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IN THE CONTEXT OF CONVENTIONAL PROJECT DELIVERY

The Degree and Appropriateness
Of Environmentally Responsive Design

by

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Abstract

There is evidence that industrialized societies are consuming resources and discharging more waste than the earth can produce and absorb. These are brought about by the behaviour of many unsustainable actions by individuals in the 'consumer society'. They are perpetuated by many interconnected factors and development of land for public and private use is one factor that has neglected the collective costs of development. These collective costs consider ecological and social indicators of the 'health' of society as well as the economic ones of profit or job creation. Clients, prime contractors and architects are the three influential project members that can affect significant changes in land use and building, depending on their understanding of the conventional delivery process and the applicability of alternate, more responsible processes.

To understand how architects can positively and directly influence this move away from unsustainable practices in conventional project development, the project members and their responsibilities are defined. Also, the alternate process of 'environmentally responsible design' (ERD) is developed which lies between conventional design (currently destructive) and 'sustainable' design (an 'ideal' design which respects environmental, social and economic needs and limitations), where the degree of its adoption is dependent on the level of commitment the influential project members.

To understand the process of project development and the type of interactions that the project members have with one another during the course of development, numerous interviews were conducted. These revealed the project member's responsibilities, concerns, reservations and insights as they related to environmentally responsive and conventional project delivery processes.

Five main conclusions were realized from the research: (1) that currently, environmentally responsive design is not properly understood, marketed or controlled and this lack of understanding is undermining its legitimacy and adoption; (2) that the analysis of the construction industry by environmental groups is not sufficiently complex to provide viable alternatives; (3) that environmental efforts must concentrate on creating self-reinforcing settings that lower the systemic resistance to ERD; (4) that architects, as project coordinators, are best positioned to improve the development process to support ERD; and (5) that architects have a duty to improve the quality of the built environment and need to begin by collectively placing a higher priority on architectural 'craftsmanship' over 'style'.

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1.0 INTRODUCTION

Almost every act in industrial society leads to environmental degradation, regardless of intention (Hawken, 1993). Sustained environmental degradation evidenced by pollution, landfills at capacity, toxic waste, global warming, resource depletion, deforestation and erosion is making the Earth unable to continue to supply resources to or absorb human waste streams. Who is responsible for these acts? Hawken also quotes Wendell Berry as saying that "the world is being destroyed by the greed of the rich and powerful, [however] there are not enough rich and powerful people to consume the whole world; for that, the rich and powerful need the help from countless ordinary people." (Hawken, p. 14). David Orr (1992) argues that the severity of socially undesirable consequences increases with population, even if each individual's decisions within the population are well-intended. Since most populations around the world are increasing, Keating (1997) concludes that "Sustainable development can only be built on the basis of a sustainable lifestyle".

The architect's role in fostering 'sustainable' lifestyles can be significant: Buildings account for 17% of the world's freshwater usage, 25% of its wood harvest and 40% of its energy and material flows (Rodman & Lenssen, 1996). In Canada, the energy to heat cool, ventilate, and light buildings represents over 30% of national energy usage (Howard & Sutcliffe, 1994). It becomes the duty of the architect to promote sustainable lifestyles by designing and constructing developments that are environmentally responsible and that encourage environmentally responsible actions from its users.

There are numerous initiatives that have marketed environmental features but many are not fostering sustainable development and are undermining the legitimacy of a genuine effort to cease the practices that are harmful to the environment. Sustainability therefore needs an unambiguous definition in order to determine if sustainable practices are being followed. Sheltair Scientific Inc., an environmental consulting firm, was retained by the City of Vancouver to define 'urban sustainable development' (USD) and to offer indicators for USD to facilitate the redevelopment of South-East False Creek in

Vancouver (Sheltaire Group, 1998). Their report illustrated the generally accepted description of sustainability as consisting of three interlocking circles each representing environmental, social and economic states of sustainability. The area shared by all three circles is the area where sustainable development is achievable (see Figure No. 1):

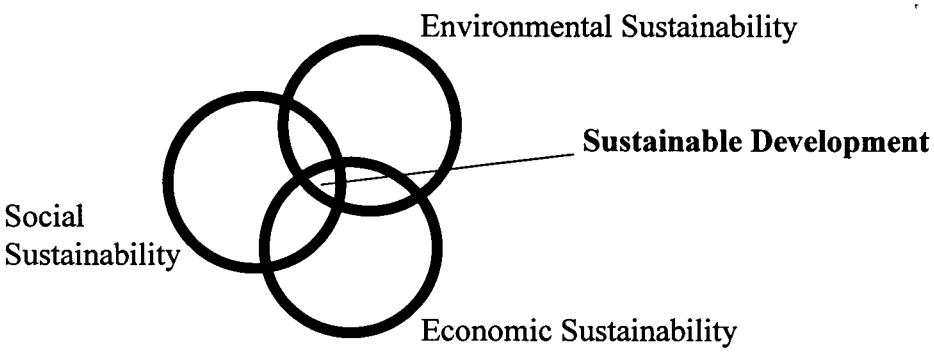

Figure 1 Conceptual illustration of Sustainable Development

Moffat explains that 'Environmentalists "approach sustainability from the perspective that human beings are using up resources too quickly and generating pollution faster than the planet can assimilate it, and if we don't do something to scale back human activity, then our ecological support systems will collapse". This perspective leads to efforts such as energy efficiency, reducing auto dependency, and creating spaces for nature within the city.' Advocates of social sustainability "believe that all of our problems, including our environmental problems, stem from the ... way we deal with each other [which is] unjust". To encourage more compassion and justice, efforts such as "affordable housing, community centers, community gardens and anything else that helps to foster and deepen the social bonds within a neighbourhood" become important. Economic sustainability requires that efforts toward the above two goals must be self-sustaining economically, that " It can't be forever beholden to government subsidy" (Blore, 1998, p.21).

Unfortunately many manufacturing companies view these efforts as opportunities to modify their image, not necessarily their practices, to give the appearance of contributing to sustainable

development (Plant & Plant, 1991). Individuals, companies and markets wanting to practice more sustainably must interact with non-sustainable counterparts to such a degree that *sustainability as it is described above is an ideal and is unattainable at this time.* This thesis therefore defines environmentally responsive design (ERD), as a part of environmentally responsive project development (ERPD), where both processes have sustainable intentions but will realistically exist as varying shades of 'green'. Within this spectrum 'light green' refers to surface, 'introductory' efforts and 'deep green' refers to efforts with profound consequences (both can result from small or large efforts). More specifically, architects wishing to design 'urban sustainable developments' (USD) today must operate from a non-sustainable, conventional foundation. Because of the responsibilities and agendas of their own firm, other project members and broader macro-economic influences, these architects respectfully fall short of USD, but have successfully accomplished some level or degree of environmentally responsive design (ERD).

Why does environmental responsibility require immediate implementation?

(1) Because the incremental changes related to 'image' or 'light-green' consumerism do not address the more serious changes such as reducing consumption. These changes, if not genuine efforts affecting policy and production will not be enough, given our previous history of sustaining natural resources. (For example, the extinct Atlantic Cod fishery, the current crises involving international limits to Pacific Salmon catches and BC forestry practices). Keating (1993) quotes The National Task Force on Environment and Economy (Report 1) which states that "environmental considerations cannot be an add-on, or an afterthought. They must be made integral to economic policy making and planning, and a required element of any economic development proposal". Sexton (1995) agrees, stating that small changes are really a "superficial change layered on top of an unchanged core organization". While fundamental rethinking and restructuring may be the eventual solution, people today are more confident in a series of incremental changes that eventually result with the same

outcome. However the rates of deforestation, fossil fuel consumption, pollution, and population are increasing much more rapidly than the implementation or compensating effects of these small incremental changes.

(2) British Columbia is at a level of environmental implementation that significantly lags behind environmental knowledge. 'Environmentalists' have been trying to prepare information for the general public and business that explains what the environmental risks are, how to prioritize them, how buildings contribute to these risks, and how significantly the adopted measures improve the situation (Wilson, 1995). As a result, many environmentalists are debating amongst themselves over the optimal allocation of resources to further the environmental cause. These questions are important but without some general consensus among the academic, political, legal and 'environmental' communities, the public perception becomes 'wait and see', leading to indifference and inaction. Thus environmentalists, journalists (Keating, 1993) agriculturists (Carson, 1962) and others agree that many proven solutions could be reasonably implemented.

(3) Without a critical mass of project members practicing ERD, environmental ideas must be relearned each time they are attempted, and each attempt is far more difficult if made within a non-sustainable setting. It is reasonable to believe that a change to genuinely sustainable lifestyles will require a timeline measured in generations, but infrequently used principles and practices must be re-learned from generation to generation. This notion of 'generation' is not only biological but also professional, for example each time an individual with 'environmental' experience is replaced by someone without it. If environmental sources and methods are not continually enforced so that they become part of the required body of knowledge, the costs of relearning each time they need to be implemented will associate ERD with excessive effort. The perception of required effort for ERD can often result in its dismissal.

(4) The author argues that the definition of 'survival', whether economic or physical or social or other, is constantly being upgraded such that the consumption rates to ensure 'survival' will inevitably exceed the production rate of the planet's resources. Today, an organization with private or public stock for example needs to return profit to the shareholders. Thus to 'survive' organizations *must* grow, in fact the rate of growth is also often required to increase, producing more to create more profit, "because its [company] responsibility [has become] only to structure its activities in such a way as to maximize its current period profit for the benefit of its owner(s)" (Sexton, 1994). Subsequently,

> if a business declines, loses market share, and experiences price erosion, environmental efforts will have to be shunted aside in favor of mere survival and capital preservation. ... As long as the environmental does not detract from or restrict growth, environmental needs are admissible. (Hawken, 1993)

There is therefore a minimum threshold below which individuals, businesses and countries believe they will not 'survive': where the need for immediate financial or physical survival outweighs any consideration of the future. Examples of this condition range from death through starving unless Madagascar's forests are logged, to poverty and hunger unless Canada's East-coast fishery is exhausted, to unemployment of architects, contractors, developers unless their prices are competitive. Each example is potentially self-extinguishing. For architects in the GVRD, producing buildings under reduced fees has compromised design and building durability and has resulted in a loss of public trust.

To conclude it is within this un-supportive macro- and micro-context that architects must attempt to implement environmentally responsive designs. The time required to change this unsustainable world may easily exceed the remaining time the surrounding ecosystems have left before they collapse. The consequences of the collapse of foodstocks and systems that deal with human waste streams are well known through humanity's previous experience with wars, natural disasters, and the collapse of governments: starvation, disease and death.

1.1 Thesis Definition

1.1.1 Thesis Purpose & Scope

At the outset of this work, the writer posed the question:

"*How can all architects design more environmentally responsive buildings and places*?"

For the purposes of this thesis, 'all architects' refers to those practicing within the Greater Vancouver Regional District (GVRD). The GVRD is a collection of seventeen municipalities (and two electoral districts) each having its own director of planning, all are heavily influenced by the more progressive and larger City of Vancouver. The City of Vancouver possesses its own charter and has a level of sophistication that enables it to directly enact policies it believes are important.

Vancouver also provides an excellent forum for this thesis because its citizens are very aware of the economic pressure for growth, the environmental and physical limits imposed by the surrounding rivers and mountains as well as social pressures, championed by the fist nations peoples and numerous activist groups. Further, the GVRD is closely tied to foreign investment and revenue derived from BC's natural resources such as fishing, forestry and tourism. Vancouver is showing an increase in its appreciation for the environment through its Greenways Program, Jobsite Recycling Program, and through initiatives such as the intention redevelop in a sustainable way False Creek's South-Eastern shore.

This thesis is directed toward the majority of architects who practice in smaller firms and who may not have the resources or prestige to keep their projects mostly design-lead. According to Tammy Shewchuck of The Architectural Institute of British Columbia (AIBC), 1350 architects are registered in BC (personal communication, August 6, 1998), of which, only 186 architects are in firms larger than 10 staff members (Business in Vancouver, May 21-27, 1996). Thus, the remaining 86% of

registered architects are either employed in-house, belong to small firms or are not currently practicing,. It also tries to appeal to leading architects as they are very influential in shaping the values of the AIBC membership, society's political and institutional representatives and the general public.

1.1.3 Methodology

An initial, broader direction for exploration was chosen and a review of the literature that describes the issues in the construction industry and the environmental protocol helped to more narrowly define a thesis topic. The literature described a historical and general understanding of the overall construction industry, construction projects and the responsibilities of the various project members that influence their delivery.

The author also attended public and industry meetings to learn of advances and new ideas emerging from the construction industry and academic research. Lectures on Vancouver's history and acknowledged North American architects; conferences on alternate project delivery processes such as Design-Build and Building Constructibility, conventions such as Buildex, Bomex and Wood Solutions Fair; seminars on indoor air quality, the Urban Development Institute's 10-part Real Estate Development Lecture Series (1997) and the Urbanarium Society's Builder of Vancouver Series (1998), and technical meetings held by the Directors of Planning for the GVRD and the BC Construction Round Table were attended.

Notably, published text as well as this thesis present a 'polished' product comprising of a series of ideas and examples that are well thought out, sequential and self-supporting. Rarely do they include the paths initially thought to be correct but that became redundant or were not pertinent to the final argument or conclusion. The un-documented yet influential circumstantial experiences occur often during the production of a building, where time and budgets are compressed, and where professionals and trades are trying to be as cost-efficient as possible while interpreting the minimum standards of

construction. This type of information is also essential to understanding how to develop realistic conclusions for this thesis. Winkler (1980) states:

> The fears, fights, uncertainties, mistakes, and confusion that are involved in every human venture, let alone one of social change, are swept under the carpet as irrelevant or somehow 'unclean' and inappropriate. Frequently, the people who read and teach have not themselves been active participants in establishing programs and, therefore, accept the available written reports as viable descriptions of what is important to know.

Thus, much of this research is based on interviews with practicing architects and other project members to confirm what was revealed during the literature review, to test the author's hypotheses and evaluate initial conclusions, and to ensure that these conclusions are as current as possible. Interviews with project members other than architects were necessary as architectural decisions are rarely made in isolation. The salaried employee as well as partners and upper-level management were interviewed to solicit information and opinions from different levels within an organization. The following professions were interviewed:

- Developers (Public and Private)
- Architects
- Prime Contractors
- Engineers
- Legal advisors (Contract and Litigation)
- Insurance Agents
- Market Analysts
- Financial Lenders
- Municipal Officials (in permits & licenses, planning and politics)

The interviewees represented the majority of the professions that contribute to the delivery of a typical building project. Project members other than those listed here (such as the building trades) were not interviewed; while their role is crucial to the success of the project, it is felt they are too far removed from the factors that influence conventional or environmental design decisions.

More architects, engineering consultants, general contractors and real estate developers (public and private) were interviewed than other project members because the literature review consistently

revealed that they have a greater involvement in the major decisions. Further, there were more interviewees that had experience delivering an 'environmental' building. This is acceptable as these interviewees had previously built projects with no environmental component beyond that which was regulated, and they still rely on commissions from projects that are not 'environmental'.

1.1.4 Thesis Structure

Chapter 1 defines the thesis and establishes the urgency for implementing environmental responsibility. Chapter 2 describes the settings and agendas within the architectural profession by which architects must make their daily design decisions. Chapter 3 describes the different project members who influence architectural design by describing their responsibilities during the process of project delivery. The resulting agendas of the client, architect and prime contractor are shown to determine the degree to which Environmentally Responsive Design (ERD) can be implemented. Chapter 4 then categorizes the different levels or 'degrees' of environmentally responsive design as a consequence of the client's agenda and period of responsibility for the project. The appropriateness of ERD strategies independent of client agendas is also explained. Chapter 5 contains conclusions that help answer the central research question originally posed in section 1.1.1: "How can all architects design more environmentally responsible buildings and places?" This last chapter contains some strategies that can facilitate ERD as well as recommendations for subsequent research.

2.0 SETTINGS & AGENDAS IN ARCHITECTURAL PRACTICE

Architects are retained early in the development process and are the largest contributors toward the success of the selected development type. The architect has always been in a position to suggest major changes in building such as issues of form, massing, material selection, building use and quality of design.

> We're primarily designers, and although we care that the water stays out and that the building stands up and will last over time, we argue most for the design, for that's the unique point of view that we bring to the table. It's important that the contractor argue equally his concerns, and the owner the financial aspects. In that creative tension between individuals, something is added to the process.
>
> David Childs, Skidmore, Owings & Meryll (Sabbagh, p.31)

Each architect can choose to believe that they, through their work, can passively reflect culture or actively shape it. If the architect believes that design manifests culture, and culture rests firmly on the foundation of our own civilization, then attempting through design to transcend the confines of a non-environmental civilization makes designing for Sustainability epistemically impossible. Van der Ryn uses this perception for justifying the design community's inability to meet standard practices let alone adopt more sustainable practices: "conventional design is failing because its epistemology is flawed" (1996, p.13). Further, that "the debate concerning style becomes irrelevant, if not irresponsible, when designs create more waste and pollution then the earth can absorb and cleanse" Crosbie (1994). With this reasoning most mainstream architects will not change to adopt sustainable practices until their culture changes.

Arguably, culture is changing, as evidenced by a greater demand for durability in residential buildings, hundreds of case studies, exhaustive lists of reference material and numerous environmental initiatives at all levels of government. For architects and clients who believe that they *can* influence culture and that believe they have control over the decisions they make, higher degrees of ERD can be directly attempted.

This chapter describes the context in which the practicing architect makes design decisions. Describing the composition of architectural firms highlights the amount of project control individual architects have relative to other firm members as well as the firm's control in the development of the project. Section 2.2 identifies the responsibilities the architect has when designing which, combined with their role as project coordinator, shape their professional agenda.

2.1 Architectural Firm Composition

Within each architectural firm, there are many roles needed to provide the services required by the project and the client. Collectively the firm will deliver architectural drawings, complete with municipal approval and a final cost accounting. Architects in addition to being design professionals will also likely coordinate the project's delivery. Depending on the size of the firm the following roles can be adopted by one individual or by many:

1. *Senior design partners*. Consider issues of building form, envelope appearance and performance and materials regarding primary experiential elements such as the overall building, its lobbies etc. They establish major milestones and design principles together with the other senior project members, namely the client (project owner) and prime contractor (project builder).
2. *Project architects.* Devise the best system to construct the building while working with the consultants to ensure a working knowledge at all scales of the project. They can also act as 'technical coordinator', where a change order must be updated throughout the process from the CAD drawings to distributing these changes to the affected disciplines, including the municipal authorities. They accept responsibility for project performance as a whole.
3. *Senior designers*. Have the technical experience to address the daily design issues that arise during the project.
4. *Intern and intermediate architects*. Are mainly responsible for the production of the drawing details which enable the sub-trades to price and construct the building. They lack the required years of actual, practical experience.
5. *Computer-aided design (CAD) draftspersons*. Develop the to-scale drawings used to define the scope of work and quantities of materials for the sub-trades.
6. *Office support personnel*. May be responsible for office organization, accounting, software and equipment upgrading and maintenance. They advise the senior members of a need for a new tool or upgrade to facilitate business.

The project architect and not the design partner is typically is in the best position to suggest effective and significant alternate strategies but this still will depend on the level of knowledge he or she possesses. It is well known that it is at the conceptual design stage where the greatest impacts can be made, but after this phase has passed, many more decisions remain which can decide the project's success.

Firm size also affects staff composition and management structure. Smaller design teams can handle the complex program of disproportionately larger client organizations. Larger firms tend to be companies that have a wide range of skills, employing a multi-disciplinary staff to handle a greater variety of commissions. Larger firms tend to be more profitable, more prestigious and are able to bid for commissions outside their region or country with greater success than smaller firms. Serge Demarais, MAIBC commented that larger firms are able compete for larger projects because they have a company structure to manage and monitor the effectiveness of each project which is similar to that of more sophisticated clients. This additional management does not guarantee success, but does increase awareness of the factors contributing to a project's success.

Architectural firms can also focus on interior design work. This work can often be more profitable as it is mostly governed by the design professional with fewer complications from engineering and construction concerns. Further, this type of work is required more frequently than building shells and facades which increases the amount of repeat work. The author believes that these architects, who can directly affect the productivity and operating energy resulting from interior design should not be excluded as valuable contributors to environmentally responsive design (ERD).

Firm Selection

The architecture firm must first compete to win the commission before assigning personnel to design the project. There is typically a two-step process when evaluating whether architectural firms can deliver the project that the client wants. The first step involves the assessment of the ability of the

firm to perform the work, based on the firm's previous commissions, experience, list of sub-contractors and workload on other projects during the time they will be needed. The second step involves an assessment of the competing fees to perform the proposed work. These steps are usually evaluated simultaneously for smaller projects where the cost of evaluating proposals is large relative to the project budget.

The architectural team that wins the commission usually provides the lowest bid. This bid may be lowest due to an omission or underestimation of costs but regardless, once the commission is awarded, the architect is bound to provide the service for the price stipulated in the contract. There are increasing numbers of complaints that the selection of the lowest tender is compromising the quality of the construction industry. A 'two-envelope' system which keeps the project's design and cost in separate envelopes is suggested to clients ("Consulting", 1995, p.10) where only the designs that best suited the clients needs and standards (independently assessed first) would be reassessed while including costs. It is rarely used in actual practice because clients and the market persist in the belief that the same level of quality is attainable from widely varying fees.

Generally, the architect is being retained less and less to coordinate the project as the "Master-Builder" and is instead offering services for feasibility studies, program development, schematic layouts, diagnosis and evaluation of problems in existing buildings, maintenance cost estimates, post-occupancy evaluation, building diagnostics, and three major preoccupations of clients: interior architecture, façade architecture and programming. Gutman (1988) speaks of the architect's awareness of the amount of control lost to other disciplines, and practicing engineering firms acknowledge the trend of declining professionalism. The reason for this "fragmentation" argues Gutman is largely due to the client's changing demands and the leverage the client has over the architect because the supply of professionals has exceeded that of construction projects, creating a fiercely competitive environment.

With publicly funded developers such as Public Works Canada (PWC) and UBC, consultants are selected from a database based on a set of objective criteria. Public Works Canada, for example, attempts to implement objective short-listing of registered firms through a "Computer Assisted Selection System For Architectural and Engineering Consultants" which selects candidates from a national inventory called The Architectural and Engineering Services Index. The initial selection is done by a three-step search: Qualification, Proximity of qualified firms to the project site; and Dollar-Value of previous opportunities (SPEC pamplet, 1990). Despite this attempt at objectivity public clients can structure the selection criteria to restrict the number of eligible firms. Efforts to include environmental design experience as a selection criterium would change the number of qualified firms and generate interest by other firms to learn ERD. However the requirement for equitable access to public commissions prevents the same teams involved in development from being continually retained. With owner-developers such as the University of British Columbia (UBC), the selected firms are further reviewed by a department committee selected by the Board of Governors and composed of personnel from Plant Operations, Campus Planning and Faculty. This representation keeps changing from project to project in an attempt to provide better balance of input during firm selection and project development.

Lastly, there is definitely a set of architects that are very influential and in high demand, acclaimed for their specific style by society and/or their peers. Some of the rewards for the acclaimed architect are greater financial security, the ability to select interesting projects and the ability to demand design-lead commissions. Architects of unique and significant projects become further immortalized since these structures are meant to be public focal points for the next 100 years. Some acclaimed architects are invited to plan cities, a major honour and responsibility as the city plan will shape future development that can either benefit or harm these new communities.

Many of the published architects whose works influence the design community are winners of design competitions. The sponsors and creators of each competition define (a) its scope of eligible entries, (b) the criteria for their evaluation, and (c) the prioritization of these criteria. For example the majority of these awards relate to new construction, which offers no feedback on the building's success in terms of operational performance over a number of seasons. Media-sponsored competitions such as Western Living's "Best In The West" also independently define the profession's 'best' architecture. The winning entries are often custom and vacation homes built in affluent neighbourhoods and while inspirational, these homes represent a small portion of what is being constructed in the residential market. That is, the bulk of architecture and architects is not being acknowledged because of the type of projects they design.

2.2 Design Criteria: Performance, Cost, Time and Risk

The client often initially retains a particular firm based on that firm's established architectural style, which can lead or follow mainstream design. Within their architectural style, architects evaluate possible design alternatives for each building material, component, and system based on the following four main criteria:

(1) Performance
(2) Cost
(3) Time
(4) Risk

Each criterion is not mutually exclusive, nor are units between criteria compatible, making the evaluation of each alternative quite subjective. The architect cannot design in Roarkian seclusion making the acceptable limits for the criteria above heavily influenced by other project members during the delivery process.

Performance

Minimum performance requirements are directly and indirectly set by the client, by the occupants and by the local climate. Often, a time-tried product or assembly is acceptable while newer alternatives or higher requirements demand that the product pass accepted testing by institutions such as American Standards for Testing and Materials (ASTM) or the Canadian Standards Association (CSA).

Building product performance in a given climate and application depends on its material properties, shape and the performance contribution from other components. The architect's 'typical' detail and material choice must be made appropriate for three levels of climate: the climate given its geographical position (degree-days, precipitation, snow, seismic susceptibility), the local climate defined by the site topography (proximity to other built and natural phenomena) and the micro-climate created by the building geometry (component exposure to concentrations of wind, sun & rain (which increase with building height) or chemical reaction with other building materials).

The length of time that component or system is expected to perform is another primary criteria of performance, which unfortunately is becoming less relative to the building life. Performance time has experienced a shift and is more associated with outlasting the warranty period or period of ownership of the project. Thus the standard of performance becomes defined as the greatest benefit for the least investment *as it relates to the client's interests.* In practice, it is becoming the privilege of the client to define 'quality' ("ASTM", 1996) which raises the question of how this new generation of standards expects to represent the public's interests.

Once the performance warranty has expired, none of the liability relating to inadequate performance rests with the builder so there is little incentive for the builders to monitor or design for the long-term performance of the building and its parts. There appears to be two perspectives on a solution to this issue: Firstly, the naming of specific development teams (developer, architect...) that commonly produce deficient buildings in order to extract compensation or to remove them from the market), and

secondly to name urban land development as a dysfunctional 'system' where no one member is partly or jointly responsible. This first perspective is supported by many individuals and groups from the general public who are frustrated that the government has allowed inferior construction to continue to be built and sold. Organizers of a public meeting, following three years of waiting for government intervention, collected from 1100 attendees building and developer names that have problems due to water leakage in the GVRD ("Hyatt", 1998). This threat of litigation (by publicly naming parties) and the potential cost implications forces governments to remain ignorant, complacent, or as non-accusatory as possible. For example, three years after the leaky condominium crisis began to be a mainstream problem, the City of Vancouver had no statistical data which might highlight certain building types, development companies or demographic groups that are associated with inadequate building performance. The final position of the provincial government concerning deficient, 'leaky' buildings, writes Dave Barrett, is that "The crisis in residential construction is a symptom of market failure, partly arising out of ineffective delineation of the roles and responsibilities of the various participants in the system." (Barrett, p. 2). Both perspectives result with the same outcome: As developers and architects will not become known producers of inferior construction and will therefore not loose market share and potentially their businesses. Liability will only be of concern when the net effect of avoiding testing to meet performance standards becomes too costly to ignore.

If the architect chooses to specify an unknown system or 'innovative' product, he/she need to prove to the local municipality that the alternative satisfies the performance intent of the governing Building Code. For example the structural engineering firm Reid, Jones, Christoffersen (RJC) required $20,000 to confirm that the strength of the re-used timber used in the C.K. Choi Centre, UBC met current construction standards. Innovation can also involve the unconventional use of conventional materials, making their performance un-proven for a given application and therefore unpredictable. Wilson (1995) comments: "It takes time to research alternative design and construction systems; new materials may not have proven track records; higher costs may be an impediment; or clients simply

might not be interested." As mandatory warranty periods increase, designing with product durability in mind will force the use of life cycle costing as part of the value analysis process, making ERD more appealing to designers and developers.

Lastly, architects, through design, can contribute to reducing energy use, environmental depletion and contamination by integrating active, 'operating' features and passive architectural strategies which also enhance building performance. Active design features encourage and rely on the users of the building to lessen their impact on the environment, for example specifying 'smart', task-oriented heating, ventilation and air conditioning (HVAC) systems or providing for recycling and reuse services. This performance is short-lived unless commissioned and regularly maintained or upgraded, which is difficult given the reliability of voluntary commitment. Conversely, passive building design relies far less on the commitment of the building users, consisting of strategies such as daylighting and natural ventilation or building products that are constructed into the building, such as highly insulated windows or increased durability of certain building components. This latter type of design can enhance building performance during the short and long-term.

Cost

Cost is another criteria that is established by the client. The client could be a Private Developer such as Polygon Group Ltd. or Intrawest Corp., a Public Developer such as the University of British Columbia or the various levels of Government. The client could also be an owner-builder such as McDonald's or any company wishing to expand or relocate to satisfy an expected market demand. It is always in every client's interest to minimize cost while still satisfying the other criteria of performance, time and risk.

The cost of borrowing is a fundamental although indirect consequence of development that affects the development of real estate and the execution of the architectural design. It can represent 40% of the cost of development (Sabbagh, 1989, p.75). The cost of borrowing for the client is affected by three

main variables: The principle borrowed, the interest rate, and the period of the loan. Clients borrow at higher rates until the project is completed, at which time the project can be used as collateral and the borrowed amount can be refinanced at a lower rate of interest. It follows that the client pressures the architect for the least expensive design to reduce capital costs, and for shorter, less forgiving project schedules.

Design is driven also by trying to maximize the leasable space which maximizes the tenant revenue thus enabling the borrower to pay back the construction loan sooner. Clients accomplish this by applying for variances to exceed floor space ratio (FSR) limits, by building the largest building possible which includes maximizing the amount of site coverage. Designers accomplish this by reducing the space taken up by the mechanical services and exterior walls which are important elements of energy saving, building durability and occupant satisfaction.

Time

The criteria of time influences design decisions such as construction techniques and material sourcing. The more quickly the project can be completed and the certificate of occupancy issued, the more quickly the client can begin receiving the revenue necessary to repay construction loans and interest. This lowers the project's sensitivity to the changes in the rate of interest as well as saves money. The client requires Returns on Investment (ROI's) or payback periods that rarely exceed 5 years to limit the amount of non-liquid assets due to the number of simultaneous, ongoing projects. Private developers that do retain ownership expect to have paid for the building and to be receiving substantial project profits after approximately 20 years.

The time of construction becomes an area where missed revenue can be viewed as lost revenue until the structure is completed. The shortening of this construction period is therefore important and is commonly achieved by 'fast-tracking' projects. This has been taken to excess where $1M per day loss in potential revenue resulted in the construction of a 1.4M sq.ft. casino within 12 months (Engineering

News Record, year+) where in this case, the cost of the structure and the corresponding design strategies were immaterial relative to the revenue from its operation. On almost any fast-tracked project, complete detailing and sourcing of materials, and iterative community involvement become un-affordable steps due to the time required to adequately address them.

Risk

Risk can be defined as 'the chance of loss' or the chance that cash flow will fall short of expectation (Riggs, et. al., 1986, p. 453). The potential financial losses for public and private developers in real estate development can be in the millions of dollars, and infrastructure or environmental clean-up costs in the tens of millions, making the assessment of risk in these areas very important. Liability is based on an assurance by the provider that the material performs its intended function. This performance is measured by testing standards and is assured by the consulting team, the testing facility, or the client. For design professionals and the construction industry in general, assuring the public regarding *performance* of buildings is a paid-for service and legal responsibility. Since architects are liable for the performance of the alternative they specify (for life), they do want to know where something has been used before, how many times it had been used, and how it had performed. However testing by the design professional is usually impractical, as in the case of the unprecedented application of commercial composing toilets to larger projects such as the C.K Choi building at the University of British Columbia (UBC). Here the client would accept the liability in part because of the University's commitment to make it a demonstration building and in part because they had 'deeper pockets' than the consulting team (F. Pagani, personal communication, July 5, 1997).

Risk assessment by other project members can also influence architectural design indirectly. Project members, if defined as entities that influence project development, would include lending institutions such as Banks which can afford to loan the capital costs, but will only endorse a proposal if the risk is sufficiently low. This requirement for condominium projects, for example, has banks requiring pre-

sales of 80 to 100 percent of the units. Amenities and finishes for the units that are visible in the showrooms then become fixed costs, forcing future cost-saving measures to occur elsewhere in the design.

Although decisions made without all the facts at any level will mean taking on risk certain individuals commit to risk more readily than others, even if the risks are high. If ERD is to be argued as a viable alternative to conventional practices, the indicators of risk need to be identified and the individuals willing to take these risks despite the potential for large losses need to be rewarded. Advocates of ERD need to acknowledge the complexity of risk analysis when developing policies or applying a new idea to large projects by retaining a risk assessment company to perform a thorough evaluation of the proposed alternative.

Since Environmentally Responsive Design does not have a significant number of comparable case studies to confirm performance (largely due to how ERD has been defined), it is similar to other unknown products /processes entering the conventional marketplace. New building materials in general are not quickly adopted without adequate testing, while warrantees for these new products are irrelevant if the manufacturer cannot remain in business. These reasons make ERD products 'risky' which may require additional investment in redundant systems to ensure that the building reliably performs.

If the project is to be design oriented, the design team could apply for the required bonding to control the project's construction. Bonding is not insurance but a guarantee of performance that the project will be completed. A bonding company must have information sufficient to inspire confidence that the team is capable of performing the work and services. *Bid bonds,* usually 5-10% of the bid, will ensure that the bidder, if successful, will carry out the terms of the bid. *Performance bonds*, usually between 50-100% of the project cost will guarantee completion of the project. *Payment bonds* may be required by the sponsor to provide financial security for those who provide labour and/or materials to

improve property. All serve as protection for the client (or owners) against lien claims by unpaid contractors.

When an issue is deemed important enough, insurance companies and government take steps to reduce the most frequent and costly claims. In 1996, the North Carolina Building Codes Council expected Exterior Insulation Finish System (EIFS) to not only satisfy higher technical standards but also to be accompanied by a 20-year warranty if it does not use an appropriate drainage system. Since no builder would issue the warranty, this has removed EIFS from that residential market. Maryland Commercial Insurance Co., covering 25,000 of the 120,000 home builders in the US, will not insure EIFS on non-commercial buildings (Rubin, 1996).

Architects do require legal council to determine their exposure for an unfamiliar project type, to develop a contract specific to a project, or to form a defense against a claimant. This claimant can even be a subsequent owner of a building, making the architect legally, if not ethically, responsible for the building's long-term performance ("Winnipeg", 1995). Contract lawyers are retained for large projects to create contracts that define the scope of work and limit the liability of the architect. Their fees are assessed depending on the project complexity and cost and the number of parties involved in the contract. Legal advisors then review, advise on, draft and negotiate the contracts to ensure that deficiencies, delays, business interruptions, risk management and claims are addressed before the work begins. This approach claims to result with projects coming to successful completion with fewer delays, claims or cost overruns.

Design professionals are expected to design to the state of the art of the profession at the time the services are rendered. They are ultimately expected to design for the end-use needs of the occupants thus should reasonably foresee problems. This charge demands disclosure of information to the client through frequent and informed dialogue. Ethically, they must get the client's informed consent and must explain the long-term tradeoffs for the short-term savings. This results with clean, signed

contracts stating that the client did or did not take the recommended alternative. (Shapiro, "Building", 1996). When the architect does require representation for litigation, the whole legal experience leaves all parties resentful of each other and under-compensated, and often destroys all public relations with the occupants of the deficient building (These occupants may have waited for years to see who would provide the reimbursement for the capital outlay to repair their homes and amenities).

Notably, retaining legal advice before the innovative ideas are firmly decided upon often results with the development team rejecting the innovation based on the conservative advice of council. Lawyers may be more supportive to innovative ERD if they were retained after the design decisions are set. Otherwise, a lawyer will tend to offer only conservative measures instead of searching for reinterpretations of existing laws that enable the team to implement the particular innovation without undue exposure (Sebastian Moffat, personal correspondence, Aug. 6, 1998).

To conclude, architects fulfill a number of roles and responsibilities within a design firm and their firm must remain competitive to be able to practice. They evaluate design criteria using the client's expectations and the firm's beliefs and they ensure the firm's design responsibility to the public. In the search for improved designs and building systems, they must be aware of the applicable restrictions to minimize their liability when practicing while at the same time interpreting legal precedent in ways that facilitate the adoption of ERD. It is ultimately up to the architect to choose to promote any initiative and it is up to the environmental community to try to make ERD the initiative that is promoted by architects to their clients.

3.0 OTHER PROJECT MEMBERS

This section describes the responsibilities of other project members throughout the development process. Within each development phase, there is usually one dominant project member that influences the architect's ability to implement 'greener' design measures. Following an overview of project phasing, the project members are explained in terms of their responsibilities which will help determine which project members can facilitate different aspects of ERD.

3.1 Project Phasing

Project phases are mostly sequential but do overlap during the project or for the many individual materials that must be chosen, ordered, fabricated and installed. The decisions as each phase is completed shape the project's broad design issues down to its specific on-site modifications. Although early decisions tend to have the greatest impact on the project, every phase has a set of important design decisions that can affect the project's success.

Project feasibility and conceptual design

During project feasibility and conceptual design, the main players are (1) the client as they retain the architect, set the budget, and expect a certain product, and (2) the governmental authorities and community groups who seek to ensure that the project addresses the public's interests. This phase sets the building's programmatic requirements that the architect is asked to fulfill. Municipal zoning (use), height restrictions and Floor Space Ratio (FSR) limits are some of the boundary conditions the architect considers in an attempt to ensure the development's 'contextual fit' into the surrounding community and regional plan.

The client and architect work with this minimum FSR to decide on site and building layout, size, shape, number and orientation to satisfy the city planners, the investors and the seller of the property. The resulting project scheduling, completion date, overall project budget, and architectural program

are then established. For residential developments, it is common for banks to require that 50% to 80% of the units be pre-sold before lending the capital to the builder. The architectural consequences of this requirement, given that the affordable cost per unit is fixed throughout design development, can be a reduced investment on design to increase available funds for marketing. Currently for multi-unit residential projects in Vancouver, marketing fees of the development now roughly equal the combined fees of all its design professionals (Georgia Straight, April, 1998).

The main structural and aesthetic design features and their materials are then decided and 'Soft' costs (financing, testing, interior finishes) and 'hard' costs (building materials, services and labour) can then be assessed Notably, furnishings, equipment and 'add-on' ERD features are defined as soft costs. While this makes soft costs as high as 25-35%, it allows these elements to later be removed from the budget to limit cost overruns, advance time schedules, or to respond to a change in the preferences of the market.

Design Development

Once an architectural firm is chosen, they typically work first with the structural engineer to ensure that the primary structure is sized and spaced safely. They then solicit information from the mechanical engineering consultant in an iterative way to provide the best design/ utilities combination for comfortable space conditioning. The electrical consultant is typically involved shortly after to develop an electrical and communication strategies for the facility. Design development results with the following three deliverables which provide sufficient description of the building for the contractors and suppliers to price and build the project:

1. The drawings, (which include site, plan, elevation and section views and window and door schedules), which in turn refer to Nos. 2 & 3 below;
2. The details, (which can show construction sequencing, generic materials and system continuity at transitions) and

3. The specifications, which list the conditions and procedures for the work and the proprietary products or equivalent products that are expected to satisfy the performance requirements of the generic materials.

Because of the increased complexity of contemporary buildings, dozens of professionals, manufacturers and contractors must use these documents in isolation to order the products and set the schedules for their delivery. Components may need to be fabricated months in advance, or be installed months in the future and only at the time of installation on site will design compatibility be confirmed. A lack of compatibility usually results in cost or time overruns and un-cooperative relationships follow, breaking down communication which could otherwise result in savings or improved design changes elsewhere in the project's phasing. The absence of details and improper or missing specifications are common sources of cost overruns and inferior or undocumented workmanship. These details are often interpreted on-site, are usually under time constraints, and are often not confirmed by the architect. King (1987) comments that this lack of focus on existing conditions in favour of design may ultimately compromise the design concept:

> Not enough time and/or consideration seems to be given to alleviate conflicts with existing conditions during design. This means that significant design modifications must be made in the field in order for many of the items to be constructed." ... "Since they were not properly considered, construction and peripheral costs were higher than anticipated, construction time was increased, and field changes were made that modified the design concept.

The most critical step and common complaint is in not bringing subconsultants earlier into the drawing development phase.

Tendering and Construction

Usually expressions of interest for the proposed construction are solicited by the architect from a list of firms or companies known for their capabilities, reputation and past working relationships. Interested bidders would then review the tender documents before forwarding them to subcontractors such as steel manufacturers, brick-makers, and window companies. Each would submit a bid given their understanding of the scope of their work based on the drawings, details and specifications.

The lowest price for the same perceived quality of materials and workmanship is usually the accepted one. The awarding of the commission based solely on fees usually underestimates the costs of actual construction, and unless the contract documents are very thorough, the prime contractor and subcontractors will try to recover lost profit through additional unforeseen (or un-included) costs. Convincing clients to pay fair price for what they expect to get becomes a fundamental step toward good design and construction. Nineteenth century architectural critic John Ruskin complained of this ages-old desire for "paying a little and getting a lot alot -it can't be done." Admittedly, for a given quality of material, its fabrication and installation, a threshold amount of investment is required and expected. When a purchaser expects to pay less they are either naïve or they are willingly taking on additional risk that the product may fail to perform its intended function.

By the construction stage, the architects and engineering consultants will make periodic reviews to confirm that the as-built construction is in general accordance with the intent and specifications described in the drawings. The primary influence on the success of a project during construction becomes the prime contractor (section 3.5) who is continually performing Value Analyses of design decisions with the main objectives of (1) determining the least expensive materials that satisfy the specifications and building codes, and (2) establishing the processes and systems that minimize fabrication and erection time. In practice, scheduling the construction to coordinate all trades working separately and simultaneously, even with flawless drawings, is usually an unachievable expectation.

When construction is completed, the subcontractors, contractors, consultants architect and developer certify that the building will perform as intended. At this point, the municipal authorities review the project before issuing permit of occupancy which may be conditional on outstanding deficiencies being corrected. Many of the project members are frustrated and tired and are uninterested in what occurs with the building following the conclusion of the construction contract even when the holdback amount (typically 10% of the stipulated price) represents their profit. When contractors are interested

in the proper completion of their work, those still working as the occupancy date approaches are often rushed by the prime consultant to leave the site to give the appearance to the client and the occupants that construction will not holding up the occupancy 'fit-out'.

Tenant 'Fit-Out', Commissioning and Property Management

With the structure and services completed, the occupancy permit is issued by the municipality and the tenants begin to customize or 'fit-out' their spaces. Tenant fit-out can be as costly per square foot as the structure itself was to construct. Once the interior finishes have been installed, the mechanical and electrical engineering consultants attempt to 'balance' the interior climate to acceptable levels. Known as commissioning, this final systems check is done before the building is legally accepted from the project members by the client. It includes procedures to optimize lighting levels, test and balance the vented air supply which controls humidity, temperature air quality and distribution to encourage human health and comfort.

During subsequent fit-ups, mechanical and electrical services and their locations are modified, and lighting levels adjusted to comply with minimum standards, based on the tasks performed, the availability of natural light and the reflectivity of surrounding surfaces. To confirm warrantees, conduct simple fixes and make future inspection and maintenance of these installed systems possible, all manuals for the different systems must be collected, copied and archived for easy reference.

Comprehensive commissioning (section 4.2.2.1) is desirable throughout the service life of the building and can be conducted by property management companies, who are responsible for the proper operation of the building in order to ensure continued satisfaction and revenue from its tenants. Often a building becomes obsolete and is replaced when the costs of commissioning become too high, even though the structure and its finishes are still in use.

3.2 Client Responsibilities

The client's agenda as defined by his/her responsibilities and objectives affects the architect's ability to control design more than that of any other project member's agenda. An architect wanting to do ERD is smart to acquire client support by evaluating the client in terms of their personnel and business goals, as well as the client's requirements of the specific project. The client has a preconceived idea of what environmentally responsive design implies and requires of a project . Their understanding of ERD will decide whether they support it, are indifferent, or if they explicitly do not want the architect to potentially compromise other building features by devoting limited design time and energy exploring 'green' options.

The client is also aware of the period of responsibility for any given building they own or manage. Thus they may have little interest in investing additional capital on operations/maintenance if the return on the investment occurs after their period of responsibility has expired, or if the additional investment does not translate to added value at the point of sale.

There are many client companies developing property in the Greater Vancouver Regional District (GVRD), each directly and indirectly contributing to the urban landscape, tax-base, regional infrastructure, and other factors that are used to measure the quality of life of residents and communities. Some clients restrict their projects to one development type, while others choose to provide many types of facilities. Each client organization engaged in development has a different relationship with the architect depending on its sophistication, reputation, public image and assets. These client strengths are leveraged according to personal or corporate agendas mostly during the beginning phases of project delivery.

There are three general client types, distinguished from each other by the reasons each has for development. These reasons and the subsequent responsibilities each accepts helps decide in a very direct way the level of ERD the architect can propose.

1. Clients who develop real estate to privately improve operations: The private owner-builder.
2. Clients who develop real estate for private profit through sale or lease: The Private Developer.
3. Clients who develop real estate for public benefit through facilities and services management: The Public Developer.

3.2.1 The Private Owner-Builder

Clients who are private owner-builders typically develop property with the intention of owning, using and managing the site themselves. Generally speaking they retain project control as they are *investing* in a building that will provide future, secondary benefits for the company such as additional space, improved location or services. The long-term interest in the performance of these owned structures and their components and services means that design decisions can consider payback periods for better design that extend into the operation phase of the building. If the expanding or new business management is not sophisticated due to the infrequency of new development, the owner-builder may be unaware of the costs (and benefits) associated with thorough design and conscientious construction. The resulting frustration of high costs make this client highly risk-adversive which can limit proposed ERD strategies. Architects are retained by these clients primarily to provide a facility for client operations and will be most successful at convincing these clients to incorporate ERD to enhance public image and to encourage reinvestment into the communities that the client services.

There are a large and diverse number of private owner-builders. Clients such as banks, hotel chains and restaurant franchises which require their buildings to offer a standard, recognizable building style may have an initial objection to innovative 'green' measures for fear of image inconsistency but if convinced, can become receptive to increasing degrees of environmental measures on all future projects.

3.2.2 The Private Developer

Private Development companies exist because they posses the capital and experience to erect expensive projects that individual tenants cannot afford to construct, but can afford to lease or partially own. As the costs of developing real estate increases, so does the reliance on private developers to build spaces for small businesses and residential communities.

The moral justification for private development is founded on fulfilling the perceived or anticipated demand for suitable shelter and recreational or business amenities -without which, the quality of life (or its rate of improvement) would be expected to decrease. Their business practices are inconsistent with this philosophy. While the private development companies' market research concludes people are in need of a new building, the company's *operations* must be structured to generate large profits due to the level of risk inherent in new development. This risk makes the financial outcome of doing business substantial, break-even or can force the company into receivership. Thus development of income-producing property requires that environmental strategies improve the marketing advantage of the development, in terms of providing a product with high demand, high rent, and low fit-out and development costs.

Despite their degree of project control and substantial influence in the shaping of communities, these clients claim their agenda is a result of un-negotiable external influences. Robert Schubert, the developer's representative for a Manhattan skyscraper project reflects, "But do I think the community got what is best for it? No, I think this project is too big, but that has nothing to do with [the developer], it has to do with the economics of the United States" (Sabbagh, p.46). This developer also blames its micro-economic business objectives as well as macro-economic externalities for considering only money:

> What it's about is dollars and cents. ... so we can cut through all the philosophical stuff of the architects, the planners, the sociological statements that some of the partners have made about we're saving or we're enhancing the community... That's

> all true, but what it boils down to is whether it's financible and whether there is a return to the partnership.
>
> Terry Sodenburg (Sabbagh, p. 378)

This response suggests this developer uses few non-financial indicators to define success, making developer 'success' private and corporate, not social or environmental. This developer is in the business to make money, not to make money while helping society thereby excluding the social and environmental requirements for sustainability. Benefiting society, according to Jane Jacobs ("Life", 1998) means not hurting any individual as a result of development. If a development has elements that are 'bad' for one community, these elements are likely bad for any community, and the 'bad' ideas need further thought and revision.

Without in-depth knowledge of the materials and processes (i.e., integrated teamwork) required for 'deep-green" ERD, developers are very wary of unfamiliar ERD as it represents an added risk to conventional profit margins. Conventional risk management requires much effort by developers already by limiting risk at each phase by diluting ownership (e.g., multiple development partners and limited companies) and by having an exit strategy should things go wrong (i.e., renting in lieu of selling, lowering prices). Private developers also prefer to limit risk by remaining within a particular development type and region and by retaining the same development partners. This is because private development is a knowledge-based system, the more knowledge that is retained within the company the greater the ability of the company to select projects in a specific market that have low risks and high returns. Thus investment in architectural firms by private developers usually takes a number of years, resulting with predictable results to reduce risk and uncertainty in the design aspect of development.

Private developers also remain knowledgeable in areas that are outside of development such as those factors that influence potential buyers or tenants. This client type for example needs to understand well the stock markets in case their potential tenants have investments that are susceptible to

fluctuations thus forcing the tenants to leverage a reduction in costs of their commitment which may critically lower the developer's profit margins. This makes it difficult to advocate marginally higher capital costs of ERD that would be recovered during the operation of the building. Private developers are however in an optimal position to include a few lines in the tender documents that suggest that those with experience with environmentally responsive design (ERD) would be favoured.

Private development is also rarely accompanied by post-occupancy obligations in part because their liability is primarily based on performance, which is assured by the design professionals and contractors. Private developers minimally insure defect-free structures based on compliance to regulations and as a response to consumer demands within a given market.. Typical warranty periods for new residential construction are roughly one year for small items such as drywall cracks, three years for leaks and five years for structural defects. Developers expect that these periods will lengthen but they will only extend them beyond regulations to remain competitive (Rob McCarthy, personal correspondence, July 11, 1997).

3.2.3 The Public Developer

Public developer clients are different than other clients in that:

- They operate as large organizations with strict protocols. For example Public Works Canada (PWC) is marketed as Canada's largest construction agency and the largest property management firm with 8,300 properties covering 10M square metres.
- They build to supply a service to the public that uses revenue acquired through taxation, so their projects usually require some form of public accountability and hearings during the development process.
- They will retain ownership or lease back the building for decades. This forces some consideration for the costs of operation and maintenance in addition to capital costs.

Universities are an active, high profile type of public client (University Of British Columbia has on average completed seven major projects per year since 1990, some four city blocks in size such as the five-complex Thunderbird Residences). Their reasons for building include spending financial surplus,

improving the University's accreditation, reputation or associations with the private-sector and also to provide badly needed departmental space and facilities. Due to reduced transfer payments and shrinking budgets university administrations have required alternate sources for funding (private-public partnerships or donors) to avoid reducing services and remain competitive with other universities. Private citizens and corporations offering donations do so for altruistic, political or strategic reasons. 'Donors' wishing to purchase prestige by associating with a university usually prefer high-visibility structures and these donor proposals are always considered and rarely turned down.

Because of a desire by university administrators and donors to promote the reputation of the proposed project and the University, renowned architects are commonly sought. The building user's needs risk being marginalized during the ensuing design decisions due to the agendas of university administrators, by the conditions imposed by donors, and by the agenda of the acclaimed architect. For example, while the Arts Faculty needed a building to house students and studios, the president's priority for a theater resulted with funding for only the Chan Centre For Performing Arts.

What public developers (for example UBC and the City of Vancouver) are unable to do during project development is accurately account for the complete operating and maintenance costs that result from these new structures. This is because the political and strategic indicators for success and progress promote expansion and not the optimization of existing development portfolios.

Public clients managing large portfolios do have larger amounts of operating capital to commission studies which can identify strategies that provide the best value for their investment. Public clients therefore understand the importance of collecting post-occupancy information and potentially have the necessary funds to absorb the cost of the additional assessments through the future savings that result from them. For example, Public Works Canada (PWC) produced a document on the performance and durability of building materials to better manage their building stock (PWC (no year indicated)+).

Therein over one hundred parameters affecting the durability of buildings were evaluated to effect future savings. These publicly accessible reports are not likely used by private developers despite their obvious benefits due to the lack of any post-occupancy responsibility for the operating, maintenance and rehabilitation of the buildings they have constructed.

To summarize the agenda of public clients,

1. The source of the project funding and the respective representation of the administration, the planning/ maintenance department, and the users on the project team will decide the project's emphasis.
2. These clients are receptive to reasonable payback periods because they are responsible for the building's operation as well as construction.
3. The size of the development portfolio of the public clients would suggest that a successful series of ERD and development decisions can affect a large number of building designs.
4. The learning curve of the players on environmental or successful buildings will not likely be rewarded due to the political restraint of open tendering.

3.3 Public Interest Organizations

Architects are also directly and indirectly affected by groups that in principal, seek to serve the public's interest such as community organizations, municipal & regional urban planners, municipal services for permits and licenses and local and non-local politicians.

The goals established by community boards in theory enable communities to control the development of land in accordance with their needs and priorities (positive planning) and to restore to the community the increase in the value of land that arose from its effects (public profit).

Municipal planners assess the effect of construction on the medium and long term quality of living in the communities and municipality regarding issues such as affordable housing, aquatic habitat preservation, mixed-use amenities and height restrictions relative to surrounding neighbourhoods. Regional planners are concerned with transportation corridors, regional urban expansion, agricultural

land protection and water supply and quality. The responsibilities of these individuals is significant for they encourage or restrict policies that address urban commuting, densification or sprawl, and the consequences of their decisions are largely irreversible, showing success or failure only after a number of years.

Each municipality has a department that serves a function similar to Vancouver's Permits & Licenses Department. This function assesses the buildings within the development and specific features of the development for compliance to the applicable building code, which represent *the minimum standards by which a structure can be legally built.* The City of Vancouver is careful to clarify the role of the reviewers of project plans, saying that reviewers do not 'enforce' but "encourage compliance" of the building code. Further, only a directive from City Council encouraging environmental initiatives for better construction, operation and sustainability would need to be made part of the reviewer's scope to 'encourage environmental compliance' from project members.

3.4 Sub-consultants

The strength of the design and subsequently the architectural submission is also enhanced by the reputation of other design consultants. The services and qualifications of the following sub-consultants, the level of control they demand, and when they are involved in design development by the client and architect determine their contribution to and control over design decisions. They are:

- Structural and geotechnical engineering firms
- Mechanical and electrical engineering firms
- Building science engineering firms
- Landscape architecture firms
- Design specialists

3.4.1 Geotechnical and Structural Engineering Consultants

The geotechnical engineer confirms the quality, strength and use-history of the proposed site. This information is needed by the developer before the acquisition of the site to assess any additional costs due to environmental clean-up or soil conditions. Underground services and parking can be expensive to build due to the volume of earth excavated and unknown conditions below the surface. If the excavation/substructure budget is exceeded unwanted cost-savings during the construction of the superstructure may be unavoidable. Other complications such as a high potential for soil liquifaction and flood susceptibility for example has created an 'above-ground' architectural building typology in the GVRD unique to Richmond (Jacobson, 1996).

The structural engineering consultant is asked to assess different structural materials and systems depending on building shape and size, building code and architectural intent. Primary structural materials such as wood, steel and concrete perform most efficiently in certain structural configurations, which in turn affect floor-plate layouts. Once the materials are decided, their sourcing, fabrication and erection must be resolved which can become very complex. Generally, wood prices are more erratic and concrete sources must be local, while steel requires more off-site considerations such as locating the best material cost per ton (large projects are internationally sourced) determining which plants (in which countries) should fabricate the steel members and finally how the prefabricated pieces should be transported, stored and erected at the site.

The decisions made by structural engineering firms during the design development phase tend not to affect issues during the operating life of the building. Since the structural engineer's decisions are mostly restricted to material strengths and member serviceability, specifying materials from local, environmental and socially conscious sources and encouraging column-free design for added spatial flexibility are the only sizable measures where such firms can affect worthwhile environmental

changes. Presently, the structural engineering firms in the GVRD argue that they cannot afford to research or risk unfamiliar alternatives as the discipline is over-saturated and fiercely competitive.

3.4.2 Mechanical and Electrical Engineering Consultants

Mechanical and electrical services represent a significant influence in both the design, construction and operation phases of a project with mechanical firms being the most important sub-consultants affecting ERD in terms of their effect on building performance. These consultants are retained early in the design process to work directly with the architect when presenting ideas to clients. Because of the complexities and interdependency of many mechanical and electrical systems these consultants typically are retained at the same time, work together and attend the same project meetings in close contact with the architect. The mechanical requirements and their associated capital costs are roughly determined from the criteria provided by the developer such as the amount of floor space and the number of people within the building. Further, the engineering firm's fees are often a percent of the mechanical/ electrical equipment costs which does little to encourage a reduction in active heating, ventilation, and air-conditioning (HVAC) equipment.

At the construction stage, the inter-dependency of mechanical and electrical systems, the consultant's fee structure, building shape and location and especially ranges of expected comfort conditions promote larger, more complicated and more expensive mechanical systems. In the mid-1980's, one principal of a mechanical engineering firm commented that for a skyscraper project,

> The material and labor costs of the various mechanical and electrical systems take up about 30% of the total construction cost of the building. There is the cost of the floor area occupied by the equipment, 6 or 8% of the total. If you add to that the volume of space that is occupied ... between the floors, through the ducts and pipes, in the various machine rooms ... the mechanical and electrical systems account for [an estimated] 60 percent of the cost of the whole building. Sabbagh, p.307

More importantly, the decisions made by the mechanical engineering firm during the project's development continue to affect the facility during the subsequent operating and renewal cycles of the

building. Depending on the strategy used, the mechanical system can be difficult to service or understand by the different people that are charged with up-keeping it. Over time this can lead to significant losses in system efficiency and subsequently, occupant productivity.

There is a high priority by the developer to minimize the mechanical system or opt for strategies that create the least impact as the system detracts from the amount leasable floor space and adds to the capital costs. Innovative architects and mechanical/ electrical firms are more resourceful in achieving appropriate lighting levels and thermal insulation levels, while others continue to use familiar, generic HVAC analyses instead of newer, task-oriented analyses to save consulting costs. The preferred strategy is natural conditioning where passive solutions are integrated in the early stages of design to avoid the many problems of active systems such as system malfunctioning or misuse by occupants and maintenance staff.

This is also true as active, high efficiency electrical and mechanical services are often complicated and require periodic testing, balancing and maintenance. Often the superintendent is unqualified although expected to understand the HVAC systems sufficiently to adjust them properly and in a lasting way. Hit-and-miss attempts at problem-solving that result cause occupant frustration and vindication for clients wanting to put in less useful, efficient and expensive systems. Further, periodic monitoring and preventative maintenance is rarely done because it is believed that it is more cost-effective to address the problem once it has become a nuisance. Since the likelihood of unqualified personnel and infrequent inspections is high, passive and direct designs are more likely to be reliably successful.

Don Holte, president of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) is enforcing his privilege as president to select an initiative that is important to him. He is actively advocating the 'greening' up of ASHRAE membership's practices by asking and assisting them to develop designs that provide greater space conditioning than before but that rely far less on active systems. He knows this is possible if the mech./elec. consultants work with the architect

and the building envelope consultant early in development to harmonize the project's design. With passive conditioning strategies, increases in immediate and long-term energy savings and occupant comfort and productivity become less sensitive to system maintenance. The client must be convinced that these three designer groups can be trusted to develop the building together in the earliest phases of design.

3.4.3 Building Envelope Consultants

The building envelope has traditionally been the realm of the architect but increased complexity of buildings combined with high competitive fees for architectural services has made it difficult for architects to properly ensure the envelope's effectiveness as an 'environmental separator' (weather barrier). The building envelope's performance as a system can vary considerably according to materials, components and design styles, as well as the climate on each side of the envelope, where specific envelopes tend to be preferred in certain markets systems (such as stucco cladding in the GVRD). Building Envelope firms familiar with building science have therefore emerged in the GVRD to address to an excessive number of premature envelope failures resulting in water leakage and subsequent damage to building property.

This consultant's primary focus is to recommend the appropriate building envelope design that can separate interior and exterior environments according to the performance-based Part 5 of the Building Code. The degree of influence that these building envelope firms have on project design development is still relatively minor, involving modifications to completed architectural drawings and detailing, if they are retained at all. Their inclusion in the project's development often occurs late in the design process which results with a reliance on material resistance (usually caulking) and not proper design to achieve longer-term envelope performance. Reputable specialists are aware of the importance of their involvement earlier in the process and are eager to offer advice.

In 1996 the City of Vancouver requires the mandatory retention of Building Envelope Specialists (BES) for buildings. The accreditation for BES is in the form of seminars, course-work and exams administered by the Architectural Institute of British Columbia (AIBC), but it is not viewed by envelope experts as an equivalent replacement for long-term, focussed experience which previously defined the 'specialist' designation.

3.4.4 Landscape Architecture Firms

Landscape architects are familiar with the natural processes relating to the landscape and can best interpret the fit of a building and its landscaping into its natural context or introduce natural landscapes into urban projects. The building's orientation, durability, exposure to sun, wind and rain can improve or worsen the general design and performance of the building as much as the success of the architectural program and traffic patterns.

The public and private developers that have been interviewed prefer to involve landscape architects from the project's outset but their involvement is mostly to create obvious cosmetic benefits to the project's image. The civic authorities also prefer to see the landscape plans first because the public benefit of the landscaping is as valuable to the community as the proposed architecture. Private developers will include 'greenness' beyond the minimum municipal requirements if it adds value to the development. One private developer states: "The more we can spend on trees the better because people will pay to live in a place that has mature landscaping". But there is a clear limit to the landscape architect's influence: "... but you can only save as many trees as will fit around the building -because of the FSR's, you have to have a certain footprint".

Landscaping using exotic flora and which requires high maintenance are poorly adapted to the local climate, which is different from xeriscaping techniques that independently thrive while contributing to

the surrounding flora. This aesthetic and synthetic form of landscaping is largely controlled by the client's agenda and promoted by developer awards such as The Georgie Awards.

3.4.5 Special Consultants

Special consultants can be individuals or a collection of different firms and can be local or international in origin. Recognition and project variety are highly desirable consequences of design teams that are awarded commissions for complex projects. Securement of these projects is usually possible through joint ventures with specialists that compliment each other to collectively provide the necessary technical breadth and depth. The complex, sizable and lengthy contracts such as the Hibernia oil platform, Toronto's Skydome or CANDU reactors produce structures that are elegant and sophisticated but are primarily designed for durability and engineering efficiency. Due to their size and uniqueness, numerous environmental studies are performed to best predict the consequences of its construction and operation.

These consultants have significant influence on design decisions relating to their field of expertise. They are retained only for that purpose however and design decisions such as ERD that deviate from the specific agenda are rarely accommodated. Specialists defined by the special projects they work on represent a relatively small but influential portion of the design community. Fortunately the benefits from or requirements for having environmental or energy specialists as part of project teams on building projects is increasing as projects at smaller scales impact, for example, on fish-bearing streams.

3.5 The Prime Contractor and Subcontractors

Prime contractors (PC) have substantial control of the project during the construction phase where the primary deliverables are building on-time and on-budget as defined by the contractual agreements and feasibility analyses. They are retained by the client to build the project using the construction documents that have been produced by the architect and approved by the regulating authorities. Based on this interpretation the materials are sourced and priced, and the systems are fabricated. The prime contractor constantly tries to minimize labour costs through in-plant fabrication, choosing low bidders, minimizing construction materials (through more efficient structural engineering systems and architectural layouts) or through reductions in the need for temporary 'staging' facilities. Juggling all of these complex issues leaves little time for decisions not related to the timing and costs of construction.

Because of the consequences of their decisions which at this stage are often irreversible and potentially very costly (Li, 1996), senior members of the prime consultant's (PC's) opinions are more valued by the client than project architects or partners of architectural firms regarding most of the remaining decisions. The PC's advice to the client is often to invest more at the latter stage of the project or maintain constant monthly expenditures. In actuality, relative to total project cost, the penalties of investing more earlier in the development process (e.g., on better design) are small (Li, 1996). The importance of producing thorough, clear documentation at the design phase despite this additional cost early in development means fewer revisions during latter phases where the architect has little control or involvement.

There are two types of prime contractors, general contracting companies (GCs) and project management companies (PMs). General contractor fees are usually proportional to the cost of the project, they will build what the architect has designed and have little interest in suggesting (or

transferring savings accrued from) less costly methods. Further, unless the contract documents are very thorough, the general contracting company may try to increase or recover lost profit through additional unforeseen or un-included costs. Because the General Contractor is not explicitly working for the best interests of the client there is a higher potential for opposition or litigation with simple and complex projects.

Project Management Company fees on the other hand are mostly independent of the project cost, thus they act on behalf of the client to further minimize costs and schedules. So, "With no financial involvement other than its fee, completing the project at or under budget was desirable to enhance its reputation." states Art Newsbaum, Vice-president of HRH Construction (Sabbagh, p. 185). Because of the required level of management, PM companies are involved during the design stage. Project managers subsequently have greater control over the design development and a greater interest in working with the architectural firm than general contractors. This additional level of management also requires higher contracting fees earlier in development. The savings from the PM services must be large, direct and reliable, making PM fees viable for medium to large-sized projects.

Subcontractors

The architect rarely interacts directly with the subcontractors ('instructing' the trades on how to do their job may leave the design professional legally exposed). However the completeness, clarity and redundancy of building systems indicated in the architectural drawings and specifications have a profound impact on the ability of the trades to adequately price and perform their scope of work.

To limit liability, subcontracting firms contractually need to ensure their work is independent of the work of the other trades. This segregation, both as a legal move and as an attitude amongst tradespersons can sacrifice the performance and success of the building as a whole. One of the masons from the skyscraper project documented by Sabbagh comments: "The difference between us and [an architect] lies in the fact that an architect feels that [the project] is a monument to the world, whereas

we think it's a masonry wall, and there's been thousands of masonry walls built in this city". It only takes one tradesperson adopting this compartmentalized job description to risk compromising the integrity, performance and success of the whole building. The subcontractor's comment "I'm only going to do so much. The rest is someone else's responsibility" (Sabbagh, p. 199) can also arise from a reaction to clients who commonly and wrongly pressure subcontractors to include extra work without an extra charge outside of the original bid.

Because of the compartmentalized approach to project construction most disagreements occur from oversights at the connections between the various trade responsibilities and materials. Trade sequencing at these interfaces is rarely seen in typical 2-D architectural details and in the GVRD, 3-D details, some even 'exploded' for clarity or illustrating the construction sequencing are emerging to change the standard and sophistication of the contract documents. This better representation reduces on-site ambiguity and requires an increase in architectural competence regarding design constructibility and presentation. This prescriptive format has proved to be necessary because labourers and tradesmen can have little experience and so are often unaware of the principles governing design.

3.6 Tenants

For investors and developers the major milestone is the project's completion date, or issuance of the permit of occupancy, so that the users can begin customizing their spaces. The earlier a project is finished, the sooner the revenue can be generated to cover initial expenses. Unless the facility is owner-occupied, the tenants can exercise significant amounts of leverage by providing prestige, a high volume and/or type of faithful consumers, usually longer lease periods or substantial amounts of floor space. Once these tenant types are committed, the reputation and financial stability of the project is largely set and filling the remaining spaces becomes easier.

User fit-ups occur several times throughout the life of the building as user groups expand, shrink, move-out and in, or remodel due to the wearing of materials or changes in corporate image. This form of user fit-up is not considered in the development of a building even though the repeated costs of the renovations can exceed the initial cost of the building. Review of the specifications of one 4-storey fit-up for Public Works Canada (PWC, 1995) showed that changes to mechanical and electrical specifications/ drawings were by far the most important considerations which is typical of such work (200 & 100 pages respectively). They were followed in this project by interior walls, doors, glazing, and finish hardware, general instructions, partitions and other specifications (another 150 pages collectively). Some architects are specifically retained to design interior spaces in existing buildings to suit a client's programmatic and aesthetic needs.

3.7 Property Management Companies

Property managers are sometimes retained to list their operating requirements for the project while it is still being designed and financed but are rarely involved in decisions regarding the construction of the facility. The value of a commercial building is defined by its net revenue divided by a capitalization rate[1]. Keeping the building value high and ensuring a maximum revenue is mostly done by finding an optimal location to keep lease rates high and tenant vacancy low. Tenant occupancy is also dependent on employee comfort and corporate image which are provided for by the proper functioning and appearance of the building.

Operating and maintenance issues in Property Management magazines are widely discussed because these owners are responsible for the building's continued operation and tenant satisfaction.. Issues such as improved insulation, optimizing a building's service life, energy & environmental HVAC upgrading, all promote environmentally better buildings which use life cycle costing and economically

reasonable payback periods for improved systems. Sophisticated property managers are aware of the prioritization of retrofit options to maximize energy savings and increase occupant comfort.

Property Managers administer operating functions such as leasing, garbage service, paper recycling, operation of in-building food services, provision of parking, courier services, information hardware support, and security for building parking, property and occupants. Usually one individual, either an on-site landlord/building superintendent or an off-site property management agent is expected to coordinate a building's operations. While the agent is usually better able to liaise with building owners to argue prompt component renewal, retaining a PM does not guarantee better service as these agents have many properties to manage, are less aware of the daily concerns and quick-fixes required by the occupants, and may act only in the owner's best interest.

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[1] The capitalization rate is dependent on the vulnerability of the building's market and the market itself at the time of the sale. This rate is usually around 10%. Thus a building generating $2,000,000 rent per year but costing $500,000 to service per year would be worth approximately $15,000,000 (net revenue divided by the capitalization rate).

4.0 ENVIRONMENTALLY RESPONSIVE DESIGN (ERD)

The preceding sections identified the responsibilities of architects and the many project members that influence architectural design. With this knowledge, one can begin to decide which project members should be approached with suggestions for environmentally responsive design as well as how ERD strategies should be argued to encourage their acceptance. Since the client is the controlling member throughout the whole process, this chapter groups ERD strategies according to the client's agenda, who then is more likely to attempt ERD and require its use by other key players. This breakdown of environmental initiatives is intended to dissolve much of the lack of familiarity towards ERD but to encourage the acceptance of ERD the following three keys for implementation are essential if ERD is to be successful in mainstream practice.

4.1 Three Keys To Implementing Environmental Responsibility

The reasons not to incorporate some environmental strategies within each project are in large part due to a lack of properly marketed information regarding realistic environmental alternatives, a lack of influential individuals to promote environmentalism, and a lack of strategic focus toward the creation of settings that make ERD easier each time it is attempted. These three keys can associate ERD with continued success, for "an image of success ... is invaluable, and wide communication to key people of realistically reported results can forestall possible unfounded criticism" (Goldenburg, 1971, p. 410). This success will encourage its increased acceptance and use by the Industry.

The first key is to realize that the process of innovation, such as is required for ERD, is almost always driven by specific individuals. Determining the personal and professional agendas of project members who affect design to assess their willingness to innovate or try something better is where advocates of ERD can best place their efforts. It is true that architects choosing to advocate ERD will have a finite amount of time and energy for the task, and less available time and energy for other interests and

deliverables. Creating change is a difficult, involved, and stressful experience that can result with the decision to reject the initiative because of the personal cost. Even so, ERD is one way for architects and project members in the construction industry to professionally implement their personal beliefs, which are largely derived from:

- Age, gender, religion, generational values,
- personal values and experiences,
- professional background developed during school and work,
- professional and personal future expectations.

All these realities create a paradigm for private living and acceptable practices in business, which also changes according to changing public opinion. The paradigm for architects in the 1950's with 'cheap' energy and post-war expansion was different from those practicing in the 1990's where issues such as the protection of parkland and urban traffic congestion instill a different awareness of what issues are perceived to be important considerations in design. The bulk of architects practicing today are between 40-50 and so have the values of the Baby-boomers (MacLellan, 1997). Assessing what each architect (or project member that affects design) believes is currently important in his/her life will help to decide if environmental effort is worth investing in that person.

Arguably much of the resistance to ERD is due to the initial learning curve and the risk that the investment might not be recovered in time or recovered at all. People and firms like to do what they are good at doing because they have developed a skill to a level where less effort can produce more profit, relative to when they were first learning the skill. Firms may not want to implement innovations such as ERD for fear of losing the expected current or future revenue which is required to maintain payment schedules for the office space, equipment and employee salaries.

The willingness to change can decrease with age or experience. Individuals pass from a learning mindset in school to a 'downloading of knowledge' mindset when employed despite a commitment to their professional development. Most post-secondary graduates and junior personnel tend to be

ambitious, energetic and inspired. While many senior personnel agree in principle that it is a good idea to practice innovation and be proactive, they are also more aware of the effort and investment required to change the course of established company or business practices. Changing this course often causes reductions in productivity and profit in the short term which, if they are only indicators of effectiveness, will reflect negatively on management. Further, the power these older, more influential personalities have due to their professional commitments can keep them too busy to handle anything new. Justifying a drop in productivity to attempt innovative ERD is therefore only possible with the support of senior staff and can be made more permanent by changing corporate policies or mission statements to include ERD. Company policy which recognizes value and profit from strategic realignment to some degree of ERD can remove part of the pressure felt by upper-level managers to consistently achieve short-term growth or profit.

Without top-down support from *influential* individuals advocates of ERD will likely be viewed as not understanding the business requirements set by senior management within a practice or their clients. "A quality assurance program is effective only if management is committed to it. Management is not only the principals but also design professionals at all levels within the firm." (Shapiro, 1996). Also, the senior partners and company executives are the ones that meet during the feasibility and conceptual design phases of each project, phases known to have major influences on the direction and success of the project (Tatum, 1987, Kartam, 1996, Rutherford, 1989).

It is also essential to identify project delivery methods, projects, administrative and company structures and especially the people that form them as resistive to sustainable initiatives. These people can purposely neutralize or discredit ERD initiatives, associating failed strategies with ERD and sustainability in general. The architect wishing to practice ERD for the first time should do so with individuals already predisposed to the idea, ensuring that ERD is reinforced as successful. So architects need to determine whether they can implement ERD best within or outside the architectural

firm or project, depending on the firm's agenda, client interest and available capital. The system chosen must allow these potential problems to be avoided, managed or removed, because

> There will always be problems; nothing ever runs smoothly .. To be aware ... of the inevitability of problems is one thing; to anticipate their occurrence and to plan or devise internal mechanisms for handling them is quite another. (Goldenburg, 1971)

The second key is realizing that the accessibility and representation of ERD information, so that it can be used with familiarity, is critically important in getting all architects to adopt more environmental practices. Below is a ranking of information sources that are accessed by all designers and senior decision-makers in development to inquire about an unfamiliar subject or product. There seems to be little distinction in the order of these lists among professionals, but the prime contractor and subcontracting trades do rely on marketed, available technologies and less on the principles that created the product. The listing, from most to least valuable for the design professionals, is not statistically representative but does represent common preferences.

The following four ways of obtaining information are the ways that can best transmit environmental strategies into the workplace so that they become self-reinforcing:

1. *The people with which one works directly.* This is done quickly by phone, email or fax.
2. *A network of personal connections.* If coworkers do not know, they can likely refer someone who does, as individuals that do require specialized information often belong to a small circle.
3. *Products Library.* Products materials are largely supplied by manufacturers for marketing purposes. Text and photographs describe material performance
4. *Case Studies (& previous, in-house projects).* Very valuable if appropriate. They represent a concrete example that has been tried before where performance can be confirmed. If the case study is external, interviewing the users and original designers is possible. Previous in-house projects are consistently used and act as templates for current project drawings which make improvements incremental and rarely develop from conceptual beginnings.

Another nine ways have been identified below. These formats for information are already well-established or may be becoming more popular, but will not likely approach the same success as those already mentioned.

5. *Construction Industry Association Journals.* Highly specific and important to particular disciplines, e.g., CHMC, AIA, APEGBC, Facilities Manager & Property Management Magazine.
6. *Seminars.* Relevant topics may not occur frequently, lecture can be informative and very inspirational, often involving non-local 'experts'. Those in attendance already believe the specific topic to be important to their practice.
7. *Specialized technical journals.* Accurate, objective, highly specific and important to particular disciplines. Often substantiated with testing. e.g., NRC/ IRC.
8. *Professional/ Business Magazines.* Cover trends and highlight what is interesting not necessarily what is important. e.g., Architectural Details Magazine.
9. *Design Manuals.* Highly specific and useful if appropriate. The contract documents can specify appropriate performance or refer to them as guidelines.
10. *Books.* Locating relevant, unfamiliar information usually too time consuming for this media, information may be outdated, but historical procedure, such as many NRC publications can be valuable.
11. *Trade magazines.* Interpreted as marketing tools and not objective sources for information. They typically contain only positive reviews of products.
12. *The Internet.* Used as a broad sweep to locate individuals with experience. Senior staff are more likely to use the sources above. 'Net' access, information retrieval and low computer-literacy makes the search for information time-consuming and frustrating. Searching for the appropriate website requires the careful use of search words.
13. *Compact disc databases.* An unfamiliar format, not yet enough breadth of available information, and the databases must be purchased.

Since experienced, senior personnel establish company policy regarding professional development which in turn establishes the breadth, depth, and format of its information resources and the professional development of their employees, representing ERD information to them is of great benefit. With company support more junior personnel have the liberty to access other sources of information. Even so, when architects wish to practice some form of ERD, or when an environmental requirement is unavoidable, whichever least costly way to acquire and include the required knowledge

in the design is usually the one used[1]. This isolated research can discourage relationship-building with experienced environmental consultants. Without this relationship according to the forms of information above, advice regarding even greener practices is less likely to be solicited.

Notably, thousands of publications, television and radio programs, films, billboards, and other media sources and all the commercial advertising within them also subconsciously identify what is meaningful and appropriate to project members and the buying public. Each medium has its own readership, geographical distribution, frequency of publication, and corporate agenda which affects the reporting in terms of balance and coverage of issues: whether the focus is local, generic, consumer-oriented, first- or best-covered. 'Business in Vancouver', 'The Globe and Mail', 'Harvard Business Review', 'The Vancouver Sun', 'The Georgia Straight', 'Architectural Digest', 'Newsweek', or 'The Enquirer' all promote their interpretation of 'information'.

Environmental issues are being increasingly covered in the public and professional literature to a point where they are becoming 'mainstream'. These frequently accessed forms of media collect and present information that helps to define the contemporary perception of 'valuable knowledge'. Thus there is a qualitative but blurry distinction between what information is important, and what information is interesting. In the absence of scientific substantiation the consequences of our non-sustainable practices and the benefits of ERD as a valued solution should be argued to affect a critical mass of people to facilitate sustainable lifestyles. Making ERD appealing for its use by the media and physically putting it in-house for use by professionals are good strategies to facilitate its dissemination.

Obviously the best-received articles take the point of view of how to turn the treatment of an environmental problem into a business opportunity. Inspirational testimonials of successful environmental businesses are highly motivating and give confidence that the initiators of change are

[1] e.g., a one-time explorations by a salaried employee vs. technology transfer from an independent consulting firm.

not alone but are acting as part of a greater, solution-oriented (not 'doomsday'-oriented) collective. For example, 3M corporation between 1975 an 1985 saved $537M by reducing air pollution by 120,000 tons, waste water by 1 billion gallons, and solid waste by 410,000 tons. It was achieved through 3000 separate initiatives, a strong mandate from the top management of the corporation, linked with the ongoing support and assistance to line employees. This accomplishment fostered in 1986 an expectation of 90% reduction in emissions by 1990, with an eventual goal of 'zero' emissions. While 3M and environmentalists market this story as an example of making profit from preventing waste -which appears to be the case- it is physically impossible to engage in production without also consuming resources and emitting waste in some form or another.

The third key is to realize that environmentally responsive design is not simply a matter of procedure or technique, and if interpreted as a list or a group of criteria to be satisfied, the risk of compartmentalizing the design and construction process can inhibit or even harm the process of designing toward sustainability. Instead, "A fundamental process in environmental design [becomes] creating the circumstances where a procedure can actually be used, and can continue to be used" (Winkler, 1980, p. 403). Thus the most lasting strategies are the ones that result in the creation of 'settings': policies, frameworks, regulations, laws, guidelines etc. that can continue to exist and be used without the individuals that created them.

Therefore the architect's efforts are initially best spent establishing a framework for ERD at the firm's policy level so that a protocol exists when trying to implement ERD for specific projects, or a policy for professional development exists that encourages better designs. Prototype or 'flagship' ERD projects must also be marketed and used to establish this protocol, otherwise they become isolated efforts. Without an accepted framework, a key architect's departure can be used as an opportunity for others to retire a program. For example, the Planning Department of the University of British Columbia (UBC) had only one person pushing an environmental agenda. This person was successful

in convincing post-secondary institutions to produce and adopt "Environmental Guidelines for Universities and Colleges in British Columbia" (1995) , which was modeled after the experience gained while developing the C.K. Choi Center for Asian Studies -an environmental flagship building at UBC. Even if this initial, key person departed, the document and institutional commitment to its consideration during project development would still exist.

The settings that are created must also be self-reinforcing in that the setting rewards and encourages the continued use of the new process. Thus, associating environmentally responsive design (ERD) with success through successful first steps as well as identifying personal agendas of key influential people is crucial toward the widespread adoption of settings.

4.2 Degree Of ERD: Duration of Client Responsibility

Canadian Mortgage and Housing Corporation's (CMHC) Healthy Housing initiative (CHMC, 1996) identifies five characteristics for a 'healthy' house: Occupant health, Energy efficiency, Resource efficiency, Environmental Responsibility and Affordability. These categories need to be regrouped according to the client's length of obligation to the project if they are to be successfully argued. This defines three client types and subsequently three levels or degrees of ERD commitment toward sustainability. Each degree has already a number of industry lead initiatives in place, however these initiatives need to be understood as belonging to a larger goal. Thus, the client type who (1) constructs a project may also (2) plan to operate it, and may further (3) be receptive to long-term social and environmental performance.

Sebastian Moffat's circles of sustainability (see page 2), CMHC's categories, and the construction industries initiatives (subsequently described) can be mutually supportive if they are subdivided according to the intent of the client when undertaking development. Each client type will be receptive to at least one of the ERD methods listed below:

4.2.1 IMPROVING BUILDING CONSTRUCTION:
Methods that only increase financial return during the project's construction.
A) Moffat's circle of economic sustainability (see page 2):
Options: Environmental commitments during construction (Introductory level).
B) CMHC's category of affordability.
C) Industry-lead initiatives such as Value Engineering, Building Constructibility and Design-Build Partnering.

4.2.2 IMPROVING BUILDING OPERATION:
Methods that also increase financial return during the project's service life.
A) Moffat's circle of social sustainability:
Options: Environmental commitments to building operation (Medium level).
B) CMHC's categories of Occupant health and Energy efficiency.
C) Industry-lead initiatives such as Building Commissioning, designing for Occupant Health, Energy Efficiency and Water Efficiency

4.2.3 INCREASING 'DEEP GREEN' BENEFITS:
Methods that also enable the project to provide benefit to future generations.
A) Moffat's circle of environmental sustainability:
Options: Environmental commitments to qualitative, longer-term benefits (Advanced level).
B) CMHC's categories of Resource efficiency and Environmental Responsibility.
C) Industry-lead initiatives should follow from research-industry partnerships such as Forintek Canada Corporation's Athena Institute, which is benefiting from a partnership between the wood, steel, concrete (and other) industries that reveals the embodied energy of specified construction materials and assemblies.

Determining what each project member is willing to explicitly address in this listing will determine the extent of sustainable content in the project. The hope is that, once these degrees of commitment are known, the project members will seek profitable, unique, and cooperative ways to realize 'deep green' benefits through their projects.

The client and the architectural firm belonging to this first type for example will typically build according to demand, will acquire the least expensive materials to provide the desired quality or performance, and will sacrifice profit only as a final cost-saving measure. Given these project

member objectives, arguing ERD as solutions to stop and reverse the local and global environmental problems becomes irrelevant. Therefore only a small subset of ERD solutions may apply to the specific client and architectural firm.

The applicability, contractual structure and company requirements of the following unconventional project delivery 'techniques' can produce better ERD buildings because the project members are beginning to rethink the way they deliver buildings. Of course the client's representative and the financial analysis for each proposed project will generally prefer one approach to project delivery, the architect will need to be able to identify the best initiatives that will convince influential project members to consider even a partial adoption of ERD.

4.2.1 Improving Building Construction

Environmentally responsive design methods that improve building construction for clients seeking only to produce a building with reliable, low capital costs are receptive to approaches and techniques such as Value Engineering, Building Constructibility and Design-Build Partnering. Each approach requires a shift in the way of thinking of the client toward greater responsibility for the project and each is industry-initiated, meaning that the following green design initiatives are already being done, opening architecture and the Industry to deeper forms of green development.

First, Introductory Level:
Environmental Commitments During Construction:

- **Harmonize Building Systems (Smarter Design & Development)** (passive & active strategy) -- Capital and operating costs have been reduced by including a building envelope that works with the lighting and HVAC systems to shape and condition the spaces proposed by the architect. Increased building envelope costs are offset by smaller HVAC systems and lighting. Proper sequencing of materials and components that are more independent of one another will create greater independence of component performance and greater system redundancy.
- **Reuse Buildings** (passive strategy) --Utilize existing buildings and infrastructure (brownfields) instead of developing open space (greenfields) is often less expensive than

building new but can be difficult to budget due to costs of soil and building compliance to current Codes.

- **Reduce Material Use** (passive strategy) --Optimize design to make use of smaller spaces and utilize materials efficiently. Some additional design time may be needed, but overall, this strategy should save money, particularly with larger projects and multiple-building developments. The cost of disposing unused construction materials is becoming a consideration relative to the cost of buying them[2].
- **Minimize Construction & Demolition Waste** (passive strategy) --Return, reuse, and recycle job-site waste. BCBC audited their construction/ demolition waste streams and found they have recycling value that offsets to a degree the tipping fees for the landfill sites. The GVRD also offers assistance and a Job Site Recycling Guide for this purpose. Additional labour to sort and recycle waste is often offset by the savings in disposal costs, though these vary by region and sorted material can sometimes be sold for a profit.

The following industry-initiated techniques can create settings that support the above initiatives. If partially or wholly adopted they open the project member to other project-enhancing possibilities.

Value Engineering

Value engineering (VE) or Value Analysis (VA) is a tool that is always used during construction regardless of which project member is in control or which delivery process is selected. It can be successfully expanded to work as a tool for the implementation of environmentally responsive design. In theory it involves substitution of building parts and processes for less expensive alternatives while considering the balance between capital and operating/ maintenance costs over time. In actuality, it is more widely understood as 'what is the most cost-effective decision' at the time of construction which may result with a series of small reductions from each area of the project during the latter half of construction. Typically, trimming a project's amenities and components piecemeal instead of as large amounts earlier during development is more likely to cause a failure of the facility's performance as a system.

The provincial government has recently required UBC to formally use Value Engineering for all its buildings over $250,000. Its use does yield a net saving to the client, but the cost reduction of

materials and systems is partially offset by the time and cost of improved design. For the yet-to-be-constructed Earth Sciences Building, VA saved $800,000 from the construction cost, while the additional fees to the architect, quantity surveyors and other VA members amounted to $250,000-$300,000. While this analysis usually occurs informally at every level during project development, the consultant fees are lowest and potential savings highest when VA is performed early in the process. Its formal analysis is taken seriously by other public developers, for example the Technical Value Department of British Columbia Buildings Corporation (BCBC) amounts to approximately 1% (10 people) of their overall salary budget.

Value Analysis only becomes distinct as a method when it is explicitly initiated by sophisticated owners working with reliable and modifiable budgets. It can greatly and collectively benefit development when it is used formally if the size of the project(s) makes the effort cost-effective. There is a risk that designers, who have already delivered the drawings and have exhausted their budgets, are often expected by their client to make the required change orders and correct the drawing sets without additional compensation. Some design firms refuse to do this and the drawings and specifications in many areas no longer accurately document the as-built conditions.

Building Constructibility

Constructibility can be defined as "the optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives (Construction Industry Institute, 1986). Iteration between the design intent and the realities of construction in the early phases of a project allows for innovative construction approaches and the use of advanced technology. This is accomplished by discussing design and development decisions as they relate to general sources of materials, likely modes of transporting or producing materials, general sequence of

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[2] A 4x10 5/8"drywall sheet cost $8 to buy and up to $4 to landfill. Not installing it may be possible, saving on drywall compound, tape and paint. (Note: Vancouver Public Library was to have exposed concrete ceilings, but following construction they needed to be painted white, or lighting loads needed to increase to meet lighting standards).

construction activities, types and approximate numbers of construction equipment required, quality control standards, contract scopes and packaging, potential claims and disputes and the preferred method of dispute resolution (Tatum, 1987). Failure to acknowledge these issues during design can result in a building where construction costs are exceeded and deficiencies make the building prematurely obsolete and less enjoyed by its occupants.

Constructibility efforts must be client driven (Constrution Industry Institute, 1987). Private Sector clients (owners) are usually able to select the contractor of their choice, soliciting and compensating their participation throughout the planning and design process. Public sector owners however have the requirement for competitive, equal-opportunity bidding during the tendering phase. So retaining a contractor during the design process will likely prevent that contractor from bidding for the subsequent construction contract due to the potential conflict of interest and perceived "unfair advantage". This is circumvented in the United States for example by soliciting construction contractor input at 'Project Constructibility Symposia'. These forums are open where contractor 'advantage' is limited to added insight into the project scope for those who participate. Indirectly, it furthers technology transfer by developing contractor interest in earlier project phases and by showing a willingness to change on the part of the architect and client by considering the contractor's point of view.

Design Build Project Delivery

Design-build project delivery was possible following the relaxation of the AIBC's professional rules in May 1993, allowing the architect to also be the builder. Design-Build (DB) can be defined as "Project delivery methods that enable clients to employ one firm that takes single-point responsibility for delivering the required building and associated services in accordance with defined standards and conditions" (AIBC, 1996). That is, Design-build allows both designers and builders to operate together to tender one bid that includes the integrated cost of the drawings, the hardware and the labour. Because each partner influences the other's treatment of a design issue, fewer unexpected

problems should arise; and conflict will most likely arise between the regulated architect and the unregulated contractor. Busby + Associates Architects have successfully completed a number of DB projects and believe this partnership works well.

The senior DB partner can either be the designer, due to his/her understanding of aesthetics and social precedent for a given building type or community, or the builder who has the necessary assets to financially secure the project. At the small project application (up to about 2000 m^2) the architect can control all stages in construction. Medium and larger-sized projects require that the architect address larger issues such as bonding, financial capacity and professional versus business roles. The architect's ability to lead design typically decreases with project size because project and thus design control belongs to the project member who is willing to risk the most equity. Architectural firms wishing to acquire equity will find that they will become vulnerable to project cost overruns but the equity will afford the architect greater access to, and profit from, larger projects.

Design-build has experienced varying degrees of application and success in other non-North American countries and is used for the majority of projects in Great Britain. In Canada, DB does not yet have a reliable case precedence in issues of liability, insurance and bonding or project quality which can affect availability and costs of professional insurance coverage. It is not being resisted by the industry or architects in the same way that ERD is, despite similarities in terms of project member consultation and case precedence. This is because unlike ERD, DB is perceived by architects as a way to make their practice more successful. Design-build is not sector-dependent, projects both public and private can benefit from its usage.

4.2.2 Improving Building Operation

Improving building operation is valued by clients who are responsible for post-construction costs associated with inadequate operating systems both within and around the completed development. Life cycle analysis (LCA) is an internationally accepted tool that can measure these costs. It enables designers to make choices that are based on the repair and replacement cycles of the project's components and systems. It represents a paradigm shift in the reasons for building: building a long-term asset in lieu of a commodity that provides short-term gain.

If LCA is to become a tool for product selection it will make ERD more competitive only when the length of time used to compare product performance is limited to the length of the commitment the client has in the development. The decision-maker's life cycle or the period of the marketing strategy therefore governs the amortization period, not the life cycle of the product. The Barrett commission found that "there is no evidence to suggest improper maintenance procedures are an element in creating the leaky condominium crisis" (Barrett, p. 54) which implies the problem lies within the development phase where issues relating to durability were inadequate. Conversely, Polygon Group Ltd., a private developer of multi-unit residential housing claims the problems are maintenance-related: "The problem with life cycle costing is that as developers, we are in the business of selling a commodity, where you keep the customer happy for a certain length of time, but then it is the owners who are responsible for looking after the building". For LCA to be adopted at the development phase, developers must begin to convince the market that added cost for LCA translates to value-added.

LCC can still yield a poorer environmental alternative. For example after an involved LCC analysis of different heating systems over a 10-15 year period for a new building at UBC, it could not be conclusively proven that electrical heating costs more than steam heating because UBC receives preferred customer (lower) electricity rates. The installation of electric baseboard heaters occurred despite the fact that it is well known that properly maintained steam heating is far more efficient, and

that electricity as a high-grade energy source is mismatched for this type of low-grade usage. Further, many clients do not perform LCC due to the lack of reliability in future costs of materials, labour, fuel, or future social or market preferences. The longer the period of comparison, essential for encouraging component durability and reduced environmental damage, the lower the reliability of the extrapolations.

Another obstacle to LCA is a lack of investment capital for the value-added design choice. Plant operators at the University of British Columbia (UBC) know that preventative maintenance makes good financial sense but say UBC does not receive enough funding from the Provincial government to fix what is already critical (e.g., leaking steam pipes). Its Plant Operations department would prefer to approve the maximum capital cost (for example glass pipes for highly-efficient steam distribution) to give lowest possible operating and maintenance costs. They also prefer a very minimal mechanical system not only because of its high capital cost (15-30% of the building cost) but also because it is the first large item that will need replacing. As UBC continues to build new structures while being unable to efficiently maintain its existing building stock it complains that the maintenance of its buildings will become increasingly more difficult. Through efforts from Harold Kalke, a private developer on UBC's Board of Governors, is now beginning to forward future costs for infrastructure maintenance to developer's fees through an additional levy of approximately five percent of the cost of the building.

Wilson's priorities for green building (1995) that appeal to clients who value and pay for maintenance and operating costs are noted below.

Second, Medium Level:
Environmental Commitments To Building Operation:

- **Maximize Longevity** (passive strategy) --Design for Durability and Adaptability. Not in all cases, but it usually requires a larger initial investment. Preventative maintenance also requires ongoing investment, though it is generally cheaper over the long term than repairs induced by poor maintenance.
- **Improve Occupant Health** (passive strategy) --Provide a safe and comfortable indoor environment by reducing materials emissions (VOC's) and improving IAQ. Most

measures will increase costs, but they often are easily justified based on the increased health and productivity of building occupants.

- **Save Energy** (active & passive strategies) --Design and build energy-efficient buildings. Reduced HVAC loads may also reduce equipment costs.
- **Save Water** (active & passive strategy) --Design buildings and landscapes that are water-efficient. (Most measures will add to the cost. Some savings from lower water/sewage bills, and longevity of on-site septic systems can offset additional costs. Designs that promote stormwater infiltration are usually less expensive than storm sewers.
- **Protect and Enhance Site** (passive strategy) --Preserve, restore and maintain local ecosystems and biodiversity. Some of these measures cost less, some more than standard practice. Maintenance costs with xeriscaping are often much less than for conventional practice.

It is through LCA that the 'intermediate' level of environmentally responsive design (ERD) is defined to include building commissioning, designing for occupant health, energy efficiency and water efficiency. These practical and established methods become strategies for environmentally responsive design when they are put into the greater context of the practitioner's pursuit of sustainable development. The client and architect ideally can take advantage of these commitments to improve building operation in addition to the commitments to improve building construction.

Comprehensive Building Commissioning

Commissioning of buildings is initially performed to ensure that the client at the time of handover of the building, is receiving the functioning system they paid for. Comprehensive building commissioning includes the continued monitoring of building services and components after construction, and is initiated by many clients because high energy and repair costs diminish profits and un-commissioned systems consume labour resources. Commissioning reduces the amount of construction materials that do not meet Specification, Code and Regulatory compliance that otherwise would have been used during construction. It also facilitates the assessment of the degree of inefficient usage and weathering of parts that enable some forewarning of future costs and thus the required contingencies for a quality replacement instead of quick-fix solutions due to crisis-level failures.

Commissioning is highly individualized, depending on the consequences of loss associated with not commissioning the project. Different players are interested in commissioning different aspects of a facility and so develop their own informal methods. For example one architecture firm first developed one building's design from 100 hours of field observations of similar facilities in operation. The original assumptions and scenarios for each function in the building were documented, then the building's rooms were revisited to compare the original design perception with how residents and staff actually used it. Another informal method by a private development firm involves the maintenance of a binder that contained cost control summaries from previous projects (over 100, each approx. 10 pages in length). New projects can then be modeled from previously completed ones in terms of cost, constructibility and durability issues and informal forums can be held six months after the completion of a project to evaluate its success and to suggest what might be done differently in the future.

Obstacles to commissioning include incomplete construction documents such as the exclusion of explicit references to commissioning, aggressive construction schedules and a competitive bidding environment which breeds adversarial relationships between project members. To reduce the exposure to these obstacles, the client at the outset must request full commissioning in the bid documents, and must retain an independent agent to evaluate the performance of the completed work. The main resistance by clients in paying for building commissioning is that there is an unjustified expectation that tendered bids (the project budget) accounted for all the foreseeable and unforseeable conditions, and that all inconsistencies in the architect's design were resolved. The client does not feel that they should pay more to confirm what they have already bought.

Of UBC's six project delivery phases: (1) Planning, (2) Definition, (3) Implementation, (4) Commissioning, (5) Operation, (6) Evaluation, only the first three phases have funds allocated for their execution. Commissioning is only marginally implemented through a 'commissioning engineer' who is retained to keep hundreds of mechanical units on many buildings functioning for the campus, which

leaves no time for proactive assessments of equipment. Engineers must rely frequently on personnel from Plant Operations to efficiently maintain and fine-tune these systems, but since commissioning for non-professionals typically involves viewing a video and a witnessing a demonstration of how to turn the system on, they do not have adequate training or experience. Thus even with UBC's requirement of maintaining updated equipment documentation, only the mechanical engineers are able to properly interpret them and can only do so when something goes wrong.

Freda Pagani, previously with the Planning Department, UBC believes the architectural profession needs to make commissioning part of their basic architectural services as the only way to ensure that what is designed is in fact built. If architects follow through construction and evaluate post-occupancy usage, the costing and success of their designs would greatly improve. Further, project managers do not yet have an ethical code nor a regulatory body to enforce it, and while architects and engineers may not adhere to their code it is still a remnant which does have the goal of making the profession learn.

Occupant Health

Attempting to ensure occupant health during the operation of the building and its surrounding site can be done at the design phase. Clients and architects can provide for a healthy and comfortable indoor environment by controlling the quality of the air circulating through the building by replacing stale air with fresh outdoor air while keeping it free of pollutants. Air movement is best achieved with passive designs that use pressure differentials between different areas of the building. To supplement passive ventilation, an active system is usually required to provide continuous air movement to minimize interior surface condensation and limits mould growth. High quality filters and central vacuuming can also remove unwanted particulate from the indoor environment.

Occupant health is also affected by the off-gassing of installed building products as they age and project members that value occupant health can address these issues beyond the required minimum

standards. The 'new smell' from carpets and kitchens, for example, is due to the volatile organic content (VOC's) in the air released from 'curing' solids and liquids. Continued exposure to these VOC's can cause headaches, nausea, and other discomforting symptoms that can lead to increased sick leave and lower occupant productivity. Architects specifying low off-gassing interior finishes (e.g., low VOC paint), low-toxicity drywall fillers, and minimal gluing (solid wood instead of particleboard, plywood or OSB & laminated finishes) can reduce VOC's. Today, low VOCs are common ERD criteria but design efforts, supported by clients sharing the view of 'designing for operation', need to adopt 'deeper green' design objectives which, from the outset, must minimize the installation of these emitters.

Occupant health and welfare is also a significant area in environmental building evaluation protocols such as Building Research Establishment Environmental Assessment Method (BREEAM) and Building Environmental Performance Assessment Criteria, for Office buildings in British Columbia (BEPAC). These building evaluation tools among other objectives attempt to "provide a common and verifiable set of criteria and targets so that false claims regarding environmental friendliness can be avoided" (BEPAC, 1993, p.2). These issues are being actively addressed through harmful product identification and better design and conditioning to reduce owner liability to health claims.

Energy Efficiency

Relative to other Canadian cities, Vancouver's mild and rainy climate and affordable utility rates do not support energy or water conservation as strategies of high priority. However, BC Hydro's continuous commitment to initiatives, programs and sponsorship has greatly increased the popularity of conservation strategies.

Energy conservation is important to clients wishing for smaller, more reliable and less expensive HVAC systems, to utility companies wanting to avoid exceeding total and peak-rate system capacity, and to occupants wanting lower energy bills without significantly changing their lifestyles. Increasing

prices due to diminishing, convenient fossil fuel sources will be inevitable and will ultimately force conservation of fossil fuel sources and promote alternative sources. Locally, the public opinion and ecology surrounding Vancouver will not support another dam to satisfy increased demand for potable water or electric energy. While energy conservation in this mild climate is a lower priority than building durability or occupant productivity, it remains as an inevitable future reality.

Lowering energy consumption automatically lowers the downstream impacts of its combustion. Combustion of fuel energy from vehicles accessing the building, the building systems and the materials used to construct the building itself sends thousands of tones of particulate and carbon dioxide (CO_2) into the local and global airstreams. CO_2 for example is responsible for increasing the ground-level ozone that causes respiratory problems for residents in Abbotsford (municipality downwind of urban and industrial Vancouver) and for decreasing the high-altitude ozone that protects us from cancer-causing ultraviolet radiation.

Much energy is required to service and condition 'internal-load dominated' deep-plan buildings. Their HVAC systems need to be focused on controlling an environment created by the lighting, ventilation fans, office equipment, and occupants, instead of being designed to control the effects due to exposure to the exterior climate. Electric lighting is the dominant area where architects can effect electrical energy savings. Minimum, task-based lighting levels set by the Institute of Electrical and Electronics Engineers (IEEE) were previously met in many buildings and offices in particular by architects specifying single-switch grid lighting, a convenient but highly inefficient way to illuminate employee workstations and the workplace.

Conversely external-load dominated residential dwellings can utilize 1/2 to 1/4 of the energy normally consumed when passive and active designs for energy efficiency are properly used. When careful design of the building envelope becomes a high priority the result can be reliable, passive, energy-reducing design strategies such as super-insulated walls, floors and ceilings, and a continuous air/

vapour barrier. Advanced framing techniques by the structural engineer and specification of better windows and frames by the architect can reduce thermal losses. Passive solar gain such as solariums as buffer spaces or skylights to increase day-lighting can offset heating costs by 25%, reducing the required capacity and cost of the space conditioning units. High-efficiency lighting, heating and ventilation equipment reduce further the utility costs when active systems are required to meet occupant comfort levels. Heat exchangers can also help, transferring up to 70% of the temperature of outgoing, stale air to incoming, fresh outdoor air.

Lastly, the occupant's comfort level is often defined by limited ranges for relative humidity, temperature, and air movement. All three can be linked through a psychrometric chart that uses three axes to identify an area where the occupant is comfortable. Large energy savings can be achieved by widening these comfort ranges which results in less equipment and operating costs. The success of this solution demands a behavioural change (e.g., asking occupants to dress appropriately) that today is unlikely but not impossible given current expectations of living which view tight climate control as a value-added service that is in demand by a discriminating public.

Water Efficiency

Water efficiency can be integrated in design to reduce the user's utility fees, but in the GVRD the cost of water as a resource is still too low to justify the installation of available water-conservation strategies. Architects can ask that two plumbing systems be installed, one for potable water and one for used tap water (grey water) for irrigation or other lower-quality uses. Water in larger water tanks can be a temperature regulator, acting as a heat sink reservoir to offset cooling and heating loads. The use of cisterns to collect rain water for irrigation and reduce the peak stormwater flows can also reduce the building's demand on municipal distribution systems for water supply and discharge.

Currently low-flow toilets (80% reduction, CHMC, 1996), taps and shower heads (60% reduction) are the more commonly adopted measures by architects, clients and occupants to reduce water

consumption. Moving to a user-pay system from a flat rate system for water consumption while increasing water utility rates will induce more profound behavioural changes. These changes will be necessary to help supply a growing population during peak demands while still operating within system capacity.

4.2.3 Increasing 'Deep Green' Benefits

There are numerous ways to make land development more environmentally friendly through planning and design such as improving construction techniques or operations/ maintenance efforts. As project members and society come to collectively value the intent of the objectives already described, all architects can more easily implement 'deep-green' designs strategies that may have little direct financial savings but that restore the quality of the land, nature and social community. The natural environment that surrounds cities contains large amounts of bio-diversity, which is an indicator of the health of the ecosystem on which human survival must rely. Reducing resource extraction and ecosystem pollution through personal and professional commitment to denial, reuse, repair and recycling is considered the best option to make human activity more 'sustainable'. These advanced efforts are largely driven by the client's and project member's personal beliefs.

Wilson's priorities for green building (1995) that appeal to these clients are noted below. The remaining two characteristics of CMHC's healthy houses of resource efficiency and environmental responsibility are categorized here to appeal to this client type's long-term (e.g., 100's or 1000's of years) commitment beyond financial returns during construction (short-term, e.g., 1-5 years) and operation (medium-term e.g., 1-50 years). They relate to sustainability in its broadest sense: that human behaviour influences and is influenced by many interconnected systems. These systems can be in a steady state or in a state of flux, depending on the intervals of time that are considered.

Third, Advanced Level:
Environmental Commitments To Qualitative, Longer-Term Benefits:

- **Create Community** (passive strategy) --Design communities or site project to reduce dependence on the automobile and to foster a sense of community. Smaller and shorter roads, services lines and storm sewers should reduce costs but obtaining zoning variances can be time consuming. Developers and citizens do not have the extremely high cost of infrastructure on their minds, they pay their taxes and assume the maintenance of the services increases linearly. Locating close to buyer markets, downtown centres, and mixed-use developments encourages more free time, fewer traffic accidents & congestion due to reduced commuting. This also includes off-peak usage of space for outside-of-work related programs and conducting business with companies that profit share with employees and local communities.
- **Match Grade of Energy With Use** (active & passive strategy) -- Bringing electricity to a site is far more energy-intensive than other energy sources such as natural gas. Use solar energy for natural day-lighting or for electrical/ heat storage for a later use wherever feasible. While lighting is a high grade use requiring high-grade electric energy, ambient heating is considered a low-grade use best satisfied by ground-source heat, hot water or steam. By cascading from higher to lower grades of energy while using the byproducts at different exchanges, consumers are much more energy conscious and efficient.
- **Select Low Embodied Energy Materials & Processes** (passive strategy) -- The architect may also consider using materials that require less embodied energy -the energy needed to extract, produce and deliver the component from its original source. For example, wood requires nine times less energy to manufacture than steel (CWC, 1994, p. 10). Forintek Canada Corp., in conjunction with the Steel, Wood and Concrete industries have developed measures to assess the amount of energy required to make a product available for installation at the job-site. The different byproducts are converted to units of energy so the designer can evaluate which materials minimize the strain on the earth's energy resources. Embodied energy must also be weighted with its required operating energy when choosing a given material. The Athena Institute was established to lend support to a computer program model developed to compare the environmental impact of different choices in construction (Trusty, 1993). Embodied energy and recycled materials do make it into BCBC's decision-making, but there is still a lack of information.
- **Green Up Businesses & Building Occupants** (active strategy) -- Discounted parking stalls for carpooling vehicles and locating business near public transportation can save money for employees while reducing the number of parking spaces the business must provide. Informal competition between departments regarding conservation strategies for electricity, paper, travel miles can encourage behavioural changes.

These commitments are part of a much larger set of options[3] (Sheltaire Group, 1998). There are also a large number of ways for each objective to be carried out. A complete listing would distract from the thesis focus, which requires commitment from project members to the first two green commitment lists for Construction and Operation. Belief in, and economic return from, these first two lists through

life cycle costing must occur first for architects working with other project members. Politicians and urban planners are more receptive to arguments for the implementation of these intangible benefits.

Architects should not try to advocate one material over another, although there can be clear choices for which materials are environmentally better for some applications. Architects should however encourage the clients and the AIBC to support or promote the methods of analysis that consider these 'greener' objectives which is now possible[4]. Changing the method of evaluation of products will make these qualitative and longer-term benefits more valued and eventually more economically relevant.

4.3 Appropriateness of ERD: Assessing Project Size, Complexity & Location

With the various degrees of Environmentally Responsive Design (ERD) identified according to project member agendas, the proposed development itself needs to be assessed for its potential for ERD. The conventional assessment of project feasibility begins with the market analysis, which defines the threshold limits required for undertaking development. Each project type has characteristics such as complexity, size and location that affect the type of ERD strategies that can be implemented, independent of the commitment of the client or architect to sustainability.

4.3.1 Project Complexity & Size

Building projects are becoming increasingly complex, and, as such, architects believe they do not have the time or fees to include ERD. This excuse comes mostly from the project member's uninformed opinion of what ERD can provide. Admittedly, some projects due to their specific circumstances outside of the control of the project members can limit the degree of ERD based on appropriateness.

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1. [3] For example, there were 69 objectives that were relevant to the Southeast False Creek Development in Vancouver

[4] The comparison between wood and steel framing for a 3m x 30m wall revealed the wood wall used 25% less raw material by weight, 1/3 energy to extract, manufacture, transport & construct, 1/3 CO_2 emissions, significantly lower air pollution such as sulfur dioxide, nitrous oxides, methane, particulate and VOC's, 1/25 water consumption and far less water pollution, but did produce 30 kg more solid waste (Canadian Wood Council, 1996).

Allan Russell, co-author of The BC Construction Roundtable's Guide to Happy Projects -Good Practice Template lists the reasons for and consequences of increased project complexity:

- Technological developments in materials, building systems and information systems
- Increased number of applicable regulations
- Increased accountability to a growing number of project stake-holders
- The pressure for faster project delivery
- Intense competition resulting in small profit margins
- Increasing fragmentation of the Building Development Process
- The number of specialists grow to cope with the increased complexity
- Materials are sourced on a world-wide basis
- Strategies including further fragmentation are used to handle risk and reduce cost.

Specific building projects themselves serve public and private interests, and are built for owners and for anticipated markets, they can be small or large, conventional and also innovative. Each circumstance for the informed designer should trigger a set of ERD strategies that would most likely be considered by the client and project members. For example, firms using alternative 'green' materials when practicing ERD often need to prove product equivalency to the governing Building Code. This is more easily done with the larger, more complex projects as the project team often has an increased range of considerations that may fall outside the applicable building codes and an administrative structure to handle them.

However, larger projects can also discourage ERD efforts. They typically limit the number of local manufacturers that an architect can solicit to supply the necessary production volumes, the consultants that can produce the necessary designs, or the project managers that can coordinate the trades and build the project. Since these projects typically require manufacturers that service a larger geographical area, these more remote suppliers can have higher transportation costs and longer lead-times. Further, large projects may need extra funds for renting, securing and managing an additional, nearby site for the storage of delivered materials from distant manufacturers. Often large orders and the need for lower prices results in the sourcing of non-local products. While usually less expensive, development companies acknowledge that they are buying a potential problem (Sabbagh, p.314). The

inability for the interested parties to inspect the subcontractor's progress on the order and increased lead times for defective and additional orders has the potential to seriously delay the construction schedule, or to force the installation of substandard alternatives.

4.3.2 Project Location

The receptiveness of projects to ERD is also affected by project location in terms of local modifications to Building Codes, material sourcing and installation, and a durable, locally acceptable aesthetic. These issues make certain ERD construction solutions unaffordable in one location yet profitable in another.

Areas or municipalities within a province that are subject to regionally specific natural phenomena such as climate or soil composition will structure their own Building Bylaws to reflect specific development, practices and products. For this reason the National Building Code of Canada (NBCC) is separately adopted by each of the provinces and further modified by municipalities to accommodate regionally specific concerns. For example, the GVRD's physical and economic setting has precipitated the widespread use of substandard performance from walls, windows and roofs relative to other cities in Canada. Vancouver is known to be the most aggressive city in the GVRD as it attempts to establish better standards of construction due to its sophistication and its unique ability to enact building bylaws without provincial approval. For example, only the City of Vancouver has bulletins 96-02 and 96-25, which prescriptively require specific building features such as a mandatory cavity between the cladding and sheathing.

4.3.3 Aesthetic Durability

Durability of buildings and their parts can also refer to a durable style. Frank Loyd Wright's 1920's prairie-style homes still look appealing by today's standards, but the multi-coloured building glass

used in the 1970's has lost much of its visual appeal. 'Aesthetic durability' as a rarely-discussed criteria of environmental design is not related to physical resistance of materials to their climates. Environmentally responsive designers need to create an aesthetic that will continue to appeal to occupants and owners to avoid premature renovations of finishes or spaces that may even justify the demolition of the building.

Some municipalities base product preference on prestige as well as performance, for example Land Development Agreements for the City of New Westminster strongly discourage the use of vinyl cladding in lieu of stucco cladding because the former looks 'less affluent'. Solar panels, for example, are an environmentally preferred source of energy because they circumvent fossil fuels and municipal distribution systems. Assuming the regional climate and energy costs are favourable enough to make solar panels economically viable, the public and the architectural community might not install them because they can appear unattractive.

The criteria of successful performance and attractive aesthetics over time establishes 'vernacular architecture' which does possess this durable aesthetic. However many of today's architects are influenced by the post-modernist movement and generally have a bias toward new materials and the search for a 'new architecture', as evidenced by many architectural award criteria. Vancouver's *new* architecture has come through the synthesis of foreign styles and new materials with a local climate where the architect's reliance on prescriptive designs has proved to be inadequate. Stucco, the cladding of choice in the GVRD is a material that requires specific mix designs, proper application and continued maintenance, but has only been proven to work in climates and building systems that have far less continuous periods of rain. Design features such as overhangs change the natural climate adjacent to a building, which more closely matches the climate in which the cladding materials perform well. However the financial disadvantage of overhangs, municipal planning department

preference for stucco, and local public desire to live in buildings that are from other climates has rendered stucco less capable of meeting performance periods of drier climates.

5.0 CONCLUSIONS

The purpose of this thesis was to identify possible mechanisms that will facilitate the incorporation of environmental design into current mainstream architectural practice. The researcher found that environmental strategies first require a clearer definition among project members and increased, accurate public representation. Only then can environmental strategies, from introductory 'light green' to more profound 'deep green', be understood and willingly adopted by project members. With each successful environmental initiative, its widespread use subsequently redefines the paradigm of good building practices.

The degree of environmentally responsive design strategies is dependent primarily on the client's agenda in terms of their liability during their period of ownership of the project and their perception of what ERD offers to them in return. Appropriate practice of ERD will strengthen the legitimacy of the movement toward more responsible, sustainable development.

For those designers wanting to affect direct changes toward sustainability, the implementation of environmentally responsive strategies that match their level of responsibility or influence on others should be their primary focus. With time, entry level practitioners will acquire greater influence within and outside their organization, influencing greater numbers of people more directly and in more profound ways. They may begin by reducing the consumption of office paper as work-study students, informally discussing environmental alternatives as entry-level designers, specifying environmentally-friendly materials as a project managers, financing projects through lending institutions with environmental platforms or changing the firms business practices explicitly as principals of the firm. The applicability of the many secondary conclusions, insights and mechanisms found in this thesis can be used to convince others or oneself of the viability of the continued commitment to environmental practices.

The following five main conclusions emerge from the research:

5.1 Clearer Definitions

Project members must be given a clear understanding of the many possible and appropriate options of environmentally responsible design and development, where ERD consists of practical applications within the broader idea or intent of sustainable development. Their should be a stricter interpretation of the words 'natural', 'environmental', 'sustainable', 'light/deep green' and the definition of the criteria that proves goods or services as 'environmental'. These critically-accepted distinctions should be widely published and legally-defined to separate superficial marketing from genuine effort and to facilitate the prosecution of fraudulent claims, as even some environmental groups have been found to support un-environmental practices (Tokar, 1991, pp. 42-51). This labeling is necessary to counter the loose interpretation of ERD by project members which results in a predisposition to resist it due to perceived cost increases. It also serves to preserve the public trust of the 'environmental movement' and establishes a measure for marketing higher levels of environmental commitment, which can confirm that a company is implementing greener and greener practices.

5.2 The requirement for greater sophistication from environmental organizations.

Environmental advocates must recognize the complexity of project development and actively and strategically provide appropriate information to support development and design decisions. Environmental groups successfully justify and provide solutions at the planning and political levels but require more focus at the micro-economic level of individual businesses, because project members in reality are businesses. Environmental groups need to study further the complex cause-effect relationships of the public and project members to identify and target alternate professions affecting project development such as market analysis firms. This information becomes effective when it is

promoted using comprehensive marketing techniques to the same breadth and depth used by established, influential lobby groups.

The literature arguing for the adoption of more sustainable practices is becoming increasingly more sophisticated, with numerous references providing hundreds of examples and listing hundreds of support networks. A large number of these arguments focus on political and urban planning issues and are not appropriate or sufficiently sophisticated for application to individual businesses or projects. The client, architect and prime contractor must be repeatedly shown that environmentally responsive design (ERD) is able to match the agenda of different project members. More specifically, environmental agencies need to teach the principals and employees of architectural firms how to convince the client to benefit from front-end investment in conventional development process (i.e., changes to performance, cost, time and risk benefit the client). Environmental agencies are beginning to provide case-studies containing financial information of environmental projects to developers as well as architects.

ERD strategies need to be more than specific, technical solutions or generalized think-tank solutions (Roseland, 1998) if politicians are to be convinced to pressure developers. Measurement tools such as BEPAC and the emerging building criteria used for Green Building Challenge '98 become appropriate only when the design criteria of performance, cost, time and risk are properly considered. Arguments for increased environmental responsibility must have greater support from professionals that can perform risk analyses, financial analyses (i.e., ERD effects on the cost of borrowing) and market analyses (develop buyer profiles) as they relate to individual projects or business practices. Therefore environmental agencies must spearhead initiatives into other professions that influence the information clients use to establish the boundary conditions at the conceptual design phase.

5.3 The involvement of influential people for the purpose of creating settings that facilitate ERD is required before ERD can be widely practiced.

Architects need to create settings that make it easier for architects and clients to use ERD on later projects. People are the most important mechanisms for implementing ERD, either through the chain of public opinion and politicians to establish policy or through public and private-sector individuals acting independently. However pressure to innovate often disappears with the departure of the promoter. Environmentalists need to establish frameworks and corporate policies that support ERD and that are structured so they may outlive their initiators in all areas of project development.

Architects must gain control of the knowledge on how to encourage society to become more sustainable. Architecture is one of the most influential professions in society and architects are obligated to be responsible for society's direction and effect on the environment: The Commission of Inquiry Into the Quality of Condominium Construction in BC reminds architects practicing in the Province to "safeguard their professional oath to 'uphold the professional aims, and the art, and the science, of architecture and thereby improve the environment' " (Barrett, p. 32).

5.4 Architects must accept their role as project coordinators and argue to the client the benefits of earlier involvement of selected sub-consultants in project phasing.

Architects need to accept their role as project coordinators and can best do this by advocating the benefits of bringing the landscape architect, envelope consultant and mechanical/electrical consultant forward into the conceptual design phase. Further, to encourage 'deep green' development, they should seek to bring environmental consultant experience into the conceptual design phase.

ERD will be more readily received by clients if it is discussed informally at the conceptual design phase. The architect is the only project member that is required to be involved throughout project development and as such is in a position to respond to the client's concerns immediately regarding environmentally responsive design (as a quick-access information source, this ERD expertise will be asked for more frequently). The alternative, the retention of an environmental specialist or consultant,

means the architect (or regulating authorities) must convince the client to spend money on unclear, 'extra' services of yet another consultant.

The mechanical/ electrical services and building science issues are the most important considerations for the architect to bring forward in the design process to effect short- and long-term cost savings for the client. This expertise early in design development can minimize the extensiveness of future fit-ups through issues of building durability, more passive HVAC strategies, increased program flexibility and interior finishes that are more independent of the building structure.

5.5 Architects need to accept their role as designers by ensuring design integrity and promoting craftsmanship. They need to encourage the continued application of craftsmanship through professional recognition.

Architects must demand more, not less, project responsibility. With more responsibility comes greater liability but also higher project control and potential for profit which is the only way to make architects 'more successful'. The only long-term way to meet this responsibility is for architects to collectively rediscover and practice the craftsmanship of architecture. The principles of the 'craft' and not the 'style' of architecture as it relates to the building in areas other than interior design, promote some fundamental characteristics of sustainability such as building longevity.

Designing for building longevity becomes a tangible first step for architects new to ERD and can make possible a paradigm shift for defining 'great' architecture. Evaluating longevity will necessitate public and private sector acceptance of life-cycle analysis -the tool that redefines construction *costs* as future asset *investments.* This is key to connecting shorter-term economic sustainability with longer-term socio-environmental sustainability. Building science is a specialization that is beginning to emerge with life-cycle replacement issues as its main argument and property management magazines already promote this form of analysis. The public and industry must identify this established area as an

important step within ERD to increase the familiarity of ERD as a compliment to conventional practices.

Acclaimed architects must be convinced to market ERD through their published projects. Architectural competition awards must begin to shift entry eligibility to account for longer-term performance. Including ERD criteria such as increasing occupant comfort or energy/ time efficiency or local social activity will require evaluations only after several seasons of building use to truly herald an architect's design as successful.

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