INNOVATIVE DESIGN AND CONSTRUCTION SOLUTIONS FOR IMPROVED THERAPEUTIC HEALING ENVIRONMENTS

J. Yang[1] and A.D.F. Price

Department of Civil and Building Engineering, Loughborough University, Loughborough, Leicestershire, LE11 3TU UK

Healthcare facilities need to be designed as innovative healing environments that improve quality of care, aid the recovery process, promote therapeutic goals and improve operational efficiency. A £5 billion hospital development programme has been designated to develop new healthcare infrastructure and upgrade existing hospital facilities to meet increasing demands of healthcare across the UK. This main aim of this paper is to collate information on current developments and practice in relation to therapeutic environments. An extensive review of literature relating to current practice has been undertaken. Relationships between the physical environment and patient recovery have been investigated in order to assess the potential impact of healthcare built environments on the healing process. Critical factors which impact on the performance of a healthcare facility, such as building layout and stakeholder participation have been examined. The benefits from innovative design and construction solutions, along with the barriers to innovation, have been highlighted to identify the opportunities for improving the quality of healthcare provision.

Keywords: construction, design, healing environment, healthcare infrastructure, innovative.

INTRODUCTION

In 2001, the NHS announced one of the biggest building programs in the world, funded by £5 billion from the private sector, and hospital building stands at the top of this investment programme (Granville, 2001). Alan Milburn (2001, p7), the Minister of Health, argued that the programme provided an opportunity *to "design in from the start the space, the flexibility, the infrastructure in which staff can deliver the best quality care"*. He also emphasised that it is possible to develop *"from the outset an appreciation of the importance of the patient environment to recovery and rehabilitation"*.

Innovative healing environments very much depend upon the design and construction of healthcare facilities that contribute to the quality of care and recovery process whilst promoting therapeutic goals and enhancing operational efficiency. Previous research has linked quality of care, patient health and wellbeing with the physical characteristics of the healthcare environment (Douglas and Douglas, 2004 and 2005). More specifically, there is clear evidence that the physical environment of hospitals can affect the healing process, for example: reducing the level of anxiety and stress

[1] j.yang@lboro.ac.uk

Yang, J, and Price, A D F (2006) Innovative design and construction solutions for improved therapeutic healing environments. *In:* Boyd, D (Ed) *Procs 22nd Annual ARCOM Conference,* 4-6 September 2006, Birmingham, UK, Association of Researchers in Construction Management, 959-968.

(Beauchemin and Hays, 1998; Pattison and Robertson, 1996); shortening recovery periods following surgery through better view of surroundings environment (Ulrich, 1984); increasing social interaction through improved building layout; positioning of furniture to increase patients' wellbeing (Somner and Ross, 1958; Baldwin, 1985); significantly diminishing pathological behaviours through the creation of supportive building environments; establishing links between built environments and patients' recovery (Gabb, *et al.*, 1992); and provision of appropriate space and conditions to decrease patients' recovery time and maximise the use of therapeutic environment (Ewing, 2005).

AIM, OBJECTIVES AND METHODOLOGY

The main aim of this research was to gather evidence and information that would help to explore the relationship between the physical and healing environments, thus identifying good practice aimed at improving the design and construction of healthcare facilities. The research focused on reviewing recent literature in relating to: healthcare built environments; innovative design and construction solutions; measuring the performance of healthcare infrastructures and facilities; and barriers to innovation. The main objectives of the research were to:

- extract information from literature, evidence of current practice through the UK, the US and EU;
- establish the linkages of physical built environment and its impacts on patient recovery;
- review current solutions for the design and construction healthcare facilities;
- identify key factors relating to healthcare facility performance; and
- explore barriers to innovative design and construction solutions for healthcare facilities.

THERAPEUTIC ENIVRONMENTS

The concept of designing therapeutic environment is not new (Francis *et al.*, 1999), however, relationships between environmental stimulus and response are complex and not fully understood (Canter and Canter, 1979). According to Gesler *et al.* (2004 pp.117-128): the therapeutic environment of hospitals relates to their physical, social and symbolic design; and the aim should be to produce facilities that are: *"clinically efficient; well integrated within the community; accessible to consumers and the public; and encourage patient and staff well-being"*. Many new facilities are now being delivered against very tight deadlines and committed to for 25-30 years without sufficient time to adequately plan. Delivering an uninterrupted service during the re-construction task is problematic, and little is understood about the way different built environments support the spectrum of service delivery processes and impact upon healthcare delivery costs and benefits (Farrelly, 2002). The applications of technological innovation for the design and construction of healthcare infrastructures and facilities, and the barriers to implementation of innovative solutions also need to be better understood (Eide, 2003).

BUILT AND HEALING ENVIRONMENTS

Researchers in design and architectural disciplines have demonstrated that people are sensitive and responsive to the stimuli that they receive from built environment (Beer and Higgins, 2000; Francis and Glanville, 2001; Hosking and Haggard, 1999). There is considerable evidence to support the claim that the design and construction of built environment can have a significant impact on clinical outcomes (Sorian, 2006). Researchers in the US and the UK have studied the various impacts of the built environment on patients' health, wellbeing and recovery from illness, thus demonstrating how the design of healthcare environments can affect clinical and health outcome (Ulrich, 2003; Pattison and Roberton, 1996; Beauchemin, 1996). Various studies (Hilton, 1985; Keep, 1980; Rubin and Owen, 1998) have demonstrated that the design of the built environment can help to reduced anxiety, the need for palliative medications, tiredness and disturbance.

Built environments that support healthcare delivery must develop patient focused environments that enhance patients' health and recovery processes (NHS, 2004). Integrated design and construction approaches have been used to develop hospitals with physical environments that have a positive influence in patients' health and recovery outcomes (Tung, 1971; Cox and Cox, 2000). Douglas and Douglas (2005) examined patients' perceptions of hospital environments and assessed the influence of built environment on patients' health and wellbeing. The findings suggest that supportive built environments with good layout and accessibility can create an overall inviting, calming and engaging healthcare environment for patients and their families leading to improved patient recovery (Anonymous, 2005; Wendler, 1996).

Lawson and Phiri (2000) compared the outcomes of patients treated in modern designed hospital wards with similar patients cared for in older hospital environments. They concluded that the refurbished wards had better recovery results and shorter times for the healing process. However, it is difficult to determine how much of the improvement was associated with the physical environment and how much was associated with the subsequent improvement in healthcare service provision or the introduction of new technologies. The whole process is highly integrated, thus creating complex environments and systems to be studied.

MEASURING HEALTHCARE FACILITY PERFORMANCE

Many healthcare facility performance factors can be easily quantified, such as maintenance and running costs, however, many are of a highly subjective and qualitative nature where the perceptions of a wide and diverse group of stakeholders need to be taken into account. The contribution of the healing environment to facility performance (hence value) is in itself highly complex with many qualitative and qualitative factors that need to be taken into account. Several studies have investigated the influence of building layout, wards locations and views on the performance of healthcare facilities (Vogt, 1990, Taturm, et. al., 2004; Tung, 1971; Taturm, 2005). However, according to Toole (2001), performance is not only affected by the physical characteristics but also by the behaviour of users and surroundings. Doctors, nurses, patients and visitors have been studied to determine their influence on healthcare infrastructure performance (Shimizu, 1997; Hasegawa, 1994). The research findings demonstrate that:

- individual patient recovery rates have improved;

- motivation of doctors and nurses is enhanced;
- management culture stress and absence of doctors and nurses have been decreased considerably; and
- patients' attitude, violence to staff etc have been significantly reduced.
- The performance of healthcare facilities has been measured by examining factors such as surgery, staff performance and cost using systematic tools, program and indicators to distinguish performance of healthcare service and facilities, for example:
- patient recovery outcomes after clinical operations have used to determine the hospital performance (Gross, *et al.* 2000);
- decision support systems have been developed to deal with key factors such as staff performance and healthcare equipment in relation to overall performance of healthcare facilities (Anderson and Brown, 2001);
- the Baldrige Program was designated to measure the performance of healthcare provision by examining factors such as healthcare services and delivery, patient and consumers focus, marketing, human resources, cost effectiveness, leadership and social responsibility (NIST, 2003); and
- hospital running costs were used as a key indicator to address the performance of healthcare facilities across the USA to improve overall performance (Isham, 2006)
- The measurement of healthcare facility performance thus requires a holistic approach that takes into account the associated degree of complexity. This research has focussed on innovative design and construction solutions and their impact on the healing environment. Literature has emphasised the potential influences of design characteristics such vision, building layout, lighting and their role in providing an innovative healing environment. There are many claims that better healing environments can also have a positive influence on staff (doctors and nurses) productivity (NAHBRC, 2000; ASCE 1994).

INNOVATIVE DESIGN AND CONSTRUCTION SOLUTIONS FOR HEALTHCARE FACILITIES

- Innovative design and construction solutions can lead to economic, social and environmental benefits associated with the provision of new or improved products/services, as well as decreasing the cost existing productions/services (Slaughter, 1998; Latham, 1994). This also applies to healthcare where innovative solutions can help to create appropriate healing environments, reduce costs, improve affordability and reduced risks (Seaden, 1996; Shimizu, 1997). More innovative design and construction solutions for healthcare infrastructure are needed to satisfy increasing demands for better healthcare provision and high quality healing environments. Bossink (2003) demonstrated how the innovative design and construction of hospitals could improve healthcare provision, hospital staff productivity and patient recovery. Other examples of innovation design and construction solutions for healthcare infrastructure include:

- innovative hospital layouts to improve privacy space and aid rapid recovery (Okoroh, *et al.*, 2003; Harrison, 2001);
- better use of outdoor facilities including green space and good external views (Kearney and Winterbottom, 2005);
- innovative approaches to the design and construction of built environments that integrated well with and complement modern technologies, thus creating better healing environments (Wayne, 2003);
- the use of sustainable building components and materials to reduce life-cycle cost of building related products including replaceable windows, doors and facades (NAHBRC, 2000; Toole, 2001);
- recovery and waiting room areas are key to design and construction process, the early these equipment are delineated, the more efficient the design process can be (Uhlik and Himze, 1998);
- improved design standards and solutions for improved floor areas, and ventilation and room sealing to make a clean, intermediate and contaminated environment for patients (Johnson, 1998); and
- integrated and innovative methodologies and frameworks aimed at: reducing design and construction costs; and improving operational effectiveness of healthcare facilities (Hess, 2002; Schmitt, 2006).
- Modern approaches to procurement, as listed below, have also been adopted and have encouraged more innovative approaches to the design and construction of healthcare facilities, for example:
- design and build approaches that integrate design professional/engineers with construction contractors to improve value by encouraging more innovative solutions, and reducing risk, schedule growth and cost growth (Shah, 1996); and
- Public Private Partnerships have been widely used in the UK and US to improve healthcare provision using private finance and better risk management (Winch, 1998; Miozzo and Dewick, 2002).

BARRIERS TO INNOVATIVE SOLUTIONS

- Mitropoulos and Tatum (2000) stated that barriers to adoption of innovative solutions in construction industry can be classified as:
- technological barriers: attributions of technological innovation, market pull (i.e.: demands, competition), technology push that is the chance offered by new technology to enhance operations (Tatum, 1989);
- organisational barriers: managerial attitude toward technology, organisation values innovation, and technological capability related to new technology, inefficient resources (Price and Chahal, 2006);
- financial barriers: cost effective technologies and include lack of awareness about new idea; and

- people: problems in communicating how these idea could be effective, risk and liability from third parties (i.e.: owners, designs and policy makers) and struggle to change (Paulson and Fondahl, 1980).
- A recent study (CORDIS, 2006) demonstrated that the main barriers to innovation in healthcare sector also include:
- the obligation to procure products most economically and practically;
- a lack of understanding of marketing requirements and end users' (patients and doctors) needs; and
- a lack of collaboration between developers, users and investors.
- Innovative solutions can be found for most aspects of healthcare: its delivery to consumers; its technology; and its business models. Substantial time and money has been invested in developing new solutions aimed at improving healthcare in the US (Herzlinger, 2006), however, the implementation of many innovative solutions has failed and proven to be very costly. Herzlinger (2006, p.60) suggested that the reasons behind such failures several factors could be classified as follows.
- **Players:** stakeholders in health care sector.
- **Funding:** financing for innovation's development and paying for products and services.
- **Policy:** government regulation of healthcare.
- **Technology:** understanding how and when to adopt or invest in its critically important.
- **Customers:** the empowered and engaged consumers of healthcare – patients.
- **Accountability:** empowered consumers and cost-pressured payers are demanding accountability from health care innovator.

Middleton (2004, pp 3-6) suggested that there are possible solutions for reducing the barriers to technological innovations in healthcare service, these include:

- improved communications between industry and policy makers;
- increased investment in developing new technologies; and
- more industry involvement in development of innovations for healthcare.

According to Herzlinger (2006), if the barriers to innovation are to be reduced, legislation and regulations in the US need to change, thus making it easy for organisations/firms to reap the financial benefits from their innovations.

CONCLUSIONS

Increasing demands for better healthcare provision across the UK have created a need for innovative design and construction solutions that improve the healthcare environment and help to achieve a more cost effective healthcare service. Information on current developments and practice in relation to therapeutic environments has been reviewed. Relationships between the physical environment and patient recovery have been investigated and the potential impact of healthcare built environments on the healing process has been assessed. Critical factors which impact on the performance

of a healthcare facility, such as building layout and stakeholder participation have been examined.

Previous research has demonstrated that factors such as building layout, positioning of furniture and ward colour can have significant impacts on the healing processes. The measurement of healthcare facility performance and factors which affect performance have been discussed, for example the influence of doctors, nurses, patients and building characteristics.

The benefits from innovative design and construction solutions, along with the barriers to innovation, such as technology, finance, people and communication have been discussed.

There is clear evidence that computer based solutions, such simulation of physical layout against a range of value criteria could help to model innovative therapeutic environments and reduce some of the barriers to innovation. The use of integrated design and construction and Public Private Partnerships have also been used to encourage innovative solutions through better risk management.

There is a considerable amount of information and knowledge available regarding healthcare infrastructure design, construction and performance, however, most is highly fragmented and not easily accessible. This fragmentation presents an opportunity for the development of a highly accessible resource in relation to innovative design and construction solutions, healthcare facilities performance to improve healing environment and cost efficiency. Other opportunities for further research includes:

- development of integrated ICT based solutions in relation to design and construction for healthcare facilities;
- establishment of a holistic approach to the measurement healthcare facility performance;
- development of frameworks and processes for continuous improvement; and
- investigation of the impacts of policy, technology, user requirements to remove existing barriers to innovative solutions for healthcare.

REFERENCES

Anderson, G. and Brown, A. (2001) *Development and Testing of a Decision Support Tool for Healthcare Performance Measurement*, Canadian Health Services Research Foundation, http://www.chrsf.ca.

Anonymous (2005), The Unfolding and Healing of Analytic Boundary Violations: Personal, Clinical and Cultural Considerations, *Journal of Analytical Psychology*, **50**, 661-691.

ASCE, (1994) *Material for Tomorrow's Infrastructure: A Ten-Year Plan for Deploying High-Performance Construction Materials and Systems*, Civil Engineering Research Foundation Report, 94-5011, New York.

Baldwin, S. (1985) Effects of Furniture Re-arrangement on the Atmosphere of Wards in a Maximum-Security Hospital, *Hospital and Community Psychiatry*, **36**, 525-528.

Beauchemin, K.M. and Hays, P. (1998) Dying in the Dark: Sunshine, Gender and Outcomes in Myocardial infarction, *Journal of the Royal Society of Medicine*, **91**, 352-354.

Beer, A.R. and Higgins, C. (2000) *Environmental Planning for Site Developments*, London, UK: E & EN Spon.

Bossink, B.A.G. (2004) Managing Drivers of Innovation in Construction Networks, *Journal of Construction Engineering and Management, ASCE,* **130**(3), 337-345.

Canter, S. and Canter, D., (1979) Building for Therapy. In. Canter, D. Canter, S. (Eds.) *Designing for Therapeutic Environments*, Wiley, New York. 1-28.

CORDIS, (2006) Boosting Innovation through Public Procurement, *European Innovation*, Issue 2, http://aoi.cordis.lu/article.cfm?article=1591&lang=EN

Cox, H and Cox, D. (2000) Hospital without Walls: A Journey through the Healthcare System, *Journal of Nursing Practice*, **6**(2) 105-109.

Depart of Health (2004). *The NHS Improvement Plan Putting People at Heart of Public Services,* London, UK: HMSO.

Douglas, C.H. and Douglas, M.R. (2004) Patient-Friendly Environments: Exploring the Patients' Perspective, *Journal of Health Expectation*, **7**, 61-73.

Douglas, C.H. and Douglas, M.R. (2005) Patient-centred Improvements in Health-Care Built Environment: Perspectives and Design Indictors, *Journal of Health Expectation*, **8**, 264-276.

Eide, S.L.K. (2003) Waste Handling Excellence, *Health Estate Journal*, **57**(1) 41-43.

Ewing, R. (2005) Building Environment to Promote Health, *Journal of Epidemiology and Community*, **59**(7), 536-537.

Farrelly, E. (2002) Taming St Vincent's, Architectural Australia, **91**(4) 58-63.

Francis, S. and Glanville, R. (2001) *Building A 2020 Vision: Future Healthcare Environment*, London, UK: The Stationary Office.

Francis, S. Granville, R. Noble, A. Scher P. (1999) *50 Years of Ideas in Healthcare Buildings*, Nuffield Trust, London.

Francis, T.E.F., Egbu, C. and Gibb, A.G.F. (2003) Designing Facilities Management Needs into Infrastructure Projects: Case from a Major Hospital, *Journal of Performance of Constructed Facilities, ASCE*, **17**(1), 43-50.

Fulop, N. (2002) Speech to the Telemedicine Forum, Royal Society of Medicine, London, 29th May 2002.

Gabb, B.S., Speicher, K. and Lodl, K. (1992) Environmental Design for Individuals with Schizophrenia: An Assessment Tool, *Journal of Applied Rehabilitation Counsel*, **23**, 35-40.

Gesler, W., Bell, M. Cutis, S. Hubbard, P. and Francis, S. (2004) Therapy by Design: Evaluating the UK hospital building program, *Health and Place*, **10**, 117-128.

Gross, P.A., Braun, B.I., Kritchevsky, S.B. and Simmons, B.P. (2000) Comparison of Clinical Indicators for Performance Measurement of Health Care Quality: A Cautionary, *Journal of Clinical Performance in Quality Healthcare*, 8(4), 202-211.

Harrison, L. and Heywood, F. (2000). Health Begins at Home: the Health and Housing Interface for Elderly People. *Reviews on environmental health*, **15**(1/2), 149.

Hasegawa, Y. (1994) Developments and Trends of Construction Robotics in Japan, *Proceedings of the 25th ISIR Conference*, ISARC, Hannover, Germany, 236-242.

Herzlinger, R.E. (2006) Why Innovation in Health Care is so Hard, *Harvard Business Review*, March 2006, 58-66.

Hess, J. (2002) *Review of Operations, Amerada Hess Corporation*, New York, NY, USA

Hilton, B.A. (1985) Noise in Acute Care Areas, *Research in Nursing and Health*, **8**, 283-291.

Hosking, S. and Haggard, L. (1999) *Healing the Hospital Environment*, London, UK: Spon.

Isham, G.J (2006) Towards National Healthcare Performance Standards, *The American Journal of Managed Care*, **12**(6), 309-310.

Johnson, J. W. (1998) Lessons from an Outpatient Surgery Centre, *Journal of Architectural Engineering*, **4**(2), 83-86.

Kangari, R. and Miyatake, Y. (1997) Developing and Managing Innovative Construction Technologies in Japan, *Journal of Construction Engineering and Management, ASCE*, **123**(1),72-78.

Kearney, A.R. and Winterbottom, D. (2005). Nearby Nature and Long Term Care Facility Residents: Benefits and Design Recommendations. *Journal of Housing for Elderly,* **19**(3/4), 7-28.

Keep, P.J., James, J. and Inman, J. (1980) Windows in the Intensive Therapy Unit, Anaesthesia, 35, 257-262.

Latham, M. (1994) *Constructing the Team: Joint Review of Procurement and Contractual Arrangement in the United Kingdom Construction Industry*, Department of Environment, London, England.

Lawson, B. and Phiri, M. (2000) Room for Improvement, *Health Service Journal*, **110**, 24-27.

Middleton, S. (2004) *Barriers to Innovation in the Development of New Medicines in Europe and Possible Solutions to Address these Barriers*, EFPIA November 2004.

Miozzo, M. and Dewick, P. (2002) Building Competitive Advantage: Innovation and Corporate Governance in European Construction, *Research Policy*, **31**(6), 989-1008.

National Association of Home Builders Research Centre (NAHBRC) (2000) *PATH Technology Roadmapping, Report Prepared for Partnership for Advancing Technologies in Housing,* Washington D.C.

NIST (2003) *Baldrige in Health Care: Performance Excellence Delivers World Class Results*, National Institute of Standards and Technology, U.S. Department of Commerce, CEO Issue Sheet.

Okoroh, M.I., Gombera, P.P. and Ilozor, B.D. (2003) Managing FM (Support Service): Business Risks in the Healthcare Sector, *Journal of Facilities*, **20**(1/2), 41-51.

Pattison, H.M. and Robertson, C.E. (1996) The Effect of Ward Design on Well-Being of Post-Operative Patients, Journal of Advanced Nursing, **23**, 820-826.

Paulson, B.C. and Fondhal, J.W. (1980) *Development of Research in the Construction of Transportation Facilities: A Study of Needs, Objectives, Resources and Mechanism for Implementation,* US Department of Transportation, Washington D.C.

Price, A.D.F. and Chahal, K. (2006) A Strategic Framework for Change Management, *Construction Management and Economics*, **24**, 237-251.

Rubin, H.R., Owem, A.J. (1998) *Status Report: An Investigation to Determine Whether the Built Environment Affects Patients' Medical Outcomes*, Martinez, CA, USA: The Centre for Health Design

Schmitt, K.J. (2006) *Healthcare Infrastructure and Optimizing Healthcare Process, Siemens, AG Medical Solutions*, Erlangen, Germany,

Seaden, G. (1996) Economics of Innovation in the Construction Industry, *Journal of Infrastructure System, ASCE*, **2**(3), 103-107.

Shah, J.B. (1996) Innovative Design/Build Approach: Ambassador Bridge Project, *Journal of Management in Engineering*, **12**(4), 58-61.

Shimizu, H. (1997) *Recent Technology Developments for Long Span Bridge*, MSc thesis, MIT Cambridge, Mass, USA.

Slaughter, E.S. (1998) Models of Construction Innovation, *Journal of Construction Engineering and Management, ASCE*, **124**(3),226-231.

Somner, R. and Ross, H. (1958) Social Interaction on Psychogeriatric Ward, International *Journal of Social Psychiatry*, **4**, 128-133.

Sorian, R. (2006) *Measuring, Reporting and Rewarding Performance in Health Care, Commission on High Performance Health System*, the Commonwealth Fund, New York.

Tatum, C.B. (1989) Organising to Increase Innovation in the Construction Firm, *Journal of Construction Engineering and Management, ASCE*, **115**(4), 602-617.

Tatum, C.B. (2005) Building Better: Technical Support for Construction, *Journal of Construction Engineering and Management, ASCE,* **131**(1), 23-32.

Tatum, N., Rodenbeck, S. and Williams, R. (2004) Engineering the Backbone of Public Health, *Journal of Water Resources and Environment History, ASCE*, 167-173.

Titropoulos, P and Tatum, C.B. (2000) Forces Driving Adoption of New Technologies, *Journal of Construction Engineering and Management, ASCE*, **126**(5), 340-348.

Toole, T.M. (2001) Technological Trajectories of Construction Innovation, *Journal of Architectural Engineering,* **7**(4),107-114

Tung, A. (1971) Civil Engineering in Health Care System, *Journal of Professional Activities*, **97**(1),87-94.

Uhlik, F.T. and Hinze, J.H. (1998) Trend in the Construction Needs of Hospital Facilities, *Journal of Architectural Engineering*, **4**(4), 132-134.

Ulrich, R.S. (2003) Evidence Based Environmental Design for Improving Medical Outcomes, Healing by Design Building for Healthcare in 21st Century, http://www.muhc-healing.mcgill.ca/english/Speakers/ulrich_p.html

Ulrich, U.S. (1984) View through a Window may Influence Recovery from Surgery, *Science*, **224**, 420-421.

Vogt, B.M. (1990) *Evacuation of Institutionalised and Specialised Populations*, Oak Ridge National Laboratory, Oakridge, Tenn.

Wayne, R. (2003). Towards a Wider Construct of Health in the Built Environment, *EDRA (Environment Design Research Associate) Workshop* 2003, Scotland, UK.