

## EMERGING ISSUES IN BUILDING DESIGN

**Raymond J Cole**

*School of Architecture, University of British Columbia, Canada*

**Keywords:** Buildings, Environment, Sustainability, Climate Change, Materials Production, Dematerialisation, Demobilisation, Decarbonisation, Information Technologies, Green Buildings, Building Controls

### Contents

- 1. Introduction
  - 1.1 Changing Context
  - 1.2 Sustainability
- 2. Environmental Context
  - 2.1 Green and Sustainable Buildings
  - 2.2 Climate Change
  - 2.3 Clean Energy
  - 2.4 Material Resources
    - 2.4.1 Materials Production
    - 2.4.2 Materials Use
- 3. Technological Context
  - 3.1 Direct Technologies
  - 3.2 Indirect Technological Advance
    - 3.2.1 Demobilization
    - 3.2.2 Dematerialization
- 4. Social and Cultural Context
  - 4.1 World-Views
  - 4.3 Space-Time
  - 4.3 Automated and User Control
- 5. Conclusions
- Glossary
- Bibliography
- Biographical Sketch

### Summary

Buildings are a functional and cultural necessity, they are complex human creations, and they last a long time – more than most human artifacts. Moreover, buildings represent significant capital investment, both financial and ecological. Changes in society's priorities manifest themselves in changes in building design. This paper provides an introduction to the five papers included within the topic of *Emerging Issues in Building Design*, and identifies some of the key issues that will shape the priorities in the design of buildings during the 21<sup>st</sup> century. It also exposes the combinations of technological and cultural advances that will be required to create the necessary performance gains. The substance of the paper is structured in three major sections: the *Environmental* context, the *Technological* context and the *Social and Cultural* context.

The *Environmental* context explores the environmental issues and associated costs will directly and indirectly shape the new millennium and therefore increasingly underpin almost all aspects of human settlement and building design. Climate change is presented as the dominant concern. Although building design and construction impacts directly and indirectly on a host of resource use and ecological loadings, only those that frame the subsequent articles are considered. The *Technological* context distinguishes between technological advance that *directly impacts* on building design buildings e.g., solar technologies, from that which has an *indirect* impact – information and communication technologies, clean energy technologies etc.

The *Social and Cultural* context examines the conflicting world views of ecological constraint and the technological freedom; changes in perception of space and time; and automated versus personal control over environmental conditions within buildings. At the centre of an ecological-based world-view is that humans are an integral part of the natural world and are constrained by its production and assimilative abilities. The emergence of the Internet and the promise of a “Hydrogen Economy” – may well change human preference and expectation and action, and transform our understanding of energy and environmental problems, future environmental policy, the strategies that we implement, and what and how we build. Notions of *space* and *time* were relatively well understood in the pre-information-age and shaped human settlement patterns and building design. By contrast, the use of information and communications technologies and new patterns of social and economic activity, space and time dimensions are becoming compressed and perhaps more flexible concepts. Responding to and reconciling of the environmental imperative to support the diverse and specific nature of place within the homogeneity of a global information and business culture will profoundly influence the future of buildings. Finally, the type and extent of building control and automation is an implicit issue in contemporary building design – with both advocates for fully automated buildings and those for placing greater responsibility in the hands of the building occupants. These fundamentally different views underpin key strategic difference in building design – from the intelligent building through to many green building practices that place greater dependence on users engaging actively with the buildings they occupy.

## **1. Introduction**

Buildings are a human necessity – both functionally and culturally. Functionally, they provide the spatial and environmental context for human activities: providing sufficient space and comfortable conditions consistent with the task in hand are essential design requirements. Culturally, buildings provide a manifestation of the aspirations and technological capabilities of the society to which they belong.

Buildings are complex human creations. Their design involves the interaction and coordination of a wide range of professions, within a multitude of regulatory agencies and jurisdictions, and typically with demanding time and cost constraints. Their construction requires the involvement and phasing of numerous skills and trades, and changes in operation and use can compromise the initial design intentions. More confounding, unlike other artifacts that enjoy the benefits of prototype development,

mass production and subsequent correction and refinement, almost every contemporary building is a “one-off.”

Buildings represent significant capital investment, both financial and ecological. Almost every attempt to bring a new emphasis to building design is subject to the litmus test of cost and, most typically, this is the capital or initial cost. Not only do costs seldom account for the benefits that may accrue over a building’s life as result of higher initial investment, but the broader societal costs of poor quality building or poor environmental standards are not acknowledged within current accounting methods. Environmental issues and associated costs will directly and indirectly shape the new millennium and therefore increasingly underpin almost all aspects of human settlement and building design.

Buildings last a long time – more than most human artifacts. The decisions made during design have profound ramifications both for future occupants but also to society at large. The current discussions of “Fuel Poverty” in UK (Rudge and Nicol, 2000), for example, suggest that the health and mortality among the poor and elderly in Britain may be a legacy of decades of poor energy performance standards of houses. As such, the rates of replacement of the building stock, initial performance standards and the ability to upgrade performance over time, assume considerable importance within the environmental debate. Simply improving the performance of new buildings - making them more resource efficient and with increased potential for recyclability and reusability - will be insufficient to realign the built environment towards a sustainable future. Attention must be directed at the use and upgrading of existing buildings. Discussions related to the rehabilitation and reuse of buildings has been largely within the domain of historical preservation. Changing attitudes toward resource use and environmental limits to growth will require us to rethink the environmental value of existing buildings and their constituent materials. Indeed, along with developing new skills, knowledge, and attitudes on environmental issues, architects will have to learn to be more “curators” of the built environment rather than “creators.” (Levinson, 1993)

### **1.1 Changing Context**

Indigenous and vernacular building practices are typically offered as examples of an excellent fit between human culture and place – where economy of means, knowledge and response to local climate were key underpinnings. More significantly, perhaps, is the evolutionary nature of such practices in which shared knowledge and trial and error development occurred until socially and technologically acceptable solutions emerged and these traditions subsequently passed to future generations. Influences and improvements were of course made as a result of “imported” knowledge, but the sense is that changes occurred slowly and the fundamental underpinnings were quite stable over extended periods of time. By contrast, rapid change is a consistent feature of many contemporary societies and for many people the “contemporary world is becoming a smaller, faster, and less certain and more complex place.” (Gann, 2000, 76) This change is also reflected in built form. New emphases to design derive from the necessity to respond to either imposed changing societal needs – real or perceived - or reinterpretations generated within the design professions. Some of these *influences* can be of immense importance, others quite whimsical. The ways and extent to which these

changing needs are explicitly expressed in a built work varies with different architectural practices. These *responses* can also be either substantive or superficial.

Despite more rapid societal changes, because of the scale and complexity of the building industry, the building delivery process is only capable of slow adaptation rather than sweeping overhaul. The pace of change in the built environment is often largely determined by the rate at which issues concerning use are resolved, including the need to revise regulations and understand costs and benefits (Gann, 2000, p80). New emphases to building design are typically first captured by leading edge buildings. These are held up as exemplars of emerging priorities and typically enjoy considerably greater media coverage than their actual numbers represent. But the true measure of the significance of leading edge buildings lies in the extent to which mainstream practices are realigned in their wake. Superficial changes may occur to mainstream building practice with relative frequency but fundamental design and performance improvements of buildings evolves more slowly.

This section explores emerging issues in building design. The five papers included within this topic identify some of the key issues that will shape the priorities in the design of buildings during the 21<sup>st</sup> century. They also expose the combinations of technological and cultural advances that will be required to create the necessary performance gains. Since architecture does not change unless the context in which it occur changes, as an introduction to these detailed explorations, this introductory paper identifies the anticipated changing context that building design will occur in the near and intermediate future.

## 1.2 Sustainability

Following the publication of the Brundtland Commission's report, *Our Common Future*, (WCED, 1987) sustainability has emerged as a widely held and necessary notion to guide all future human endeavors. Sustainability will require that we become less wasteful of natural and human resources, take appropriate steps to maintain a healthy, productive planet, and place greater worth on the welfare of future generations. Sustainability has environmental, social and economic dimensions, embraces all facets of human activity (e.g., industry, transportation, food production etc.), and spans local actions through to redressing the major inequities that exist between developed and developing nations. Sustainability represents the single most significant agenda that human settlement and building design will be required to address and, as such, will be a recurring underpinning to the majority of ideas raised in this section.

At the most basic level, ecological sustainability implies that future generations should enjoy continued *access* to resources. Although this typically infers *natural* resources, since buildings transform both renewable and non-renewable natural assets into human artifacts it is the *total capital*, both natural and physical, passed on to future generations that is of consequence. (Solow, 1993) This reinforces the importance of durability, adaptability and other performance aspects of buildings that enhance their longevity.

Within the transition toward sustainability, other significant advances are occurring in parallel with our emerging understanding of environmental issues and the possible

directions that society could and should take to address these issues. Building design over the next few decades will be directly and indirectly shaped by a changing context that includes both technical and socio-cultural issues. Technical issues include designing buildings that satisfy demanding environmental requirements and accommodating advances and diffusion of information and communications technologies. Socio-cultural issues include inevitable changing work habits and user expectations in response to environmental dictates and potential offered by information and communications technologies, as well as anticipated an aging population and other demographic changes. The extent to which these technological and cultural scenarios conflict or support the notions embodied in specific building environmental technologies is critical in understanding change.

## 2. Environmental Context

The recorded scale and rate of global environmental degradation represented defining characteristics of the 20<sup>th</sup> century. The environmental context within the 21<sup>st</sup> century will present an increasingly critical influence on future building design.

Notwithstanding the importance of social and economic needs and constraints, the health of the biosphere will remain the limiting factor for sustainability. Resource use and resulting environmental degradation have always been unavoidable parts of human existence. Although historically these effects have often been intense and catastrophic, they have been localized and modest in scale compared with the biological production and assimilative capabilities of the planet. The current scale and the types of human activity, however, are producing impacts that are both dispersed and close to or exceeding global limits of production and assimilation.

Continued degradation of the biosphere through over-exploitation and abuse not only diminishes its ability to produce essential resources but also its ability to recover from such abuses. A prerequisite for sustainability is the maintenance of the functional integrity of the ecosphere so that it can remain resilient to human induced stresses and remain biologically productive (Rees, 1991). Ecological *constraint* – the need to curb expectations and live more modestly within the biological capabilities of the planet - has been the major message of the environmental movement. The question of unabated growth in the “throughput” of energy and material to satisfy human demand is critical. As Rees (1999) argues “empirical evidence suggests that resource consumption already exceeds the productive capacity of critical biophysical systems on every continent.” He further suggests that “waste production already breaches the assimilative capacity of many ecosystems at every scale.” The *ecological footprint* provides probably the most graphic portrayal of the mismatch between biological productivity and current human-imposed demands. An *ecological footprint* refers to the *area of land* required to biologically produce all the resources consumed by a community and to assimilate its wastes, indefinitely. (Wackernagel and Rees, 1996) *Figure 1* shows the ecological footprints and the remaining available “carrying capacity” for a number of countries. The disparities between the ecological footprints is considerable as is the fact that the majority of countries far exceed their own carrying capacity – requiring the appropriation of resources and assimilative capability of other regions.

Recognition of global environmental degradation has precipitated several international initiatives and milestone events. The 1972 UN Earth Summit while focussing attention on pressing issues also exposed the considerable inequities in resource use between the 3<sup>rd</sup> world and developed nations and the mistrust that the former has for the latter. A burgeoning global population was considered the most pressing concern— both environmentally and socially. The extrapolation of geometrical growth in population over the last century “signaled a foreboding picture of massive, unsustainable growth, accelerated resource depletion, and accompanying famines and health crises.” Lutz *et al*, 2001) However, although the world’s population has doubled since 1960 and quadrupled in the twentieth century, the rate of growth is slowing down. Austria’s International Institute for Applied Systems Analysis (IIASA) forecast that world population, currently just over 6 billion, is likely to rise to a peak of 9 billion by 2070 but by 2100 will have fallen to 8.4 billion and continue falling. (Lutz *et al*, 2001) The diminishing population is projected to be accompanied by an increase in the number of elderly people, especially in Western Europe and Japan. Currently 10% of the world’s population is over 60, by 2100 this will be over 30%.

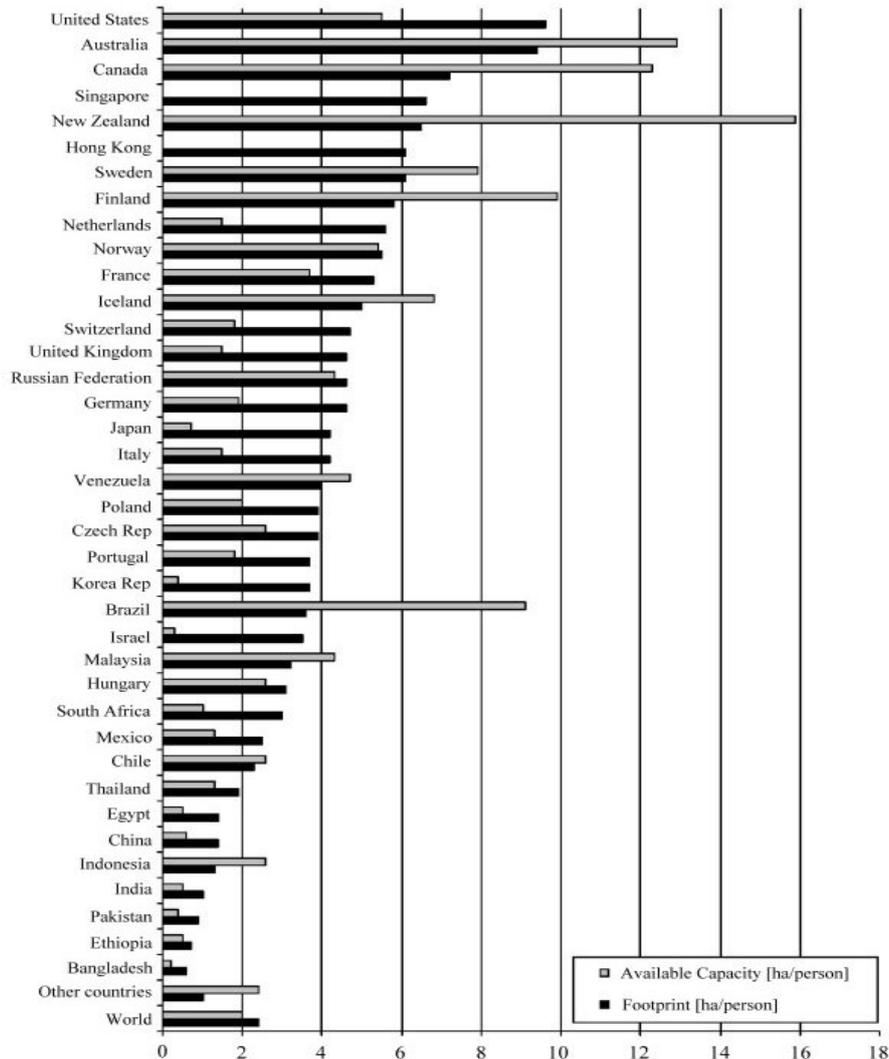


Figure 1: Ecological Footprints for selected countries.

These anticipated demographic changes will have profound implications on the amount and types of building that will be required in the latter half of the 21<sup>st</sup> century as well as the relative proportions of new and renovation building projects.

The 1992 *UN Earth Summit* in Rio de Janeiro, although yet again exposing profound differences between developed and developing nations, formalized the need to jointly address the imperatives of energy, environment and ecology (Edwards, 2001):

Energy:	Global warming Future supplies
Ecology	Biodiversity Rainforest protection
Environment	Water resources Land and farming

The important point was the mounting international recognition of the need to place constraints on the deterioration of the planet's natural capital.

The mechanisms by which higher environmental standards for building will be achieved is clearly of considerable importance. The anticipation is that mounting international concern for environmental issues will translate into concerted *political intent*, and that this would subsequently translate into *environmental policy*. Within this context, the regulatory process would increase minimum acceptable environmental requirements for building design and other voluntary mechanisms and initiatives would be triggered that promote awareness and demand for increasingly improved building performance. While recognizing the necessity for environmental regulations and legal standards, Tenbrunsel *et al* examine the potential dysfunctional nature of the regulatory approach to environmental problems (Tenbrunsel, Wade-Benzoni, Messick and Bazerman, 1997):

- Standards often lead to a focus on how to meet that standard, rather than on how to optimally deal with the underlying problem.
- Standard-based systems can change the incentive systems for individuals and promote *self-interested* rather than *societal-based* behavior, and ways of exploiting their weaknesses.
- The focus on complying with existing rules can inhibit innovation and creativity in solving environmental problems.
- The excessive use of legal standards to govern behavior may replace one's *intrinsic* motivation to behave in an environmentally friendly manner with an *extrinsic* motivation driven by environmental standards.

-  
-  
-

TO ACCESS ALL THE 25 PAGES OF THIS CHAPTER,  
Visit: <http://www.eolss.net/Eolss-sampleAllChapter.aspx>

## Bibliography

- Ausubel, J.H., (1996) Can Technology Spare the Earth? *American Scientist*, Vol. 84, March-April, 1996, pp167-179
- Benyus, J. *Biomimicry* Quill, New York 1998 pb.308p
- Bordass W., Bromley, K., and Leaman, A., (1995) BRE Information Paper - Comfort, control and energy efficiency in offices, Building Research Establishment, UK., February, 1995
- Bordass W. and Leaman, A., (1998) Environmental Quality: the new agenda, BIFM Annual Conference, Queens, College, Cambridge, UK, 22 September 1998
- Bordass W. and Leaman, A., (1997) Future Buildings and their Services: Strategic Considerations for Designers and Clients. *Building Research and Information*, 25: 4, 190-195.
- Brand, S., (1999) *The Clock of the Long Now: Time and Responsibility*, Weidenfeld & Nicolson, London.
- Buchanan, P., (1984) "Only Connect," *The Architectural Review*, October 1984, no. 1052 pp 23-25
- Castells, M., (1996) *The Rise of the Network Society*, Blackwell Science, Oxford.
- Cook, J. "Post-industrial Regionalist Architecture: Defining a Regionalist Architecture," *Journal of Architectural Education*, Fall 1987, v. 41 n. 1, pp62-64
- Edwards, B., (2001) *Rough Guide to Sustainability*, Royal Architectural Institute of Architects Publications, London.
- Ellis, P., 'A.J. Information Library', *Architect's Journal*, April 14th 1982
- Gibberd, J., (2001) The Opinion of Gibberd, *Sustainable Building* (3), p41
- Graedel, T.E. *et al*, *Industrial Ecology*, Prentice Hall, 1995
- Gumpert, G., and Drucker, S.J., (1996) Media Technology as a Determinant of Urban Form, IN: Proceedings of Evolving Environmental Ideals, 14<sup>th</sup> Conference of the International Association for People-Environment Studies, Stockholm, July 30-Aug. 3<sup>rd</sup>, 1996, Ed: M.Gray, pp 362-368
- Heerwagen, J. H., and Ouye, J.A., (1999) Strategic Commissioning: Integrating Human and Organizational factors into Building Performance Evaluation. *Proceedings, National Conference on Building Commissioning*, Session 16: Market Transformation Research & Evaluation, Portland OR, May 3-5, 1999
- Houghton, J.T., *et al*, eds. (1990) *Climate Change: The IPCC Scientific Assessment*. Cambridge: Cambridge University Press.
- Houghton, J.T., *et al*. (1996) *Climate Change 1995: The Science of Climate Change*. Cambridge: Cambridge University Press.
- Levinson, N., "Renovation Scoreboard." *Architectural Record*. Vol. 181. January 1993. p. 70.
- Lynas, M., Kyoto could even make things worse, *The Guardian* (UK), Friday July 27, 2001
- Lutz, W., Sanderson, W., and Scherbov, S., (2001) The end of world population growth, *Nature* 412, pp543-545
- Meadows, Donella H., Places to Intervene in A System, *Whole Earth*, Winter 1997, pp78-84.
- Pallasmaa, J. (1994) Six Themes for the New Millennium, *The Architectural Review*, Vol. 196, No. 1169, July 1994, p74-79
- Rae, M., 'Lighting Control: Some Conclusions' National Research Council, Canada, 1984, p.1
- Rapoport, A., (1969) *House Form and Culture*, Prentice Hall, Englewood Cliffs, NJ
- Relph, Edward. (1976) *Place and Placelessness*. London: Pion Limited.
- Rees, W.E., (1991) 'Conserving Natural Capital: The Key to Sustainable Landscapes', *International Journal of Canadian Studies*, 4, Fall 1991, pp7-27

Rees, W.E., (1999) The built environment and the ecosphere: a global perspective, *Building Research and Information*, Vol. 27 4/5, pp206-220

Romm, J., Rosenfeld, A., and Herrmann, S., (1999) *The Internet Economy and Global Warming: A Scenario of the Impact of E-commerce on Energy and the Environment*, The Center for Energy and Climate Solutions, A Division of The Global Environment and Technology Foundation, Version 1.0, December 1999

Roslin, M., (1996) Making Connections, IN: Proceedings of Evolving Environmental Ideals, 14<sup>th</sup> Conference of the International Association for People-Environment Studies, Stockholm, July30-Aug. 3<sup>rd</sup>, 1996, Ed: M.Gray.

Rudge, J., and Nicol, F., (Eds) (2000) *Cutting the Cost of Cold*, London: E & FN Spon

Scott, A., (1998) Introduction: A Time for Change and Innovation, IN: *Dimension of Sustainability*, Ed. A. Scott, E & FN Spon: London

Solow, R., 1993, An Almost Practical Step to Sustainability, reviewed in *Resources*, 110, Resources for the Future, 116 P Street NW, Washington DC, 20036-1400

Tenbrunsel, A., Wade-Benzoni, K.A., Messick, D.M., Bazerman, M.H., The Dysfunctional Aspects of Standards IN: Bazerman, H., Messick, D.M., Tenbrunsel, A.E. & Wade-Benzoni, (Eds), *Environment, Ethics, and Behaviour* The New Lexington Press, San Francisco, 1997, p 105-121

Wackernagel, M. and Rees, W., (1996) *Our Ecological Footprint: Reducing Human Impact on the Earth*, The New Catalyst Bioregional Series, New Society Publishers, Gabriola Island.

Weizsacker, E. et. al *Factor Four: Doubling wealth, halving resource use*, Earthscan, 1998

WCED. *Our Common Future*. [The Brundtland Report]. (1987) Oxford: Oxford University Press (for) UN World Commission on Environment and Development.

Yashiro, T., (2001) Incentive for Industrial Ecology in Building Sectors. Paper presented at OECD/IEA Joint Workshop: The Design of Sustainable Building Policies, OECD, Paris, 28-29<sup>th</sup> June 2001.

### **Biographical Sketch**

**Ray Cole** is a Professor at the School of Architecture, University of British Columbia where he has been teaching environmental issues in building design for the past twenty-six years. Dr. Cole heads the *Environmental Research Group* at the School of Architecture, which is the focus of environmentally related research within the School and has served on numerous national and international committees related to buildings and the environment. Dr Cole was selected as a North American *Association of Collegiate Schools of Architecture Distinguished Professor* for “sustained commitment to building environmental research and teaching” in 2001 and 2003 he received the US Green Building Council’s Public Sector *Leadership Award*.