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We are all outdoor animals

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Abstract

Although we spend most of our time indoors, we are really outdoor animals. The forces, which have selected the genes of contemporary man are found outdoors in the plains, forests and mountains, not in centrally heated bedrooms and at ergonomically designed workstations. Fifteen generations ago, a period of little consequence in evolutionary terms, most of our ancestors would spend the majority of their waking hours outdoors, and buildings would primarily provide only shelter and security during the hours of darkness. Even when inside, the relatively poor performance of the building meant that the indoor conditions closely tracked the outdoor environment.

This paper proposes that our evolved but anachronistic responses to the environment are significant in how we respond to the modern indoor environment, although they are overlaid and masked by much faster moving cultural values. The proposition is only weakly supported by scant and indirect evidence, ranging from the almost universal recognition of the desirability of daylight to our love of potted plants. In spite of this the implications for building design are discussed briefly, together with wider environmental issues such as urban development and energy consumption.

THE CASE OF THERMAL COMFORT

The conflict between the notion of optimised highly controlled environments and quasi free-running ones has surfaced recently in the issue of thermal comfort. Two schools of thought have emerged - those that believe that thermal comfort is best described by thermal neutrality brought about by a steady state heat balance, and those that believe that thermal comfort can be achieved within a range of thermal sensations, provided adaptive behaviour is possible. The former school, uses climate study data to support its theory, epitomised by the work of Fanger [1], whilst the latter uses evidence from subjects in real buildings, typified by the work of Humphreys and Nicol [2].

Few would suggest that either represent bad science, yet they seem to reach significantly different conclusions. Why is this? One explanation would come as no surprise, that people behave differently in different contexts. It is not surprising that the subject, who has been told how to dress, been told how to sit, been told what task to do, is in an unfamiliar room or chamber with no windows to open or warm radiator to draw closer too, responds differently from a person working in their study at home. They know that there is a cold beer in the fridge or a warm sweater if needed. This has in fact been tested directly by Oseland [3], who observed that the same group of subjects when tested in three contexts - climate chamber, workplace and their home became progressively more tolerant - accepting winter comfort temperatures 3ºK lower than in the climate chamber, with an intermediate value in the workplace.

If we move outside the home we find that people become even more tolerant. Affluence and air travel enable people to expose themselves to an extremely wide range of climates, very quickly. Outdoor leisure activities such as sunbathing, swimming, windsurfing, trekking, skiing and mountain climbing all expose the participants to quite severe degrees of discomfort. Millions of people from northern Europe flood to the Mediterranean at the hottest time of the year, to experience what conventional criteria would classify as "uncomfortable climatic conditions". This voting with the feet must be taken seriously. How do we reconcile this behaviour with the belief that the optimum environment is one that invokes a feeling of steady neutrality?

The thermal comfort has received considerable attention in the last few years and the importance of *adaptive opportunity* has been identified [4,5,6]. This is the real and perceived freedom to make adjustments to the local environment (open windows, deploy shades) or to one's own status (remove clothing, move to cooler part of the room, alter posture). Recent work at Cambridge by Guedes [7] shows in a large sample of office workers in Portugal, a positive correlation between thermal satisfaction and the perception of adaptive opportunity, even when the opportunity for action is not taken. This suggests that there a

psychological as well as physical aspect to adaptive behaviour.

In another Cambridge study by Nikolopoulou [8], it was found that people sitting outdoors in public places, in cold conditions reported significantly higher satisfaction when free to suit themselves when to leave, than when waiting to meet someone. This indicates that the element of choice has a significant and measurable effect.

ADAPTATION AND SURVIVAL

In our ordered lives today, it is easy to forget the vital role that adaptive behaviour plays in survival. The response to thermal discomfort is a good example. "Feeling slightly chilly" - what seems like a minor irritation at the onset is in fact a highly effective early warning system which triggers a range of complex physiological and behavioural mechanisms to stabilise our body temperature. So successful is this that with a few minor departures the body core temperature is stabilised to +/- 0.5ºC for about 80 years.

The success of this adaptive ability is remarkable. If we include the human skill of the provision of shelter, which is only an extension of the kind of adaptive actions we have been referring to above, then it has resulted in the human species occupying climatic extremes wider than almost any other species. This has been achieved by sustainable technologies using no fossil energy. This is in contrast with the present situation where half of the world's energy consumption is accounted for in buildings, for the most part struggling to provide an artificially uniform environment. This has contributed to our having consumed as much fossil energy in the last 30 years as has ever been consumed in the history of mankind.

If we look at extreme feats of survival, again we see evidence of this inherent adaptive skill. Only the Arctic and Antarctic regions have defied permanent habitation although they have been the locations for epic feats of survival. There are many other examples, in times of war or natural disaster, where people without special training in survival techniques have nevertheless survived by highly skilful responses to the environment.

This vestigial survival instinct, is fortunately, rarely called upon in our everyday lives, and attracts little attention. However, there are several other indicators of our outdoor ancestry. Jet lag is a good example. Here we become painfully aware of the body's 24 hour, or circadian rhythm when we are asked to make a presentation at a meeting at 3 am our time, when everyone else in the room thinks that it is the middle of the afternoon. Clearly there must be a purpose behind the rhythm, which relates our body's wakefulness to the daily cycle of light and dark, warm and cold.

DAYLIGHT AND HEALTH

Closely related to this is Seasonal Effective Disorder (SAD). Sufferers show symptoms similar to jet-lag, but in this instance it is due to the shifting of the circadian rhythm with respect to the daily routine (rather than the other way round). This phase shifting occurs when people are deprived of the synchronising effect of the daylight. Thus the symptom is sometimes observed during winter in people living in high latitudes, a "natural cause", but also it is thought to be present at low level for many people working in poorly daylit buildings. It is thought to be a contributory factor to Sick Building Syndrome, which is particularly prevalent in deep plan air-conditioned buildings, which are predominantly artificially lit.

A field study was carried out here at Cambridge by Cawthorne [9] where occupants were monitored for light exposure (in the vertical plane of the face) over a normal working week, in two different buildings; one a modern deep plan hi-tech office, and another a well daylit laboratory. A dramatic difference was observed with the occupants of the daylit building frequently receiving illuminance greater than 2000 lux. In the artificially lit building, illuminance values rarely exceed 100 lux. Other workers [10] had already demonstrated that the phase synchronising ability of light was dependent on its intensity, and on the time of day that the subject was exposed, morning being the favourable part of the day.

Here we begin to see design implications. The facility for occupants of a building to be close enough to a window to receive high levels of illuminance - in excess of 1000 lux, rarely experienced in artificial lighting, makes demands on the planning and detailed facade design, as well as the management of space. It might be as well too, to ensure that one's teenage children occupy well-lit east-facing bedrooms!

It seems to be widely recognised that daylight has special spectral qualities. These are not normally found in artificial sources, although specialist manufacturers are now marketing full spectrum lighting in luminaires that attempt to reproduce the spatial distribution of daylight and provide polarisation similar to natural skylight. It is claimed by one manufacturer, Virtual Daylight™ that *"individual task times can be reduced due to greater visual efficiency.... raised morale from reduced environmental stress supports better work from healthier, happier people"*.

A more common experience is the observation that people will tolerate much lower illuminance levels of daylight than artificial light, particularly in diminishing daylight conditions at the end of the day. It is not unusual for people to continue reading a newspaper at levels as low as 50 lux, at least 5 times lower than would be recommended for artificial lighting levels for reading.

Closely related to the value of daylight is the issue of outdoor view. This has attracted attention in healthcare. Work carried out in the 80s by Ulrich [11] showed that patients recovered more rapidly when able to view a middle distance natural scene including trees, than when viewing a blank wall. But even without view, the dynamic quality of daylight seems to have an intrinsic value in the healing process. Keep, James and Inman [12] reports on a comparison between the Intensive Care Units at

Plymouth and Norwich. It was found that patients from the Norwich unit which was windowless, had a much less accurate memory of their length of stay, were subject to greater problems of disorientation, and the incidence of hallucinations and delusions was twice that at Plymouth, although the windows at Plymouth were only translucent providing daylight, but no external view.

Indeed the value of daylight and sunlight in hospitals has long been recognised. In a survey of 30 European hospitals carried out in the 1880s, Saxon Snell makes a typical observation of the General Hospital of Berlin *"The free admission of sun, light and air, to every part of the sick wards, and the regulation of ventilation by natural means ..... were the subjects of minute study and attention"*. In a comparative analysis of the 30 hospitals he includes tables of the area of glazing and openable area of window per bedspace. These values ranged from 1.5 to 3.5 m^2 and 0.5 to 3m^2 respectively.

Sunlight has had a rather bad press lately, but there are schools of thought, which present strong evidence that sunlight, in particular UVA and UVB also have beneficial effects on health.

Before leaving the topic of light altogether it is relevant to report on a study carried out by Parpairi [13] on visual comfort, the results of which are closely parallel with the thermal comfort results reported earlier. She correlated reported visual satisfaction of students working in three Cambridge libraries with objective measurements of luminance distribution from which various glare indices could be calculated. Correlation was poor, and it was found that even where conventional criteria identified a "bad luminous environment" - e.g. direct sunlight and reflections resulting in disability and discomfort glare, satisfaction was still high provided that two conditions were present. These were

1. that a view of high landscape value was present
2. that the occupant had some freedom to change orientation or move out of the sunpatch

Environments with very bland and uniform illumination did not score particularly well.

NATURE IN BUILDINGS

It is uncontroversial to say that man has an almost universal love affair with gardens. Our gardening endeavours range from the humblest window box to massively expensive planting schemes in public places, where historically, the value of the planting has been accorded almost a divine status, such as in the Moorish gardens of the Alhambra. Even the most formal of gardens, in spite of their high level of human intervention, allow nature in; the dependence upon the seasons, the day to day weather, and the vagaries and uncertainties of the botanical occupants contrasting with the permanence and artifice of the infrastructure. At the other end of the scale the English tradition of landscape gardening is perhaps a poignant indication of man's love of the wild, albeit often an idealised and over-indulgent one.

As man has retreated further indoors, so he has brought tamed nature, the garden, indoors with him. Conservatories and atria are large-scale manifestations of this. Ideally, the atrium would be so designed to give the plants sufficient daylight and fresh air to thrive. All too often however, the design of atrium becomes subordinate to an architectural programme, and the plants, like the building's occupants, have to be sustained by energy-consuming services.

At a smaller scale, we see the ubiquitous use of indoor planting. The plants, usually tropical forest species, do not enjoy their habitat, but the occupants enjoy them and even seem to show measurable benefit. In a study in Norway, Fjeld et als [14] compared two large groups of office workers in a cross-over study in about 60 individually occupied office rooms, one group having quite extensive foliage planting, the other group having none. Complaints of neuro-psychological symptoms, such as fatigue, headache and concentration problems were reduced by 23% in the case of the rooms with plants, similar to the reduction in mucous membrane and skin problems.

In earlier work [15] there had been reports of physical improvement in air quality by indoor planting, namely the reduction of contaminants such as formaldehyde, benzine and carbon monoxide. However in Fjeld's study, due to the nature of the filtered mechanical ventilation system, it was claimed that the air quality was already high. In conclusion, the authors suggested that "an improvement in the feeling of well-being" was the most likely explanation for the reduction in the complaints – by implication a psychological effect due to the visual presence of vegetation in the room. They also cite the earlier observations of Ulrich on the healing effects of visual contact with vegetation.

The use of flowers and vegetation are such a normal part of our indoor life that we do not pause to question why we do it. Flowers and houseplants are a multi-billion pound international industry. Do we ever stop to wonder why we import rose buds from South America, involving the most up-to-date technological logistics to import a fragile, vulnerable, "useless" object, which within a week will be rotting on the compost heap?

CONCLUSIONS

The paper asserts that we have a deep hereditary affinity for the natural world and that modern life in the built environment increasingly isolates us from it. We have presented two types of evidence for this – unconscious behaviour such as, for example the circadian rhythm, and conscious behaviour such as our house plant buying habits.

If this assertion is true, then there are two corollaries

1 we should bring more nature into our built environment,
2 we should design in those characteristics similar to which we have evolved in the natural world.

The first is straightforward, but the second, less so – what are these characteristics?

We have already referred to the success of man's adaptation to his surroundings. One of the characteristics of the natural world is its variety (in space) and variability (in time), and the opportunity and the need to make adaptive responses. Should we be providing this in our buildings by a closer coupling of the interior with the outside. Or is it possible for the built environment to provide an equivalent richness, together with the challenge and opportunity to respond, without the engagement of nature - a kind of "virtual nature"? (Already the Japanese are introducing perfumes into the air-conditioning system and playing forest sounds through the PA).

These are questions, which are going to become increasingly relevant as urbanisation continues and the pressure to build bigger and deeper buildings grows.

In the mean time, a brief, which requested a "rich and varied environment with a close relationship with nature" is hardly likely to raise objections. Not only does it beg for a creative and architectural response, but it is far more compatible with low energy passive design, then the highly engineered artificial environment buildings. The looser control of environmental conditions should not be seen as a weakness provided that the means and freedom of responding are also present. Rather, the denial of the need and freedom to respond to natural stimuli should be regarded as seriously as any cultural deprivation.

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