Manufacturing weather: climate change, indoors and out

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In many parts of the world, the indoor climate – by which I mean temperature, humidity and ventilation within buildings – has been transformed over the last two centuries in ways that are of direct consequence for global warming and (outdoor) climate change. In this short paper I consider the relation between indoor and outdoor climates. I do so first with reference to representations of the outdoor environment as embodied in lines of scientific enquiry and technical/physiological research around which contemporary expectations of indoor 'comfort' have come to depend. While these ideas position human beings as physiological entities, they also reproduce social conventions about the body and in particular about sweat – a natural form of thermoregulatory control, but one that has become something of a social taboo. Especially in hotter climates, the built environment is configured and equipped with technologies designed to protect inhabitants and preserve them from culturally inappropriate physiological reactions and sensations. This approach to bodies as to buildings is consistent with wider projects like those of using technologies to 'tame' nature. As we now know, the energy and environmental costs of this endeavour are unsustainably high – the resources consumed in 'managing' the indoor environment are, ironically, one of the more significant causes of outdoor environmental change. This conclusion points to the need to develop more forgiving and more sustainable understandings of people and their relation to environments indoors and out. Though concentrating on the manufacturing of indoor climates, this paper raises wider questions about the cultural and historical intersection of ideas about the weather, as manufactured, as 'natural', and as part of the routine organisation of daily life.

The parameters of comfort:

This is not the place to provide a full review of the history of indoor climate control but when it became possible to manipulate indoor environments with some precision, new questions arose: what sort of outdoor weather should builders and engineers seek to mimic indoors? (Cooper, 1998; Ackerman, 2002). Laboratory based studies, initially conducted in the 1920s, sought to determine and define 'optimal' conditions for the average human. Having conceptualised people as essentially physiological entities, thermal comfort researchers worked hard to isolate the seemingly universal parameters of an optimised indoor environment. Around the world today, many building codes and energy models contain within them assumptions and expectations derived from the work of Ole Fanger (1971) whose comfort equations continue to underpin standards developed and used by the American Society of Heating Refrigeration and Engineering

Fanger's understanding of thermal comfort is based on a 'heat balance' model. Accordingly, situations in which the rate of heat loss equals the rate of heat production by the body are taken to be necessary but not sufficient conditions for comfort. One reason why they are not sufficient is that heat balancing may be achieved through sweating – however, 'too much' sweating is socially problematic. Comfort is consequently also understood as a function of a 'preferred' sweating rate – something that relates to physical activity, but also to situation, cultural setting and context. Since thermal comfort equations are designed to apply universally, and since they treat the human body and its relation to the environment as a matter of biology and physics, these social aspects are routinely bracketed out, 'black boxed' and simply buried in the calculations. There are two points to make here. One is to underline the irredeemably social and historical qualities of scientific enquiry and engineering: in short, these sciences are products of their time. The equations in terms of which heating and cooling equipment is currently sized consequently embody and reproduce culturally specific assumptions about appropriate forms of clothing, sweating, shivering and smelling. Though treated as absolute 'facts', these understandings have often short and very specific histories.

For example, over the last two hundred years, 'fresh air' has been highly valued to the point that buildings themselves have been seen as problematically restrictive; heat has been variously feared (Kupperman, 1984) and desired, and the sunshine has been sought and shunned (Carter, 2007).

The second is to notice that ideal climates, as defined through the sciences of thermal comfort, are in fact rather rare. To be more exact, ideal indoor climatic conditions (i.e. those which meet Fanger's definition) are rarely reproduced consistently and reliably 'in nature', hence the need for massive investment in additional heating or cooling, mostly indoors but sometimes also in gardens and other forms of semi-outdoor space. The energy and outdoor environmental costs of maintaining these narrowly defined conditions of human comfort are huge. Heating and cooling accounts for around 50% of the energy used in buildings (Nicol, 2007) and air-conditioning is spreading rapidly across the fastest growing cities in the world.

Standardised definitions and expectations of indoor comfort have become 'normal' by virtue of being designed and reproduced around the globe. Bit by bit and in ways that are undoubtedly fuelled by multi-national interests in manufacturing and infrastructural development, what used to be diverse, seasonally sensitive, 'local' indoor weather patterns accompanied by also local conventions and competences in modifying and varying patterns of activity and clothing, are being replaced by a highly uniform indoor climate, itself an outcome of a universalising mode of scientific enquiry. These trends matter not only for outdoor climate change, but also for contemporary interpretations of the relation between nature, science and culture. I comment briefly on the social significance of sweating as a means of illustrating these relations.

Sweat and society:

Sweating is an essential part of the body's own thermoregulatory system, this being a complex arrangement that is supremely well adapted to respond to changing climatic conditions. However, sweating is more than a biological phenomenon. I have yet to find a good cultural history of sweating yet the saying that, "horses sweat, men perspire and women merely glow" gives a sense of its symbolic significance.

Preventing and getting rid of culturally undesirable forms of sweat is currently big business, as demonstrated by the market for deodorants and anti-perspirants, the details of which also hint at the delicately balanced position of the 'natural' body with respect to sexual attraction and disgust (Douglas, 1966). In this respect it is important to recognise the link between sweat and smell. Not all sweat smells but related conventions to do with the freshness of air (and not only temperature) are also important in how the indoor environment is managed. Ole Fanger is again a key figure here, being the author of the 'olf' – another standard unit, this time of odour. Again purging the indoor environment of natural smells requires heavy investment in what are often resource intensive systems of ventilation.

Indirectly, sweat and smell are big business for those associated with infrastructural design, planning, architecture and engineering. Mechanical systems of cooling remove or at least limit the need for the body to do the work of thermoregulation, and hence reduce the levels of sweat involved. In effect, bodily functions are deliberately delegated to complicated bits of technology. The result is a form of social order and 'civilization' that strips us human animals of odour and dampness. This is entirely consistent with a fortress-like strategy of building and indoor climate control designed to keep variable and essentially threatening 'outdoor' weather patterns at bay and to create and maintain a standardised bubble of protected space indoors.

Scientific and technical agendas and related concepts of body and social propriety are interlinked and are in turn part of a wider political and economic order. As suggested above, the systems of knowledge associated with the fortress approach require "cheap energy, a disregard for the planetary atmosphere, an ascendant engineering elite, technological

regulation, powerful corporations, and cooperative governments" (Shove et al. 2008, p310). Understandably enough, ways of thinking that were developed in the pre-climate change era reflect the periods and tribes that made them possible. As we now know, the result was "a method of rationalising the body (activity, clothing, humidity, air flow, temperature all working toward a perfect balance); along with an essentially bourgeois mechanical logic of controlling the built environment and the everyday possibilities it affords. By these means, middle class ideals, including those of distance from sweaty labour, have been made available to all" (Shove et al. 2008, p310). It is increasingly clear that this hegemonic model along with the conditions from which it is derived and on which it depends no longer apply.

Reinterpreting the body and the climate, nature and culture:

If the fortress model is unsustainable, what might take its place, and what alternative understandings of body, weather, science, nature and culture might take hold in the face of indoor induced outdoor climate change?

There are already signs of environmentally inspired reactions especially to the grip of standardized and standardizing concepts of comfort. In response to global climate change, a new science of adaptive comfort is growing in influence Outside the laboratory, people have reported being comfortable at temperatures ranging from 6 to 30 degrees C. (Shove 2003). Across this band, field studies show that expectations of comfort vary seasonally and demonstrate impressive variety in how societies have defined and managed the relation between themselves and the elements.

In addition, there is some indication that the power of the 'clo' (the standard unit of clothing – a business suit – embedded in design equations), and the 'olf' (the standard unit of smell used in specifying levels of ventilation) are being called into question. For example, in 2005 the Japanese Environment ministry introduced the 'Cool Biz' campaign. This encouraged companies to turn down the air conditioning, set thermostats to 28 degrees Celsius (82 degrees F), and allow employees to wear less than one clo during the summer months. Cool Biz fashion shows featured new styles of light weight office wear and adaptations by means of clothing alone have apparently led to a reduction of CO2 equivalent to that emitted by a million households in a month. This is not the same as a more-sweat policy, but promotional images from the Japanese campaign suggest that a bit of damp around the armpit is nothing to be too worried about.

It is especially interesting that American reporting of this initiative talks of the need to 'endure the shame' and cites as wholly unpleasant the experience of an expatriate American manager whose neck, back and palms got sweaty as he worked through the summer in his Tokyo office (Moffett 2007 pA1). As these contemporary responses imply, the discomfort of being obliged to spend the working day in sweaty clothes has a very specific cultural history.

As indicated above, there is no reason to expect current conventions to last for ever, and hence no reason not to imagine a social and cultural recovery, perhaps even a celebration, of sweat as the comfortably cooling expression of our own beautifully calibrated, supremely elegant thermoregulatory system. Such a discovery would in turn require a significantly new approach to the design and development of indoor environmental infrastructures, broadly defined.

Future comforts?

In practical and political terms, going forwards almost certainly means re-encountering (rather than deleting or denying) the body; re-differentiating social practices in ways that make sense of a more variable, more diverse and perhaps more interesting indoor climate; and actively cultivating all the very many ways in which we already interact with the indoor-outdoor conditions around us. In terms of research and especially with respect to scientific enquiry,

the history and future of mass-produced, manufactured weather raises a range of familiar and novel topics.

The idea that scientific agendas and problems are shaped and framed by the societies and cultures in which they are formed is not at all new. Nor is the tendency for 'science' to reproduce and foster universalising and standardising forms of knowledge: this applies as much to understanding the weather outdoors as it does to the indoor climate. When dealing with the indoor climate – perhaps more than forecasting conditions outside – understanding the relation between the human body and its immediate environment has been a prominent theme. In framing this as a matter of blood flow, evaporation and heat balance, rather than of meaning, convention and culture, thermal comfort researchers have bracketed out, and sometimes actively denied, the diversity of sociotechnical arrangements associated with multiple and multiply varied interpretations of 'normal' comfort, clothing and practice, and of 'normal' seasonal variation.

What then of the future? Can we look forward to new kinds of indoor climatic research, to more diverse styles of clothing and building design, and to new social and cultural conventions? Or should we, on the other hand, expect to see more defensive architecture and more energy intensive systems installed and developed in response to the possibly well founded fear of increasingly wild and unpredictable weather outdoors? As these questions make clear, the challenge of climate change is not only one of adopting the right kind of design and engineering: it is also bound up with the definition and production of knowledge, with paradigms and mentalities and with forms of feedback between problem definitions and research agendas within the social and natural sciences.

Concluding comments:

In this paper I have considered issues that wind between discussions of indoor and outdoor climates. The standardising sciences of indoor comfort generated a definition of outdoor weather as threatening, variable and unreliable: in short as largely uncomfortable. Ironically, the outdoor climate is changing, and arguably becoming more threatening, in part because of the energy required and consumed in maintaining 'comfort' conditions indoors. Realisation of the anthropogenic causes of global climate change has promoted reconsideration of the indoor environment: do we really 'need' these standard conditions all year round and all over the world? To date, it is true that most effort has focused on increasing the efficiency with which these now taken for granted 'standards' are delivered, but some commentators go further – calling the very future of comfort into question, calling for a much more extensive debate about the dynamic social and cultural relation between bodies, sweat, clothing, heating, and ventilation and for deliberate effort to exploit existing diversity in pursuit of more sustainable and by implication more variable and flexible indoor environments.

In presenting the problems of indoor and outdoor climate change in this way, I have tapped into and sought to contribute to long standing debate about the role of technical and scientific expertise in society – raising a number of familiar questions about how knowledge is professionalised and standardised, and about the kinds of tacit assumptions upon which it depends. These themes – how is the climate known, measured and made visible – have their equivalents in social and historical studies of meteorology. In addition, I have contrasted standardising forms of scientific knowledge with more diverse, variable and localised understandings – recognising that comfort is also usefully understood as an active and creative achievement, the details of which are to an extent still laden with culturally specific significance. Again this approach has its parallels in efforts to study and understand 'folk' knowledges of outdoor weather systems, broadly defined.

Taking a step back, these common concerns point to a wider moral and political agenda that has to do with how the 'weather' is interpreted, and about legitimate grounds for intervention. In relation to the outdoors, efforts to 'geo engineer' the 'natural' weather are both problematic

and controversial. By contrast, parallel initiatives indoors have a long and surprisingly respectable - or at least taken for granted - history. What is of course missing is an appreciation of the point that one is of direct consequence for the other: in a sense building scientists; designers, manufacturers and producers of construction materials and technologies have been busy 'geo-engineering' the outdoor climate all along, but without this being recognised as such.

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