

TOWARDS A FOURTH SKIN? SUSTAINABILITY AND DOUBLE-ENVELOPE BUILDINGS

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ABSTRACT

In several well publicised designs for 'green' office buildings, the zone of mediation between inside and outside has been increased by the addition of a second building envelope. When interpreted as exemplars of sustainable architecture, the addition of a second wall in these buildings is questionable both biophysically and psycho-culturally. More constructive design strategies acknowledge the wider biophysical contexts of the human ecosystem, the prudent use of material and energy resources throughout a building's life, make realistic use of climate, and promote psycho-cultural needs arising out of ecologism.

KEYWORDS

Architecture, biophysical sustainability, office building, double-envelope, ecologism, energy efficiency, modernism, psycho-cultural sustainability.

ENERGY EFFICIENCY AND SUSTAINABLE ARCHITECTURE

Over the last decade, the focus of ecological architecture has moved beyond that of the narrow goal of energy efficiency, through its growing attention to human comfort and healthy work environments (Pilatowicz, 1995). Emphasis on energy costs-in-use has given way to research into life-cycle embodied energy costs, elevating the relative importance of efficient construction and maintenance processes (Baker, 1992; Treolar, 1993). Moreover, energy

efficiency has been placed into the broader context of social sustainability. A sustainable society may be identified as one "which is capable of meeting basic human needs while maintaining resilient and diverse ecological systems. Basic human needs encompass a person's needs for social recognition, personal meaning and self-expression, as well as more widely acknowledged physical requirements of shelter, health care and security" (Blake, 1992). Thus, (ecological) architecture must aim at satisfying human society's psycho-cultural and biophysical 'needs', with energy efficiency being considered an especially significant *sub-goal* of biophysically sustainable architecture.

Architects have given considerable attention to external 'wall-filter' design, out of concern for energy efficiency. The conceptualisation of the wall as a selective filter, has only been possible with the advent of curtain wall technology, which facilitated the separation of the environmental control function of external building membrane from its task of load-bearing (Fitch, 1972). Subsequently, there has been a history of experimentation, ranging from fully sealed and one hundred percent clear-glazed fenestration, to complex combinations of solid and diaphanous membranes (Johnson, 1947; Assemblage, 1994). Recent experiments with the building envelope have also been matched by changes in architectural space. Secondary-spaces, first popularised as energy efficient design solutions during the 1970s in the form of sun-spaces and atria (Bednar, 1986), have undergone transformation into the 'double-envelope' - its extension being a narrow interstitial space between two transparent walls of glass. These buffer spaces increase the breadth of the entire building envelope to control extreme fluctuations of temperature (Chevin, 1994; Foster, 1993; Russell, 1992). This paper explores the biophysical and psycho-cultural sustainability of the double-envelope.

DOUBLE-ENVELOPE BUILDINGS AND BIOPHYSICAL SUSTAINABILITY

In Foster Associates' 1992 design for Commerzbank Tower, and in Future Systems' Green Building project, double-envelopes have been incorporated to improve energy efficiency, natural ventilation and natural lighting. Despite these projects being acclaimed by the architectural press as the leading edge of a new 'green' architecture (Chevin, 1994; Russell, 1992a), when interpreted as *exemplars* of sustainable architecture, the addition of a second envelope may be questionable on a number of counts:

- Materials: Are these a wasteful use of material resources, if a well designed single skin might achieve comparable comfort and energy efficiency?
- Embodied energy: Does the trade off between increased embodied energy and maintenance relate favourably against cost-in-use energy saved?

○ Life-cycle: Does the complexity of form undermine sustainability in terms of addition, retrofit, and recyclability? Do high-tech mechanics have greater risk of failure and higher maintenance costs? (Burrall 1991)

The double-envelope might be a sound design option to improve energy efficiency in the retrofit of existing buildings. But does it make sense to commit material resources to enclosing areas that are not occupied? Providing people could occupy this environmentally variable interstitial space it would become a more attractive proposition, especially in mild temperate climate zones where the extremes are not great - the 'buffer' being transformed into the 'minimal shelter'.

General criticisms can also be levelled at these particular buildings as exemplars of sustainable design, especially in terms of an ecological systems approach:

○ Material source: The materials in these envelopes appear to be high in embodied energy. Will they be manufactured using a renewable energy source, and/or from an energy source low in carbon emissions ?

○ Building use: Sustainability implies a critique beyond that of the individual building. On that basis, one has to question the validity of single-use buildings, set in business precincts - necessitating inefficiencies of commuting in terms of time, energy and even the loss of community (Rodger, 1992).

○ Energy triggers: Is the scale of these projects too large? Large interventions are likely to trigger large flows of energy thereby increasing entropy and reducing the amount of available energy (Fay, 1995).

Given the capacity of the human ecosystem to absorb human actions, not all buildings need necessarily meet strict environmental standards. Symbolic, monumental and religious architecture, building types of cultural importance, might reasonably stand outside ecological critique, for example the Sydney Opera House. In contraposition, commercial buildings do not conform to those building types, because they are not designed as democratic foci of the community, and thus should be expected to meet environmental standards. (Diprose, 1995).

Before embarking on complex solutions such as the double envelope, architects must ensure a self-critical design approach, and ask fundamental questions as to the source and type of materials used; the total embodied energy versus cost-in-use; and future scenarios of building use, retrofit or the potential for recycling components; or whether this building is of a type that warrants exemption from ecological critique. Given the latter case of exemption from

environmental standards, a double envelope might be justified on the basis of comfort and aesthetics, but by definition could no longer be justified on the grounds of energy efficiency.

DOUBLE-ENVELOPE BUILDINGS AND PSYCHO-CULTURAL SUSTAINABILITY

Critique of the psycho-cultural sustainability of these two exemplars of 'green' design, is more strongly related to their use of glass, and to their tower form, than to their double-envelope configuration (discussed in Diprose and Robertson, 1994). Despite this, and the difficulty of attributing meaning to architectural forms, brief comment on the double-envelope shall be made (Lipman and Parkes, 1989).

Traditionally Western architecture has attempted to overcome nature physically and symbolically, and through the potential of the high-energy industrial world this notional goal has moved nearer to reality (Simmons, 1993). In opposition to the modernist project, ecological architecture attempts to subvert the notion of overcoming nature through the physical and symbolic reunification of humans with nature (Pearson, 1991). Crucial to the success of reunification is the manipulation of the 'zone of mediation' between the artificial and the natural - the interior world of human shelter and the natural environment. Some ecological architects adopt the position that minimal shelter is necessary for genuine reconnection with nature (Watkins, 1991). Despite this not being feasible nor desirable in certain environments, reconnection with nature appears a valid reaction to the highly controlled climate-rejecting artificial environments designed at the height of modernity (Hawkes, 1976). When considering the addition of a second envelope architects concerned with reconnecting humans with nature must carefully weigh up the following:

○ If a seamless transition between human and nature is preferable, do multiple layers of glazing assist in softening the transition between inside and out? Might this second envelope be considered a further barrier - visual transparency disguising its true reality? (Of course, the connection to the 'wilds of nature' is somewhat fictional, given that these buildings are set in the heart of urbanity)

The problem of reconnection with the environment is not the sole difficulty with these particular examples of double-envelope. Another crucial tenet of sustainability is that of equitability (Pearce *et al*, 1989). 'Equitability' implies equality of opportunity through intellectual and physical participation within the built environment (Blake, 1991). Thus in considering the addition of a second envelope the architect must carefully weigh up the following question:

○ Does the 'high-tech' complexity of the double-envelope design solution elevate the building beyond the realm of genuine intellectual and physical engagement?

In the examples under review, encapsulated staff are able to open windows into a secondary sealed computer controlled environment, but they can neither enter the interstitial space, nor make contact with nature external. The means by which their office environment is controlled is automated to such an extent, that the management of services and means of repair will always necessitate expert assistance. Thus participation by those housed in this type of environment might at best be illusory, or at worst illegal - analogous to the 'criminal' participation of the freelance duct-work engineer in 'Brazil', the film that satirises the architecture of Orwell's Nineteen-eighty-four.

RECLAIMING THE FOURTH SKIN: TOWARDS THE THICK FRIENDLY WALL.

The double-envelope allows greater control over natural ventilation and solar radiation through the use of multiple skins as climatic buffer zones facilitating a solution to the architects' inappropriate desire for visual transparency (Diprose and Robertson, 1994). These solutions have arisen from the intellectual challenge of synthesising the glass skyscraper with ecologism, a process which implicitly constructs the design problem in such a way that ignores ecological reality (Lamb, 1991). Starting with the false premise of the transparent tower, the problems of excessive heat gain, glare and noise are exacerbated by its elevationally undifferentiated, highly transparent fenestration (Hawkes, 1976). Yeang's design strategy, although not perfect, seems a more profitable way of generating green architecture, placing climate ahead of form in the design hierarchy (Yeang, 1994). Similarly, simple measures such as careful orientation and external sun-screening need to be considered prior to the complexity of formal solutions such as the double-envelope (Olgyay, 1957). Solutions which manipulate a wide palette of design elements should be investigated as alternatives to double-envelope schemes, and compared in terms of aesthetics and energy efficiency. Regarding resource use and building lifecycle, it is likely that the more simple, low-tech and loose-fit the alternative is, the greater the chance of sustainability (Gordon, 1974). A more realistic 'modern vernacular' approach to form, which acknowledges the constraints of bioclimate and psycho-cultural sustainability, is likely to distort the purity of modern building envelope, breaking it down to the more humane and equitable adhocism of a 'living' wall - building occupants inhabiting, controlling and recreating the fourth-skin into a 'thick friendly wall' (Robertson, 1992). (But here we perhaps diverge into the realm of ideology - of architectural anarchy versus architectural totalitarianism.) In the final analysis it is not our contention that the double-envelope be discarded as a design option, rather that its

biophysical and psycho-cultural advantages be clarified before the double-envelope is described as a configurational element of *sustainable* architecture.

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