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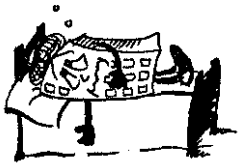
THE COSTS OF POOR INDOOR AIR

by David Finn, M.Eng., P.Eng.



The concept of "green building" usually brings to mind the use of building products that take less energy to produce, the design of buildings that use less energy to heat, or the recycling of construction waste, that is, efforts to reduce the impact of buildings on the environment. There is another element in this concept - a "green building" will minimize the impact of negative indoor environmental factors on us, the occupants.

The major economies of the world, including Canada's, are now dominated by service industries. Most of the people employed in these industries work indoors. There is considerable opinion that the productivity of service industries can be enhanced by improving the quality of the workplace. This approach could reduce absenteeism and health care costs associated with poor workplace environments (thus reducing non-productive employee costs). Such improvements could also result in work of higher quality and in greater efficiency. Canadian data on these phenomena is relatively scarce, but a look at US figures is eye-opening:

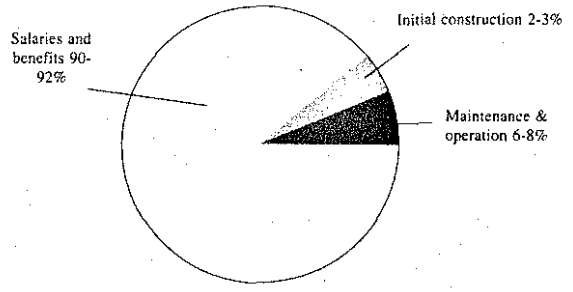
- Direct medical costs associated with indoor pollution in the United States could range from US$500 million to over US$1 billion a year, while the costs of lost productivity related to absenteeism could be as high as tens of billions of dollars a year (Woods, 1989).
- Alan Hedge, an internationally-respected researcher at Cornell University, estimated that in 1988 workers' compensation claims costs American companies over US$50 billion for minor afflictions such as headaches, and up to US$75 billion for illnesses related to poor indoor air quality, in particular.
- Each 1% productivity improvement could contribute an additional US$10 billion to the American economy. Various researchers have estimated that productivity improvements of up to 20% may be achieved by improving work conditions.

Proportional impacts on the Canadian economy are likely, since both countries derive almost 70% of their respective Gross Domestic Products (GDP) from the service sector and have similar economic structures. These costs are not an economic abstraction, bur represent real negative impacts on thousands of individuals and businesses every year. Builders and designers who have been involved with "sick" or "problem buildings" can also be negatively affected, facing damaged reputations and in some cases, litigation.

Airborne particles, bacteria, glare from lighting, cold drafts and traffic noise are all examples of factors in the indoor environment that can have a negative effect on productivity. These factors are typically categorized as being related to indoor air quality, thermal comfort, lighting and noise - the major physical characteristics of the indoor environment. Indoor air quality, in particular, has received considerable attention in recent years.

What are buildings used for?

Over 90% of the total cost of running an office during an estimated 40-year building life is dedicated to occupant salaries and benefits, as compared to less than 10% for initial construction, operation, maintenance and renovation of the building (Hedge, 1991). Far too often, construction and operation budgets are squeezed without sufficient regard for the impact on occupants and their associated costs - a lack of appropriate investment in the quality of the workplace and inadequate design are common phenomena.



Costs over the life of an office building

INDOOR AIR QUALITY

The energy crisis of the early 1970s is recognized as the advent of the era of "sick buildings". Buildings were designed to be much "tighter" and both natural and mechanical ventilation rates were reduced as energy-savings measures. In 1973, ASHRAE (the American Society of Heating, Refrigerating and Air-Conditioning Engineers) Standard 62-1973, Ventilation for Acceptable Indoor Air Quality, was halved to 2.5 litres of outdoor air per second per person. The increasing use of synthetic materials in furniture and interior finishings compounded the problem as off-gassing of chemicals contributed to higher concentrations of indoor pollutants. Use of recycled materials, mentioned above as a "green building" option, may also contribute to the problem. The World Health Organization now estimates that between 1.5 million and 2.5 million Canadians are routinely exposed to poor indoor air.

Poor indoor air can produce effects ranging from headaches to legionnaires' disease. Although the specific causes of these effects are sometimes difficult to isolate, it is generally accepted that inadequate ventilation is the primary culprit in most cases (see, for example, ASHRAE Journal, September 1987).

Mechanically ventilated buildings are widely reported to have a higher incidence of problems than naturally ventilated buildings, which is likely attributed to the reduced amount of fresh air supplied to occupants through mechanical ventilation.

SOLUTIONS?

The search for solutions to indoor air quality problems is probably the most active area of indoor environment research and development. Some of the general approaches being taken are described here:

Increased ventilation rates - Simply increasing the amount of fresh air supplied to the building interior may be one solution. One recent cost-benefit study compared increased ventilation costs with absenteeism costs associated with upper respiratory problems. The study showed that incremental costs associated with raising ventilation rates from those typically found in "sick buildings" to those found in healthy buildings would pay for themselves in less than a year due to reduced absenteeism (Holcomb and Pedelty, 1994).

In 1989, ASHRAE revised its ventilation standard to increase ventilation rates to 10 litres/seconds/person in non-smoking areas and 30 litres/second/person in smoking areas. Compliance with this standard (ASHRAE 62-1989) is voluntary, however, and is not called for in every project. Last year the US-based National Energy Management Institute estimated productivity savings of billions of dollars if every office building in the United States were upgraded to ASHRAE 62-1989. Compliance with this standard is also regarded as providing "acceptable indoor air quality" in many courtrooms.

Continued on next page

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Distributed services - Increasing ventilation rates does not always solve the problem, however. The additional fresh air is only effective if appropriately delivered to the occupants. To this end, a trend has recently developed - providing multiple independently controlled systems in a building, with each system conditioning a particular work zone. The Umeda Center Building in Japan, for example, has 12 heat pumps per floor, allowing small "cells" of workstations to have independent control of temperature and air flow. Providing a higher degree of local control allows occupants to tailor air conditions to their needs and may result in more satisfied and productive workers.

Individually controlled workstations - Modular workstation units capable of connecting to local outlets for conditioned air (and heat, power, data, etc.) have been developed by a number of American companies. Conditioned air is supplied in sub-floor space and distributed through vents or nozzles in the workstation; task lighting is integrated with the unit. These workstations provide each worker with a high level of control over local environmental conditions and have been claimed to dramatically improve productivity (Lorsch and Abdou, 1994). Under floor "task air systems" have also been developed, and although not integrated with the workstation unit, they are based on a similar philosophy of providing individual control over local ventilation. Local control also holds the promise of energy savings, as air, light and heat are delivered only where needed and not to unoccupied space.

Low emission materials - If attempts at evacuating pollutants are not successful, controlling the source of the pollutants may be more effective in improving air quality. It is, however, important to identify which gases are emitted by particular building products before source reduction can be pursued. The development of techniques and tools for measuring emissions will help manufacturers create safer materials and thus allow designers and specifiers to choose safer products. By reducing pollutant sources, ventilation rates may also be reduced and energy conservation initiatives pursued with less negative impact on indoor air quality. The Institute for Research in Construction (IRC) is currently building a new material emissions laboratory which will be capable of measuring emissions from virtually any source from building materials to office equipment in the indoor environment.

FUTURE DIRECTIONS

Building owners and designers have increasingly recognized the importance of providing a supportive workplace, but are usually faced with a difficult question: where should we spend our money to maximize productivity? The consideration of the relative importance of indoor air quality, lighting, acoustic and thermal conditions to occupant health and performance is central to wise investment. Furthermore, increasing occupant expectations concerning the indoor environment are likely to result in more demanding codes and standards, as well as in improved design specifications and commissioning tools for indoor spaces. Continued research on the indoor environment - in particular, occupant reactions and performance - is critical to achieving these goals. As a contribution to the pursuit of this research, ITC has recently begun construction of a second new facility, the Indoor Environment Research Facility, that will be the largest of its kind in North American.

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See page 20 (back cover) of this issue, for a list of references for Mr. Finn's article.

TUNS GETS NEW CHANCELLOR

Ruth Goldbloom, C.M., D.Hum.L., LLD., has been appointed Chancellor of TUNS. A native Nova Scotian and graduate of McGill University, she has been Regent at Mount Allison University, Chair of the Board of Governors of Mount Saint Vincent University, and Chair of the Dalhousie University Annual Fund.

Dr. Goldbloom has received several awards for her volunteer activities including the 1978 Human Relations Award of the Canadian Council of Christians and Jews, the 1983 CASE Volunteer of the Year Award; in 1992 she was appointed a member of the Order of Canada.

She is currently President of Pier 21 Society, a member of the Standing Committee on Business Development for the Medical Research Council of Canada, The Canadiana Fund, and the Customer Council for Canada Post.

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M.W. Zelmer

REVISIONS TO THE 1994 APENS STRICKEN LIST

APENS apologizes to the following members who were listed in error on the 1994 APENS Stricken List published in the October/November 1994 issue of THE ENGINEER (Vol 6, No. 1)

2449	G. Parker
3771	B. Hanson
4408	J. Hiscott
6168	H.C. Williams

The following members holding a License-to-Practice in Nova Scotia were omitted from the stricken list published in the last issue:

14934	H.Kang
14954	J. Fisherr
14964	J. Hendrey
14976	J. Edward
14984	W. Schnurr
15014	R.D. Swift

Correction to the APENS Registration for September 1994 published in the last issue of THE ENGINEER

Engineer-in-Training
E.A. Halif should read E.A. Halef

THE COSTS OF POOR INDOOR AIR

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Holcomb, L.C. and J.F. Pedelty, "Comparison of Employee Upper Respiratory Absenteeism Costs with Costs Associated with Improved Ventilation". Presented at the ASHRAE 1994 Annual Meeting, Orlando, Florida, June 25-June 29, 1994.

Lorsch, Harold G. and Ossama A. Abdou, "The Impact of the Building Indoor Environment on Occupant Productivity". Presented at the ASHRAE 1994 Annual Meeting, Orlando, Florida, June 25-June 29, 1994.

National Energy Management Institute, *Productivity and Indoor Environmental Quality Study*, Alexandria, VA, August 1993.

Woods, James E. "Cost Avoidance and Productivity in Owning and Operating Buildings". *Occupational Medicine - State of the Art Reviews*, Vol. 4, No. 4, October-December 1989, pp.753-770.