MATTERS

MATTER

'Do no harm' states the Hippocratic oath. And buildings? Do no material, and environmental harm?

photos Bruno Klomfar

Martin Rauch's rammed earth wall at Feldenkirch Hospital, Austria

Fionn Stevenson considers the tangled relationship between taking Eco–Design seriously, healthcare architecture and building with care

Flat on my back, leather straps, tubes, shiny metal, plastic, cotton gowns, green, white, bright lights, and the smell of fear. I am two years old and having my stomach pumped for drinking the 'wrong' lemonade (it was a bottle of white spirit). Sixteen years later, I am visiting my mother in hospital. Similar tubes, metals, plastics and bright lights, but now in the ward rather than the theatre. She is apparently in a 'recovery room'. The same smells, the same materials – even in the waiting room. As a result I, like many others, have been left with an enduring phobia in relation to hospitals and hate visiting them, either as a patient or guest. I also have an abiding passion to see hospitals become more humane places to stay and work in.

The strongest associations are through my senses.

Hospitals have a very particular materiality, associated with efficiency and cleanliness. They are clearly buildings designed to minimise the risk of infection and maximise efficient healing. They are optimal environments that exude high technology and a reassuring sense of reliability, when they are anything but this. The risk of cross infection is a serious one in our hospitals,[1] the pressures on staff are increasing daily due to ever more complex administration and technology, and the design credentials are under ever-greater scrutiny in the UK through cost-cutting Public Finance Initiative (PFI) deals. Human and mechanical failure is a daily occurrence, and trying to minimise risk in hospitals is an increasingly chancy business. Despite this, cancer cure rates are going up and the length of stay in hospitals for routine illnesses and operations is going down. Clearly the doctors and nurses are doing their jobs as well as ever. But how well are the buildings doing in terms of helping to heal people? And, just as importantly, how well are they doing in the sustainability stakes?

Sustainability and the resource issue

For the health professionals, sustainable design is a relatively new concept, following on from the 'deep plan' hospitals of the 1970s and 80s which were supposed to save energy by minimising the external envelope. Even today, UK hospitals still use over twice as much mechanical servicing compared to French hospitals[2] despite having far less external surface area.

The key sustainability issues are social, economic and environmental ones. For hospitals, this means access for all, affordability, conviviality and minimal environmental impact. It is only within the last few years that environmental issues, beyond the need for energy conservation, have been considered within health building design strategies. Issues of minimising waste, environmental specification of materials, and minimising transport, are new areas to be tackled.

Underlying an environmental design strategy for hospitals are two key prerequisites:

1. The recognition that environmental design is an intrinsic part of healthcare design and provides multiple benefits both economically and socially.
2. The understanding of environmental design within an ecological framework that links local issues to global ones, and recognises buildings fundamentally as a process rather than just a product.

There is a general consensus through government sponsored research that buildings are responsible for over 50% of all CO^2 emissions, and that reduction in transport impacts is a key factor in promoting sustainability by reducing the climate change impacts of emissions.[3] Beyond the need to reduce energy demands in hospitals, is the need to reduce resource use and waste, both of which have major implications in themselves for transportation. Hospitals have traditionally been excused from this agenda, as reflected in their high capital and maintenance costs, because they are saving lives.

Ecological thinking recognises that hospital procurement operates within a highly complex system of resource transformation. Raw materials are extracted, refined, converted into building products and constructed into buildings. Unfortunately, despite PFI with its requirements for maintenance costs to be factored in to the life-cycle analysis of hospitals, this system is not assessed beyond the construction and maintenance stage to take account of the complete environmental life-cycles and impacts. Is anybody thinking about how we take our hospitals down, with minimum environmental impact and maximum resource recovery? Who is thinking about the environmental consequences of using bonded 'easy clean' (but non-recyclable) cladding panels?

The 'old' hospital

The 'old' Victorian hospitals, which still figure so vividly in our imaginations (and in some cases in reality), relied heavily on natural systems to deal with infection and promote well-being. The benefit of solar radiation was recognised in the south-facing sanatoriums for treating tuberculosis, while tall rooms and high windows helped to optimise the natural ventilation of these buildings, assisted by gentle displacement ventilation systems. Materials used included both natural wood and stone, as well as artificial fired earth tiles and bricks. These materials were relatively benign in terms of indoor pollution, giving off little smell. The palette of choice extended to about fifty building products in the UK at this time. Huge wards and relatively crude operating theatres meant, however, that these institutions were intimidating and unwelcoming.

By contrast, the last generation of hospitals relied heavily on post-war technologies developed through military industrial research, and used a variety of plastics and metal compounds. Some of these are both highly toxic in manufacture, as well as giving off fumes (in the case of PVC and other plastics) within the indoor environment that have proven ill-health effects.[4] The materials were used on a 'one size fits all' basis to ensure that every part of the hospital was as 'clean' as possible. This resulted in a monotony of spaces and a sense of disorientation through lack of contrast despite there being over 50,000 building products to choose from, of which half are synthetic.[5]

Hospitals have a very particular agenda in relation to resource use. They have to keep people alive by avoiding possibilities of infection, traditionally understood as being primarily through airborne transmission. This has led in the last thirty years to a massive investment in mechanical servicing to 'clean the air' and 'optimise' comfort conditions that avoid infection, using the cheap, but relatively poisonous, energy bounty offered by the oil and nuclear industries. With today's knowledge concerning environmental pollution and non-renewable resources, this option is dwindling as a credible solution to preventing infection.

Neither the Victorian nor the Post-war generations of hospitals have produced environments that are particularly convivial or sustainable. To achieve this, nothing short of a radical rethink is required in terms of how we understand the use of resources and, in particular, the right materials in hospitals to promote healing.

The new 'humane' hospital

The government response to the need for greater conviviality and sustainability in hospitals has been to focus on design through several initiatives, two of which focus specifically on the design of the buildings. The NHS now has specific targets for achieving sustainability as well as a new independent body to promote good design in hospitals.[6]

A primary way of improving our experience of hospitals is by focusing on the way in which we *experience* them, both in terms of orientation and our senses. This requires designers and engineers to switch their interest away from perfecting the mechanistic models used to fight infection and concentrate more on using the appropriate resources for different situations that benefit user well-being. High-risk areas such as intensive care and operating theatres will always need strict ventilation strategies and wash-down materials that repel the slightest grain of dirt. But what about the other areas: the wards, the corridors, the waiting areas – the places people really need in order to heal? These require a different approach which engages positively with our sense of smell, sound, vision and touch – the very basic experiences which nurture us.[7]

Promoting well-being requires a careful balance of visual stimulus, pleasant and changing scents, gentle sounds and warm touch.[8] A sense of familiarity and ease of orientation to help us feel secure in a vulnerable situation is also desirable. We have to translate the ubiquitous desire for personal 'nursing' care into buildings which provide similar 'nursing' qualities.

Of all our senses, touch and smell affect us more profoundly than sound and vision, as they engage our brain at a very primitive and profoundly emotional level.[9] The design of hospitals at present is dominated by the traditional visual training of architects and the client requirements for efficiency. The new 'humane' hospital model challenges us to address these senses and engage with the user directly. The primary means of doing this is through our choice of materials, combined with a sustainable approach to ventilation, temperature and humidity control. At the same time, the imperative for sustainability has offered a golden opportunity for design professionals to adopt a more ecological approach to specifying materials that simultaneously address these issues of well-being.

Healthy resource use – the 'breathing' hospital

At a period when allergies are at an all-time high in the UK with over 34% of 13-14 year olds suffering from asthma, and a prediction that half of the UK population will suffer from allergies by 2015 according to a recent report by the Royal College of Physicians in London, it is clear that illness induced by our environments can be reduced by using materials that minimise pollution and optimise humidity levels to prevent infection, viruses and allergic reactions.[10]

Air-conditioning has been a mantra for hospitals for decades, but use of this technology is questionable given the difficulty of cleaning miles of ductwork, the huge amount of energy expended both in the installation and running of all this machinery and the costs. Norwegian building regulations now demand that all ductwork must be cleaned – twice – before the building is even opened, and there must be a regular cleaning regime in place. The use of non-porous materials for cleaning purposes has also exacerbated the problem of controlling humidity, forcing the air-conditioning systems to work even harder.

In Europe a new approach to ventilation is being adopted, one which uses the natural properties of materials to control humidity. The hygroscopic properties of certain natural materials (their ability to absorb and de-absorb moisture) enables moisture and humidity levels to be regulated within rooms by allowing wall and ceiling surfaces to 'breathe' vapour in and out of their surfaces.[11] For this 'breathing' to be effective over a period of time, the materials, such as wood or unfired earth, require a certain depth beyond simply being a veneer.

Closer view of the rammed earth wall at Feldenkirch Hospital, Austria.

By developing a humidity control approach using material hygroscopicity, combined with natural ventilation strategies such as shallow plans and openable vents in non-critical areas, large amounts of unnecessary air-conditioning can be replaced. Additionally these same materials, if they are relatively heavy, can also help to regulate temperature by absorbing and evening out temperature changes, due to their thermal mass. These two properties have the triple effect of reducing energy used to control temperature and to control humidity, as well as reducing the energy required to construct unnecessary servicing equipment in the first place. Air filtration can be relatively low-key, with replaceable filters placed at the point of air entry to control pollen and other pollutants.

And suddenly the whole strategy begins to pay multiple dividends. Hygroscopic natural materials such as stone, wood and unfired earth also tend to be odour-neutral, biodegradable, low energy in manufacture and maintenance, as well as being relatively pleasant to touch (neither too hot or cold) and sound-deadening. They also have reassuring associations of home and nature, both of which have proven health-enhancing effects.[12] These natural materials also provide a key sense of orientation for the users of hospitals, by generating differentiated surfaces and textures as compared to the more anonymous artificial materials.

Natural materials in hospitals today

As we increase our understanding of infection control and the natural properties of raw materials, so we are able to expand the palette of natural options in hospital design without increasing the risk. We can outgrow our addiction to a 'quick-fix, one-size fits all' materiality, which was only possible due to the high energy manufacturing costs being artificially subsidised by fossil fuels and hidden pollution costs. There is no free lunch with nature, and these costs are now coming back to haunt us, whether through resource wars or increased asthma rates.

Bjorn Berge's seminal work *The Ecology of Building Materials*, offers a whole new 'old' approach to designing with natural materials. He recovers much lost knowledge both in relation to careful detailing and in appropriate use of natural materials. His lists of non-renewable materials and their relative scarcity values turn metals such as zinc and copper and fossil-fuel based plastics into endangered species[13] and demands that we replace these where practicable with more easily extracted and abundant materials.

Artificial materials have evolved for a reason, however. They are optimised for performance and are generally tougher, stronger and both quicker and easier to build with than natural materials. Or are they? The problematic health effects of glues and resins in new products are today leading many designers back to natural materials that are more benign to construction workers and the users of buildings. In many instances, with careful design, natural materials are more easily maintainable and replaceable.

In *How Buildings Learn*, Steward Brand points out that far more resources are spent on maintaining and upgrading buildings than are used to construct them in the first place[15]. It makes sense to think of buildings in 'layers' of materials, working from the most durable for the longest lasting 'layer', the structure – to more replaceable materials for outer 'layers' such as finishes, furnishings and services. To translate this into hospital design means using the tough artificial materials on corners, openings and critical spaces, and the more natural ones on wall surfaces, ceilings, and casual floor areas.

In Austria, Martin Rauch is pioneering the use of unfired rammed earth – raw mud to you and me – to produce beautiful walling that enlivens hospital waiting spaces while also controlling the atmospheric temperature and humidity. This is the same material that is used by most of the world to construct their buildings, and has been used continuously for over 10,000 years.[15] Unfired earth can come in a variety of forms: prefabricated boards to replace high-energy-using plasterboard, bricks to replace fired bricks internally, and PISE (Pneumatically Impacted Stabilised Earth) – the rammed earth that is almost as strong as concrete in terms of compressive strength. It provides a perfect compliment to the use of timber in hospitals because, unlike timber, it has a relatively high thermal mass.

Procurement issues –the bigger picture

If natural materials are so good for hospitals, why aren't we using them more?

There are a number of reasons here, which are all interlinked and are primarily to do with our value systems. It is relatively easy to implement technological change compared to changing people's value systems, and yet that is precisely what is needed in the construction sector.

At present, construction time and labour is the biggest perceived adjustable cost margin in hospital design, and has led to construction and product design that favours time over the use of renewable resources. The relatively short payback periods demanded by a conservative market disfavours innovative and 'slow' building processes even if they have greater environmental and health benefits in the long run. This has been overcome in European countries such as Germany through intense educational programmes for the construction sector and the securing of trusted building standards for innovative construction materials.[16]

Quality Indicators such as Key Performance Indicators (KPI's) still prioritise 'just in time' mentalities over environmental consciousness. It is no coincidence that the Environmental Performance Indicators (EPI's) for hospitals are still embryonic.[17] As for Health Performance Indicators (HPIs – you saw it here first) these are not yet even on the horizon for the construction industry in terms of actually how healthy buildings are for people.

Procurement methods now favour PFI over partnerships, leaving the contractor to lead the design, with the emphasis again on cutting costs. The latest venture in this area in Scotland, the new Royal Infirmary for Edinburgh, is an example of how PFI cuts corners when it comes to sustainability, with little concern for transport issues or for minimal environmental impact through the judicious use of materials and design/construction techniques. A major opportunity was missed to innovate with more environmentally benign specifications and natural 'air-conditioning' technologies. It's back to the 'one size fits all' mentality of spreading the same materials and technologies' standards throughout, which the accountants adore for its simplicity.

But life, nature, isn't simple. It has a glorious complexity, which we are only just beginning to understand. Our tentative models for understanding our environment, such as ecosystems, chaos theory, fractiles and biomimicry are still rarely used in building design. Procurement has to fit into this bigger picture and move beyond fiscal accounting in environmental and health accountancy. Using natural materials more appropriately in hospitals would represent a small step on this journey, and could make a world of difference to people's personal experience of their time in hospitals. It certainly would have made a difference to mine.

1 There is a ten per cent risk to patients of catching HAI (healthcare associated infection) and an even higher risk of developing it after leaving hospital (source: *Future Healthcare Network Briefing* No.3, June 2003).
2 Article in Building Design, 13.2.04
3 *Department of the Environment, Transport and the Regions* (2000), Building a Better Quality of Life: A Strategy for more Sustainable Construction. p.17
4 Berge, B: *The Ecology of Building Materials*, Architectural Press, Oxford and Hall, K (2000) and Warm, P: *Greener Building: Products and Services Directory*, The Green Building Press, Carmarthenshire, (1998). Also available on the web as 'Greenpro'.
5 Roalkvam, D: *Naturlig Ventilasjon*, NABU/NFR, (1997)
6 The Future Healthcare Network is a learning network to explore the shape of healthcare and what will be required by 2010 and beyond; the website is www.nhsconfed.org/fhn. The NHS Environmental Assessment Tool (NEAT, available from NHS Estates) sets out targets and a checklist for sustainable design in health buildings.
7 Pallasmaa, J: *The Eyes of the Skin; Architecture and the Senses*, Academy Editions, London (1996). This is a key text for understanding the interaction of our senses with buildings.
8 Day, C: *Places of the Soul; Architecture and Environmental Design as a Healing Art*, Aquarian Press,Wellingborough (1990). Day was one of the first of the new generation of ecological architects in the late 20th Century to articulate the possibility of buildings promoting healing in themselves.
9 Pallasmaa, J: Op. cit.
10 Oie,L: *The Role of Indoor Building Characteristics as Exposure Indicators and Risk Factors for Development of Bronchial Obstruction in Early Childhood*, NTNU, Trondheim, (1998). Norway and Halliday, S: *Low Allergy Housing Interim Report for DTI Partners in Innovation Scheme*, UK, (2002)
11 Berge, B: *Ecology of Building Materials*, p.251
12 Lawson, B et al.: *The architectural healthcare and its effects on patient health outcomes.*The University of Sheffield (1998/01)
13 Berge, B: *Ecology of Building Materials*, Table 1.3, p.20
14 Brand, S: *How Buildings Learn: what happens after they're built*, Orion books ltd, London, (1994), p.13
15 Houben, H and Guillaud,H: *Earth Construction*, Intermediate Technology Publications, London, (1984), p.3
16 Morton, T and Little, B: *Building with Earth in Scotland: Innovative Design and Sustainability*, The Scottish Executive, Edinburgh (2001). pp 39–44
17 The UK government has developed a series of Environmental Performance Indicators which can be found at: www.constructingexcellence.org.uk/resourcecentre

Fionn Stevenson is senior lecturer at the School of Architecture, Faculty of Duncan of Jordanstone College, University of Dundee, and was co-organiser of 2003's 'Breathing Space' healthcare and design symposium