
67

Passive People

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Dr. Nick Baker studied physics but has spent the majority of his professional life working in building physics as a teacher, researcher and consultant. His particular interests lie in energy modelling, thermal comfort and daylighting, on which topics he is widely published. His recent work has focused on the refurbishment of the existing building stock and on the impact of human behaviour on energy consumption in buildings.

When I look back to the early 1980's when I first worked at the Martin Centre and compare the position then of what we now call sustainable design, with its position in the public realm now, the difference is vast. Sustainability is everywhere – or thinks that it is (I'll come to that later). The other day I drove behind a massive refrigerated truck from Eastern Europe, with the slogan "On the road to a Green Future". PV panels are around every street corner, and on a trip across the North Sea from Holland to Harwich that I made recently, wind turbines were just visible all the way. New buildings adopt insulation levels unthinkable 25 years ago, and even high levels of retrofit external insulation, then thought to be far too expensive, are commonplace. The agonising question that I ask myself is; how much has it been influenced by that small band of enthusiasts at 6 Chaucer Road, or would it all have happened anyway?

I should explain, that the Martin Centre was based in a lovely Edwardian house in arcadian Chaucer Road, and was the home of a few PhD students, post doctoral researchers of which I was originally one, a few staff and a director, Dean Hawkes. There were three main research groups – earthquake studies under Robin Spence, acoustics led by Mike Barron, and building use and energy studies led by Dean. I joined initially in 1979 to

Netley Abbey School (see also page 29).

work with Dean on design guidance for passive solar schools for Hampshire County Council. After a four year period with Energy Conscious Design (ECD), and architectural practice specialising in low energy design (and design research), I re-joined the Martin Centre and the Department of Architecture, as a Lecturer in Environmental Design, in 1985.

What I would like to do now (with a slight bias toward work I was involved in), is to place our work over the intervening years in the context of the present status of sustainable design.

Solar architecture was largely technology lead with two distinct camps – active and passive, and to some extent this was exemplified in the low energy school designs by Essex County and Hampshire County respectively. Whereas Essex were promoting solar thermal panels, heat pumps and a much more engineered environment (an 'exclusive' design in Dean's terminology), Hampshire wanted to follow a much more 'selective' path. Following the work on school environments by Di Haigh, where she had monitored temperatures and made behavioural observations simultaneously, Dean had proposed "the ideal section" where the solar gains were separated from the occupied space, reducing the risk of thermal discomfort. My task was to work with the Hampshire architect (Dennis Goodwin) to turn the theoretical idea into a real project.

Initially there was some uncertainty about the way that the solar gains actually displaced auxiliary heating – i.e. the coupling to the heated space. In solving this, we realised that the most persistent thermal load for a densely occupied space such as a classroom is the ventilation load, and thus the design should encourage the gains to be located where the incoming fresh air enters the building. In the Hampshire designs, this was a conservatory, which was used for circulation only, and thus needed only a loosely controlled internal environment. This carried the further advantage of exploiting higher temperatures unlike circulating systems where a lower temperature threshold is set by the room temperature. So the concept of Solar Ventilation Pre-heating (SVP) was born.

At this time, there had been a bit of a love affair with domestic conservatories (I believe it was the subject of François Penz's PhD) but again the exact mechanism by which the indirect solar gain became useful, was uncertain. Brian Ford had monitored a domestic conservatory in Milton Keynes that had a fan to create circulation whenever the temperature threshold in the conservatory was reached. Following this the Energy Technology Support Unit (ETSU), a nationally funded body, funded several projects looking at the benefits of conservatories. I started one of those projects during my time at ECD (and later continued it at the Martin Centre) ¬– developing the SVP concept further – for the airflow to be wind and stack driven, and for it to be possible to take place in direct gain spaces. This work involved controlling the distribution of the leakage of the envelope, and flow paths within the building, in relation to pressure coefficients.

Closely related to the conservatory was the atrium. Ever since Dean and Richard MacCormac had proposed the covering over of the courtyards that Sir Leslie Martin's work on land use had proposed, there had been a tacit assumption that atria were "low energy features". There seemed to be little monitored evidence of this, and one of our interests was to develop a simple model of the advantages and disadvantages of glazing over a space between buildings.

In order to carry out the studies above, we had to develop physics-based computer models, and this brings me to the computing revolution of the 1980's. Most computer users were then recognisable by the boxes of punched cards they carried around with them, frequenting the 'terminal room' where they sat at teleprinter like machines. There was a new breed, however, who had met the Commodore PET, the Apple Euro, and of course a bit later, the BBC, developed here in Cambridge by Acorn computers. I was of that group, and once bitten was prepared to trade the power of the main-frame Pegasus for the hands-on simplicity of the micro-computer. Mine was a Radio Shack TRS-80 with 16kB memory. I remember Greg Moore (a main-frame man working on a daylighting model) putting his head round the door and saying, "Good for games, I suppose, but they'll never catch on"!

We organised a workshop on atrium design, partly to test our design tools. I remember two things – firstly phoning up the Computing Centre and asking if I could borrow two or three micro-computers. "What are they?" came back the response. I also remember the night before the workshop. After two days work refining the BASIC code and adding some refinements, whilst saving it to magnetic tape (we used a portable tape recorder!) the computer crashed and I lost the lot. I worked all night to re-write it and I remember clearly that the dawn was breaking and the birds were singing in the Martin Centre garden before I finished.

Much of our research funding came from the European Union. A pre-requisite of funding was that the project should have partners from several European countries, and it was because of this that I met so many colleagues and made so many friends amongst this close-knit "passive solar community". I say "so many", but in fact it was quite small compared with today; it was predictable who you would meet at conferences and who were the authors of papers. One of my first European projects was the Assessment for Solar Energy in Europe, most of which I carried out at ECD. It was during this project and later, the Passive Solar Handbook (I wrote the chapter on Atria,) that I met Theo Steemers, who was in charge of the passive solar programme. I later worked with his son Koen, both at ECD and at the Martin Centre where he came to join the first MPhil year, and later take his PhD.

I also became involved with Owen Lewis of University College Dublin who was organising a number of solar design competitions. Our role was to develop some quantitative design tools, one of which was the LT Method. This assessed the balance of advantage and disadvantage of solar gains against the use of daylight to displace artificial lighting, in terms of glazing area and orientation. It introduced the concept of passive and non-passive zones, a natural development of Dean's concept of 'selective' and 'exclusive'. It started life as a manual method using lots of little graphs that were included in the competitor's pack. A decade later LT Europe was launched – a computerised version with a graphics interface, climatic database, and overheating predictions.

Amongst the more bizarre tools provided by us for the competitions, *Solar Architecture 1* and *2*, *Working in the City*, *Zephyr*, and *Living in the City*, was a cardboard cut-out daylight factor meter. Just pre-dating cheap electronics, this relied on the ability of the eye to match two luminous patches. Our contribution to design support continued. Koen Steemers and I wrote *Energy and Environment in Architecture* (2000) which included the LT Method. In the field of daylighting we edited the *European Daylighting Handbook* and wrote *Daylighting Design in Buildings* (2002).

Demonstration was very much part of the nationally and European funded projects, i.e. showing that the ideas developed actually worked in real buildings. This proved to be much more difficult than it sounds since in the real world of construction there are so many compromises, and it is difficult to isolate out the impact of a particular measure. I was involved in BEST (Building Environmental Science and Technology) 2000, a project that tracked the design, building and performance of seven large non-domestic buildings, and also ZED (Zero Energy Development), sustainable design at an urban scale. Later I was part of the expert panel on REVIVAL (Retrofitting for Environmental Viability Improvement of Valued Architectural Landmarks), a project to implement sustainable refurbishment of existing buildings, and was the author of a book with material drawn from the project entitled *The Handbook of Sustainable Refurbishment* (2009).

One of the most intellectually stimulating projects was PASCOOL – a Euro acronym for anything to do with passive cooling. We ran the thermal comfort task, and stepped right into the Fanger versus Adaptive Comfort debate, the latter field having been re-ignited by Mike Humphries and Fergus Nicol, ex-BRE and then at Oxford Brookes. Our work, a logical extension of that by Di Haigh a decade earlier, linked objective data measured at the personal scale rather than room scale, with their self-reported comfort level. We were looking for evidence of behavioural adaptation, where the actions of the person are consciously and unconsciously influenced in their drive to avoid discomfort.

Apart from the technical challenge of designing personal loggers which had to look like a Walkman so that users could wear them in public, other unusual work included placing one of our MPhil students in the wind-tunnel, and another recording the post doctoral researcher Mark Standeven getting up from a chair, with time lapse photography.

One of the outcomes of this study was to propose the notion of 'adaptive opportunity'. This went a long way to explain the apparent discrepancy between comfort prediction's by Fanger's heat balance approach, and the reported comfort levels found in field studies – the latter always seeming to be far higher than predicted. Fanger's data was collected from subjects in climate chambers where their behaviour was totally restricted, whereas the real world provides many opportunities for a subject to reduce discomfort, ranging from moving a chair out of a sunpatch, to having a cold drink.

The work on adaptive behaviour in thermal comfort had focussed interest on the occupant rather than technical issues, and much of our research moved in that direction. There had been a time in the early years that human occupants were regarded as a real nuisance in building monitoring as they kept doing things that were unpredictable and affected the results. It was not until around 2000 that it was fully appreciated that we have to study buildings *and the occupants*, and that the way that occupants behave has a vital role in the performance of the whole system.

Very interesting research was often introduced through PhD studies and I would like to mention just four. Maria Heleni took the personal thermal comfort monitoring outdoors and found even stronger effects of adaptive behaviour, and Katrina Paparia discovered parallel effects in visual comfort in libraries. Both of these studies also highlighted human tolerance of "natural causes" – i.e. non-optimum conditions that have a visible natural cause. This has triggered a growing interest of mine in how our response to the built environment is influenced by our genetic past, when humans were living predominantly outdoor lives.

In another PhD study by Stamatina Rassia we studied how occupants move around workplace buildings. Much of the then current thinking was to minimise circulation; however we were interested in movement as a form of exercise to promote health, and were thus looking to increase it in a positive and rewarding way. Using personal accelerometers and ultrasonic position fixing technology, we were able to map movement and energy expenditure. One of the first findings of note was that working in the office environment can form a significant part of the total daily energy expenditure.

Finally I would like to mention the work of Aoife Houlihan, which nominally focussed on the environmental impact of tourism. This broad subject was narrowed down to the issue of Green Certification in the hotel industry and the findings were quite disturbing, showing that many of the schemes give no indication of real environmental impact and are little more than marketing devices.

This brings me to my final thoughts, because they too are concerned with the degree of self-delusion in which governments, institutions, industry and individuals indulge. For many, the word "sustainable" has become an empty comfort word – not even a sincere aspiration. This is no better illustrated by the quest for guilt-free "sustainable" diesel fuel. This has in fact led to the growing world cereal shortage, which as ever will hit the poorest nations the most.

I sincerely believe we have got to focus our attention on consuming less, and wasting less. Our challenge as architects is to design buildings and plan our communities where wasting less is automatic and using less is the attractive option.