Area:
90 sq. m

Occupancy:

10-12 people

Activities:

Design, Individual Work,
Group Work, Discussions

Critical Factors:

Concentration (for individual work)
Group work
Flexibility
Meeting codes
Barrier free access
Views

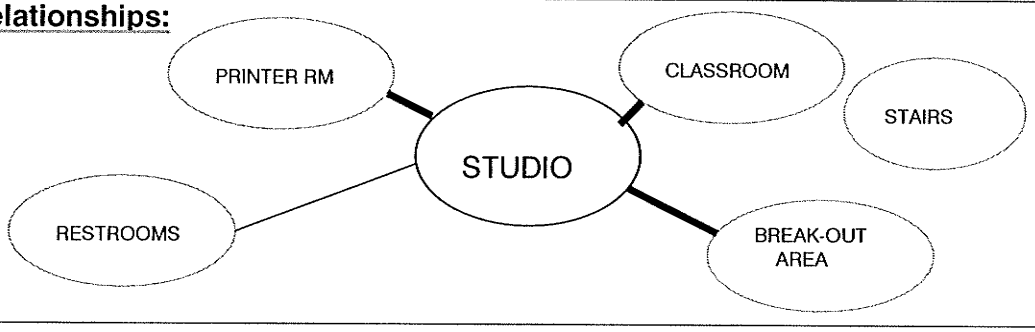
Equipments:

Desktops
Drawing Boards
Lights(Ambient + Desk)
Chairs (Work)
Lockers

Functions:

-Work area for students
-Group discussions
-Lockers for individuals working in studio
-Pin-up facility for students

Relationships:



Space:

Break- out Area (Second Floor)

Approximate Area:
70 sq. m

Occupancy:

10-12 people

Activities:

Design, Individual Work,
Group Work, Discussions
Laptop Plug-ins

Critical Factors:

Vistas/ Views
Meeting codes
Barrier free access

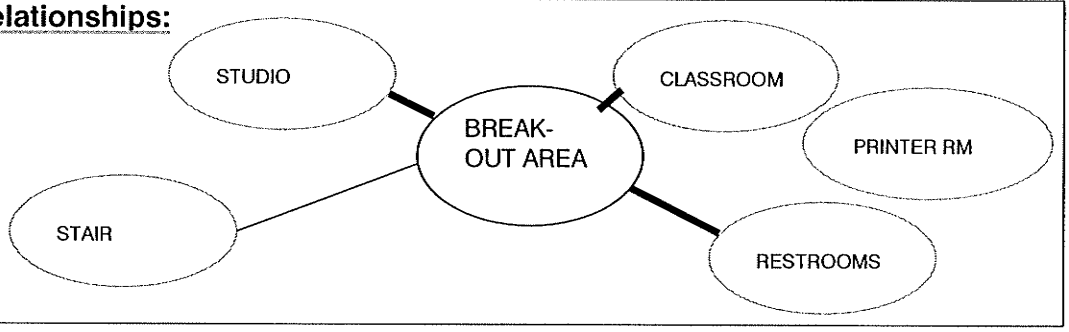
Equipments:

Seatings
Tables
Light (Desk and Ambient)
Storage

Functions:

Break out from work
Discussions with clients and individuals
Group Discussions

Relationships:



Space:

Photocopier and Printer Room (Second Floor)

Approximate Area:
15 sq. m

Occupancy:

Varies 1- 3 people

Activities:

Printing Copying

Critical Factors:

Separate exhaust
Meeting codes
Barrier Free Access

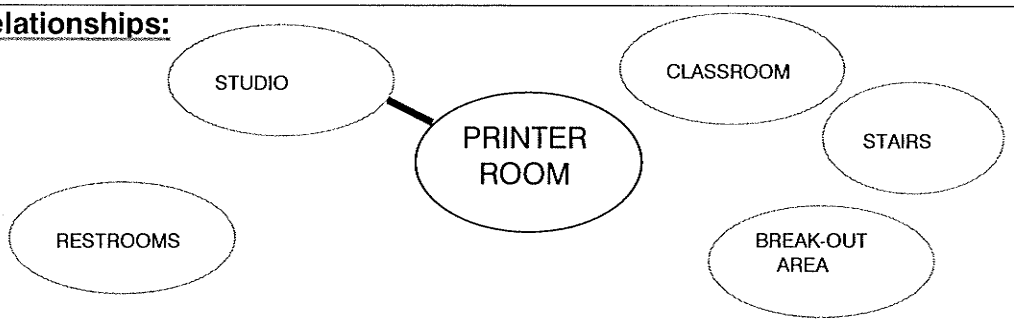
Equipments:

Printers
Copiers
Plotter
Stationery
Spring Doors (for a closed room)

Functions:

Storage space for stationery
Plotting / printing/ copying area

Relationships:



Space:

Classroom (Second Floor)

Approximate Area:
75 sq. m

Occupancy:

Varies 12- 24 people

Activities:

Classes, Education

Critical Factors:

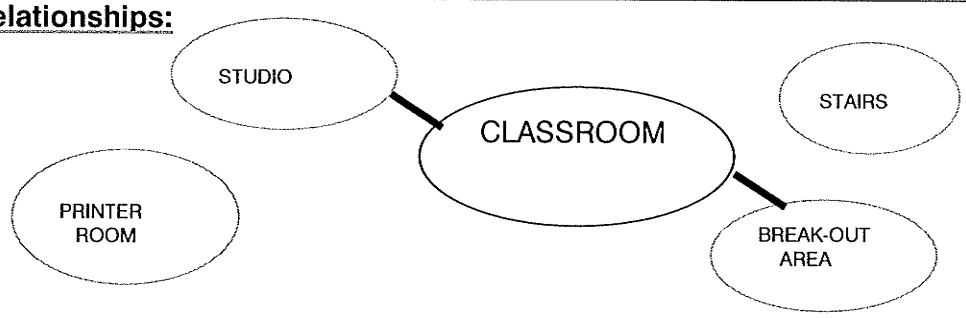
Meeting codes
Barrier Free Access
Adjoining storage

Equipments:

Stationery

Functions:

Relationships:



Appendix F - LEED™ Rating System Project Checklist

Project Checklist

LEED

Sustainable Sites — 14 Possible Points

Y	Prereq 1	Erosion & Sedimentation Control	Required
	Credit 1	Site Selection	1
	Credit 2	Urban Redevelopment	1
	Credit 3	Brownfield Redevelopment	1
	Credit 4.1	Alternative Transportation, Public Transportation Access	1
	Credit 4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	1
	Credit 4.3	Alternative Transportation, Alternative Fuel Refueling Stations	1
	Credit 4.4	Alternative Transportation, Parking Capacity	1
	Credit 5.1	Reduced Site Disturbance, Protect or Restore Open Space	1
	Credit 5.2	Reduced Site Disturbance, Development Footprint	1
	Credit 6.1	Stormwater Management, Rate or Quantity	1
	Credit 6.2	Stormwater Management, Treatment	1
	Credit 7.1	Landscape & Exterior Design to Reduce Heat Islands, Non-Roof	1
	Credit 7.2	Landscape & Exterior Design to Reduce Heat Islands, Roof	1
	Credit 8	Light Pollution Reduction	1

Water Efficiency — 5 Possible Points

	Credit 1.1	Water Efficient Landscaping, Reduce by 50%	1
	Credit 1.2	Water Efficient Landscaping, No Potable Use or No Irrigation	1
	Credit 2	Innovative Wastewater Technologies	1
	Credit 3.1	Water Use Reduction, 20% Reduction	1
	Credit 3.2	Water Use Reduction, 30% Reduction	1

Energy & Atmosphere — 17 Possible Points

Y	Prereq 1	Fundamental Building Systems Commissioning	Required
Y	Prereq 2	Minimum Energy Performance	Required
Y	Prereq 3	CFC Reduction in HVAC&R Equipment	Required
	Credit 1.1	Optimize Energy Performance, 20% New / 10% Existing	2
	Credit 1.2	Optimize Energy Performance, 30% New / 20% Existing	2
	Credit 1.3	Optimize Energy Performance, 40% New / 30% Existing	2
	Credit 1.4	Optimize Energy Performance, 50% New / 40% Existing	2
	Credit 1.5	Optimize Energy Performance, 60% New / 50% Existing	2
	Credit 2.1	Renewable Energy, 5%	1
	Credit 2.2	Renewable Energy, 10%	1
	Credit 2.3	Renewable Energy, 20%	1
	Credit 3	Additional Commissioning	1
	Credit 4	Ozone Depletion	1
	Credit 5	Measurement & Verification	1
	Credit 6	Green Power	1

LEED

Materials & Resources — 13 Possible Points

Y	Prereq 1	**Storage & Collection of Recyclables**	Required
	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
	Credit 1.2	**Building Reuse**, Maintain 100% of Shell	1
	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
	Credit 2.1	**Construction Waste Management**, Divert 50%	1
	Credit 2.2	**Construction Waste Management**, Divert 75%	1
	Credit 3.1	**Resource Reuse**, Specify 5%	1
	Credit 3.2	**Resource Reuse**, Specify 10%	1
	Credit 4.1	**Recycled Content**, Specify 25%	1
	Credit 4.2	**Recycled Content**, Specify 50%	1
	Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
	Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1
	Credit 6	**Rapidly Renewable Materials**	1
	Credit 7	**Certified Wood**	1

Indoor Environmental Quality — 15 Possible Points

Y	Prereq 1	**Minimum IAQ Performance**	Required
Y	Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Required
	Credit 1	**Carbon Dioxide (CO_2) Monitoring**	1
	Credit 2	**Increase Ventilation Effectiveness**	1
	Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
	Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
	Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
	Credit 4.2	**Low-Emitting Materials**, Paints	1
	Credit 4.3	**Low-Emitting Materials**, Carpet	1
	Credit 4.4	**Low-Emitting Materials**, Composite Wood	1
	Credit 5	**Indoor Chemical & Pollutant Source Control**	1
	Credit 6.1	**Controllability of Systems**, Perimeter	1
	Credit 6.2	**Controllability of Systems**, Non-Perimeter	1
	Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
	Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1
	Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

Innovation & Design Process — 5 Possible Points

	Credit 1.1	**Innovation in Design**: Specific title	1
	Credit 1.2	**Innovation in Design**: Specific title	1
	Credit 1.3	**Innovation in Design**: Specific title	1
	Credit 1.4	**Innovation in Design**: Specific title	1
	Credit 2	**LEED™ Accredited Professional**	1

Project Totals — 69 Possible Points

Certified 26-32 points Silver 33-38 points Gold 39-51 points Platinum 52-69 points

Appendix G - Drawings



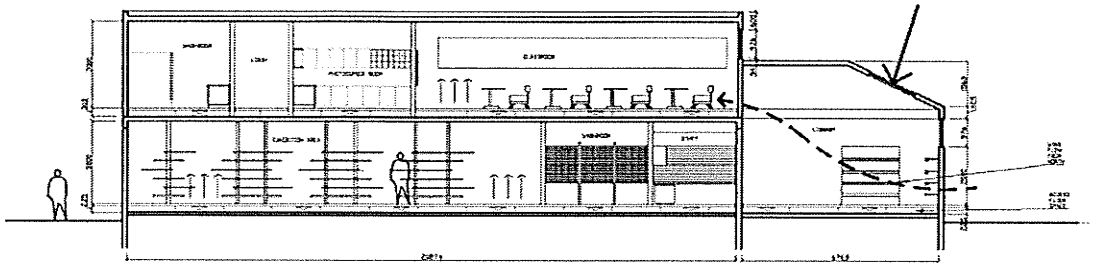
First floor plan- SDC

[By the author]



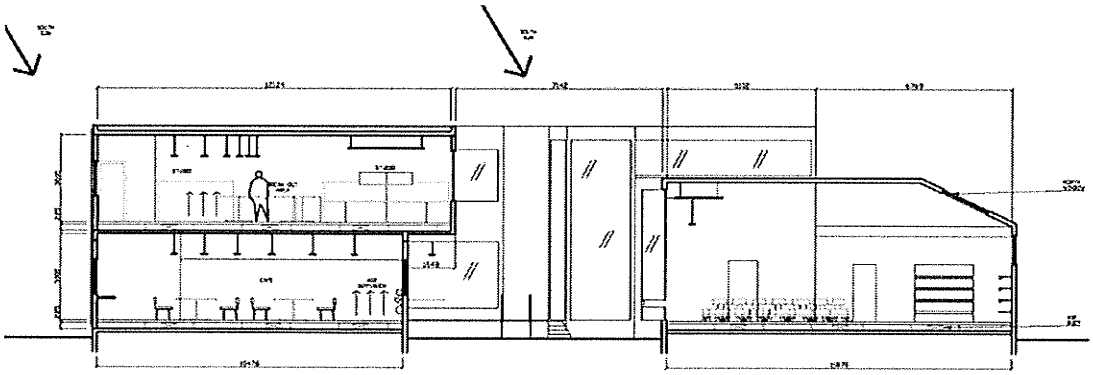
Second floor plan- SDC

[By the author]



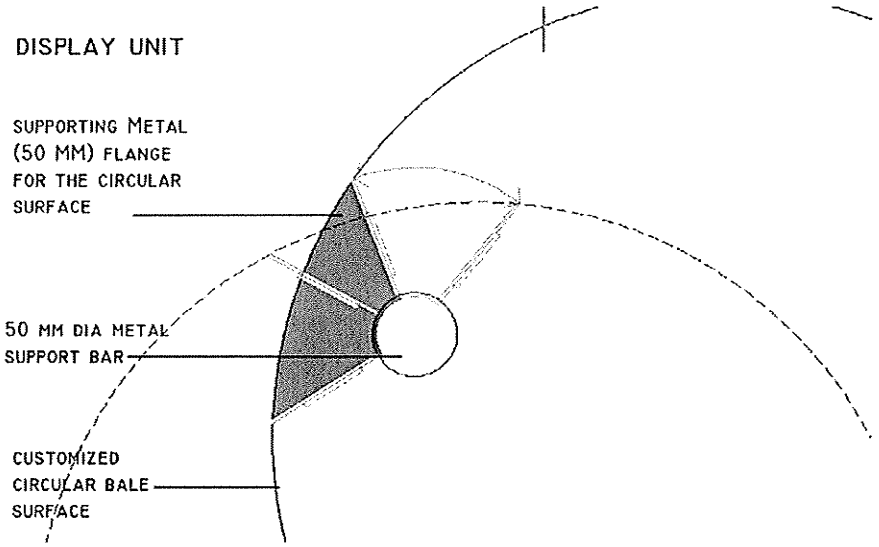
Section- Along North South Axis

[By the author]



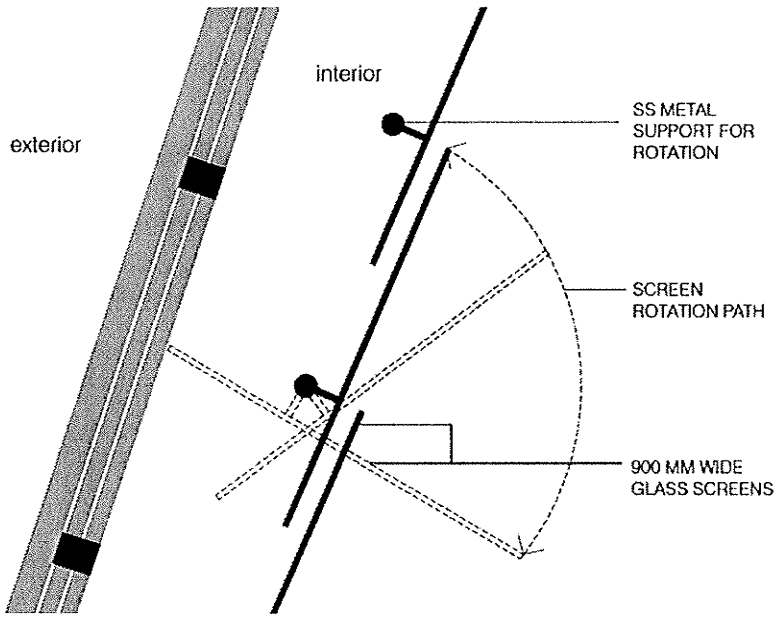
Section- Along North South Axis (through the water pool)

[By the author]



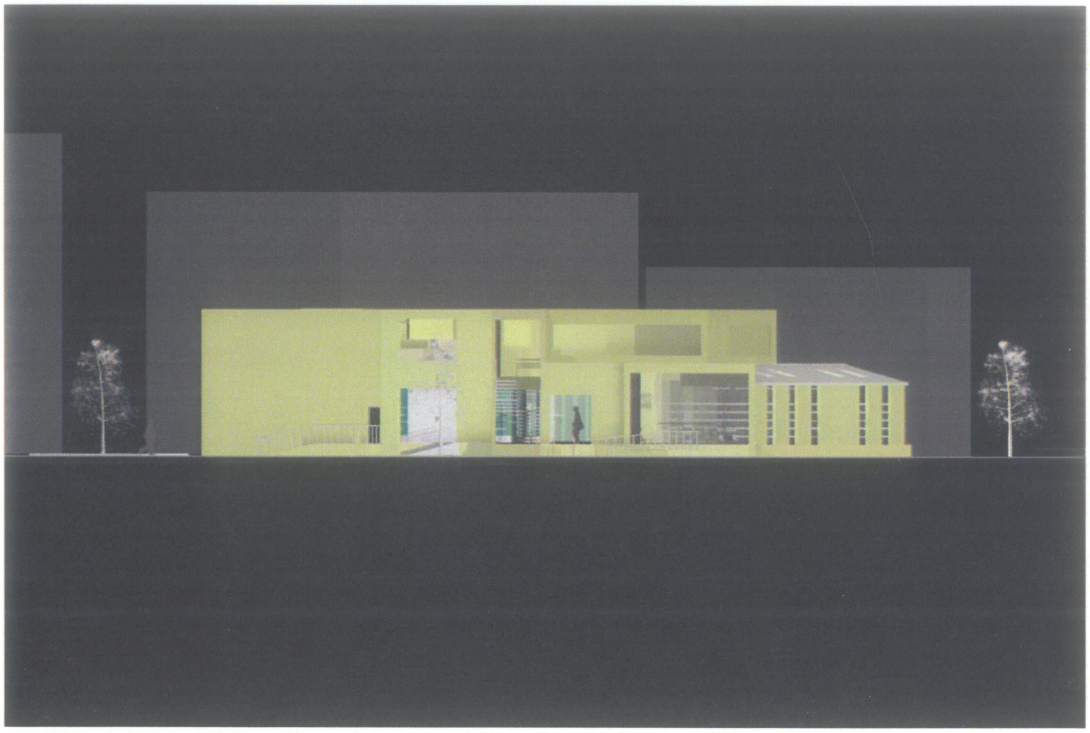
Detail- Display Unit

[By the author]



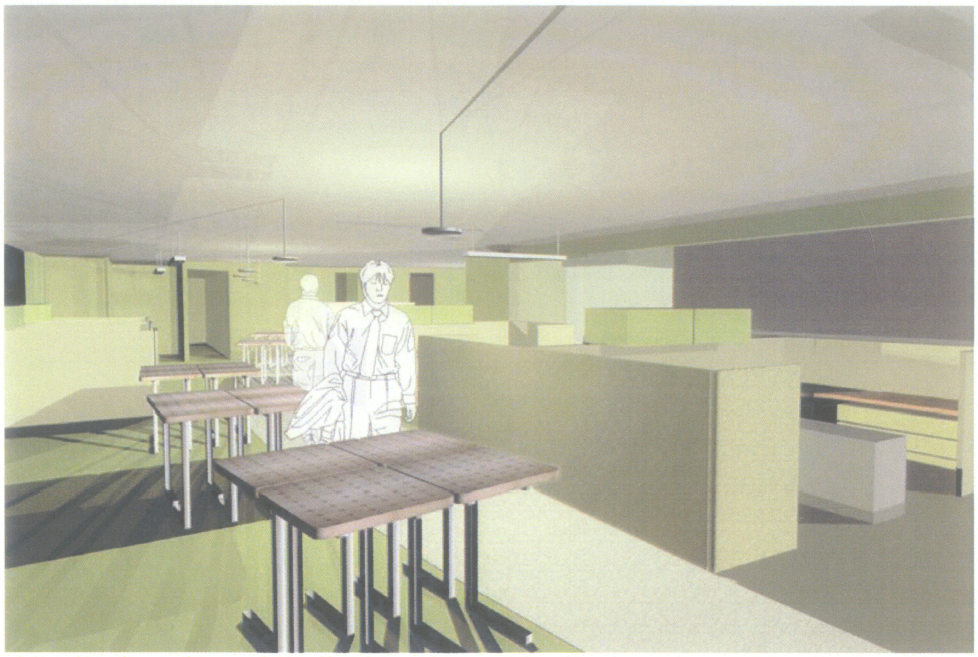
Detail- Screens on the West Wall on First Floor

[By the author]



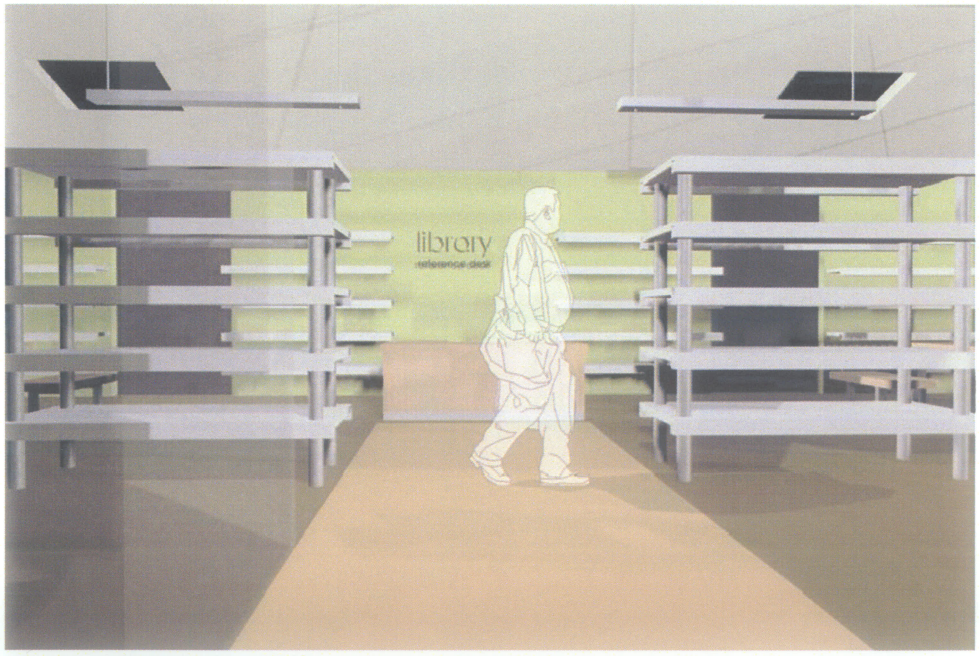
Elevation- East Face

[By the author]



View- Break-Out Area and Studio

[By the author]



View- Library

[By the author]



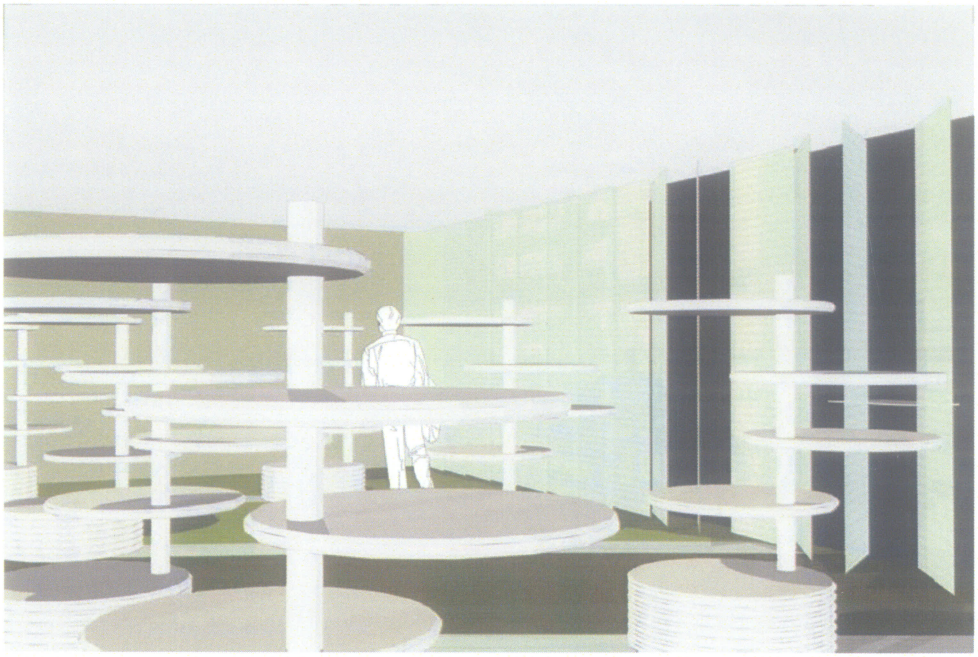
View- Library & Interaction Area

[By the author]



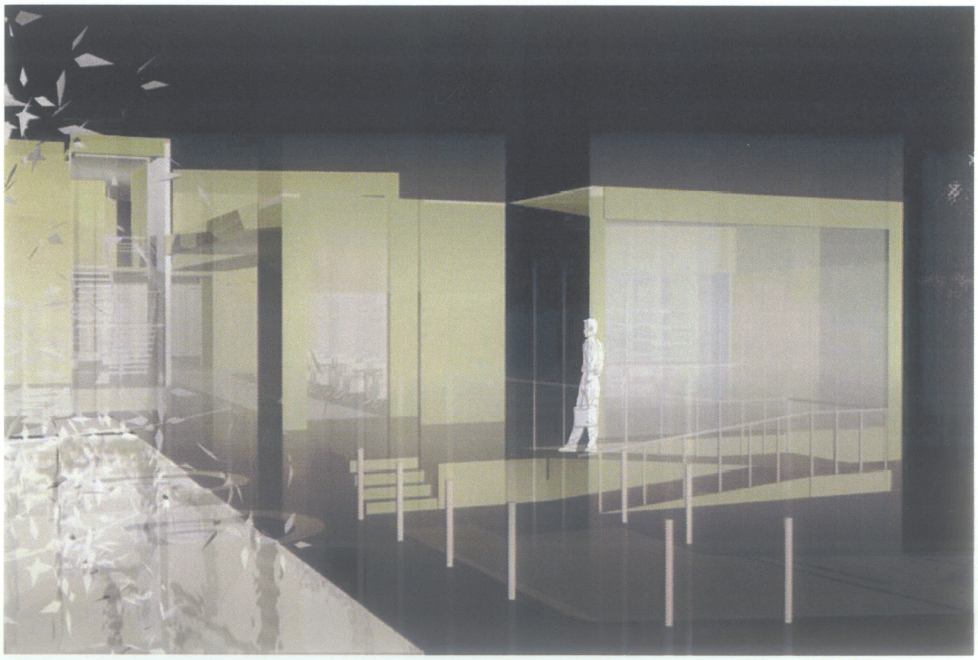
View- Path & Interaction Area

[By the author]



View- Exhibition Area

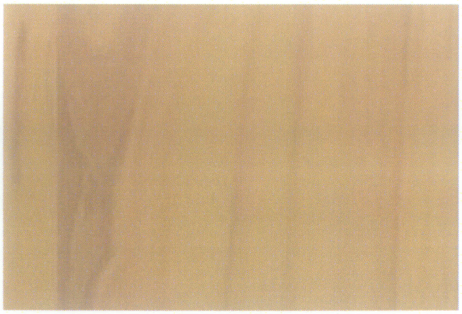
[By the author]

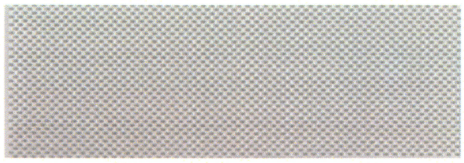
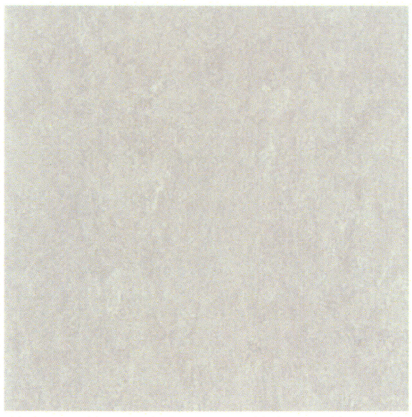
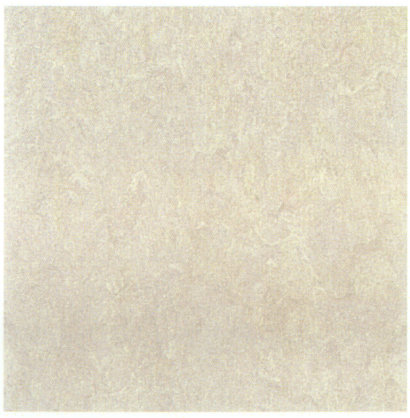


View- Exhibition Area

[By the author]

Appendix H- Material List

Code	Description	Finishes
P1	Wall finish	
P2	Wall finish	
P3	Wall finish	
P4	Wall finish	
P5	Wall finish	
PL-1	Plastic laminate for millwork and furniture	
PL-2	Plastic laminate for millwork and furniture	

M-1	Perforated metallic sheet for suspended ceiling	
M-2	Perforated metallic sheet for suspended ceiling	
LINO-1	Linoleum sheet for flooring	
LINO-2	Linoleum sheet for flooring	

LINO-3	Linoleum sheet for flooring	
LINO-4	Linoleum sheet for flooring	