

Engineering sustainability into hospitals

By Dominic Stalker, August 2008

What is sustainability

Sustainability is a buzz word in many areas of human endeavour—about that there is no doubt—but what does it really mean? On investigation, it soon becomes apparent that it is not just another over-used cliché that politicians hammer out from the rostrum in a last ditch attempt to win votes in order to get re-elected. There is in fact some real substance in the term, as well as, potentially, opportunities for some important solutions to some of humankind's most damaging activities.

Generally, definitions of sustainability refer to those approaches that provide the best outcomes for both the human and natural environments, both now, and in the indefinite future.

Hospitals, and other establishments or institutions devoted to human health care, are large buildings designed for public use that have a significant impact on the environment and economy of the surrounding community. They are heavy users of energy and water and produce large amounts of waste. Since hospitals place such demands on community resources they are natural candidates for sustainable design.

Applying sustainability to the healthcare sector

The principles of sustainability can be applied to the design, construction, operation and activities associated with a given establishment. In general most of the work on sustainability undertaken to-date has related primarily to sustainability within the energy usage and waste disposal contexts. It has applied less to the activities within the building as these are to some extent regarded as predetermined by the medical profession. At the Alliance for Natural Health (ANH), we are advocating the broadest possible interpretation of sustainability, arguing that the term should apply also to the conduct of medical practices, which should emphasise preventative healthcare in order to reduce the future burden on the healthcare sector, particularly by largely or partially preventable,

chronic diseases such as heart disease, cancer, obesity, diabetes and osteoporosis, which currently represent the greatest burden.¹

Sustainable building involves considering the entire life cycle of a given building, taking environmental quality, functional quality and future values into account. The Organisation for Economic Co-operation and Development (OECD) has identified five objectives for sustainable buildings:

- Resource Efficiency
- Energy Efficiency (including Greenhouse Gas Emissions Reduction)
- Pollution Prevention (including Indoor Air Quality and Noise Abatement)
- Harmonisation with Environment (including Environmental Assessment)
- Integrated and Systemic Approaches (including Environmental Management System)

Sustainable construction is defined as "the creation and responsible management of a healthy built environment based on resource efficient and ecological principles".²

Sustainably-designed buildings aim to lessen their impact on our environment through energy and resource efficiency. Their design is based on the following principles:

- minimising non-renewable resource consumption
- enhancing the natural environment
- eliminating or minimising the use of toxins

Sustainability requires efficiency, planning and long term strategy and, as has been shown by the UK's National Health Service (NHS), short-term, politically-driven attempts to improve efficiency and sustainability have proved to be largely ineffective and a waste of public funds.

The structure of a hospital should, ideally, be designed to maximise the efficiency of its functions. Key functions include:

- bed-related inpatient functions
- outpatient-related functions
- diagnostic and treatment functions
- administrative functions
- service functions (food, supply)
- research and teaching functions

The physical relationships between these functions determine the configuration of the hospital. Certain relationships between the various functions are required. The flow diagram

¹ World Health Organization (WHO) Global Strategy on Diet, Physical Activity and Health: <http://www.who.int/dietphysicalactivity/en/>

² Building Energy Efficiency Research project at the Department of Architecture, The University of Hong Kong; <http://www.arch.hku.hk/research/BEER/sustain.htm>

below (Figure 1) shows the movement and communication of people, materials, and waste.

Thus the physical configuration of a hospital and its transportation and logistic systems are inextricably intertwined. The transportation systems are influenced by the building configuration, and the configuration is heavily dependent on the transportation systems. The hospital configuration is also influenced by site restraints and opportunities, climate, surrounding facilities, budget, and available technology. New alternatives are generated by new medical needs and new technology.³

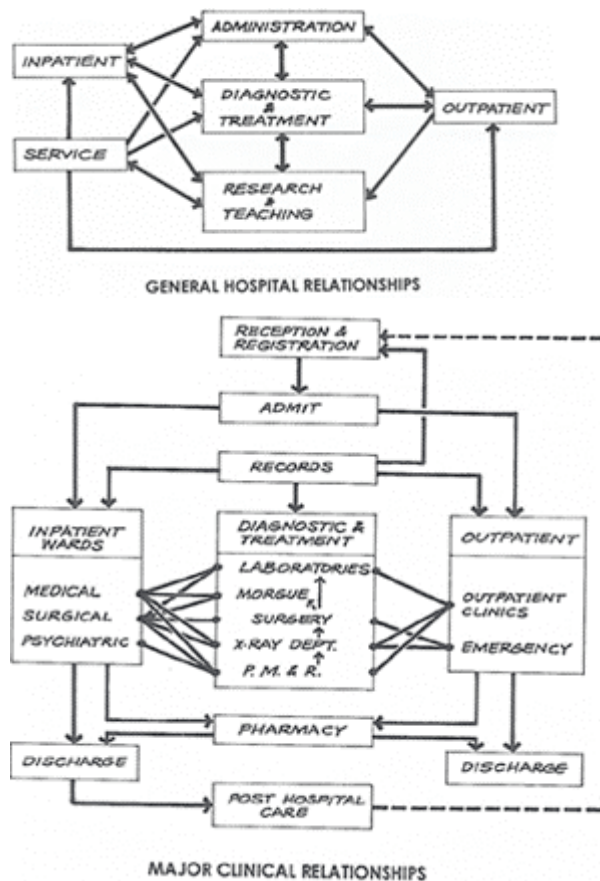


Figure 1: Flow diagram showing key functional relationships within a hospital (Source: Whole Building Design Guide)

There are several organisations that have done extensive research into how a ‘sustainable hospital’ should be built, supplied and run. For example, in the Green Guide for Health Care (GGHC)⁴ and in recommendations given by Leadership in Energy and Environmental Design (LEED)⁵, it is made clear that the research on sustainability should firstly begin with the environmental side of the construction of the facility. This should include selection of the

³ <http://www.wbdg.org/design/hospital.php>

⁴ Green Guide for Health Care: <http://www.gghc.org>

⁵ Leadership in Energy and Environmental Design website: <http://www.usgbc.org/leed>

most appropriate facility location, preferably a 'brown field site' and in the sourcing of building materials, which should obviously be from accredited sustainable sources.

Other considerations are that a detailed environmental waste disposal system must be implemented and a commitment must be made to recycling as a crucial component of ongoing operational sustainability. The electricity consumption of a modern day hospital is, as is to be expected, enormous and early planning and implementation of both site sourced energy and a commitment to sourcing supplies of all other requirements from renewable energy providers will reap dividends in the medium and long term.

Transport to and from the facility should be minimised while being free flowing with alternative modes of transport being readily available. It is therefore important that at planning stages, detailed links with efficient public transport providers are written into the project.

However, ensuring that environmental sustainability criteria are met is not the only concern. The remit should be much wider to ensure true sustainability in the wider sense of the term and concept. It is, for example, critically important that a functional and effective healing, treatment and work environment is developed. The GGHC's view on this is that it's important to ensure treatment or recovery rooms have easy access to a natural outside habitat and a highly efficient air ventilation system that provides high quality, fresh air for both patients and staff. The GGHC's research also emphasises that there should be no patient and limited employee interaction with any waste, especially chemical or heavy metal.

The ANH upholds that there would be little point in ensuring that every aspect of design, construction and operational function have been based on the principles of sustainability, when there has been no equivalent measures considering the treatment or preventative regimens offered to patients. The ANH's own research indicate that orthodox medical

practice as it presently stands through most parts of the so-called developed world are far from sustainable.⁶

Ultimately, a fully sustainable healthcare system should consider healthcare delivery based on a cradle to grave prevention philosophy, in so doing massively reducing the overall burden on disease treatment, presently the primary activity of hospitals.

How sustainable are most contemporary hospitals?

History shows that the bulk of the existing hospital base in most countries has been built to meet particular needs at particular times, and then, as given facilities fail to be adequate owing to changing technologies and demands, add-ons and adjustments are made in an attempt to compensate. This type of evolution has created a desperately inefficient and unsustainable healthcare system. Efficiency has often been regarded as a distant concern because of the perceived value of the life-saving function of hospitals. Strangely, despite the fact that Californian hospitals are some of the biggest energy consumers in the State, they are exempt from the Californian Title 24 Energy standards⁷.

Apart from issues of design, it is clear that from a cost/benefit viewpoint there is very low efficiency, and therefore sustainability, within the orthodox healthcare sector. For example, in the USA, in the medical system is currently responsible for some 98,000⁸ deaths associated with preventable medical and surgical injuries, an estimated additional 90,000⁹ deaths from preventable infections in hospitals and a further 106,000¹⁰ fatalities from side effects of properly prescribed medicines. The irony of these disconcerting statistics is that these statistics make the US medical system—the very system entrusted by the majority to

⁶ Alliance for Natural Health White Paper: ‘Sustainable Healthcare: Working towards the paradigm shift’: http://www.anhcampaign.org/files/080609-SustainableHealthcare_WP-public.pdf

⁷ Frances Moore. *A new approach to sustainable design at Palomar Medical Center West*, AIA, LEED AP, Senior Associate at CO Architects. Accessed via: <http://www.highbeam.com/doc/1P3-1518820351.html>.

⁸ Zhan C, Miller MR. Excess length of stay, charges, and mortality attributable to medical injuries during hospitalization. *JAMA*. 2003; 290(14): 1868-74.

⁹ Jarvis WR. The Lowbury Lecture. The United States approach to strategies in the battle against health care associated infections, 2006. *J Hosp Infect*. 2007; 65 Suppl 2: 3-9.

¹⁰ Lazarou J, Pomeranz B, Corey PN. Incidence of adverse drug reactions in hospitalized patients: A meta analysis of prospective studies. *JAMA*, 1998; 279: 1200–1205.

protect its health—the third greatest killer, following hard on the heels of heart disease and cancer. The picture is actually similar in most western countries.

Building sustainability into new healthcare facilities

Hospitals are by their very nature complex. The key to building sustainability into new buildings is about achieving as much integration with nature as possible from the outset and this should be taken into account using a holistic systems analysis approach where every aspect of design, function and operation are considered, in relation to the desired output. The output of course is much more than just an efficient building that has used sustainable construction and design principle—it's actually about achieving sustainability in everything from design through to the delivery of healthcare services.

Although this is a departure from how modern hospitals are perceived it does in some ways, ironically, bring us closer to the hospital building traditions of the 19th century. In that period, hospitals were built with the principle that the healing process would be largely supported by natural processes, therefore wards and rooms were focused on gardens and natural ventilation. Additionally, the use of natural products—herbs in particular—was a key part of many treatments. Unfortunately, with time, technology has been the decisive driver of hospital development and healthcare deliver and natural solutions have been largely overlooked.

What constitutes sustainable? Based on areas delineated by the GCHC, a summary of key functions is as follows: -

- **Energy and atmosphere:** - Ozone depletion, CO₂ emissions from building, transport to hospital, emissions from hospital themselves. As much energy as possible must be produced on site through sustainably resources. If the energy is coming from the power grid it must come from a source that has no net emissions
- **Environmental quality:** High quality air ventilation systems as much natural air as is possible making sure there is no involuntary exposure to tobacco and reduce exposure to any waste and or heavy metals, with both patients and employees having easy access to outside and natural surroundings.
- **Energy Efficiency:** make sure buildings are meeting sustainability standards. Reduce energy consumption of medical equipment. Optimise the use of water/energy and crucially make sure that none goes to waste

- **Chemical and waste Management:** minimize airborne chemical waste, sort all waste off site so no harm can come to patients in the event of a fire and ensure patients and employees are not affected by any toxic waste. Reduce pharmaceutical waste into sewage. Recycle waste and avoid landfill and incineration as much as possible.
- **Environmental services:** Protect wildlife and if possible integrate into a natural hospital environment. Reduce human exposure to any toxins, environmentally friendly cleaning procedures, support sustainable organic food production, recycle items that would be disposed of and ensure health of employees by reducing exposure to mercury and other heavy metals

Of course, missing from this list are the actual healthcare practices employed. It is clear that preventative healthcare is a much more sustainable approach and healthcare providers need to take the delivery of preventative approaches much more seriously. This is most likely to occur through the development of strategic alliances with non-governmental organisations, research and educational institutes, with a view to helping people to take greater responsibility for their health. Lifestyle management systems which include practical and relevant education and support on diet, nutrition and physical activity would need to be central to any delivery of preventative healthcare, as would be the need to focus on the young who have the most to gain from such advice and support.

A truly sustainable healthcare provider has to revalue its priorities and remember that its function is more than just dealing with sickness. It is about finding the most sustainable approach to the maintenance of the highest possible standards of health and wellbeing and therefore it needs to appeal not only to the sick but also to those that are currently clinically free from disease. There is an enormous wealth of evidence that light, space and the outdoors are important factors in the healing process.

The School of Natural Resources and Environment, The Complementary and Alternative Medicine Research Center, University of Michigan, Ann Arbor, USA. Articles completed a detailed study were four components of well-being were used as a framework for literature selection: physical psychological-emotional social, and spiritual in order to extract theories, hypotheses, and experimental evidence that interaction with nature positively affects multiple dimensions of human health. Physiological effects of stress on the autonomic nervous system are lessened. Psychologically, deficits in attention can be restored or minimized, and that people report feeling greater satisfaction with a variety of aspects of

life. The presence of the natural world promotes social health by encouraging positive social interaction and lessening the frequency of aggressive behaviour. Spiritual well-being is enhanced through the experience of greater interconnectedness, which occurs when interacting with the natural world. The literature reviewed provides evidence to support the intuitive belief that interaction with the natural world is a vital part of biopsychosocial-spiritual well-being. Incorporating the natural world into healthcare could provide health benefits and improve the design of healthcare facilities. Applied more broadly to society, this knowledge may change the way we approach public health, guard and manage natural resources, and design environments for human use.¹¹

A hospital will always be loaded with highly complicated technology, however this needs to coexist with a more holistic and natural environment. If the technologies and building bring both patients and staff closer to a feeling of working in a natural environment this is likely to aid the healing process. This might be as simple as using high quality glazing systems coupled with top end ventilation which, as well as having the obvious effect of lowering the energy costs, may well also result in less requirement for patients to draw blinds or curtains and therefore they will benefit from the natural light.

Within a facility there are a number of engineering opportunities that can be incorporated into the building stage that will result in long term sustainability. Some key functions may be:

- **Integrated waste water treatment systems** are designed Ecosystems that use plant-based technology to treat and manage wastewater, grey water, rainwater and storm water for on-site re-use, irrigation or release. Because they are based on soil and plants rather than concrete and metal, designed ecosystems can potentially treat wastewater with low costs and low maintenance
- **High efficiency lighting and air handling systems** currently incandescent lights are basically electric space heaters that give off light as a by-product. They are VERY inefficient, wasting most of the power they consume as heat (100w tungsten filament is 2.6% efficient¹²).

¹¹ Irvine KN, Warber SL. "Greening healthcare: practicing as if the natural environment really mattered". *Altern Ther Health Med*. 2002 , 8(5):76-83

¹² Keefe, T.J. (2007). "The Nature of Light". Retrieved on 2007-11-05.

- **Low flow plumbing fixtures** including toilets, faucet aerators and showerheads have been developed that save substantial amounts of water compared to conventional fixtures while providing the same utility.
- **Quality window and light provision** is now supported by glass technology can reduce the amount of energy net lost through windows by 90%.
- **Court yards and garden provision**
- **Patient controlled light programming** (evidence shows that having control over ones environment reduces stress)

Ultimately if a building is going to be truly efficient and sustainable, engineers and architects must collaborate from the outset and all be fully committed to look at their part of the project with the view that they will endeavour to make it more efficient more productive and ultimately this will result in less waste. The key goal is to create a comfortable healing spaces for patients, and productive workplaces for staff a comfortable, healthy hospital includes things like good lighting, natural ventilation, good signage and non-threatening areas surrounded by green spaces.

Challenges

The challenges in delivering true sustainability into the healthcare sector are enormous. Most governments work towards a short term agenda based around re-election, so the immediate expense required will always be closely scrutinized and questioned.

The existing control of healthcare by the pharmaceutical industry¹³ has meant that pharmaceutical-based healthcare has become the predominant approach to healthcare over the last half century. Transitioning healthcare towards approaches which emphasise lifestyle and dietary approaches, as proposed by the WHO, presents a very substantial challenge owing to entrenched approaches and medical training which do not currently stress the importance of prevention, diet or physical activity in healthcare.

The perceived cost of implementing sustainability is generally regarded as being the single greatest constraint. This reluctance to spend money can be seen in data drawn from the Health Facilities Management / ASHE 2008 Green Design & Operations Survey where the top

¹³ House of Commons Health Select Committee report, “The Influence of the Pharmaceutical Industry”, 2005: <http://www.parliament.the-stationeryoffice.co.uk/pa/cm200405/cmselect/cmhealth/42/42.pdf>.

5 reasons for not building fully sustainable were: higher initial cost (78%), increased cost over traditional materials and systems (73%), competing investment and spending priorities (72%), a perceived lack of immediate return on investment (47%) and lack of information or evidence on the benefits of green construction (28%).¹⁴

Many facilities are currently located within the confines of cities and in areas of high commercial value meaning available land for gardens and improved interactions with the natural environment are limited.

However, technology that supports sustainability moves forward on a seemingly daily basis. This rapid development can actually present a challenge for implementation as decision-makers may be concerned that today's technology may be outstripped by what becomes available tomorrow.

Given the challenges to implementation of true sustainability, it is possible that some of the most pioneering and progressive steps will be taken in the private, rather than public, healthcare sector, where private investment funds could be more easily prioritised for this purpose.

Conclusions

In the future, I believe that sustainable hospitals will not just be those that are efficient in the use of energy resources or those that have been very conscious of using sustainable building materials. They will also include facilities and healthcare approaches that take into account humans' intrinsic association with nature, so creating a healthcare system where there is maximum compatibility between modern technology, the natural environment and the human body.

This will dramatically improve the long-term performance and value of the healthcare sector, by advancing more holistic approaches to building design, construction and operation, as well as a more holistic approach to medicine and healthcare.

Gordon Brown, the UK Prime Minister, was reported in the July 2008 issue of the magazine *Health Facilities Management*, saying: "There is no perfectly green hospital out there, we see pockets of success, and they are growing. Wherever they are in the process, they should

¹⁴ Carpenter D, Hoppszallern S. Greening up. Hospitals getting savvier on sustainability. *Health Facil Manage*. 2008 21(7): 15-21

be proud if they're making progress and recognize that the only way to get there is one program at a time. They can't do it all at once."

The gauntlet is down and, for many hospitals, there is a very long way to go.

However hard the challenge, taking serious consideration of sustainability in the design, construction and operation of hospitals, as well as in the delivery of healthcare to the public, has to be seen as a necessary step—if not in the immediacy—certainly for future generations.