1984 ?

[Fig: Title]

INDOOR POLLUTION:
IMPLICATIONS FOR ARCHITECTURAL PRACTICE

This presentation considers the implications of the emerging awareness of indoor pollution problems for architectural practice. The purpose of the talk is to identify the challenges and opportunities presented to architects, engineers and designers, and to propose a framework for the architect's response.

We will define the major issues, describe professional involvement, suggest approaches, and project some probable futures.

We will propose the concept of Building Ecology as the basis for a method of dealing with indoor pollution in architectural practice - as a paradigm for the architect's response.

CONTEXT

[Fig: Env'l poll'n photo]

In historical perspective, indoor pollution simply represents the logical extension of a growing awareness that began with Rachel Carson's watershed book, Silent Spring, an awareness that the whole environment is extremely sensitive to human activity, that pollution is a global problem, and that modern civilization (including the creation and use of buildings) carries with it a substantial burden requiring careful management of resources and wastes.

Biologist Barry Commoner has formulated what he calls the Four Laws of Ecology, presented in his book, The Closing Circle. These laws are an effort to translate the lessons of the science of ecology, the study of the inter-relationships of living organisms to their environment, into practical terms. These laws are as follows:

[Fig:..]

The First Law of Ecology:
Everything Is Connected to Everything Else

The Second Law of Ecology:
Everything Must Go Somewhere

The Third Law of Ecology:
Nature Knows Best

The Fourth Law of Ecology:
There Is No Such Thing as a Free Lunch

We will discuss the relevance of these four laws of ecology to architecture a little later and attempt to understand their meaning in architectural terms when we present the concept of Building Ecology: an application of the lessons of ecology to the science and art of designing healthy buildings.

Now, let us continue to examine the context for architects' response to indoor pollution.

[Fig: Indoor/Outdoor Ratios]

There has been a growing awareness that indoor pollution demonstrates that, while man's home may be his castle, it is not protected from much of the pollution that originates outdoors. Indoor air must be exchanged with outdoor air, and, in the process, many of the contaminants of outdoor air will enter the building. Furthermore, the rate of generation of pollutants indoors tends to be very high, and reducing the exchange of air with the outdoors results in hazardous levels of pllutants in indoor air.

Thus, the common advice given during severe smog episodes or nuclear power plant emergencies - "stay indoors and keep the windows and doors closed" - feeds on the myth that the home is somehow protected from health hazards or the contamination of the external environment. Just as Commoner's second law of ecology suggests that everything must go somehwere, so too, everything including the air we breath must come from somewhere. The advice of public agencies during environmental crises perpetuates the "home is a castle myth" and misleads the public into believing that somehow the air indoors is not affectd by outdoor air quality. In fact, we know that indoor air contains higher concentrations of most air pollutants than outdoor air.

Modern society has become so dependent on chemicals that without them, our technological lifestyles would grind to a halt. It is estimated that over 2000 lbs. of chemicals are produced every year for every inhabitant of North America. Approximately 60,000 dkifferent substances are used. The majority of this chemical production penetrates living organisms creating a generalized phenomenon named "Ecotoxicity" by the Canadian Department of the Environment. Most of these chemicals resist decay in the environment, and much of it ends up in ground or surface water.

Samples of polar ice show that pollution is globally transported; samples of air taken in the Bolivian Andes show measurable levels of PCBs, Polychlorinated Biphenyls; and the problem of acid rain demonstrates that what goes up must come down but not always directly on the heads of those who produce it.

Blood and urine from a sample of the U.S. population shows chemical residues are in everyone.

Now, indoor pollution problems have further demonstrated that pollution is truly ubiquitous. We are forcefully confronted with the realization that we must consider the environmental outcomes of all our human activities, and the design, construction and use of buildings are not exceptions.

Many indoor pollutants are known carcinogens, mutagens, or teratogens. Even when complaints about the indoor environment are reduced by effective remedial measures, we must be cognizant of the growing rate of defective births, the 1 in 5 cancer incidence in America, and the potential that exposures ot low levels of mutagenic substances today may result in genetic defects generations from now.

As designers of the indoor environment, we must apply considerably more attention to the creation of healthy, sustainable building designs as free from indoor pollution as we can reasonably achieve.

Before considering some specific actions available to architects, let us briefly review what others are doing to deal with the problem:

Scientists:

physicists,
chemists,

formerly concerned with atomic power, with energy conservation or development, with outdoor air pollution, with water pollution, with the behavior of pollutants in the environment,

are increasingly turning their attention to indoor pollution issues; to understand the sources and distribution of indoor pollutants, particularly air pollutants.

microbiologists,
epidemiologists

formerly concerned with envjironmental health issues in relationship to occupantional hazards, in the human diet, in ambient air, by smoking cigarettes,

have begun to study the health threat posed by indoor pollution.

Medical researchers

Health effects of indoor air pollutants
Medical and biological effects of environmental light

Space scientists

[Fig: astronaut in space]

NASA

Even space travel is not protected from the potential of indoor pollution. In fact, the astronauts have experienced a variety of health problems upon return to earth, and substantial research into many aspects of their indoor environments has been conducted. The criticalness of clean air in the space vehicles is extreme, so NASA has tested every material used in the spacecraft to determine chemical stability or outgassing rates.

Engineers:
ASHRAE,
ASTM
ASME
have begu;n to concern themselves with indoor pollution issues such as proper ventilation rates, distribution of outside air within spaces served by mechancial ventilation systems, ..

Public health officials
local and state
federal
have initiated programs, conducted investigations, recommended policy changes, and generally spent increasing amounts of time on the indoor pollution problem.

Building materials and equipment manufacturers
product testing
product research and development
market research and marketing

Policy makers, legislators
Fact finding
Assessing alternatives
Exploring implications of problem and magnitude of implications

Attorneys
Litigation for and against manufacturers, attorneys, injured occupants, owners, government agencies, etc. (technical journals)

II. ARCHITECTURE AND INDOOR POLLUTION - impacts on architecture:

The architects, engineers and designers have become increasingly interested in the indoor pollution problem as a result of their own experience with problem buildings or their concern for the health, safety and comfort of occupants of their structures. This interest and concern has manifested itself in several areas.

Training and education
Courses or portions of courses in schools of architecture are now devoted to indoor pollution issues.

Research
In office practice, in academic and industrial institutions, and government agencies, research is focusing on several critical indoor pollution issues:
Product performance and alternatives
Ventilation issues: outside air requirements,

distribution, control, utilization of operable windows, impacts of smoking in public buildings, separation of smokers,

Lighting: energy use impacts versus health, comfort and productivity

Habitibility

Comfort

Traditional post-occupancy evaluations and the emerging field known as "building diagnostics" are increasingly focused on the problems of indoor pollution: air quality, ventilation, thermal enviornment, lighting, acoustics, etc..

Design

Architects are exploring design alternatives which will provide more effective methods to eliminate indoor pollution or minimize its adverse effects on building occupants.

Construction

Architects perceive that many indoor pollution jproblems result from changes or defects in construction. More careful observation of construction, review of shop drawings, scrutiny of air balance reports, etc.

III. BUILDING ECOLOGY

I first proposed the use of the concept "Building Ecology" as a means of understanding and applying the lessons of ecology to the built or building environment in 1979. It is described briefly in an article appearing in the April, 1981 issue of Progressive Architecture magazine.

Defining Building Ecology

Building ecology:

The study of the inter-relationships between man, the natural environment, and manufactured environment including buildings and human settlements.

The study and consideration of these relationships can become a useful part of the architect's work. The architect is in a unique position by training, by responsibility, and by authority, to conduct this type of integrative study.

Currently, many aspects of the problem are being studied by separate disciplines. No one else takes overall responsibility for the work of the separate specialists. Often gaps or overlaps are not identified, or they are identified too late. The architect is in the best position and is best trained to coordinate and direct the integrated multi-disciplinary approach to indoor pollution problems.

Architect's are the focal point for the building development process. The architect represent the builder-owner-developer's interest, interpret the public and occupant's interests, and determine the impact of the building and the environment on each other and on building occupants.

Ultimately, one might say, that as indoor pollution represents the presence of any unwanted environmental force indoors, successful architecture can be defined as the absence of indoor pollution.

The Four Laws of Ecology (from The Closing Circle by Barry Commoner).

1. Everything is connected to everything.

2. Everything must go somewhere.

3. Nature knows best.

4. There is no free lunch.

While Commoner attributes this law to the field of economics, certainly physical laws of conservation of matter and energy support the statement as well.

These lessons have all manifested themselves in buildings/architecture as indoor pollution. Examples of these principles follow:

#1 When we attempt to conserve energy, the ;meas;ures we take have in on other components of the building; integration of systems and the processes or individuals and considerations involved in their design is required. The architect is the captain of the team and responsible for format of the relationship, specifiying the criteria for performance, reviewing the submittals/designs of subs, specialists to see that they a compatible, not at odds, and acceptable.

#2 If we pollute in one location it comes back to haunt us elsewhere. try to save energy through reduced ventilatiojhn, lkwe cerate air q;uali problmes inside.

Pollutants generated indoors must go somewhere, and if they stay within building , they can casue health and comfort problems.

Pollutants generated outdoors must go somewhere, and they often land indoors.

#3 Nature knows best; we tend to find that synthetic materials cause problems because they have not been around long enough for us to underst their harmful effects. With naturally occurring materials, a;the ;humar species has evolved during 30,000 years, learning to coexist with and properly ;utilize or avoid certain materials. the synthetic, man-made materials often pose problems simply bedfcause we don't adequately under them. they haventi been aruound long enought for us to tget the experi with them whcih dlwe khave with older a;mmaterials.

#4 No free lunch, air quality, light, space, energy, etc. have costs. M balance the costs against the benefits.

IV. ARCHITECTURE AND BUILDING ECOLOGY - The major areas of activity for architects to implement building ecology:
1) Program and development options
2) Design approaches
3) Working relationships with engineering consultants
4) Engineering approaches
5) Specifying materials - requiring more data from manufacturers
6) Construction observation
7) Closing out the job
8) Launching a building
9) Operational planning
10) Evaluating building performance for energy, comfort and habitability

VI. IMPACTS ON DESIGN

Of course the most interesting, and, in my opinion, the most promising area of architectural endeavor for reducing or elikminating indoor pllution jproblems is the design of buildings.

The decisions made on the front end, the conceptual, schematic design and their translation into the details and specifics of the building construcitoin are the most critical decision points. Wheile architects haventended t so dee indoor pollution as a ;materials selections problems and a mechanical engineering problem, in fact, decisions about building configuration, overall thermal control stragtegies, lighting conceipts, ventilation, ketc. are t;he most important decidiosn wirth regards to idnoor polutionm.

- Introduction of diversity and back-up systems for modifying environmental conditions.
- Modifications to building formal considerations, configuration.
- Changes in material choices.
- Economic impacts of indoor pollution on design choices.
- Professional and ethical considerations.

VII. PREDICTION OF TRENDS

[fig: photo of polluted sky sunset]

- more attention to site and surrounding area as sources of pollution or for easy or accessible means for handling or controlling pollution

[fig: photos from magazines advertising non-poilluiting materials
increased attention to materials specifications:

* We know a lot more about properties and behavior of materials (building and furnishings) than we did just a few years ago due to the increased awareness of the indoor pollution problem. Testing of materials and sampling of environments has jproduced information of great value.

* Furthermroe, we know a lot more about how to study the properties and bedhavior of materials

* Therefore, we will witness increased attention in architectural practice to the choice of materials and their use. This will involve review of existing data on performance and properties as an additional criteria in the materials selection process. It will involve requirements of manufacturers' representatives that they be able to provide data from tests, describe t;he tests and the results as well astheir implications. We will see increased testing of materials by architectural researchers and for architecture firms, probably limited ot large projects initially. We will also manufacturers increasignly involved through their own industry associations, in the testing of materials in standardized test protocols and reporting formats.

- increassed involvement in the close out and start up process

- more monitoring of building systems performance, electronic monitoring and control systems using electronic sensors, human input, microprocessor integration of input
[Fig: ASHRAE ads for electronic controls, monitoring]

- new approaches to ventilation air supply: Scandinavians and Germans are already looking at ventilation systems where air supply is in columns or on walls. Computer rooms with perforated raised floors
[Fig: photo from german lit from Stockholm]

- Use of telephone lines or other communications hardware for continuous feedback of sensor-acquired data or human input to monitor and control environmental conditions
- Increased individual occupant control of local environment, increasing decentralization of air supply, temperature, air movement, lighting, privacy, amenities

VIII. RESEARCH DIRECTIONS AND NEEDS
- direct reading (instantaneous) instruments for monitoiring environmental conditions (including air quality)
- materials off-gassing rates data
- control measures for off-gassing
- substitute products with more stability
- alternative HVAC designs
- alternative HVAC protocols during completion/start up of building, or on-going basis; energy conservation and control of indoor pollution
- methods for evaluating products during selection process/specifications
- methods for verfiying building performance/environmental

conditions before and during occupancy

IX. TOWARDS A NEW ARCHITECTURE - BUILDING ECOLOGY

Accepting responsibility for the building environment and the impact of buildings on the broader environment. Creating healthy environments.

FIGURES

Fig. 1

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- Barry Commoner
The Closing Circle

BUILDING ECOLOGY IS THE STUDY OF THE INTER-RELATIONSHIPS BETWEEN MAN, THE NATURAL ENVIRONMENT, AND THE MANUFACTURED ENVIRONMENT INCLUDING BUILDINGS AND HUMAN SETTLEMENTS.