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ACHIEVING ENVIRONMENTAL QUALITY IN OFFICE BUILDINGS

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This paper reports on two years of investigation by the *BC Energy Management Task Force* to develop design strategies for achieving environmental quality with energy efficiency in office buildings. The investigation had two main phases. Initially, during an intensive design workshop, two teams of architects and engineers supported by leading energy and environmental quality consultants, were challenged to reconcile environmental quality and energy efficiency in the design of a theoretical office building for a specific site and program. In the second phase funds were provided directly to an architectural practice to offset the cost of additional environmental and energy consultations during the initial stages of an office building design currently on the drawing board. During an intensive working session, the team of architects, consulting engineers, air quality/daylighting experts and construction managers examined design and cost implications of providing enhanced environmental quality in the actual project.

Solutions emerging from both these projects emphasized a clear distinction between the heating/cooling and ventilation systems, improved daylighting and visual access to the exterior and increased personal control over lighting, temperature and ventilation at the workstation (1).

INTRODUCTION

Although environmental technology, by definition, seeks to support and improve the quality of occupied space, it is often conceived, installed and operated with little consideration of the way that people actually use that space. During the past ten years energy and operating efficiency have often taken priority over building users, sometimes to the detriment of environmental quality. The responsibility for energy efficiency and environmental quality in office buildings falls within the domain of architects and engineering consultants. Professional conflicts are inevitable between architectural and engineering practice and these conflicts, which invariably find expression in buildings, are in part responsible for poor environmental quality in the workplace.

In 1986, the *BC Energy Management Task Force* through its *Building Performance Committee* initiated a program aimed at promoting a greater awareness and understanding of environmental quality and energy efficiency in buildings. The program was directed almost exclusively at the architectural and engineering professions and guided by the following premises:

- *Environmental quality and energy efficiency are parallel goals and not mutually exclusive.
- *Greater cooperation between architects and engineers is needed to ensure the uptake of high performance design.
- *Architectural and engineering solutions require better coordination in the early design stages.

This paper reports on two years of investigation by the Task Force to develop design strategies for achieving environmental quality in office buildings.

CONFLICTS OF INTEREST IN THE MARKETPLACE

Though a small number of office buildings are built to "corporate home office" standards and these may have significant environmental quality features, the majority of office construction is still "speculative grade" accommodation where only minimum conditions are met. In order to successfully enhance the baseline performance of office buildings conditions must be provided in such a way as to be responsive to the building's occupants. Building user's needs include:

Spatial Needs:

*Sufficient space to perform his or her job effectively with access to office resources and other workers.

Environmental Needs:

*Appropriate temperature and lighting; a continuous supply of fresh, clean air; protection from fumes, dust or smells produced in the office or outside; freedom from unwarranted distractions, and a measure of security and privacy of activity.

Human Needs:

*The need to understand the nature and structure of the immediate environment regardless of immediate state of activity (2).

*The need for a view and contact with the exterior to support the sense of orientation, time of day and provide visual relief; the need for natural light at least part of the time; the reassurance that "fresh" air is reaching them and the need to feel stimulated or relieved from the monotony and boredom of routine jobs.

*The need for alternatives. People respond positively to a range of choices even though they may not always take advantage of them (3). Spaces which give the sense of alternative and choice can provide a stronger feeling of support and richness.

*The need to have control over one's own personal space and immediate working environment. Personal control is defined as individual control over one's own space with the proviso that other individuals are not negatively affected.

Since each individual is comfortable with slightly different conditions of temperature, lighting and air movement the ideal would be for individual control over each parameter. By contrast current design strategy is still to provide a single uniform condition, incapable of responding to the widely varying needs of its occupants. In many cases this becomes another cause of stress (4). When access to control is reduced, particularly if the restriction is arbitrary, it will be experienced as unpleasant and will lead to attempts to reassert control (5).

Market Forces:

Building owners want maximum return for their invested dollar, the highest rental rate for the building and maximum flexibility of leasing that mimimizes risk in building management. When design professionals are charged with this mandate, functional efficiency and economics often override environmental quality considerations in spite of good professional training and the ability to deliver a better product. The current definition of "cost-effective" office accommodation centers around the provision of only those features which are perceived as immediately useful by the owner or leasing agent; office accommodation is considered solely as a commodity expressed as "so many square feet" of undifferentiated floor area. The market still does not recognize that capital and energy costs for buildings are a small fraction of the costs of the salaries and benefits of the people who work there. Even a small incremental improvement in satisfaction and productivity or reduction in absenteeism will readily offset any extra costs for improved environmental quality.

TOWARDS A BUILDING SOLUTION

Over the two year period of the project the *BC Energy Management Task Force* conducted seminars, sypmposia and workshops to define and explore the design implications of improved environmental quality.

Problem Definition:

*In recent practice heating/cooling, lighting and ventilation have been managed through a common point, usually in ceiling panels. Such systems are often inflexible and not even capable of always delivering minimal conditions for comfort.

*Windows are generally designed to optimized view or express architectural ideas often without due regard to daylight, heat-loss, glare etc.

*Mechanical and electrical systems have been neatly accommodated within the fabric of buildings and visually suppressed. Their function and control is incomprehensible to most people.

*Ceiling based central HVAC systems rely on predicted airpaths to acheive effective ventilation. If tenants interrupt the airpath with partitions or by tampering, the effective ventilation of an entire floor area may be interrupted.

Some New Directions:

The need for office buildings to adapt to changing needs during the course of their comparatively long life and to accommodate change without disruption is driving innovation on many fronts (6). Contemporary practice is clearly moving towards making a distinction between the functions of different systems and making that distinction visible within the expression of the building:

*Ventilation air is separated from heating and cooling such that each can be controlled independently of the other.

*Innovative daylighting strategies such as light-shelves separate the lighting and view functions so that each can be designed optimally.

*Mechanical and electrical systems and controls are becoming increasingly visible and accessible and thus better used and understood.

*HVAC systems are increasingly being designed floor-by floor and even on an individual workstation basis so that they can be operated more independently and in smaller units. Flexibility and adaptability are enhanced.

The office workplace is increasingly becoming a place of creative endeavour where hours of use and personal definition are more individual (7). This trend must find it's expression in building organization.

PROJECT ONE: Theoretical Design Problem

During an intensive design workshop two teams of architects and engineers supported by leading energy and environmental quality consultants were challenged to reconcile environmental quality and energy efficiency in the design of a theoretical 13,000 sq.m. office building.

Each of the teams, working independently, produced a design which gave priority to occupant health, satisfaction and productivity:

*Both took a cautious approach to energy saving when the space is occupied and an aggressive one when the space is empty.
*Both chose to emphasize the effective delivery of ventilation and lighting to the workstation rather than meeting prescribed ambient levels.

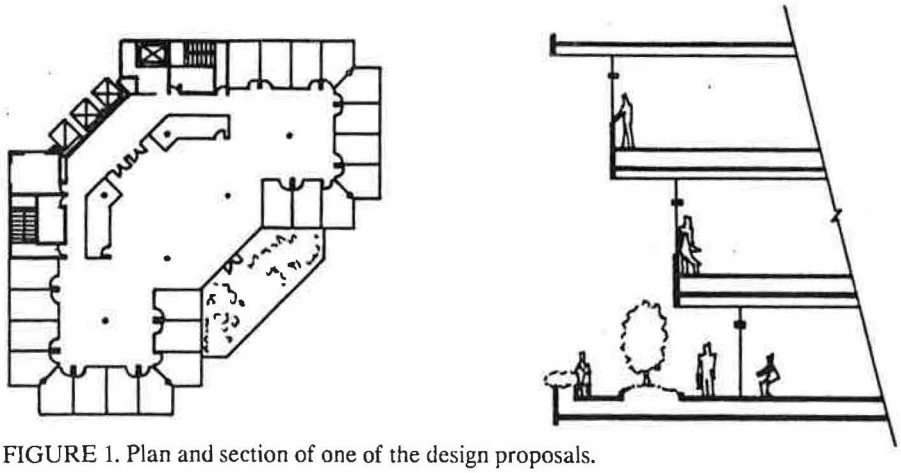

FIGURE 1. Plan and section of one of the design proposals.

Architectural Systems: The building was made as slim as possible so that all occupants would be relatively close to the building exterior and oriented so that a sense of the outdoor environment and change throughout the day could be experienced.

The building's bulk was divided into smaller elements which relate to an artificial ground plane. Landscaped overhangs were created by extending the floor plate every third floor to provide a foreground and focal point for clusters of floors, a sense of identity with outdoor spaces, and private patios with vegetation for some offices. The central terraces were oriented towards circulation zones where occupants naturally meet and therefore encourage interaction while being a visual amenity.

Where possible a floor-to-floor height greater than 3m was adopted to increase daylighting options, allow for an up-lighting system which will articulate the space and break down larger office areas into smaller ones. It can also provide air stratification well above the occupied zone to allow higher peak temperatures. Natural ventilation through small operable windows was introduced as an alternative during favourable conditions. This is possible by treating the building as a series of separate floors with minimal shafts or other connections between them and by carefully sealing these floor slabs.

Mechanical Systems: Proposed mechanical systems for both schemes centred on floor-based environmental services which permit both task light and task air which is adjustable by occupants. Conditions for tenants who work irregular schedules and are microcomputer oriented are thus improved. Systems were made understandable by separating heating, ventilation and air conditioning. Heating plants are small units placed around the perimeter with coolers on the interior. The raised floor offered the capability to drop in floor grilles, task air, and electrical and communications cabling wherever desired thereby providing flexibility for alternative partition arrangements.

Project Two: "Live" Building Project

Whereas economic feasibility was an implicit requirement in the above project, no actual cost studies were possible in the timeframe of the workshop. The need to examine the realities of cost and market receptivity therefore became the primary focus of a second project. Further funds were provided directly to an architectural practice to offset the cost of additional environmental and energy consultations during the initial stages of an 8,000 sq.m. addition to an existing two-storey building. It is sited in a suburban location with distinctively adverse noise and atmospheric problems. During an intensive working session, the team of architects, consulting engineers (mechanical and electrical), air

session, the client was represented by a commercial leasing agent who used currently accepted market norms to evaluate the various features that would be included in the design.

Floor Based Services Distribution: Although the working session focused on developing a distribution system in the structural floor, subsequent analysis was directed toward patent raised floor systems with attendant mechanical, electrical and communication distribution capability. A cost comparison with the more conventional "poke through" system of services distribution yielded an overall saving. The cost of the raised floor system could be offset by three factors (8):

- *HID ambient uplights with task lighting are marginally cheaper to install than standard overall fluorescent lighting and cost substantially less to operate.
- *savings on access to conditioned air and all types of wiring from the access floor.
- *HVAC returns using the underfloor space as a plenum.

Furthermore, if the patent raised floor could be classified as "equipment" for tax purposes it could be depreciated at 30% and thus improve the cash flow during the early years.

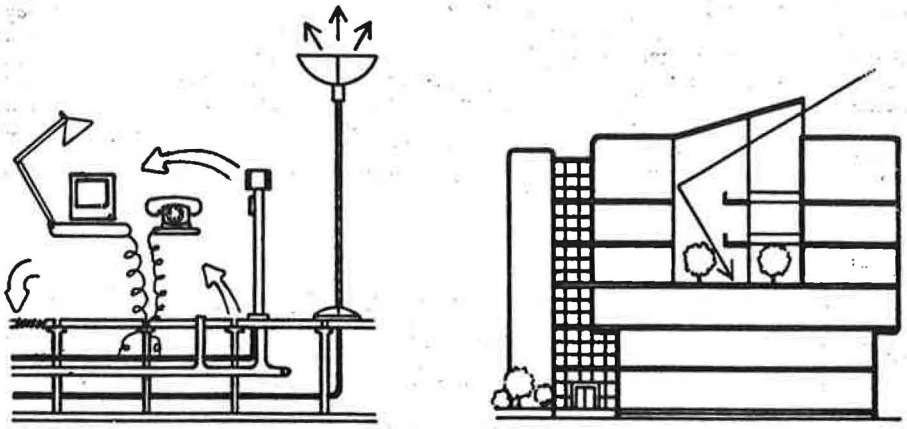

FIGURE 2. Personalised control strategy and atrium in "live" project.

Inclusion of an atrium: The relatively limited external amenities of the site suggested an inward looking scheme and an atrium was thought to offer distinct advantages. The possibility of a more comprehensive passive building which included daylighting, natural ventilation and thermal mass to temper internal temperatures was rejected on the grounds that it is difficult, if not impossible, to lease office accommodation that does not have full HVAC. Traffic noise and external pollution levels also negated the use of natural ventilation at that site.

During the working session, the role of the atrium therefore shifted to one of amenity, i.e. a place to look into. Subsequent to the workshop, however, an evaluation of the "market" suggested the value of this amenity would not be comensurate with 10-15% increase in rental rates to offset the increased construction costs (8). The strategy was thus rejected though the use of currently accepted market norms could have been challenged.

CONCLUSIONS

The problem of improving the environmental quality and energy efficiency of buildings does not appear to be solely a technical one.

Value of Team Work: It is evident that input from HVAC and lighting consultants early in the design process can lead to an improved integration of architectural and environmental

systems. If environmental concerns are incorporated and emphasized in the building program, architects and engineers are more likely to incorporate them in the evolving design. By being involved with a design from the outset, all members of the team have a common understanding of the problem. Increased design effort at this stage may create fewer conflicts during design development and construction and thus expedite the delivery of a project.

Market Forces: The bulk of the private sector market is focussed on the "bottom line" in which improved environmental quality and energy efficiency is of relatively minor significance. If the market place can distinguish between buildings having poor or good environmental quality, it is necessary to carefully define the qualities that are being offered. Leasing agents must be given a clear set of marketing ideas so that prospective tenants can see the advantages that one particular building has over another. The value of flexibility of use and possible satisfaction and productivity improvements could then be more widely explored.

Costs: There is a perception that buildings with improved indoor environmental quality and energy efficiency will cost considerably more to build. If this were the case, unless the client could be convinced that the added quality would bring a return, it is unlikely that they would opt for it. Improvements in environmental quality, however, do not always require a significant increase in capital cost. However more design time and fees are necessary to develop innovative yet cost effective designs. A compressed design time invariably forces designers to rely on previous, known solutions. Furthermore better uses of technology and alternative views of financing such as life cycle costing need to be further pursued. Significant research is also needed to explore any links between environmental satisfaction and improved productivity and reduced absenteeism which can further help to justify environmental quality features.

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