Environmentally Responsible Design: A Matter of Time

RAYMOND J. COLE
University of British Columbia

INFORMATION

The theme of information technology has been discussed in this conference, and at the outset I want to declare my personal anxiety about the Virtual World and the Nanosecond Universe of Information Technology; I do prefer the real world and I do prefer slowness; as I will show, that is the kind of "matter of time" I refer to in my title.

However, the notion of information is critical in any environmental discourse.

The frame for my argument is epitomized by an Angus Read poll which gives some sense of how important Canadians hold specific environmental issues to be. In answer to questions about the credibility of sources of information on environmental issues, government and industry were generally felt to have low credibility (incidentally, university professors were ranked high). The question is: Who do you/should you believe? The decisions that we make on a day to day basis either use the information and knowledge that is available to us, or are based on ignorance or arrogance; yet these decisions, for the most part, have adverse impacts on the natural world.

The Intergovernmental Panel on Climate Change (IPCC), chaired by Sir John Houghton, examined a series of scenarios on what our environmental future might be. They pointed to the increased burning of fossil fuels and to the manifestation of that burning in terms of increasing green house gas emission. Actually, the scenarios range from the 'business as usual' scenario to ones in which we curb our burning of fossil fuels. It is possible to track the likely degradation of various natural systems as a result of the choice of scenarios; the science community is now telling us very clearly about the errors of our ways and about the possible implications.

On the other hand, the *New York Times*, on December 1, 1997—just before the U.S. delegation set off to Kyoto to make their case about how the USA would be prepared to reduce its green house gas emissions—published a full page announcement to the effect that, "The only thing that this treaty calls down is America's economy." In other words, people's concern for reductions to green house gas emissions and for the profound implications they might otherwise have, were seen as adverse to the interests of the U.S. economy. As might be expected, most of the signatures on the bottom of the announcement came from the automotive and the fossil fuel industries.

So here we have science telling us to change our ways and there we have a resistance to change building up.

Clearly the cost of transforming our infrastructures, our industries and our built environment is going to be colossal, measured in dollars and cents, and the cost is going to be born by each and everyone of us. That cost is only going to be surpassed by one other cost—and that is the cost of inaction which will be born by future generations, our children and our grand children.

The credibility of information is absolutely central to these issues. You, as well as I, have come across a lot environmental information; it's presented to us all the time, particularly through the manufacturers of materials. Many industries see environmental issues as a potential marketing tool and therefore they want to present their materials in the best possible light. The wood industry, for example, naturally wants to present its material as well as possible and, among other initiatives, they have prepared a fact sheet at the very top of which one can read "Wood versus Steel: Some Quick Facts." (This is a reaction to the 25 percent inroads into the lumber market being made by the steel industry's steel stud construction.) The wood industry, therefore, chose to present some selected facts about the environmental merits of wood over and above its competitor, steel. Five performance issues were chosen: effluents, energy use, water demand, use of resources and CO_2 emissions, where wood clearly has less impact than steel. The conclusion is drawn that if you want to be environmentally friendly, "do it with wood."

My immediate comment is that they have chosen five environmental criteria out of a list of a hundred or so; I could easily have chosen five others which reverse that picture. In other words, it is a highly selective matter what environmental information is presented to whom.

ARCHITECTURE, TIME AND THE SUSTAINABILITY DEBATE

In Canada, after an expenditure over $1 million and four years' work, a commission's study has provided some fairly detailed life cycle assessments of a range of different materials. This provided a useful base when we made a study of selected steel products used in building such as nails, welded wire mesh, tubing. (I should mention that over the last four or five years, my work has essentially focused on life-cycle assessments of different materials and products).

In the study I have just mentioned, our aim was to find out how much energy is consumed to produce a kilogram of material or products. The assumption was based on virgin material being converted using reduction furnaces. We could establish equivalent figures in terms of CO_2 emission associated with the production of these products. When we "revisited" our results later, with a different assumption based on the increased use of mini-mills which are much more efficient and use a much greater degree of recycled content, what did we see? A significant drop (by about of half) in the energy, accompanied by a significant drop in CO_2 emission.

The point is, we are in a very volatile field and we are constantly gaining more understanding about the real issues. Also, with the passage of time, different things are revealed to us; what we hold to be true today may not be the case tomorrow. In the 1950s, for example, an advertisement appeared showing a person (clearly unmasked) spraying asbestos onto a ceiling; the slogan was "think of asbestos as the panacea of the construction world!" This is in marked contrast to our current thinking about the use of asbestos which has, of course, been banned since 1976.

Most of the environmental debate and much of the available environmental information have focused on materials and been centered around the materials industry; we have not yet, as architects, embraced what I might call the architectural opportunities or the architectural dimensions of sustainable building.

The real issues can, instead, be expressed differently, suggesting that materials should be light, durable, and recyclable or biodegradable. Also, one can think in terms of buildings which are simple to construct or which can be disassembled, updated, and easily maintained. Also, buildings as a whole could be multipurpose or sharable (the notion of sharable buildings is important when you think about economy of materials and realize how much empty built space exists at any one time).

In architectural terms, one can identify strategies to make our buildings biocompatible somehow, so that when they return to nature they do so in a very benign way. Another strategy might be to focus on industrial ecology where the waste of one industry can become the feedstock for another; this suggests that we could have an industrial system which mimics the cycles of nature without actually interacting with it directly.

Then there is the notion of dematerialization, implying that we apply increasing amounts of intelligence to our building designs in order to reduce the energy/mass flow into them. Unfortunately, architects tend to spend a lot of time on second-order problems and miss the big pictures. For example, there is a tremendous fascination in embodied initial energy and there is still little interest in reducing operating energy consumption. That is particularly significant when we look at the notion of the life cycle of buildings. Life-cycle thinking and life-cycle analysis should be the bread-and-butter framework for discussing environmental issues.

Indeed, if we start to look at what actually happens during the long life of a building in terms of energy and energy use, we end up with some important observations. Consider three possible scenarios: a building lasting 25, 50, or 100 years, and the three energy components of those life cycles: 1. The initial energy to produce the building (its initial embodied energy); 2. The recurring energy over the life of the building (for on-going maintenance and repair, and for refurbishment and the replacement of materials); and 3. The energy needed to operate the building. In the 100-year scenario, the dominant component of life cycle energy use is the operating energy; at 50 years, it is still dominant, and even at 25 years it is again dominant!

Considering the 50 year scenario: If we can improve our energy standards and reduce the operating energy by 50 percent then there is a slight reapportionment of what is most important. If we could get the operating energy down to 25 percent of current energy use, then and only then do we begin to see that the embodied energy (initial or recurring) begins to be important.

The energy required to decommission a building (as opposed to demolishing and trashing it) is also the subject of misconceptions. We tend to assume that there are only modest amounts of energy associated with the deconstruction operations, though in point of fact really deconstructing a building takes a lot more time and energy than one expects For example, most of the work force is going have to move to and from the site much more often and some of the site equipment will be running for longer than with "traditional" demolition (this point will be developed in greater depth later).

CULTURAL CHANGE VS. TECHNOLOGICAL CHANGE

The environmental issue is a crisis of culture. Yet most of the discussions on environmental issues really seem to center on technological advances whereas the cultural changes that one would expect to accompany them are really not part of the debate.

Richard Stein's seminal book, *Architecture and Energy* published in 1977, showed that while we design a building now depending on the materials available now, the building will actually be used for its full life-span of, say, 50 years and only be decommissioned at the end. Decisions made now have profound implications on a long term energy future.

An unusual picture of the consequences of designing an energy consumptive building today concerns its impact on poverty. Those who are forced to live in such a building will spend large portions of their disposable income simply to stay warm; their opportunities for betterment and for savings will be curtailed, particularly as fossil fuels will be come more and more expensive. This indicates that the energyrelated decisions we make clearly influence a social future, though in the contemporary debate, the decisions are looked at mainly for their influence on the ecological or environmental future. Buildings will become obsolete because it will become too expensive to keep them in use.

Most of the discussion about sustainability has centered on natural capital, such as the forests, the atmosphere, the oceans ... keeping them intact so that they remain healthy and biologically productive. In building, we take resources from the natural world and we transform them into the built environment and it is most of the resources locked into that environment that are passed onto subsequent generations. (This is a very elegant way of bringing the built environment issue into the ecological debate in Bruntland terms.) As a result, we should recognize that it is the quality of both the natural capital and the built world we pass on to future generations; we should be concerned about them both.

Many cultures spend a lot of time and effort worrying about the quality of buildings and how they can be successfully passed on to future generations. We even spend a lot of time saving buildings for heritage reasons but as yet we have not thought about them in the context of our environmental responsibilities. Indeed, sometimes great efforts are made (i.e., much energy is used) to preserve buildings of modest heritage value.

I remember being dismayed, on reading life support systems for a dying planet to learn that architects—who were thought of as being concerned for the betterment of humanity—were actually producing products which were having a destructive effect on the environment. Environmental design, I had to recognize, is about the integration of systems as much as about the design of the systems themselves. At the product level, we are beginning to see integration; for example a Japanese toilet is now available which controls (integrates) the use of clean water, gray water and black water. On the other hand, there is the example of vending machines for cold beverages (also Japanese, as a matter of fact). They keep the merchandise cool thanks to a photovoltaic array supporting the energy needs of the vending machine; the array is on a support separate from the vending machine which stands in the sun (getting hot) instead of being in the available shade under the solar collector.

A study of the past is useful for understanding of the future. In a conference concerning the environment held in Sweden in 1972, the profound distrust of the third world for the first was clearly stated. Also in 1972, the President of the AIA gave an address entitled "Long life, loose fit, low energy." The same year, the RIBA chose as the theme for its annual conference "Designing for Survival"—a strongly motivating notion. In 1992, environmental issues were revisited by the RIBA and this time the theme was "Designing for Sustainability." The change of wording has a profound influence on the impact of the preoccupation on architectural design. Also in 1992, but at another conference in Sweden, it was realized that there could be no simple political solution to the global environmental inequities between the Northern and the Southern hemispheres.

In the 1970s, the main environmental concern was focused on energy questions but only modest amounts of information were available and very few energy efficient buildings had been built. In the 1990s, the environmental debate has changed; there is more information available but clearly there are still not many buildings being built.

In the 1970s, autonomy was very much part of the discourse; under the guise of designing for survival, people were trying to retreat from mainstream society and make their buildings autonomous. Life cycle thinking was suggesting implicitly that these buildings would last whereas other aspects of society would crumble. In the 1990s we start to see groups or tracts of environmental buildings where the selfreliance is partly shifted to the community. Nonetheless, there is still the notion that every environmental building has to solve the world's environmental problems on its own. We just do not understand at this point in time what it is most appropriate to deal with at the building scale and what is most appropriately dealt with at the community scale.

SOME EXAMPLES OF SUSTAINABLE BUILDING

The C.K.Choi Building on the University of British Columbia Campus in Vancouver is a research center. It has become a flagship environmental building. It is only three years old, yet certain tell-tale signs are beginning to appear. They may give us some guidance as to how to proceed in the future.

One of its salient characteristics is that it uses natural ventilation. Under each of the windows is a series of small holes held open by screws to provide continuous trickle background ventilation at a rate of 20 cfm; the air coming though the vents finds its way through the occupied spaces and is exhausted by stack effect through the top of the atrium. Already the occupants have found a way to close the ventilation holes by unscrewing the blocking devices—clearly showing that there is a discrepancy between the way the building is designed and the way it is used on a daily basis.

It was predicted that in terms of energy use, the building would be 30 to 40 percent below ASHRAE 19.1 standards. During the first three months of monitoring this year, it was found to be in the order of 15 to 20 percent greater than ASHRAE 19.1. To say the least, this raises questions about how one actually arrives at the numbers.

The C.K.Choi building is the interdisciplinary home for people conducting research who also have offices in their departments; they actually visit the C.K.Choi building occasionally. So far the main part the building is unoccupied. If one does the energy analysis per square meter, the results may not look too bad, despite the figures I have just quoted. But if one were to take occupancy into account as the base line for energy evaluation, one would be obliged to question how good the performance of the building actually is, and then ask whether indeed one needed the building in the first place.

One of the most controversial aspects of the building has been the composting toilets. Though they have been discussed widely, the "social" aspects have not been spoken about. When the building first opened, many of the occupants feared using the toilets and actually went across to another building when the need arose. Also the storage bins under the toilets have to be raked periodically; so the physical plant service had to develop a new job description before deciding who is to take on the task. Moreover, when the building first opened and the Campus Planning Service inspected it, they noted that there was an 11" diameter stainless steel chute leading from the toilet to the composting bin—a potential danger of small children falling in; now faced with a problem of responsibility, a notice was put up by the University to the effect that "small children should be accompanied by an adult!"

These are all adjustments—unforeseen adjustments—that had to be made, not for technical reasons but rather for social concerns.

Because of the recycled external wall materials, it became difficult to evaluate the building by the standards that apply normally to a new building regarding, for example, the uniformity of the brickwork. This suggests that issues of taste and esthetic sensibilities are likely to be challenged with the use of recycled materials.

During the design of the C.K.Choi building, the neighboring Armory building was slated for demolition. The architects spotted its old 100-foot span heavy timber trusses and wanted to use them for the structure for the C.K.Choi building. So they negotiated a selective decommissioning of the Armory to retain the 100 foot timber trusses (all the other timber was trucked off to landfill). Then they had to adjust the trusses to suit the designs of the C.K.Choi building. (We should remember that one of the criteria one uses for designing for deconstruction is the use of mechanical connections, and indeed the trusses had bolted joints). Nonetheless, after having gone through 90 percent of the recycling effort by taking the trusses down carefully, time still being money, a chain saw was the quickest way of finally disassembling the unwanted parts of the trusses!

At that point in time, another unexpected problem came up. When the materials were laid out, the timber had to be regraded for contemporary structural use. The City Inspector approached his task on the assumption that all the timber had to be acceptable to be used in any part of the building, resulting in a 90 percent rejection rate. To get around this problem, the structural engineers had to go through a whole selection process and identify specifically where each piece of wood would be used in the finished design. So there was a significant increase in the engineering time spend in identifying which piece of timber would be used where, singly or in combination, to fulfill the specific structural needs in the building.The mechanical jointing I have referred to is proposed on the simple (simplistic?) assumption that at a future date, time and effort will actually be applied to disassemble and reuse the building components and that by then it will be worth while to do so in purely economic terms.

The use of salvaged materials in the C.K.Choi building has raised the ante significantly. The consequences of using recycled materials obtained by decommissioning were unexpected and the discussion that centered around the use of salvaged materials has been unending.

Interestingly, the Materials Testing Laboratory for the City of Vancouver is now being built. It is a small building where over 90 percent salvaged materials and components are included. The challenge originating in the C.K.Choi building has now been taken up—by another client and another architectural office. Now let us turn to the Sainsbury Center for the Arts designed by Sir Norman Foster and Associates in 1977. It houses an arts center for the University of East Anglia. Everything about the building speaks about designing for change, that is to say designing for an uncertain future. The building design was based on the use of a kit of parts where each part is interchangeable in anticipation that when the accommodation becomes insufficient, the building would simply be "extruded" to provide additional space and an upgrade to meet the new set of needs.

Despite this, when the time came in 1991 to provide new accommodation, the building had become such an integral part of the University with a well established presence on the campus, it was decided to place the new addition underground so as not to violate the appearance of the existing building! This is quite a telling example of how the unexpected can occur in the context of designing for the future; there can be a whole series of human and cultural events that can have taken place in the interim which negate the initial assumptions.

In 1977, the Kitsun solar townhouse project was completed in a typical Vancouver suburb. When the project first appeared on the street, it horrified neighbors and passers by; it had passive solar walls with dark surfaces and elaborate insulating curtains that came down in cool winter nights and on hot summer days. In terms of appearance, the townhouses were fundamentally different and stood out from the normal variety of the suburban street. Energy wise, the performance of the houses was remarkable: Only 10 percent of the energy use per square meter.

A decade later (1989) the buildings had already been modified by the occupants. Another decade later, even more changes have been introduced, partly to deal with technical problems and partly to personalize the street front. Without going into details, one must note that the user-induced changes were contrary to the inbuilt technical principles. Over the 20-year period, every renovation change has not been made to improve the environmental performance; on the contrary, they have actually detracted from it.

CONCLUSIONS

When thinking about performance, it is necessary to think about time. One must try to forecast trends of change and offer design guidance on how one can adjust to change through time. One can even argue that there is no such thing as a definitive building, since a building that is properly conceived has several layers of longevity; the unit for analysis is not the building but is the use of the building through time. Time is the essence of the real design problem.

Somehow we have to instill within ourselves the ability to think long term. Once we do this, the environmental agenda falls into place because the responsibility that goes with it also logically falls into place.

You have to behave so that you can increase the number of choices, not eliminate them.