

THE PRIMACY OF COLOUR

Teleton Tampico, Mexico: Expressing what it feels like to be a child

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Scientific Review: Chronobiology

Market report: Africa



June 2010
Toronto, Canada



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The International Academy for Design & Health launches the Design & Health International Academy Awards 2010 – the leading advocacy programme in the world recognising professional excellence in the research and practice of designing healthy built environments.

The awards are open to international organisations and individuals in the private and public sectors participating in research or practice, including the planning, procurement, design, construction and management of healthy environments.



Built projects or research programmes completed between 1 January 2009 and 1 April 2010 are eligible to enter in the following award categories:

Health Project (Over 40,000m²)

Lead Judge: Kirk Hamilton, USA

Health Project (Under 40,000m²)

Lead judge: Susan Black, Canada

Research Project

Lead judge: Dr Paul Barach, Australia

Sustainable Design

Lead Judge: Phil Nedin, UK

Mental Health Project

Lead Judge: Dr John Zeisel, USA

Low-cost Project in Developing Economies

Lead judge: Geoff Abbott, Africa

Elderly Care Project

Lead judge: Derek Parker, USA

Product Design for Healthcare Application

Lead judge: Colum Lowe, UK

Patient Environment and the Arts

Lead judge: Blair Saddler, USA

Interior Design Project

Lead judge: John Wells-Thorpe, UK

To download the submission form, visit www.designandhealth.com



Contributors

Mark Johnson

Integrated approaches to landscape designs can bind urban neighbourhoods together and lead to healthier lifestyles, says Mark Johnson of Civitas



Jocelyn Lum Frederick

Designers need to redouble their efforts with clients to shape a healthier built environment, writes Jocelyn Lum Frederick of Tsoi/Kobus & Associates



Mary-Jean Eastman

In 2010, says Mary-Jean Eastman of Perkins Eastman, we have a singular, generational opportunity to set new standards in healthcare environments



Anna Wirz-Justice

The design of health centres and other buildings needs to take into account the biological effect of light on different population groups, reveals Anna Wirz-Justice



Sheila Theophanides

Rapid advances in medical technology are creating new design challenges in operating theatres, writes Sheila Theophanides and Luc Dubé



Blair Saddler

John Wells-Thorpe reviews Blair Saddler and Anna Ridenour's new user-friendly book, *Transforming the Healthcare Experience Through the Arts*



Sense of optimism

As Tye Farrow suggests, the “great thing about 2010 is that 2009 is now behind us” (p21). And I have sensed that despite continuing economic difficulties in some areas of the world, we are emerging from the first ever global economic recession into a new decade with a new sense of optimism. There has been much discussion about the ‘Obama’ effect and it is true that with his presidency of the US, a signal was conveyed that opportunity is open to all of us. But there are far greater forces of change at work, as the potential catastrophic impact that climate change may bring to bear on us and our children is combined with recognition that the greed that led to the recent crisis must necessarily be replaced with a more holistic understanding of what we mean by our quality of life. The International Academy for Design & Health promotes the value of a ‘salutogenic’ approach to healthcare design, a philosophy which recognises our social and psychological needs in equal measure to our biological needs. To promote this new perspective, we will be launching a series of international symposiums and workshops in 2010 starting in Sydney, Australia, from 28-30 April (pp 38-39) and followed by events in Toronto, Canada, from 28-30 June. In Toronto, we will also be hosting the 2010 Design & Health Acad Awards, which have now opened for en (pp 2-3). If you have a project which de- to be recognised internationally, we will forward to receiving your entry.

Marc Sansom
Editorial director



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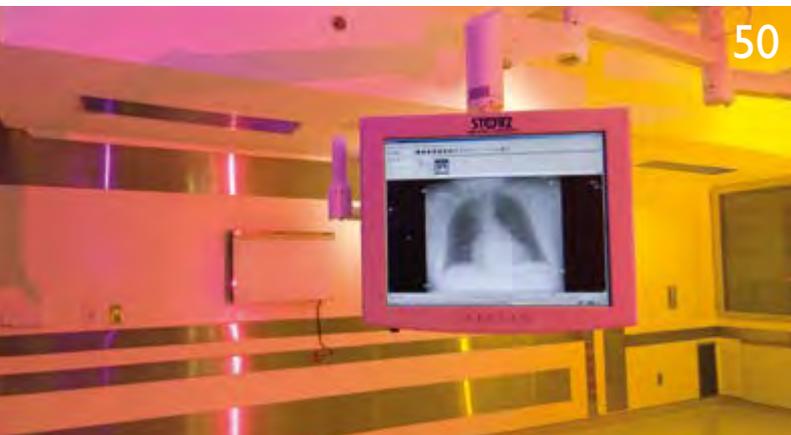
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Briefing

Elderly Care by Design 2010 has global appeal

Calls for innovative design solutions that respond to the changing and growing needs of ageing populations around the world will be led by the UK's National Clinical Director for Older People at a new international symposium and workshop in February



Dr Finbarr Martin

The part played by design in facilitating the critical but often neglected role of social interaction in preserving the health and wellbeing of older people will be one of the key messages delivered by Dr Finbarr Martin in his opening address at *Elderly Care by Design 2010: Designing Environments for Independent Living*.



Mikael Paatela

Organised by the International Academy for Design & Health at London Southbank University on 18 February, Dr Martin will be joined by some of the leading researchers and practitioners in the world to explore how better designed housing projects, hospitals, care homes and other residential environments can support independent living in old age.

Founder of the Academy and one of the speakers, Prof Alan Dilani said: "Attitudes and perspectives on ageing are changing. A health conscious and well-educated generation with new and different points of reference is emerging. More prosperous societies are also creating opportunities for people to lead an active and rich life far into old age."

With incidences of dementia forecast to rise to over one million in the UK in the next ten years, one of the world's leading authorities on Alzheimer's Disease, Dr John Zeisel, founder and president of Hearthstone Alzheimer's Care and author of 'I'm Still Here' will present his breakthrough ideas on understanding people with Alzheimer's Disease.

Chaired by Architects for Health chairman, John Cooper, the interdisciplinary event will be attended by architects, designers & health planners, nursing & care home managers, charities & elderly support groups, PCT/

SHA trust management, general practitioners, senior community nurses / health visitors, mental health & dementia specialists, estates & facilities managers, directors of health and social services, service user involvement leads, and product & service suppliers.

For more information, see pp 28, 31. To register, visit www.designandhealth.com



Attitudes and perspectives on ageing are changing

Helen Hamlyn lead research into Autism

A new research project exploring new ways to support people with Autistic Spectrum Disorders (ASD), has been launched by the Royal College of Art's Helen Hamlyn Centre in partnership with Kingwood, a specialist charity providing support for people with autism and Aspergers.

The project seeks to develop design guidance and innovative design concepts and exemplars to show best practice for design of supported living facilities for adults with ASD. Whilst much research has focused on the causes and diagnosis of ASD, less research has looked at the social implications, the need to design better environments, the implications for services and the importance of enabling the growing number of people diagnosed with ASD to have more choice and live more independently.

Critical design issues will be explored alongside factors such as ensuring dignity, increasing independence and improving

quality of life. The project will follow the people-centred approach developed over the last ten years at the Helen Hamlyn Centre to create new insight and knowledge for care providers and designers.

The project is being led by Andy Brand, research associate (lead), Rama Gheerawo research manager, Ed Matthews senior research fellow and Jeremy Myerson, director of the Helen Hamlyn Centre, RCA, and Colum Lowe, consultant research director of Being Design.

Chair of the International Academy for Design & Health's scientific committee Dr John Zeisel and its communications director, Marc Sansom have accepted roles on the project's Expert Review Panel.



Colum Lowe

Academy Awards '10 set for Toronto

The Design & Health International Academy Awards 2010 has opened for submissions.

As the leading advocacy programme in the world recognising professional excellence in the research and practice of designing healthy built environments, the awards ceremony will be held in June, 2010 in Toronto, Canada during Design & Health North America – an international symposium organised by the International Academy for Design & Health.

Attracting world experts to the judging panel, this year, the awards will feature ten categories, including: Health Project (over 40,000 m²); Health Project (under 40,000 m²); Mental Health Design; Elderly Care Design; Sustainable Design; Product Design; Interior Arts in Health; Research Project and Low Cost Project in a Developing Economy.

The deadline for entries is 1 April, 2010.

For more information or to submit, see pp 2-3 or visit www.designandhealth.com

Mexico's medical city is close to nature

Mexico: The 71-hectare Campus Biometropolis masterplan in the south of Mexico City will be designed by Foster + Partners. The campus will be a centre of medical excellence, integrating care facilities alongside state-of-the-art teaching spaces, research institutions and laboratories. The creation of a vital new nature reserve to preserve Mexico City's indigenous plants and animal species is also central to the aims of the low-carbon, mixed-use development.

This wilderness area, together with enhanced landscaped zones, will account for half of the site, providing a landscaped setting for the buildings and safeguarding the future of the land. The campus will include offices, apartments, shops and amenities to create a sustainable,



mixed-use community. The arrangement of buildings navigates a course around the Pedregal lava fields, a network of subterranean lava tube formations and caves, sections of which will be exposed to encourage scientific investigation.

The scheme, which is close to Mexico City's southern medical cluster and the National University is planned to target six key areas of medicine: cancer, cardiovascular, infectious diseases, geriatrics and pharmaceuticals.

Responding to the urban grain of Mexico City, the masterplan contains public piazzas, pedestrian streets and cooling courtyards, orientating the buildings to capture cooling winds from the north. Given Mexico City's water shortages, the campus is designed to maintain the proportion of green space through which water can be absorbed naturally into the aquifer below. Rainwater will be harvested from roofs, roads and available open space.

Nigel Dancy, design director at Foster + Partners, said: "The project will safeguard the recharging of the aquifer supplying much of Mexico City and protect indigenous plant and animal species, as well as the important geological formations found on the site."



Children's Hospital is three into one

Ireland: Dublin-based Murray O'Laoire / Brian O'Connell Associates and the London studio of NBBJ Architects have been selected to design the new 400-bed Children's Hospital of Ireland in Dublin and Ambulatory & Urgent Care Centre at Tallaght.

The facility will amalgamate the services of three existing children's hospitals, providing a full range of clinical, teaching and research specialties. David Lewis of NBBJ architects, says, "These projects offer a wonderful opportunity to advance the art and science of healthcare facilities for children."

Super-size hospital

UK: Nightingale Associates, as part of the Brookfield Constructions UK consortium, will design the £840 million super hospital in Glasgow city centre.

The New South Glasgow Hospital Campus is one of the largest hospitals ever commissioned in the UK. The new complex will span 170,000 m² and will be one of the largest "health campuses" in Europe.

It will centralise acute services currently provided by three different hospitals and will comprise a 1,100-bed adult hospital; 240-bed children's hospital; laboratory facilities and support accommodation.

The project, which is set to complete in 2015, will also contain a cardiothoracic service, a new cancer hospital; and a cardiology unit; two maternity units; two new ambulatory care hospitals, state-of-the-art screening laboratory and an A&E department.



Bidders prepare for mental health project

Canada: MAAP, Kasian Architecture Ontario and Acciona Infrastructure, which have teamed up to form AI Health Group, have been shortlisted for the design, build, finance and maintenance of a major new mental health care project for St Joseph's Health Care in Ontario. AI Health Group were shortlisted by Infrastructure Ontario alongside Integrated Team Solutions and Lend Lease Health Solutions.

The St Joseph's Regional Mental Health Care projects will involve the construction of two new facilities at two specific sites, London and St Thomas. Both facilities will serve individuals experiencing severe and persistent mental illness. The facilities for London will accommodate inpatient and outpatient services for assessment; mood and anxiety disorders; psychosis; dual diagnosis; geriatric psychiatry; adolescent psychiatry; and concurrent disorders.



St Thomas will be a new forensic mental health facility and will provide specialised inpatient and outpatient services, including assessment, treatment, outreach and support services to individuals with a mental illness who have come into significant contact with the criminal justice system.

The short-listed bidders will be invited to respond to the request for proposals, which will be released in early 2010.

WAF winners set new standards

Spain: Teleton Tampico, designed by Sordo Madaleno Arquitectos of Mexico, has won the World's Best Health Building award at the prestigious World Architecture Festival (WAF) Awards 2009 (see pp 16-17).

Teleton Tampico, in Tampico, Mexico, is a centre for disabled children, designed to allow them to interact, experience freedom and develop new skills that will enable them to better integrate with society.

The presentation of the WAF Awards took place during global architecture summit the World Architecture Festival, which was held at the Centre Convencions International Barcelona at the end of last year. Teleton Tampico was chosen by some of the world's most distinguished architects, in a highly competitive shortlist of six entries, including:

- Assuta Medical Centre, Tel Aviv, Israel; Zeidler Partnership Architects, Canada
- Home for Handicapped Children, Trondheim, Norway; Fasting Arkitekter AS, Norway
- Maggie's Centre, London, UK; Rogers Stirk Harbour & Partners, UK
- St Jozef Community Health Center, Deventer, Netherlands; OneArchitecture, Netherlands
- Kentish Town Health Centre; Allford Hall Monaghan Morris, UK

The Assuta Medical Centre in Tel Aviv, Israel, connects the city to a park, with a two tone colour scheme and angular shape giving the 500,000 sq ft building an unusual appearance



Circle's new hospital is 'like a luxury hotel'

UK: The first ever hospital completed by iconic architects, Foster + Partners has been described as 'comparable to a luxury hotel'.

Commissioned by Circle, Europe's largest private healthcare partnership, the project is the first of a chain of health campuses across the UK for the employee-owned group of 1,200 clinicians and health workers.

Opening in February, the 6,000m², three-storey building near Bath is arranged around a central light filled atrium, promoting a sense of orientation and intimacy. Public entry is from the road on the north directly into the atrium on the ground level floor.

The northern façade comprises dark panelling at the lower levels, while on the south, extensive glazing opens out to views over the surrounding countryside. The rectangular upper volume and roof, enclosing all twenty-eight bedrooms, is clad in a reflective lattice of aluminium shingles.

The double-height atrium forms the focus for patients, staff and visitors, with private consultation rooms leading from it at ground level and in-patient bedrooms arranged around it above. The main reception point, café and nurses' station occupy the atrium where daylight, drawn through the circular sky lights, is softened by a translucent fabric ribbon tracing the shapes.

Throughout the building, there is an emphasis on natural light and views: operating theatres and recovery spaces on the lower level are fully glazed to the south, looking out on to a private garden. The bedrooms on the upper floor look out onto balconies, planted with herbs and shrubs, lining the building's perimeter and oriented to maximise views across the countryside.

Spencer de Grey, head of design at Foster + Partners, said: "There is a wealth of evidence to suggest that a well-designed hospital environment can reduce recovery times."



NBBJ get green light for new cancer centre

UK: Planning consent has been granted for the development of a new oncology centre at The James Cook University Hospital.

The project is being developed under the NHS P21 programme by Interserve Health with the London studio of international architects, NBBJ as the lead designer.

The new freestanding Satellite Centre at James Cook will provide heavy diagnostic and radiation treatment services in supportive surroundings, achieved through the integration of thoughtful architecture, varied humanistic settings including art, abundant natural light and materials in a garden environment.

The project is due to complete in the summer of 2011.





Green building technologies will make a big difference in our consumption of resources, energy and our carbon emissions. However, a larger view is taking hold in the field of urban design that merges the concept of landscape as a primary tool in the fight against consumption, sedentary lifestyles, auto-dependence, public health, obesity, diabetes and asthma, as well as improving the social fabric of communities.

Landscapes are not just what surround buildings or remote, natural places that one visits on holiday. Urban designers now recognise that landscapes are systems that bind neighbourhoods together, tying whole cities into a larger functioning ecostructure. Los

Angeles is attacking this misconception head-on through its visionary plan to revitalise the Los Angeles River. Through the leadership of inspired city councillors and the mayor, the recent masterplan will make 32 miles (51.5km) of this degraded river green, accessible to people and rich with layers of restored habitats for everything from fish to the myriad of birds, small mammals and insects that together form a healthy ecosystem. As the river becomes a river once more, it will unite hundreds of neighbourhoods, centres, schools, recreation facilities and, most importantly, jobs to make the city interconnected, accessible and healthier at many levels. A river that has had a derelict influence on public health will become a green backbone to support health activities and a diversity of communities.

Greening our cities

Mark Johnson says an integrated approach to urban landscape design will lead to healthier communities

Today, as industrial economies shift to services, city

leaders around the world are seeing new opportunities in replacing failed industrial sites, rail, highway and former stream corridors with the fabrics of living green systems that cleanse urban runoff, support diverse species, provide personal mobility and connect people to people – and to the life of their local world. Atlanta is embarking on a massive project known as the Beltline – a continuous ring of landscape, trails and transit that will create a green ring of living systems that connect the core city with its outlying neighbourhoods.

In San Diego, a diverse coalition is on track to create a natural park 18 miles (29km) long linking the coastal mountains to the Pacific estuary of the San Diego River. In St Louis, private interests and city leaders are preparing to revitalise the highly depressed and decayed north side of downtown based in community partnerships to build a green community through green connections, green infrastructure and green building.

And in China designers are refitting cities with landscape systems that convey water, protect property from floods, support urban forests at massive scale and provide for a new network of interconnection for people on foot and on bikes to enjoy and grow healthier from their participation in urban landscape systems and territories.

This emerging field, which some call 'landscape urbanism', is shaping new collaborations between policymakers, elected officials, landscape architects, planners, architects and engineers. It is increasingly common that urban design is led by a collaboration of landscape architects and engineers who bring their conceptual and technical expertise together in synergistic improvements to public works and urban placemaking. These collaborations improve the sustainable health of cities themselves as well as providing significant public health advantages as cities grow, become denser and become more exciting places for a diversity of populations.

Where leadership understands that public health is an issue that requires an integrated approach to the design of their city, healthful and more sustainable results are being proven. By breaking from the old practice of letting technical and economic issues dominate, new efficiencies and new benefits are rapidly accruing to cities that make a bold step to a healthier future.



Mark Johnson, FASLA is the founding principal of Civitas of New York and Denver and a designer, author and lecturer on sustainable urbanism

The primacy of colour

Teleton Tampico, in Tampico, Mexico, is a centre for disabled children, designed to allow them to interact, experience freedom and develop new skills that will enable them to better integrate with society.

Designed by Sordo Madaleno Arquitectos of Mexico, the project recently won the World's Best Health Building award at the World Architecture Festival Awards 2009.

Providing medical, educational and psychological care and assistance, the facility provides rehabilitation and diagnosis services to handicapped children.

Located in the state of Tamaulipas, the six buildings of the 5,275m² complex interconnect and are characterised by spacious rooms, diversity of colours and outdoor green space which complement, and are an integral part of, physical therapy.

The main building is a curved gallery upon which the other elements converge in an organic composition, with large windows and access to natural daylight throughout. Complementing the built structure, the landscape is formed around a plaza, water fountains and large areas of garden space, including therapy gardens and sports courts.

Throughout the complex, the use of colour is given primacy, complementing, in the words of the architect, the "visual expression of an idea" and helping to provide an emotional context at the same time as describing the form, texture and scale of the facility. Thinking about what it feels like to be a child and their needs, the architects use colour and light to relax, please and motivate children, providing a sense of calm, joy, happiness, fulfilment and confidence.





Teleton Tampico, Tampico, Mexico

Lead architect: Sordo Madaleno Arquitectos

Architect: Iovany Fuentes Guerrero

Architect: Cándido Hernández Solorio

Architect: Jorge Jiménez Barragán

Civil engineers: Marcos Hernandez and

Mario Rogero Jiménez

Interior designer: María Isabel Gallego

Masterplanner: Javier Sordo Madaleno

Project manager: Alejandro Coeto García



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- Places and spaces for healing

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Michael Moxam, AIA



Paul Barach MD, MPH



Derek Parker, FAIA



Charles Siconolfi, AIA



Diana Anderson, MD, MArch, LEED AP

Sacred spaces

Following a year of global economic upheaval, a new world order is emerging in healthcare design. Our four experts provide a North American perspective on the drivers of change in 2010



Today's financial and economic worries, healthcare reform and sustainability efforts, paired with new technologies and patient safety issues, are creating a more competitive playing field for the healthcare industry, especially in the context of the private healthcare system. Opportunities will emerge in 2010 for collaboration as the world

aligns thoughts of efficiency and value.

A recent common denominator between the healthcare industry and the construction industry is quality and process improvement. Efficiency and a focus on risk reduction are evident in the healthcare industry in efforts to improve patient care and minimise risk domestically and abroad. Within the construction industry, the integrated project delivery (IPD) model has become the vehicle for improved design and construction processes. Collaboration between the two efforts takes shape as we fold statistics and process improvement, inherent in the healthcare spaces, into the design process as part of the IPD, creating environments around process unique to a culture and specific to a project.

Likewise, the focus on value in a competitive climate gives way to collaboration between industries – and the healthcare and hospitality industries are an easy fit. Hotel chains team up with hospitals and share construction costs, in close proximity to, or inside hospitals, designating entire floors as post-op patient rooms for elective procedures, beautifully designed and outfitted with all the necessary auxiliary spaces.

Collaboration among all these entities is necessary to serve an industry that is highly complicated, loves facts and statistics and needs to respond to current financial issues.

Eileen D Trimbach, AIA, LEED AP BD&C, EDAC, DNK Architects, US



Last year's economic upheaval presents healthcare designers and institutions with once-in-a-generation opportunities to fundamentally rethink our approach to facility design and operation. Continuing economic uncertainty will necessitate a sustained emphasis on doing more with less. As funding remains tight, healthcare institutions

around the world will continue to face difficult choices about how to spend limited capital dollars. In many cases, these decisions will result in renovation of existing facilities rather than new construction. Healthcare designers should be prepared to seize the day by developing creative new ways to yield greater value from our clients' existing infrastructure.

Technology is one area where designers should be challenging our clients and ourselves. As advances become available at an ever faster pace, have we lost ourselves in too much technology? Are differences in patient outcomes commensurate with associated technology costs? What has been lost from the practice of medicine in our race to deliver the latest modality? Similarly, should buildings always have to accommodate technology or is a more rational and sustainable approach required to design technology to fit with the existing infrastructure? Globally, we are programming our high-tech spaces to accommodate the unforeseen – but at what cost, and what benefit? Is it time to end supersizing and the need for unlimited flexibility and adaptability?

As we move ahead into a new decade, as designers we should redouble efforts to work in partnership with our clients to shape a better built healthcare environment – one that not only responds to patient needs but also respects our changing times.

Jocelyn Lum Frederick, AIA, ACHA, EDAC, LEED AP, principal, Tsoi/Kobus & Associates, US

Have we lost ourselves in too much technology?



Over the past year, our experience has been that the world of healthcare has indeed become flatter, with a worldwide demand for advanced medical technology but also a recognised need for greater efficiency and sustainability.

Economic changes have driven our North American healthcare clients to be less focused on market-driven, donor-funded buildings, but rather to consider facility improvements which enhance functional care and increase utilisation. Simultaneously, the international market has seen an increased demand for modern, patient- and family-centred facilities, aspiring to the highest level of accreditation standards and offering world-class medical technology in a culturally appropriate setting. Healing environments, sustainable design and integrated technology are now a worldwide

baseline expectation. Vast interest has been placed on healthcare facilities designed for flexibility and expansion, recognising the need to accommodate frequent change.

Healthcare providers in the international scene, and design firms dedicated to serving their specialised needs, have this singular, generational opportunity to develop new facility types and to set new benchmarks for high-quality environments focused on patient care and recovery. We have observed a range of projects, from specialised hospitals in the Middle East to cancer centres in China, from medical campuses in India and the Middle East to community hospitals in Ecuador; all of which concentrate on the basic issues of efficient delivery, clear and functional planning and high level design required to produce quality healthcare environments. In addition, international healthcare clients seek solutions responding to local and regional needs. Understanding the local process of delivery and the local considerations is an asset to design firms working in the global market.

Mary-Jean Eastman, FAIA, MRAIC, IIDA,
principal and director, Perkins Eastman, US

No one enters a hospital in a neutral state of mind



The great thing about 2010 is that 2009 is now behind us. Following a punishing year of global turmoil and upheaval, we continue to see ripple effects. Throughout the recent economic trauma there's been a sense that our world is ultimately resilient, yet many people feel burdened by added layers of insecurity.

Healthcare has always involved a quest for personal reassurance and comfort in the face of uncertainty. Even in times of relative

prosperity, any significant threat to our health, or the health of someone close to us, has a potentially devastating effect. In times of economic calamity, the impact of ill health can be emotionally disabling.

Within this context of external turmoil, hospitals should be revered with a special status as places of refuge from a troubled world. Rather than add to the burden of our illness, such spaces should be thought of as sacred: places that make profound connections with nature and have local meaning.

No one enters a hospital in a neutral state of mind. The most common emotions are fear, stress and uncertainty as patients and family struggle to cope with the added chaos life has thrown their way.

As architects, how should we respond to such a vulnerable state of mind? Should we risk trivialising such a stressful experience by creating the illusion that patients are checking into a hotel? Can they be soothed by arriving at a hospital that evokes an efficient corporate office headquarters? Or distracted by wandering through a retail shopping mall-inspired space?

Instead, we should be addressing real emotions in response to authentic needs for comfort, hope and meaning. Let's dedicate ourselves to designing hospitals that lift the spirits of people going through life-changing experiences.

While we can't predict whether there are economic bubbles or champagne bubbles over the horizon, we can predict that an authentic approach to the design of hospitals as sacred spaces will help people weather adversity.

Tye Farrow, senior partner, Farrow Partnership Architects, Canada

With the world's population headed for a lengthy old age, what are healthcare providers doing to enhance quality of life for dementia sufferers and their carers? *Veronica Simpson* reports

Dementia is a disease of the brain that directly impacts on an individual's sense of who they are and where they belong. As the disease progresses, recollections of significant events, places and people fade; the ability to navigate through even familiar territory is affected; sequential tasks become problematic – even simple procedures such as cleaning teeth or getting dressed. Gradually one's sense of competence, validity and place in the world become eroded and behaviour and moods can be erratic or inappropriate.

For decades, people suffering from dementia have been medicated and institutionalised – taken

from their homes, rich in historical and contextual associations, and placed in a building designed not for their comfort, dignity or reassurance but for efficiency and security. Is it any wonder that the 'problem behaviours' often associated with dementia, and especially Alzheimer's disease, are apathy, agitation, anxiety and aggression – what environmental design and Alzheimer's care specialist John Zeisel calls the 'four As'.

Designing for dementia

Treat the person, not the disease

Fortunately, there has been a dramatic shift in the perception and treatment of

dementia over the last 15 years, thanks to pioneering research in the US, Europe and Australia. Maria Parsons, dementia care lead for UK-based extra-care and elderly residential developer Sanctuary Housing cites a 1998 article in the *Journal of Dementia Care*, 'Design for Dementia' by Mary Marshall (who was, until very recently, director of the University of Stirling's Dementia Services Development Centre) and colleagues, as pivotal in focusing national interest on a more humane approach.

"It introduced the subject at a time when the values of person-centred care were in the ascendancy; the biomedical model of dementia was shifting in favour of a social care paradigm where dementia is regarded as a disability and attention is paid to the amelioration of environmental factors that create excess disability," Parsons says.

Since the 1990s, an enormous body of research – including Zeisel's – has demonstrated how the right environment, with the right model of care, can reduce stress-related behaviours and enhance quality of life for both carers and

cared for. The design approach is all about facilitation – facilitation of wayfinding, independence and engagement. Key guidelines include the following:

- Landmarks, in the form of artworks, sculpture or shifts in colour and texture, help with recall and interpretation.
- The domestic-style presentation of kitchen and dining spaces and lounges helps signal the appropriate activities.
- Doorways are either emphasised – if the resident is encouraged to use them, say, to get into a garden – or camouflaged if they lead to service or exit routes.
- Corridors are designed in a loop, so that residents aren't confronted with a dead end. This helps to turn 'aimless wandering' into 'purposeful walking', says Zeisel.
- Resting points, mementos or activities are



The living area at HammondCare Horsley creates a home-like atmosphere



Client: University of Stirling
Architect: Burnett Pollock Associates
Cost: £1.5m
Funding: Dementia Services Development Centre/University of Stirling
Completion: March 2002
Landscape architect: Annie Pollock, Arterre Landscape Architects

Iris Murdoch Building, University of Stirling, Scotland

The first UK public building to incorporate all the recommendations for dementia-friendly design, the Iris Murdoch Building was named after the famous British author who suffered from dementia in her final years. Architects Burnett Pollock Associates worked closely with Stirling University's Dementia Services Development Centre to represent exemplary dementia design.

The building contains both open plan and cellular office space, some residential accommodation for visiting academics, seminar space and a small living unit where design and technology aimed at helping those with dementia and their carers are demonstrated. The layout aims to minimise confusion, maximise transparency and aid orientation. Window ledges and alcoves along corridors are designed to hold mementos and souvenirs in order to trigger meaningful associations. It is festooned with artwork – wrought iron, stained glass and paintings – created by people with dementia to highlight the great creativity that people with dementia often enjoy. A teaching space opens out onto a dementia-friendly paved garden designed by Annie Pollock, featuring mosaic details and wide, low walls so that scenery can be enjoyed while security is assured.

introduced along the way.

- Activities, from making hot drinks to making art or music, are encouraged through access and availability.
- The provision of secure and appropriate gardens – easily accessed – encourages gentle exercise, activities (such as gardening) and opportunities for peaceful contemplation.
- Welcoming and friendly social spaces also help to encourage visits from friends and family, thereby reinforcing the resident's sense of self-worth.

A combination of all these elements not only reduces stress on the part of the dementia sufferer but also enhances their sense of competence and contentment, which makes the job of caring for them easier, as Zeisel has proved through the implementation of these ideas in his own specialist 'assisted living' homes, Hearthstone Alzheimer Care. Zeisel told **WHD**: "We use the environment as treatment. We also plan the environment in a way that enables people to flourish. If you carefully do what these models suggest, you can achieve incredible results."

Alan Dilani, architect and founder of the International Academy of Design and Health, has been working closely with Scandinavian elderly care providers and government departments to create guidelines for dementia design and care. His proposed model frames the aforementioned design concepts within a conceptual trio of quality of life components – 'vita activa', 'vita contemplativa' and 'vita restorativa' – facilitating activities, engagement and restoration through accessible design, community involvement and cultural encounters.

He says: "With the right model of care and design, you can definitely reduce the reliance on drugs and staff. Spending money on design in this way could even lead to savings for governments and to a quality of life that's missing in the case of most frail elderly people."

Other parts of Europe have also been engaged in an enlightened reframing of their dementia care. Architect



Belong Wigan, UK

Pozzoni Architects worked closely with Belong, a specialist care home developer, to create a model of contemporary, 'village-style' community residences for people with dementia that would support both residents and carers with the latest dementia-specific design ideas. Six brick and cedar-clad 'households' for around 11 individuals each, with en suite private bedrooms, are grouped in three storeys around a central 'street' where daily activities stimulate and encourage interaction and independence. A bistro café, fitness suite, shop, hair salon, social centre and licensed bar create a hub for residents, their visitors and the local community, 'normalising' the high-quality but secure environment. Corridors are minimised and views onto gardens or out of balcony windows maximised. Each household has its own kitchen, lounge and dining space, creating a greater sense of security and privacy. Belong Wigan is the second such scheme that Pozzoni has designed for the group. A 54-unit extra care/assisted living building of one- and two-bedroom apartments will open on the same site in January 2010, maximising community interaction and facility use.

Belong Wigan, UK

Client: Belong Construction/CLS Care Services

Architecture and interior design: Pozzoni LLP

Cost: £4.8m

Area: phase one: 3,686sqm; phase two: 4,115sqm

Schedule: first phase, opened January 2009; phase two is due January 2010

Contractor: G & J Seddon Construction

Quantity surveyor: Davis Langdon

Structural engineer: JCA Associates

Landscape designer: TPM Landscapes

Damian Utton of the UK's Pozzoni Architects set off four years ago on a global tour to assess dementia facilities and saw much in Europe and Australia that was praiseworthy. In particular, he admired the models of care that have emerged in the Netherlands and Sweden, with dementia sufferers looked after in small, family-style dwellings of six persons at most, with a 'house mother' type carer who orchestrates, and involves residents in, domestic chores and shopping to maintain involvement and independence. For various reasons, he says, such a model is considered uneconomic in the UK. But he cites a number of private care home providers who have settled on similar, family-style setups with a maximum of 11 inhabitants (see Belong Wigan case study).

Stirling leads the way

The driver for many evolutionary changes in the architecture of dementia services globally has been the Dementia Services Development Centre (DSDC) at Stirling University in Scotland, which was founded 21 years ago. The Centre runs workshops and design awareness training, demonstrating its model of dementia-friendly design, via the bespoke Iris Murdoch Building on its Stirling University site, to carers, architects and health professionals from all over the world.

Professor June Andrews, who recently took over from Mary Marshall as director, says: "This week alone we will be

showing 20 Japanese architects around the building. At our last seminar we had French, Maltese and Scandinavian architects here. I don't think there's any equivalent organisation in the world doing what we're doing."

The design ideas pioneered here have made quite an impact. "The Scottish government has now stipulated that all primary care premises must be built along dementia care principles," she adds.

The Iris Murdoch Building was designed by Edinburgh-based architects Burnett Pollock and was the first UK public building to be designed along dementia-friendly principles. There is much clever guidance incorporated in the building's handsome, modern frame, such as contrasting wall elevations. Where one features a regular pattern of small (openable) windows, another offers large, glazed doors, while another has a curved, unbroken surface. Says partner David Burnett: "If you make each elevation different, the areas are easier to identify. For the same reason, all doors into the courtyard are a different colour – so if you come out of the red door, you can find your way back in via the red door."

Although a lot of its features would seem like common sense – views through to kitchens, rather than solid walls, glazed doors to kitchen units so contents are visible, wardrobes without doors – it can seem 'revolutionary' to architects and designers who attend the now legendary summer schools, says Burnett. Though the building was designed nearly a decade ago and the practice has taken its ideas forward in other ways, Burnett says: "One of the things that still delights us about the building is how well it works. If architects always thought about how they can

produce clarity so that people with impairments can navigate their way around [their buildings], they would produce far better buildings for everybody.'

The DSDC now has affiliates in Belfast and elsewhere around the globe and it runs an awards scheme for all private sector care homes, bestowing bronze, silver and occasionally gold awards on those premises which have done the most to incorporate dementia-friendly schemes (for details of courses and training go to www.dementia.stir.ac.uk).

Sadly, within the NHS, there is less likelihood that any bespoke dementia designs will find their way into care homes. Jacques Mizan, a UK GP and design champion, says: "That ship has sailed as far as the NHS is concerned." He points to the NHS's current practice of trying to keep the frail elderly at home as long as possible and mentions the current enthusiasm for 'telehelp' systems, such as a web cam that can be fixed to someone's TV and through which they can communicate with the hospital, when necessary. What a prospect: a life dependent entirely on the television and technology, with only a disembodied voice for help or reassurance!

It has fallen, instead, to the private sector to implement pragmatic design solutions and, in many cases, they are doing so – as far as funds and business models allow. Sanctuary Housing's Maria Parsons says: "We have to square ideas with costs and extra care is expensive. In Scandinavia, they're very happy to put up lots of 10-12 person dementia-specific cottages in the countryside. We have to build care homes for 60-80 people; ideally

HammondCare Horsley, Australia

Client: HammondCare

Architect: Allen Jack & Cottier Architects

Cost: AUD\$15.473m

Area: 24,268sqm (site), 6,106sqm (building)

Completed: July 2009

Contractor: Grindley Constructions

Six individual single-storey timber-frame cottages, designed to a domestic scale, house 15 residents apiece in HammondCare's Horsley development, which has 40% financially disadvantaged residents. Each unit has its own laundry and kitchen facilities, normalising the everyday activities and environment. Bedrooms (5.1sqm) and communal living rooms are personalised and cosy. Service corridors are kept away from normal circulation and can be accessed only by staff via keypad door controls. "We want to reduce the stimuli that agitates and design in as many positive stimuli as possible. We try to manage risks and reduce boredom," says HammondCare chief executive Stephen Judd. Stable doors allow for views into kitchens and the central, communal courtyard and individual cottage gardens are sensitively landscaped, accessible and contained, with generous eaves providing shade from solar glare. The building includes offices and a staff training block.





Childers Place, Amarillo, Texas, US

The inspiration behind Childers Place is to create a tranquil, therapeutic environment where 'residents want to live, guests want to visit and employees want to work'. More than two-thirds of this Perkins Eastman-designed facility is given over to skilled-care residential space. Here, residents live in 10-person units, with private, 350 sq ft (32.5sqm) bedrooms all with views or terraces onto which the bed-bound can be wheeled. Six households of 10 are arranged into three neighbourhoods to create shorter walking distances to central facilities, which are open to the wider community. Small-scale dining and care options provide greater flexibility. Offices for local and national senior-related agencies are situated on the first floor, encouraging interaction and engagement with the facility from all generations and abilities.

Client: Mary E Bivins Foundation

Architect: Perkins Eastman

Cost: US\$18,250,000

Area: 105,000 sq ft (9,755sqm)

Schedule: master planning October 2003;

construction June 2005; completion March 2007

Landscape architects: Wolff Clements & Associates and KDC Turner Partners

Structural engineer: GRAEF

Mechanical engineer: Brown Consulting Engineers

Electrical engineer: Reynold Engineering Associates

Civil engineer: Keys and Sheehan Engineering

Contractor: Western Builders of Amarillo

we'd like to break it down into groups of 11-15 but it often doesn't work out like that because it's still pretty expensive to do that within the shell of the building."

Where business models and demographics allow, however, Sanctuary homes for the frail elderly endeavour to facilitate elements of enlightened care and design, such as its Wantage Nursing Home, developed with Wantage Care Charitable Trust and Oxford Primary Care Trust. A homely, welcoming scheme, it includes sensory gardens, bedrooms that open out onto social areas (not corridors) and strong links with the community.

Dementia care down under

"I don't think you're spending less per head in the UK than we are in Australia. It's just a question of the way we are spending it," says Stephen Judd, chief executive of one of Australia's leading dementia-services providers, HammondCare. An independent Christian charity with around 800 homes under its umbrella – 85% of them incorporating dementia specific design – its first purpose-built dementia service centre was opened January 1995.

Australia's model of dementia care is less medicalised than in the US or UK, says Judd, and the use of basic dementia design principles is now fairly mainstream and widespread. "It's not rocket science," he adds. "We know all the key elements – small, domestic-scale environments that are secure and enabling, rather than disabling, work well for people who don't have dementia too. Everything we have built for the last 15 years has been along that model of small cottages, fully self-contained, with flexibility of schedules."

Around 65% of dementia care provision is from similar church or charitable organisations in Australia, functioning with government subsidies. While admitting he may be biased, Judd reckons the charitable organisations have a reputation for 'effective and efficient' models. However, even he



The plan for Childers Place in Amarillo, Texas was designed to create a tranquil environment

reckons that there was “substantially more innovation in the sector 10 years ago than there is now”.

The US has been ahead of the curve in terms of dementia-specific design, as one would expect given its wealth of pioneering design champions combined with the private healthcare market's competitive imperatives. One of the best-established architecture firms in this sector, Perkins Eastman, recently completed a project that has won several awards for its sensitivity to the needs of frail elderly residents of all types.

The Childers Place project in Amarillo, Texas, provides elegant, spacious and tranquil accommodation for the elderly (see case study). Daniel Cinelli, principal and director, says: “Our first Alzheimer's-specific scheme was 15 years ago. We did a lot of research back then. And a lot of what we learned about people with acute dementia then we have put into all our assisted living schemes – things like multiple wayfinding cues. This scheme is divided into three neighbourhoods, and every neighbourhood has a strong, theme to it in interior finishing, colour

and furniture. Each neighbourhood has its own separate landscaped courtyard, which also has different themes, including aromatherapy and one that is more geared to activities.”

The scheme aims to maximise flexibility, enjoyment and engagement. “It's about creating a safe haven that also feels like home, so your children will come and feel free to make themselves comfortable too,” he comments. There are window seats that turn into beds for overnight stays. There is also the latest in monitoring technology so that, while allowing frail residents as much independence as possible, family members and care staff can monitor any changes in routine that can signify deterioration. Motion and touch-sensitive technology tunes into the daily patterns of residents and night-time restlessness or daytime activity can be monitored remotely via a secure website.

There is no palliative care on the site – it is brought to the resident, when required, and each spacious (350 sq ft, or 32.5sqm) resident room is fully geared up for medical assistance. Says Cinelli: “We really wanted to increase the size of the room for three reasons: one, to make the best room for the resident; secondly, to make the best room for visiting family; and thirdly, to make sure that you can use it as a hiring tool for staff.”

Once the resident is settled, there is no reason for them to be moved on. Says Cinelli: “And if they want to wheel the bed out and smell the Texas sky for one last time, they can do that.”

Veronica Simpson is an architectural writer

- Learn more at Elderly Care by Design 2010 on 18 February in London. For more information, see pp 9, 28 & 31 or visit www.designandhealth.com

More information about dementia-specific design

DSDC publications:
Cunningham C et al. *Design for people with dementia: Audit tool*. DSDC; 2008.

Various authors. *Best practice in design for people with dementia*. DSDC; 2007. This is a resource pack which includes ‘Designing interiors for people with dementia’, ‘Designing lighting for people with dementia’ and ‘Designing gardens for people with dementia’ as well as a ‘Dementia design checklist’.

Other publications:

Cooper Marcus C, Barnes M. *Healing Gardens: Therapeutic benefits and design recommendations*. New York: John Wiley & Sons; 1999.

Dilani A and Morelli A. *Health promotion by design in elderly care*. IADH; 2005.

Utton D. *Designing homes for people with dementia*. London: Hawker Publications; 2006.

Zeisel J. *I'm still here: changing your mind about Alzheimer's*. New York: Avery; 2009.

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The Amity Aged Care facility at Sutherland Hospital, Sydney



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An international symposium examining how investment in the design of environments for older people can support independent living launches this month, reports *Prof Alan Dilani*

Timeless

Elderly populations around the world are growing at a rapid rate, increasing the demand on healthcare services. Simultaneously, attitudes and perspectives on ageing are changing. The figures shown in a UN report suggest that the number of people over 60 years old tripled to 600 million between in the second half of the 20th century, and the number is set more than triple again by 2050, reaching two billion or 22 per cent of the global community.

A health conscious and well-educated generation with new and different points of reference is emerging. More prosperous societies are also creating opportunities for seniors to lead an active and rich life far into old age. This development is creating a demand for changes both in health and social care service delivery and in the design of physical environments for the elderly.

Incidences of dementia and related diseases are expected to rise to over one million in the UK in the next ten years, whilst the number of people globally with Alzheimer's Disease are expected to rise to 43 million by 2025 and to 81 million by 2050.

People with dementia progressively lose their coping abilities and perceive their environment as more stressful, resulting in anxiety and behavioural syndromes that require constant supervision.

If the environment fails to support their specific needs, the person may become disorientated, be unable to express their needs and show signs of agitated and disruptive behaviour.

Evidence shows that problematic behaviour in people with dementia is strongly related to the degree to which residential environments fulfil their needs. Treatments are needed to sustain their retained abilities and to reduce problems such as verbal and behavioural agitation, depression, and social withdrawal.

A combination of pharmacological, behavioural and environmental approaches could be the most effective treatment in improving health, behaviour, and quality of life for elderly. Medical care cannot be separated from the physical environment in which it is delivered. The outcome of pharmacological care and environmental design is an important part of the therapeutic process.

Good design can have a therapeutic effect on the behaviour and quality of life for people with dementia. The quality and character of the designed environment for the elderly should be considered to be a powerful instrument capable of improving health and well-being.

We look forward to seeing you at Elderly Care by Design 2010 to participate in a debate that is already shaping our lives and those of the ones we care for.

Prof Alan Dilani is founder and director-general of the International Academy for Design & Health

Elderly Care by Design 2010: Designing Environments for Independent Living

Elderly Care by Design is a new international symposium and workshop on 18 February in London, launched to help support a breakthrough in understanding how the design of the built environment creates the context for human health and wellbeing in old age.

Following a keynote presentation from the UK's Acting National Clinical Director for Older People at the Department of Health, Dr Finbarr Martin, world experts, including Dr John Zeisel, president of Hearststone Alzheimer's Disease and author of *I'm still here*, and Mikael Paatela of Paatela & Paatela Architects in Finland will present the very latest research findings and examples of best practice around the world, in support of the following objectives.

- Exploring how the built environment can support the delivery of high-quality, integrated health and social care services that support independence
- Identifying the key design features of psychosocially-supportive environments
- Reporting on international case studies of environments for older people
- Identifying new technologies to support independent living
- Addressing issues of capital investment, service improvement, changing care pathways, cleanliness, social isolation, access to outdoors and nature, comfort and control, privacy and dignity, interiors, art and furnishings



Dr John Zeisel



Mikael Paatela

For more information or to register, visit www.designandhealth.com

Despite its devastating health problems, Africa is making vital inroads towards self-sufficiency, with the private sector playing a key role, writes *Emily Brooks*

Supporting role

In June 2009, the International Finance Corporation (IFC) launched a major new private equity fund specifically for African healthcare projects. Over the next 12 years, the Heath in Africa Fund will invest between US\$100m and \$120m in private-sector health services, from hospitals and clinics to insurance companies and medical manufacturing companies.

"The fund emerged as a result of a study published in 2007¹, which identified that the private healthcare sector in Africa lacked access to capital, both for loans and equity – people who are prepared to make investments and try and grow a company," says Scott Featherston, senior investment officer at the IFC. "If you wanted to maximise your return you wouldn't invest in healthcare in Africa; you'd maybe invest in communications or IT. Investors are expecting a return, but there is a philanthropic motivation as well."

Part of a US\$1bn programme by the IFC and the World Bank, it represents a new way of addressing Africa's health problems.

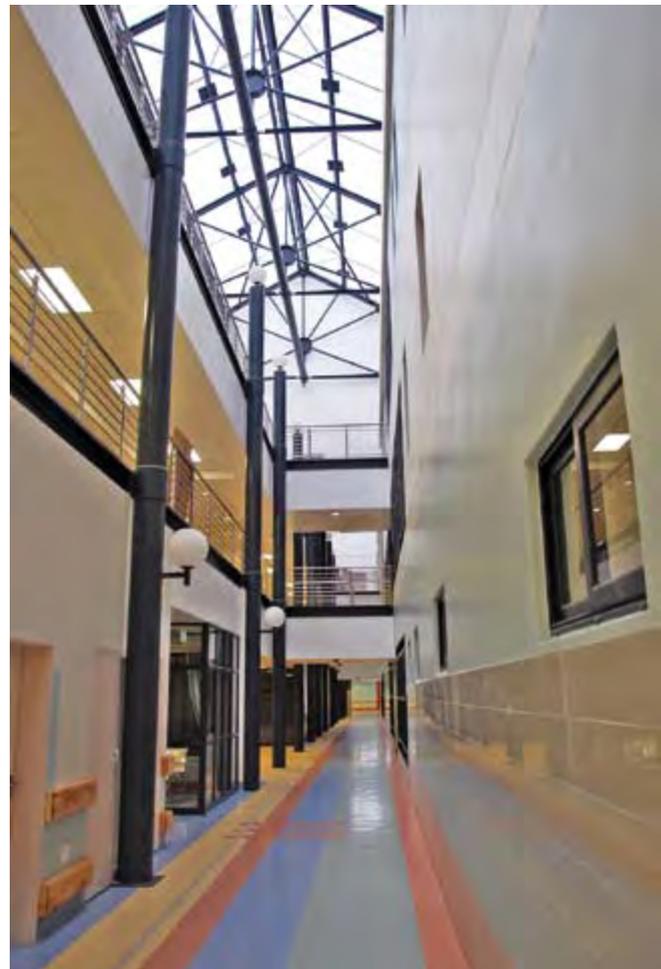
Rather than tackling disease or other clinical issues, this package is intended to target some grassroots problems: lack of infrastructure, inequitable systems that fail to support the poor – a far-sighted approach that is intended to sow the seeds of self-sufficiency for African healthcare.

"This fund is specifically excluded from providing funds to companies that only serve the rich, but it will be investing in places where a middle class is starting to emerge," says Scott. "The only way you're going to set up self-sustaining companies is if they serve a population that can afford to pay something for them."

One of the first beneficiaries will be a still-undisclosed hospital company in Nairobi. By investing a majority stake in hospitals, the fund would effectively have a say in their running, bringing knowledge and expertise of systems and management that can be crucially lacking.

While these far-sighted projects take root, life goes on for Africa's billion-strong population, many of whose mother countries labour under an unimaginable healthcare burden. HIV/AIDS, TB, malaria and maternal health are enormous issues, as is a huge disparity between skilled healthcare workers in rural and urban areas and a shortage of healthcare workers overall. Although physical infrastructure is badly lacking in many areas, the vast majority of fatalities are from preventable diseases and new hospitals filled with highly trained staff are not the answer – instead basic, if very widespread, intervention is needed in the form of public health professionals and community nurses who are able to focus on prevention and education, particularly in rural areas. A recent AMREF scheme saw 1,180 community health workers from 188 Tanzanian villages trained to increase awareness about malaria prevention and the use of mosquito nets. As a result, child mortality in the district dropped from 231 deaths per 1,000 children in 2006 to 195 per 1,000 in 2008².

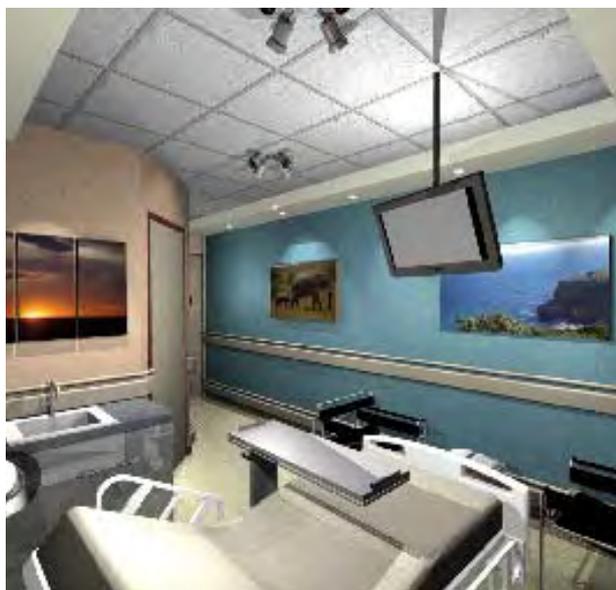
Generally speaking, governments are overwhelmed by the demand for public healthcare services and are increasingly turning to the private sector to fill the gaps – a huge opportunity. As the IFC found, however, finding investment for those private facilities is the hard part. Its discovery is backed up by a 2007



The OPD atrium at Baragwanath Hospital facilitates easy circulation

book published by the World Bank, aimed at physicians or other 'medical entrepreneurs' looking to build their own facilities³, which asserts that "a major barrier to the development of the private health sector is the scarcity of long-term capital". Intended as a step-by-step guide to setting up a new hospital, the book identifies a lack of specialist healthcare architects as a further barrier to building a successful facility and says that those practices without this experience often design hospitals "from the 'supply side' perspective. That is, architects work with an eye to what is deemed good architecture, or what will facilitate construction, rather than functionality of design, such as the ease of movements of patients and staff."

While this may be true for the small-to-medium-sized hospitals being built by entrepreneur physicians, healthcare architectural expertise within Africa is growing, as is the number of external practices working on projects there, usually in partnership with domestic architectural firms. Nightingale Associates has had a Cape Town branch since 2004; the practice has just been shortlisted for work to improve Uganda's largest state-owned hospital, Mulago National Referral Hospital. Perkins+Will has been active in sub-Saharan Africa since 1999, when it was commissioned to create a new masterplan for Agostinho Neto University



Bayelsa State Teaching Hospital, Nigeria

Client: Bayelsa State Local Government

Architect: Ngonyama Okpanum & Associates

Project cost: approximately US\$30,000,000

Bayelsa State is a fast-growing area in along the south Nigerian coast and a 500-bed hospital is currently under construction to serve its population. With the building's envelope already constructed, South African architectural practice Ngonyama Okpanum & Associates was contracted in 2007 to undertake the interior fit-out of the hospital and enhance its existing plans. The practice says of its proposal that it "lays much emphasis on the creation of an environment where superior and quality medical services are delivered to the community in a congenial homely atmosphere, thereby enhancing the therapeutic potential for rapid treatment of patients".

The building takes a semicircular shape, with major departments fanning out from a central 'hospital street'. Considerable study was made of both the hospital's needs and human behaviour patterns in order to devise the interior; with key considerations including circulation (of both patients and staff), wayfinding, accessibility, energy efficiency and flexibility with regard to future expansion. For example, the admissions ward has been remodelled not just to improve patient flow but also to allow access for paraplegics, with single seating and a lowered admissions counter. The pharmacy has been relocated right next to the hospital entrance, as opposed to being next to the service areas to which patients would have had to travel a long way.

The décor focuses on high-quality finishes fit for a modern hospital interior. Services such as room and reading lights, medical gas outlets, switch sockets, data points, nurse call systems and night lights are all neatly integrated into the design.



Bayelsa State Teaching Hospital (top to bottom):
typical single-bed ward; main entrance approach

in Angola. With the first phase of construction nearly complete, the firm is scheduled to begin a secondary phase involving the university's medical school and eventually a new teaching hospital.

Bill Doerge, principal at Perkins+Will who heads up its African interests, says: "We're seeing an increase in [healthcare] activities in most global markets, including Africa, and we are currently talking with groups about healthcare projects in Angola, Tanzania, Kenya, Senegal and the Ivory Coast."

British architect and healthcare specialist John Cooper, who in conjunction with Sheppard Robson is currently working on early plans for Johannesburg's Nelson Mandela Children's Hospital, identifies the biggest barrier of all to western firms working in the developing world: "Our wage structure is twice, maybe three times, that of India or South Africa and their build costs are maybe a third of ours, so we can never compete. Whereas we would normally get 4% of, say, a £100m budget, instead we'd be getting 4% of £30m, but we'd have to do the same amount of work."

The Nelson Mandela Children's Hospital only adds up, he says, because of the involvement of two South African practices, Ruben Reddy and GAPP, "who are doing 55% of the work". Cooper says that from what he has seen in South Africa so far healthcare architects there are "exceedingly good".

Humanity for Children paediatric clinic

Client: Humanity for Children

Architect: Sheikh Ahsan ullah Mojumder,

Department of Architecture, Bangladesh

University of Engineering & Technology

This was the winning entry in the international Architecture for Humanity competition – a paediatric clinic for Humanity for Children, a US-based charity that seeks to eradicate preventable illness in children and their mothers in East Africa. The entrants, of which there were more than 900 from 50 countries, were asked to design a generic clinic that might work across several terrains and locations. They were also asked to address problematic issues such as security (potential thefts) and power/water supply, and to focus on the use of available resources and local materials.

Sheikh Ahsan ullah Mojumder's winning design is based around an open courtyard with a residential block for medical staff (since it is anticipated that attendants would travel a long distance to the rural clinic and stay for several days). The buildings consist of several modular components that make it easy to adapt the design to steep or flat terrain and are constructed from thick mud walls, timber posts and frames, corrugated iron sheets for the roof and thatched infill walls – materials that are readily available in east Africa. A slight inward taper of the mud walls ensures structural stability. It also uses a rainwater collection system, natural ventilation and cantilevered roofs to provide shade.

Humanity for Children is still working to raise funds to construct the clinic.



Children for Humanity: space for teaching and interaction (left); view from the occupational therapy building (below)





Chris Hani Baragwanath Hospital: courtyard connecting outpatients department with pharmacy and administration (above); main waiting area near entrance (below)

Nkonyama Okpanum & Associates is a practice with four offices in South Africa. It has worked on several high-profile projects, including the fit-out of Nigeria's Bayelsa State Teaching Hospital (see case study) and a huge overhaul (part demolition, part newbuild and part refurbishment) of Soweto's Chris Hani Baragwanath Hospital, which, with 3,200 beds, is claimed to be the biggest hospital in the world.

The practice has a forward-thinking, international outlook that puts research at the heart of every project. "We believe in a 'from practice to research and from research back to practice' approach," says its principal, Innocent Okpanum. "Once you finished something, you have to study your mistakes. Then you know how to improve what you've done. And that's translated into new work – it's an ongoing process."

Okpanum is passionate about the 'humanisation' of healthcare buildings and the process of creating them – whether that means putting a strong emphasis on design

guidance, with all the principal stakeholders in a project sitting down to define their relationships and work collectively to establish the needs and functions of a facility, or to banish, for example, shared

Governments are overwhelmed by the demand for public healthcare services

wards in favour of single rooms, where patients can be admitted, treated and discharged in privacy. This philosophical approach, which Okpanum picked up during years of study in Italy, is at odds with many of those in his profession in Africa. "Creating symbolic places – and that absolutely includes hospitals – has the ability to change the international perception of a country. Unfortunately, most of my colleagues see architecture as an island: they haven't really understood that architecture is politics; architecture is economics; architecture is ethics; architecture is values; it is everything."

Emily Brooks is an architectural writer



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Royal Women's Hospital, Melbourne (Image: Woodhead)

Office of Aboriginal and Torres Strait Islander Health (Image: ARUP)

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Topic areas

- Salutogenic health perspectives, theories and application
- Innovation in health planning and preventative care models
- Design and architecture for health and wellbeing
- Sustainability, climate change and global health
- Emerging medical technology and its impact on health



Southland Base Hospital, New Zealand (Image: MSI)



Royal Children's Hospital, Melbourne (Image: Bates Smart)

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Global perspectives

The first of a new series of international symposiums and exhibitions will bring leading speakers from around the world to Sydney at the end of April to provide a global context for health infrastructure development in the Australasian region, writes *Marc Sansom*

Australia and New Zealand's successful history of socio-economic development has established their reputations as two of the best places in the world to live and work.

In a globalised and increasingly interdependent world, however, the continuous improvement of the quality of life of the citizens of all nation states will be founded on the recognition that a healthy population is the cornerstone for social development and economic growth. Today's rapid movement of individuals and populations living in ever larger, multi-cultural, urban environments, combined with the equally rapid evolution of the knowledge society means that the world we live in today is one with few boundaries.

In the 21st Century, the health of nations is a global issue.

At the same time, a rising public awareness of the importance of health and wellbeing and increased demand for well-designed, humanistic environments, set against the rising cost of healthcare, rapid advances in medical technology, ageing populations, climate change and world poverty, is placing ever greater pressures on health systems around the world.

A new paradigm that recognises that human health is significantly related to the designed environment is needed. A 'salutogenic approach' to health infrastructure development embedded at the core of a preventative care strategy changes the focus from risk factors and the treatment of disease to a more holistic understanding of healthy environments.

The salutogenic perspective and a focus on wellness factors can be used to inspire innovative design and infrastructure solutions, meeting objectives for enhancing human health by facilitating an active lifestyle, and enabling the successful management of physical, psychological and emotional stress in our daily lives. This application of 'salutogenic' approaches to health infrastructure development can be one of the most cost-effective and enduring approaches to improving public health and containing costs.

Design & Health Australasia 2010 will explore global 'salutogenic' perspectives on the planning, procurement, finance, design, construction and operation of health facilities within the local context of infrastructure development in the region.

The symposium will discuss how 'salutogenic approaches' to health infrastructure development in Australasia can provide a more cost-effective context for enhancing human health, wellbeing and quality of life. We look forward to seeing you in the city of Sydney.

Marc Sansom is a director of the International Academy for Design & Health and editorial director of World Health Design

Design & Health Australasia 2010: Global Perspectives. Local Identities. An International Symposium & Exhibition

Venue: Hilton Hotel, Sydney

Date: 28-30 April, 2010

Design & Health Australasia 2010 is an international symposium and exhibition, launched by the International Academy for Design & Health that aims to bring a global perspective to health infrastructure development in the region by:

- Evaluating different international models of care, and the latest health theories and perspectives based on the salutogenic approach
- Reflecting on the socio-economic factors impacting on the design and development of health infrastructure in Australasia including demographic change, medical technology, patient choice and cost
- Reporting on case studies of health buildings that are delivering real and measurable benefits in the region and around the world
- Recommending actions and initiatives to improve the design quality and operational management of the health infrastructure in Australasia
- Exploring how to create a sustainable infrastructure that supports health, wellbeing and quality of life and meets the region's social, environmental and economic goals

International Speakers



Prof Ian Forbes,
Australia



Dr Liz Gale,
Australia



Dr Ray Pentecost,
USA



Prof Paul Barach,
USA

Design & Health Scientific Review

What a difference (almost) a day makes?



Dr John Zeisel is chair of the international advisory board of the International Academy for Design & Health and president of Hearthstone Alzheimer Care

Babies wake us in the middle of the night. Teenagers stay up all night. A brisk walk in the sunshine for an hour in the morning gives us an energy boost that lasts all day. Jet lag travelling west has different effects than jet lag when travelling east. As we age we tend to get up and go to bed earlier than when we were younger. People living with Alzheimer's sometimes get upset in the late afternoon and wake up at night without knowing what time it is. Older people in nursing homes often doze off in the

early evening. Wirz-Justice and Fournier's article on light, health and wellbeing explains the brain science behind all of these behaviours – chronobiology; the science of biological rhythms. It addresses the age old question of the place of basic science in design practice by showing how recent discoveries in the biology of the eye and careful neuroscience analysis of circadian rhythms can play a central part in healthy design decision-making.

The authors ask an important question: "Are we, through insufficient awareness of chronobiology, doing damage to people's health and well-being as a result of the way in which we design the built environment" – from individual house design to the planning of cities. The answer is a resounding yes; and we need to pay attention.

Some of the many design decisions that knowledge of this science can and should be affected, according to this article, include: housing design that provides access to bright natural sunlight in the morning when we wake up; indoor lighting and access to daylight that reflect a natural light-dark/day-night cycle in intensive care, neonatal units, in centers for those who are paraplegic, in nursing homes and in residences for people living with Alzheimer's; sustained high "bursts" of light for an hour in the morning in schoolrooms; shifting blue and red colour spectrum lighting at different times of the day in indoor environments; higher light in the evenings in environments for the aged; offices that do not obstruct access to natural entrainment cues such as views of the direction and azimuth of the sun; urban design and planning that provides access to natural zeitgebers; artificial light sources in public and private areas that minimise light pollution at night especially in residential areas.

One thing is certain. I shall never forget that our endogenous internal clocks run in almost (circa) 24-hour (diem) cycles, the reason this phenomenon is known as "circadian" rhythm.

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Light, Health and Wellbeing: Implications from chronobiology for architectural design

Anna Wirz-Justice PhD,
Colin Fournier AA Dip (Hon)



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Ergonomics and Flexibility: The operating room of the future

Sheila Theophanides OAQ, MRAIC, AIA,
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Surgical Clothing Design: Dressing up for surgery

Noemi Bitterman DSc, Anna Becker MSc,
Yoel Donchin MD

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Patient Accommodation: A comparative study for therapeutic daylighting design

Md Ashikur Rahman Joarder, Prof Andrew Price,
Dr Monjur Mourshed



Elderly residents enjoy the sunlight at the Pozzoni Architects' designed Belong Wigan centre for people with dementia

Light, Health and Wellbeing: Implications from chronobiology for architectural design

The design of health centres and other buildings needs to take into account the biological effect of light on different sectors of the population

*Anna Wirz-Justice PhD,
Colin Fournier AA Dip (Hon)*

Chronobiology is the science of biological rhythms, more specifically the impact of the 24-hour light-dark cycle and seasonal changes in day length on biochemistry, physiology and behaviour in living organisms¹. In the last 20 years, chronobiology has moved from its somewhat obscure scientific corner to a high-impact mainstream research field, notably with respect to the discovery of clock genes and peripheral oscillators – and a novel photoreceptor in the eye with specific input to the circadian system.

Key discoveries in human chronobiology are related to the impact of light. Recognition

of the so-called 'biological effects of light' by lighting manufacturers has led to interest in developing new lighting systems that integrate this knowledge. Is it time for the medical mainstream to take notice of what neuroscientists know about the body clock? And is it also time for architects to do so?

These questions were explored at a symposium for architects, lighting engineers and manufacturers, initiated by Society for Light Treatment and Biological Rhythms (www.sltrb.org), in order to develop approaches to bridge the gap between these disciplines.

Main questions

Two timely questions to start this interdisciplinary discussion are:

- Do chronobiologists feel that their research has reached a point where clear conclusions can be drawn in terms of the drafting of design guidelines? Do they understand what architects and lighting engineers want?
- Do architects and lighting engineers feel that chronobiologists have provided enough information for them to be able to understand key principles and be in a position to evaluate how chronobiology might affect design?

On these issues, there is a marked difference in positions between the two groups taking part in the debate. The scientists, on the whole, remain cautious and circumspect, reluctant to draw hasty conclusions and to see them turned prematurely into design recipes. For them, the key questions seem to be: how can we obtain additional data? What type of further research is required?

Architects, lighting designers and manufacturers working within the realm of applied science are accustomed to working with imperfect and incomplete data; they are used to jumping in at the deep end, to cutting corners methodologically and to making 'live', full-scale experiments rather than conducting rigorously controlled laboratory research. We need to bridge the two cultures to find a compromise – to provide a short guide to chronobiology, however incomplete, that can be used as a design tool.

Radicality and urgency

The second set of questions concern the perceived magnitude of the potential impact and the urgency of the measures that may need to be taken.

- How radical could the impact of chronobiology be on architectural design?
 - How urgent is it to look into this matter?
- Are we, through insufficient awareness of chronobiology, doing damage to people's health and wellbeing as a result of the way in which we design the built environment, not only so far as individual buildings are concerned, but also with respect to cities and urban landscapes?

On the above two questions, it is pertinent to draw a parallel with the impact that scientific research into global warming and environmental sustainability (also very cautious at first) has had on the disciplines dealing with the built environment and with the corresponding professional practices and industries.

It is clear that architecture and urban design, as well as lighting engineering, product design and manufacturing, have been profoundly affected in the last few years by the recent (albeit rather late) growth of awareness concerning the impact of the built environment on sustainability.

The majority of building regulations and product specifications have now been changed (or are in the process of being changed) to reflect changing priorities concerning the environment and the above listed disciplines have, as a result, been revolutionised in the span of a decade. The world around us, on all scales, from the design of lighting fixtures to the layout of cities, is changing rapidly.

Are we to expect a comparable design revolution once the criteria related to chronobiology are fully understood and embedded into practice?

Standards and regulations

The third set of questions relates to consensus:

- How close are we to being able to establish design standards related to chronobiological criteria?
- Would such standards lead to mandatory regulations or would they be laid down in the form of guidelines?
- How would they be implemented and monitored?

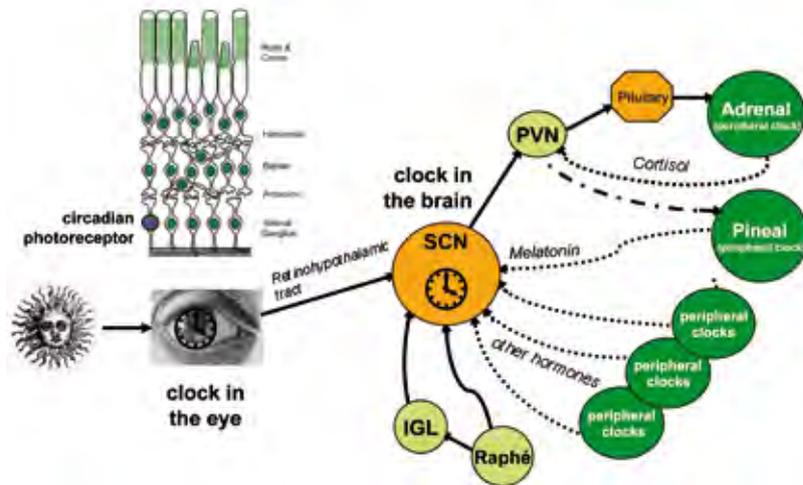


Figure 1: Schematic of the circadian timing system

The central circadian clock in the suprachiasmatic nuclei (SCN) drives downstream rhythms through neuronal output to the paraventricular nucleus (PVN) and hence to the pituitary (hormones) and the pineal gland (melatonin), and to peripheral organs (adrenal, liver, muscles, etc) which also contain circadian clocks. There are hormonal feedback loops to the SCN and direct neuronal input from other brain regions such as the raphé nuclei (which contain serotonin, a neurotransmitter implicated in mood and sleep regulation), and the intergeniculate leaflet (IGL) of the thalamus. A clock in the eye gates light input to the SCN via the retinohypothalamic tract. This pathway leads directly from the circadian photoreceptors in about 1-2% of the ganglion cells of the retina, which contain the photopigment melanopsin sensitive to blue wavelength light

Conflicting criteria

The fourth set of questions involves conflicting requirements. Design criteria related to environmental sustainability remained for a long time in sharp conflict with other criteria (and conventions) affecting design – in particular aesthetic criteria. 'Green architecture' was confronted with powerful taboos within sophisticated international architectural circles. Its connotations were perceived to lie with aesthetically mediocre, narrow-minded and reactionary design. Is this prejudice likely to raise its head again with respect to the design criteria that might emerge from a better understanding of the principles of chronobiology?

One of the main potential conflicts resides in particular with energy consumption:

- Would a greater awareness of the importance of chronobiology lead to higher levels of artificial lighting illumination and hence higher energy consumption?
- Could this be offset by design principles and guidelines calling for a greater use of natural daylight, and focused, timed, artificial lighting application?
- How can natural, endogenous biological rhythms – circadian and seasonal – be balanced with a 24/7 society where economic and social requirements take no notice of the

geophysical environment?

With this broad set of questions in the background, the task is to integrate knowledge from the disparate disciplines. In order to understand the important implications of circadian rhythms for health and wellbeing, a brief summary of the state of our knowledge in chronobiology is required.

The human biological clock

The circadian timing system consists of a number of linked elements (Figure 1) (reviewed by Hastings *et al*²). Each of us possesses a biological clock in the brain. This central pacemaker is located in a group of about 20,000 neurones in the suprachiasmatic nuclei (SCN) of the hypothalamus, with an endogenous rhythm, genetically determined by our clock genes, close to, but not exactly, 24 hours. This does not mean that the biological clock is sloppy – the day-to-day precision is exact, but its periodicity is different from person to person.

The SCN sends neuronal output to various brain regions and target organs secrete hormones in a rhythmic pattern. Some hormones (such as melatonin synthesised by the pineal gland) can feed back on the central clock. Information from the environment is transmitted via recently discovered

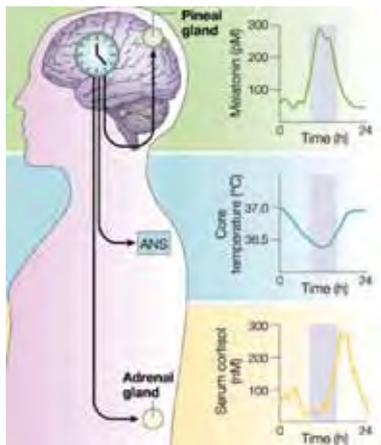


Figure 2: Schematic of selected outputs of the circadian timing system. The central circadian clock in the SCN, synchronised to the 24-hour day, drives rhythm in the periphery. Top: plasma melatonin rises in the evening before sleep and falls in the morning (and is suppressed by light). Middle: core body temperature shows a maximum in the afternoon and declines before sleep, rising after a late-night minimum in the early morning. Bottom: serum cortisol, low in the evening and early night, rises to a maximum before awakening. Reprinted by permission²

photoreceptors containing the novel photopigment melanopsin, which is most sensitive to the short-wavelength end of the visible spectrum light corresponding to blue and near-green light. These photoreceptors connect to a non-visual, retinohypothalamic tract leading to the SCN. Non-visual means that primarily information about illuminance and the light spectrum is transferred to the SCN. This is different from the classical photoreceptors (rods and cones) that connect to the optic tract leading to brain regions responsible for the sensations of colour, lines, movement and shape.

The existence of specific, highly conserved photoreceptors and a separate non-visual photic neuronal pathway to the brain of all mammals indicates the evolutionary importance of circadian rhythms for survival. Every measurable function shows a reproducible 24-hour rhythm, each with individual timing of maximum and minimum to optimise its particular role.

Rhythms that subservise a similar function cluster together synergistically; those that are antagonistic are separated in time, an admirably efficient solution.

Figure 2 illustrates this principle with three examples of SCN-driven rhythms in the periphery: the secretion of the pineal hormone

melatonin during the night (suppressed by light); the output of the autonomic nervous system regulating temperature, which has an opposite rhythm to that of melatonin, being minimal at night; and the adrenal gland synthesising the activating hormone cortisol, low in the evening when sleep should begin, rising in the second half of the night to be maximal upon awakening².

The endogenous rhythm is called circadian because it is only 'circa diem' – with a periodicity near to, but not exactly 24 hours. Internal time must be entrained to the external 24-hour day with so-called 'zeitgebers' or synchronising agents. The most important zeitgeber for humans is light. Of course, social cues, meals and exercise all play a role and administration of exogenous melatonin has zeitgeber function.

How light acts as a zeitgeber

One of the basic tenets of chronobiology is that stable synchronisation (known as entrainment) is essential for health (Figure 3). The existence of multiple clocks throughout the body (Figure 1) means that the circadian orchestra needs a conductor to ensure good entrainment³. To permit optimum functioning, therefore, the SCN must first synchronise to the environment and oscillators in peripheral organs must follow. Not all zeitgebers synchronise the same clock(s). Light and melatonin are zeitgebers for the SCN. Exercise is a zeitgeber for muscles and meals are a zeitgeber for the liver. Since synchronisation of peripheral oscillators with each other and the SCN can be a slow process, sustained, regular 24-hour zeitgeber input is necessary.

The discovery in 1980 that light over 1000 lux was necessary to affect the human circadian system entirely changed our approach to light as zeitgeber (Figure 4)⁴. This is the outdoor light intensity as the sun comes over the horizon. The finding initiated the use of bright light to treat seasonal affective disorder or winter depression (standard treatment is now 10,000 lux for 30 minutes) and more than 25 years of research all over the world has documented that light is the treatment of choice for this illness⁵. In addition, light therapy has been used successfully to treat circadian rhythm sleep disorders so that individuals' internal time is better synchronised to external time⁵.

Light at different times of day can have opposite effects on the biological clock.

This is the principle of the 'phase response curve', which helps us adjust our endogenous circadian rhythms to environmental time cues. Light in the morning induces a phase advance (rhythms are shifted to earlier, as in a transmeridian flight east) and, in the evening, a phase delay (rhythms are shifted to later, as in a transmeridian flight west). In particular, light exposure at dawn and dusk are the most sensitive times to ensure good entrainment and require much lower light intensities for a physiological effect.

Chronotype

Clock genes are an important determinant of our endogenous circadian rhythmicity. Individuals vary greatly – and this leads to differences in timing of the sleep-wake cycle, otherwise known as chronotype³. Early chronotypes ('larks') and late chronotypes ('owls') may be well synchronised, but at different phases. In addition to a genetic determinant, chronotype changes with development⁶. Children are early birds, but at the beginning of puberty, their sleep-wake cycle starts shifting later and later. At about age 20 (the 'end of adolescence'), this developmental delay reverses slowly, leading eventually to the early morning awakening and early bedtimes of older persons.

Chronotype differences can lead to problems with getting up in time for school or work or inadvertently falling asleep in the early evening – or not being able to sleep when required. This difference between biological time and external requirements has been given the most appropriate name of 'social jet lag'⁷.

Thus, one cannot advocate the same lighting requirements for teenagers and nursing home residents and one cannot assume a given timed lighting regimen is appropriate for individuals of different chronotypes working in the same office.

Circadian misalignment and health

When we measure with photometers over 24 hours how much light healthy people actually get, the results are somewhat disturbing; very few people, even in sunny climates, are outdoors sufficiently long enough to get their daily ration of sunlight for entrainment. Although indoor lighting (between 50-300 lux) is perfectly adequate for the visual system, it is near darkness for the circadian system. The human species evolved to function with

more than one hour of daylight per 24 hours – but now in industrialised nations we appear to receive too little light during the day and too much light at night.

Is the increase in mood and sleep disorders related to unnatural lighting patterns? It is clear that more and more people's working and social lives are disrupted by skewed sleep patterns. And little respect is paid to the light-dark environmental cycle by a society demanding shift work and inflexible work and school times in winter and summer¹.

There is some evidence, gathered in extreme medical environments (intensive care units, neonatal units, paraplegic centres and nursing homes), that a natural light-dark/day-night cycle is important for health and recuperation.

Architecture-related findings show that outcomes in a cardiac intensive care unit after a heart attack are better in sunny rooms compared to dull rooms, with lower mortality⁸. Similarly, hospitalised patients with depression improved approximately three days faster when admitted to brighter rooms than in rooms receiving less daylight^{9,10}. In fact, by installing brighter lights on a psychiatric ward, depressed patients had a three-day-shorter duration of hospitalisation¹¹. Increasing light intensity in the day-rooms of nursing homes where demented patients spend most of their time has also been shown to slow down the rate of cognitive decline and improve depressive mood when compared with demented patients living under normal lighting regimens¹².

Most of the evidence base for the therapeutic effect of light has come from treating mood and circadian rhythm sleep disorders. These unequivocal findings in both seasonal and non-seasonal depression, and in a variety of psychiatric and neurological disorders, provide the clinical evidence that structured light exposure – intensity, duration and timing – is therapeutic. Thus, the logical follow-up to putatively prevent these illnesses is to pay attention to daily light regimens and consider adequate light exposure as a major factor underlying health and wellbeing.

Integration and practice

Given the above summary of circadian rhythm function in humans, what are the next steps in implementing this knowledge in the development of a more 'physiological' architecture?

What are, within the disciplinary fields related to the built environment, as well as the corresponding professional practices and industries, those that might be affected by the growing awareness of the importance of chronobiology? Might the range of the affected fields be as comprehensive as that resulting from the priority that was eventually given to environmental sustainability?

These fields potentially include the following:

- product design
- interior design
- lighting design and engineering
- architecture
- urban design
- landscape design
- city planning
- transportation engineering
- utilities engineering
- building sciences

Within each of these fields, is there a sufficiently detailed understanding of the possible impacts?

Research cooperation

What type of joint research projects could be envisaged between scientists and architects/lighting designers to explore this topic further? What form could such a cooperation take?

People working in the building sciences tend, by nature as well as by necessity, to proceed by trial and error within the messy conditions of the 'real world', dealing with many parameters simultaneously, while scientists seek to isolate variables in controlled environments. Would it be feasible to bring the two together in the context of experimental projects that would explore the application of chronobiology to architecture?

What type of projects could be envisaged, and at what scale? Is it feasible to envisage the design of a prototypical 'circadian house' (workplace, hospital, etc) that would seek to address comprehensively the key principles of chronobiology?

Much can be learned from case studies of projects that have already been realised, particularly within medical establishments, schools, workplaces and retirement homes. The successful home use of light therapy by individuals with circadian rhythm sleep and mood disorders has supported the premise of an important relationship between the built environment, light-oriented behaviour and healthy functioning.

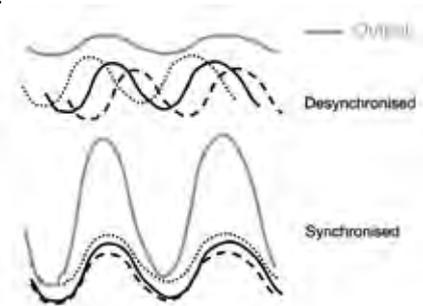


Figure 3: Schematic of how zeitgebers stabilise circadian rhythms. Coupling central and peripheral rhythms to the 24-hour day results in a high amplitude rhythm which is stable. A low amplitude rhythm is more easily shifted and less reliable day to day

Draft guidelines

We already have a few simple guidelines, though as yet without any detailed recipes.

- Homes and workplaces may need to achieve higher intensity light at certain times of day, without compromising visual comfort. However, this is not required in all parts of the room (energy dissipation) but rather near the eye of the individual. Different chronotypes will require personalised regimens.

- Specific requirements of different age groups need to be taken into account. Adolescents and young adults have a somewhat delayed biological clock and have difficulty getting up in the morning. They would profit from bright morning light as soon after getting up as possible (at the breakfast table) or dawn simulation in the bedroom. School rooms may be too dark in the morning and require a luminous burst for the first hour. In contrast, older persons have a biological clock that has shifted earlier (often resulting in falling asleep in the evening and in early morning awakening). Evening light in their preferred environment may help them stay awake until a later bedtime.

- This higher intensity light should be achieved, as far as possible, through the use of natural daylight, because of the higher levels of illumination that it offers, compared to artificial light, as well as its other zeitgeber cues: varying levels of illumination, colour temperature and sun orientation during the course of the day, from dawn to dusk. The twilights themselves are biologically active and span seven orders of magnitude below sunrise level. We need to use and extend 'intelligent' and effective daylighting systems.

- Internal spaces within buildings, should, as far as possible, be designed in such a way as not to obstruct the entrainment cues offered

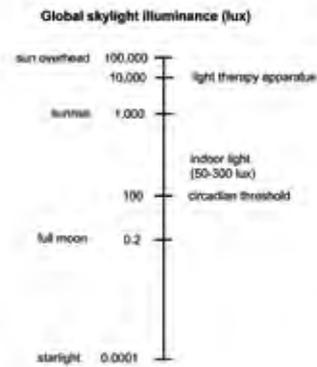


Figure 4: Range of daylight intensities visible to the human eye

by the natural environment, particularly in terms of the direction and azimuth of the sun, by minimising overshadowing and allowing distant views.

- The most common design example is the customary placing of bedrooms towards the east, so that the orchestration of early morning light conditions within the home can be in phase with the corresponding physiological timing of waking up. It may be beneficial to apply this synchronisation principle to other activities that take place on a regular basis within the home and other buildings, such as food preparation and meals, different kinds of work and educational activities, as well as leisure activities.
- In conditions where insufficient daylight penetration occurs within a building, the design of artificial lighting should seek, as far as possible, to simulate the key characteristics of natural light with respect to those variables that are significant for chronobiology.
- The spatial planning of land uses within the urban fabric should be considered with a view to fully experience the circadian and seasonal

periodicities of the natural environment.

- The discovery of the blue-sensitive melanopsin-containing photoreceptor and studies showing that monochromatic blue light is more efficacious than, for example, monochromatic green light to suppress melatonin, phase-shift circadian rhythms and enhance alertness and performance has led to rapid development of high colour temperature lighting devices. These have been installed in schools, nursing homes, and offices, with some indication of improved function of the inhabitants of these rooms in short-term studies.

However, the circadian system is not quite so simple. Recently, it has been shown that red light can sensitise the melanopsin photoreceptor to enhance melatonin suppression and phase shifting. Thus, the cones that subserve daytime visual sensory function also play a role.

Almost surely, dynamic lighting systems of the future will programme different colours for different purposes (enhancing vigilance or helping to fall asleep) in a particular sequence and in different intensities. We do not yet know enough of the specifics of this complex system. Already existing multicolour lighting devices on the market are based on insufficient circadian know-how to be used properly.

- Buildings are already equipped with numerous timekeeping devices and sensors designed to adjust various parameters of the internal environment during the daily cycle, particularly to control temperature variations via thermostats and timers. Responsive systems are also used to control lighting conditions, but until now they have not been so common. It will be necessary to ensure that

buildings are fully informed, via photosensors, of the lighting conditions within their interior environment as well as the exterior and to monitor occupancy conditions.

- Artificial light sources, both within public places and private spaces, should be designed and placed so they minimise the amount of light pollution at night, in order to achieve adequate darkness conditions in residential areas within the city and in sleeping areas within the home. Darkness is an important determinant of circadian adjustment, as is the gradual twilight transition from darkness to daylight.

This summary of questions and discussion topics at the Society for Light Treatment and Biological Rhythms meeting are to be considered the beginning of a dialogue to improve quality of life through careful lighting and building design in everyday home, work and hospital environments.

Acknowledgements

The architecture symposium and round table at the 21st Annual Meeting of the Society for Light Treatment and Biological Rhythms was supported by a grant from the Velux Foundation, Switzerland. We thank Namni Goel, Markus Haberstroh, Phillip Mead, Mirjam Münch, Jean-Louis Scartezzini and Michael Terman for helpful comments.

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Orthopaedic surgical suite, CHUM Nôtre-Dame Hospital

Ergonomics and Flexibility:

The operating room of the future

This case study of the orthopaedic operating suite at Montreal's Hôpital Notre-Dame, CHUM, examines how to design an ergonomic operating room that is ready to respond to the technological demands of the future

Luc Dubé PhD, Sheila Theophanides OAO, MRAIC, AIA

The rapid growth of minimally invasive techniques in surgery has changed the surgical environment in an irreversible way. This revolution in technology has triggered a proliferation of equipment in the operating room (OR) environment. This was a real challenge for our project, where we were confronted with building an orthopaedic

operating room that could function for both the open surgery and the minimally invasive procedures that would develop in future years. Our goal was to create a perfectly functional orthopaedic surgical suite, which could evolve over a 10-20 year period. To make an accurate projection is a real challenge, as technology and equipment will both progress and change in this time period.

What we wanted to do was to design a room that would be both flexible to new

technology and yet be ergonomic for the surgical team from day one (nurses, respiratory technicians, surgeons, anaesthesiologists, etc). The solution that we propose is applicable to other specialities with some minor changes.

The architectural concept

In developing our solution, we were confronted with multiple challenges, but the principal ones were the ergonomics and

flexibility requirements in the architectural concept. A typical operating room size for orthopaedics, cardiology and neurology is around 650-700 sq ft (198-213 sqm). What is of particular importance, though, is the functional layout of specific zones within the operating room. If a dedicated zone is provided for each group of users, then room size can vary, as long as cross-circulation between critical zones does not occur.

In the case of this OR, which was designed as an extension of an existing surgical suite that did not have a central sterile core or a separate sterile corridor designated for supplies and patient access, access to the different zones of the room were from the same points of entry: either the scrub area or the corridor. It was concluded by the user groups that the best scenario for layout was to locate the anaesthesia zone as far as possible from the room's general circulation, but in proximity to the scrub area. This layout scenario gives the anaesthesiologist access to the anaesthesia machine via the scrub area without using the corridor access. When the fluoroscopy imagery is needed, then equipment and personnel can enter through the suite via the corridor.

As the primary approach for full flexibility was the constant objective, the orthopaedic OR was designed to allow full flexibility in the orientation of the OR table within the room. This meant that the equipment booms and the laminar flow ventilation above the table needed to respond to the option of rotating the OR table 90 degrees in either direction. This would permit a left-hand or right-hand approach to the OR table, as well as a preferential torso or lower body approach in either direction. In order to enable this, the laminar flow was designed as a square form rather than a rectangular form above the table area. This, of course, increased the laminar flow sterile zone, which in turn created other challenges, notably the location of the ceiling equipment above the table.

The anchoring plates for the anaesthesia and surgical equipment booms were located in the head area of the surgical table. The anaesthesia anchoring plate was at the patient's right side and the surgical equipment anchoring plate on the central axis of the patient (in a head-to-foot direction). This configuration allows the equipment boom to

be either on the left or right of the patient. An anaesthesia mobile boom was chosen instead of a fixed telescopic service column (variable height). This was to give more flexibility in terms of the anaesthesia machine's location and could also allow a 90-degree rotation of the patient. This was also done in order to facilitate the circulation on the corridor side of the room.

Ceiling-mounted equipment layout

The number and location of ceiling-mounted booms for the orthopaedic operating room was the subject of many discussions. A simulation of equipment locations was done in a full-scale mock-up with each user group involved in the project, in order to validate the location of equipment and ensure proper ergonomics for all staff. In the case of orthopaedic open surgery, there are large numbers of instruments and surgical items that are required which need to be organised on sterile tables located under the laminar flow sterile zone, for example in hip replacements.

It is crucial to provide each group of professionals enough space to perform the

increasingly complex techniques required by current surgical activities. Moreover, in a teaching hospital context, the increasing number of residents, nurses, respiratory therapists, other specialists and trainees that are involved contribute to crowding around the patient.

In the final solution, which addressed both the orthopaedic needs for open surgery and minimally invasive surgery, five ceiling-mounted anchor plates were installed, three of which were set up with equipment booms and two others which were placed for future needs, as in the case of a remote-controlled observation camera. These additional anchoring plates represented minor costs in the immediate context compared with the costs that would be incurred to add anchoring plates, and services to add equipment once the room was fully operational.

Due to the width of the laminar flow zone above the table necessary to allow a 90-degree rotation of the table (8 sq ft, or 2.4sqm), the surgical lamps became too far apart from one another to be kept out of the sterile zone of the laminar flow. These had to be placed within the

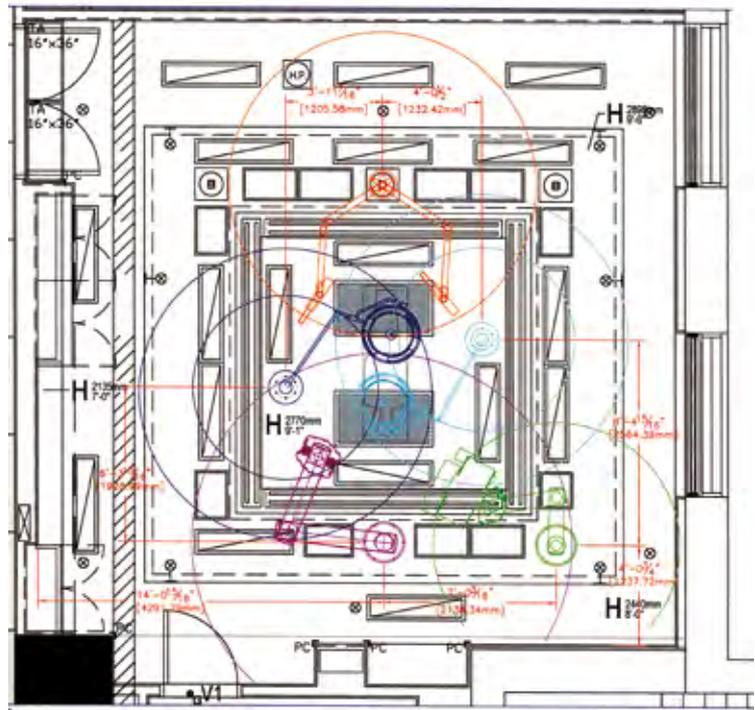


Figure 1: Ceiling plan

sterile zone in the laminar flows.

Flexibility in equipment location

The three equipment booms consist of the surgical equipment/services boom, the anaesthesia equipment boom and the monitoring screens boom.

The surgical equipment/services boom (purple colour in Figure 1) was located on the centreline of the operating table, at the head of the table (in the preferred table position) to allow greater flexibility. This allows the possibility of the equipment boom being positioned to the right or left of the patient. In the case where the table is placed at a 90-degree orientation, the equipment boom can run the entire length of one side of the patient, either on the left side or the right side.

The anaesthesia boom (green colour in Figure 1) was located at the head of the operating table (in the preferred table position), to one side of the equipment boom (the side that was more remote to the room circulation). This allows the anaesthesia boom to be near, yet out of the way of the services boom. In the case of a 90-degree table orientation, the anaesthesia boom is restricted to one side of the patient depending on the boom arm lengths.

The monitoring screens boom (orange colour in Figure 1) was located at the opposite end of the services boom along the centreline of the OR table, in order to face the surgical team. This also allows the monitors to be placed on either side of the OR table giving visibility to individuals positioned on both sides of the table. A wall-mounted screen on the side wall of the room gives further viewing possibilities to other team members positioned outside the sterile surgical field.

Ceiling height

Ceiling height in the case of this particular operating room was a serious challenge, as the room was to be built in an existing shell with an existing clear floor to slab height of 10ft 4in (3.15 metres). The minimum recommended installation height of ceiling mounted booms is 9ft 4in (2.84 metres) (according to equipment manufacturers).

In the case of tandem booms (two arms

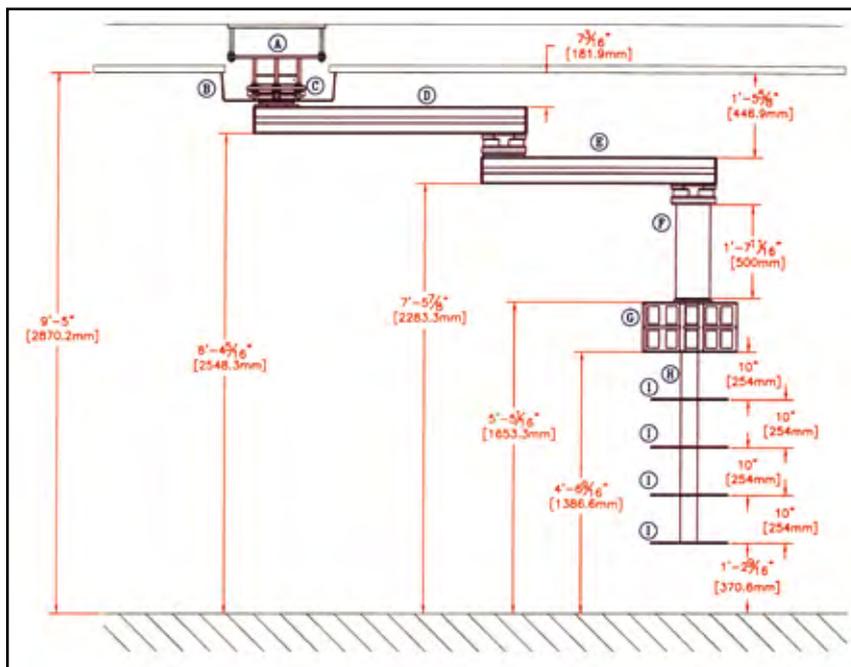


Figure 2: Cross-section of ceiling-mounted surgical/equipment services boom. A & C: anchoring plate, B: ceiling plate cover, D: first rotation arm, E: second arm, F: vertical tube, G: service column head, (gases data, telephone and electric), I : equipment shelves

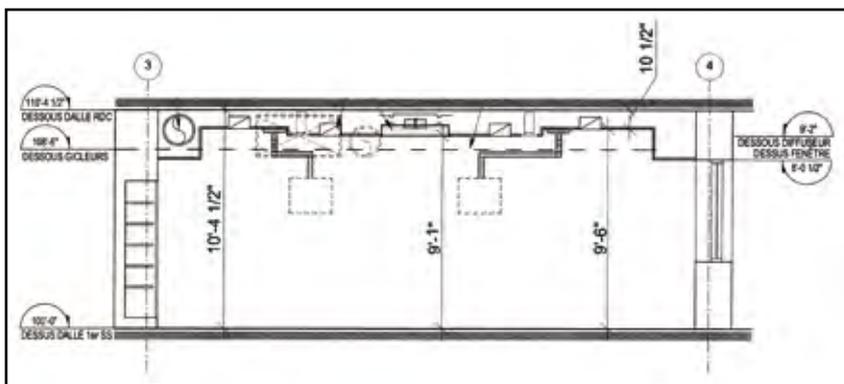


Figure 3: Cross-section of operating room

on the same bracket and anchoring plate), depending on the length of each section of each arm and the amount of equipment on each arm, this minimum requirement is critical to avoid cross-collisions of equipment and booms.

Since the laminar flow ventilation could not be accommodated within the 9ft 4in (2.84 metre) height, the centre section of the sterile zone was lowered (to 9ft 1in, or 2.77 metres) to meet the physical constraints of the ventilation and the equipment booms were positioned outside the sterile zone where the ceiling height was raised to the

minimum requirement for the equipment. The perimeter of the room was lowered once again to accommodate the multitude of other services in the ceiling.

Biomedical adaptability

Having more and more equipment in the operating room usually means that the room needs to grow larger and larger to accommodate all of the new equipment. So, how can one slow down the rate of increase of room size? Our solution was to take out some of the equipment that was not directly required inside the operating

room and place it elsewhere. Operating room design will rapidly evolve with the new generations of medical and information technology and one of the key elements in the equipment specifications that will take importance is the maximum distance from surgical fields that equipment can safely perform.

For this project we wanted to maximise the ergonomic layout of the room with the current equipment. But this ergonomic layout needed to be flexible and adaptable to future technology – equipment whose services and requirements were unknown at the present time, since equipment life expectancy is much shorter than architectural room design. This brought us to develop the concept of a 'biomedical raceway'.



Wall-mounted biomedical raceway

Biomed raceway

In a typical setting, the operating room is dedicated to one particular speciality, which limits future flexibility in room use. Any specially required changes cannot be done without major work in the architectural and mechanical-electrical service design

of the room. We developed what we call a 'biomed raceway' as a solution for increasing the flexibility of the operating room. This new raceway is a stainless steel conduit that can run horizontally along the ceiling and vertically along the wall between

every ceiling-mounted boom, lamp or other equipment location.

The biomed raceway is designed with a continuously hinged cover that can be completely sealed and reopened when additional services are needed. In this



Biomedical raceway wall



Ceiling biomedical raceway

way, the biomed raceway enables new wiring to be added without requiring wall or ceiling demolition and restoration.

Biomed hub room

This concept is part of a larger concept where the objective was to relocate equipment that was not directly needed inside the operating room to a location outside the operating room. As mentioned earlier, the multiplication of equipment in the operating room is a direct consequence of the rapid birth of new technology. Since the operating room is often already cluttered with a quantity of instruments and equipment needed for the surgical procedures, any excess equipment directly affects the ergonomic quality of the area around the operating table and, consequently, the safety of staff working around the operating table. It is because of this the concept of a 'biomedical hub room', directly adjacent to the OR, was considered.

The lack of available prime space kept the hub room to a minimum size but just large enough to keep the equipment within the

operating room to a minimum. Primarily, the hub room contains all switching and codec equipment. This ensures a dedicated secure equipment space (ideally 35 sq ft, or 3.25 metres), which by liberating space in the operating room, allows better management of the space around the patient.

Growth and change in OR

In the initial plan, the nursing station was located close to the window at the foot end outside the sterile zone. Once the operating room became operational, the nursing station was found to be too close to the instrument tables of the sterile zone. It was therefore moved from the rear of the room to one of the sides of the sterile zone where the PACS monitor location was originally planned. The relocation of the nursing station was able to be accomplished without requiring any wall or ceiling demolition or restoration. This first and simple modification within the first year of use proved the value of the biomed raceway concept.

Following further use of the operating

room, the monitoring screens that had been placed on the anchoring plate at the opposite end of the surgical equipment boom were found to be too far from the surgeons. They were removed from their original position and added to the arms of the surgical lights at either side of the table. This change was done once again, without any architectural intervention.

Equipment for full integration

As described above, various types of equipment are needed for an operating room of the future suite and most of these were located in the biomed hub room. This decision enabled more space to be given to the surgical team within the operating room.

Moreover, the flexibility of the biomed raceway will prevent potentially expensive and time-consuming closures of the OR related to intensive architectural work or modifications when equipment replacement or change is needed.

The control of equipment (such as light intensity or camera settings) and image

routing is done by integration systems (e.g. image switcher; codec, etc). This equipment is controlled by a touch-screen panel located at the nurses' desk. There is also the picture archiving and communications system (PACS) review station, which is basically a PC equipped with an LCD monitor. The locations of these elements can be a source of contamination, particularly if situated too close to the sterile instrument tables.

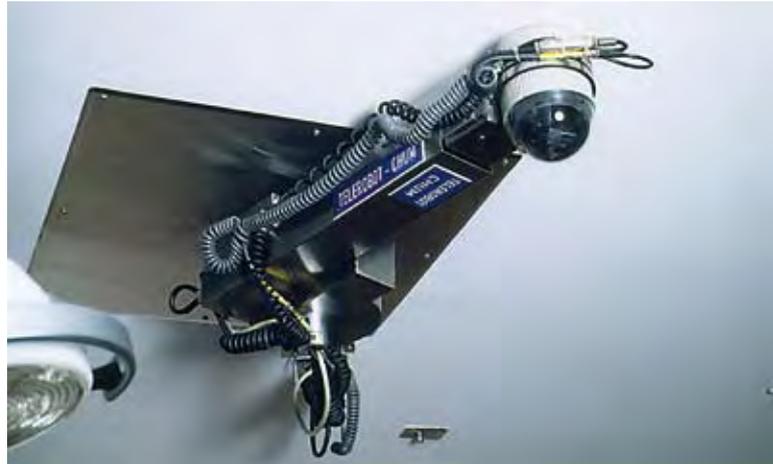
Image recording needs will continue to increase in future years, including still images and mpeg documents. Minimally invasive surgery procedure images are optimal, but there is a need for good quality images in open surgery. The old concept of a camera that is either attached to a lamp or to a separate arm is now almost obsolete. The new emerging trends are automated robotic cameras. These very versatile cameras will bring a revolution to the quality and to the documentation possibilities in operating room procedures. The next 10 years will also see the development of a range of image management software.

Future equipment

The evolution of surgery will include more and more robotic surgery. This is another example of space-consuming emerging technology. A robot's typical dimensions can easily reach platform sizes of 4ft by 4ft (1.22 metres by 1.22 metres) or more, displacing themselves with minimum turning radius requirements. Storage facilities must also be foreseen, preferably outside the operating room, when the robot is not in use.

Conclusion

The revolution of designing operating rooms is only beginning and the complexity in the design of the operating room will continue to increase in the future with the addition of more and more complex technological equipment and its integration within the operating room environment. Cardiology, neurology and orthopaedic suites are probably the most challenging to design as the equipment is becoming more and more sophisticated. There will be a need for developing more and more original approaches to increase flexibility and ergonomics in the operating rooms of the future.



Ceiling-mounted robotic camera

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Orthopaedic Surgical Suite, CHUM Notre-Dame Hospital

Surgical Clothing Design: **Dressing up for surgery**

This Israeli study of operating room clothing takes a critical look at its design, how it impacts on staff and health and safety and proposes a number of solutions for more ergonomic design

Noemi Bitterman DSc, Anna Becker MSc,
Yoel Donchin MD

The clothing worn by surgical teams has remained essentially the same for many years, in contrast to the great changes taking place in the professional levels of operating room (OR) staff, the environment in which they work and the tasks they perform. Most of the scientific literature that discusses OR clothing deals with the aseptic properties of garments, gloves, hats and masks¹⁻⁴, rather than with ergonomic and design solutions.

Nurses' uniforms outside of the OR, in contrast, have attracted a lot of attention from healthcare services and non-medical people. Their uniforms are frequently modified according to fashion and changing trends⁵⁻⁷. Physicians' traditional dress – the ubiquitous 'white coat' – has deliberately not been changed as a result of contemporary concerns about the value of 'old dress codes' in terms of patients' attitudes, trust and confidence vis-à-vis their caregiver⁸⁻¹¹.

Illustrations of surgical procedures performed prior to 1900 show physicians in street clothes or, alternatively, in distinguished

and impressive outfits. Only after the discovery of the importance of asepsis (Lister and Koch, 1876) was surgical attire introduced in order to reduce contamination of the surgical field^{3,12,13}. The first documentation of OR-dedicated dress for surgeons appeared in the late nineteenth century, when physicians began wearing bleached cotton and linen robes and rubber gloves during surgery^{3,13}. Nurses wore dresses, aprons and a special head kerchief, which did not, however, cover all the hair. In 1907, gloves came into wider use among OR nurses. Only years later were head coverings and face masks introduced for use by OR staff.

For many years, the dominant colour of OR clothing was white, symbolising hierarchy, economic and social privilege, power and authority, as well as cleanliness and reliability^{7,8}. Coloured OR clothing was introduced in 1914 to reduce the glare caused by the white walls, towels, sheets and other white elements in the OR⁵. Green was recommended, as it was complementary to the red colour of blood and tissues, relieved glare and was considered to be psychologically calming^{4,5}. Ceil blue OR suits were introduced later, followed by a

range of pastel colours (while white moved to the 'cleanrooms' of high-tech industry⁵).

In the mid-1900s OR staff began adopting unisex clothing – a uniform consisted of shirt and trousers for all personnel, regardless of the surgical team member's gender, specialty or seniority.

Historically, OR garments were made of all-cotton fabric. With the development of a new generation of materials, blends of natural fibres (cotton) and synthetic man-made fibres (polyester) were introduced. The popular blend in OR wear today is 50% polyester and 50% cotton⁵.

Surgical clothing is intended to prevent the transmission of infective agents between patients and clinical staff during surgery and other invasive procedures. In the past, OR garments were meant to protect the patient from the medical staff. Today this situation is reversed; because of the high incidence of the HIV virus, hepatitis B infection and other viruses, the need to protect healthcare workers from the patient has become a major concern. Surgical clothing is considered to be a medical device (a non-active medical device) and therefore, its production and sales are regulated (e.g. the Food and Drug Administration, The European Committee for Standardization)¹⁴. To what degree surgical scrubs and covering garments really protect in terms of level and frequency of contamination is still under debate¹²⁻¹⁶. OR clothing also has an important role in protecting its wearer from cold ORs and providing them with continuing comfort during long surgeries and extended work and night shifts.

Technical recommendations for OR clothing include a list of materials that have mechanical robust strength, durability (in high laundering temperatures) and chemical resistance. The clothing should be air and sweat permeable, be made of wrinkle-resistant material and maintain a low purchase cost and minimal maintenance expenses.

An ergonomic design of OR clothing would target reducing users' stress (e.g.



Surgical clothing has remained essentially the same for years (Image courtesy of TRUMPPF)

ensuring that the clothing is not too tight), enable convenient and easy donning and removal, sizing to fit a great variety of body shapes, be versatile and have a pleasant touch for the user. The current blend of cotton and polyester offers wrinkle resistance, minimal shrinkage, easy care, extended durability to mass and frequent washing, air and sweat permeability, long-term comfort, piling resistance and is made of a lint-free fabric^{5,7}. In other words, some ergonomic objectives are presently being met.

An important ongoing debate is whether OR clothing should be disposable or washable. This issue is important both in terms of sterility or efficiency in preventing contamination and from the perspective of sustainability and waste disposal^{12,17}.

We decided to examine the current use of OR clothing (shirt and trousers), wearing habits and preferences, in order to identify problems, consider current solutions and offer proposals for improved OR clothing based on a quantitative widely distributed questionnaire.

The study design

Observations, accompanied by digital photography, were performed in several medical centres of different sizes focusing on the clothing of the OR staff and following staff movements in OR wards and in hospital surroundings. Subsequently, a detailed questionnaire was distributed to OR

personnel (surgeons, anaesthetists, nurses and technicians) employed at 11 hospitals in different cities in Israel. One hundred and sixty people responded to the questionnaire: 61 surgeons, 41 anaesthetists, 38 nurses and 20 non-medical OR staff. Of the respondents, 38.2% were women (n= 60) and 61.7% were men (n= 97). The average age was 40 ± 9 years, weight 69 ± 12.5 kg and height 168 ± 8 cm (mean ± SD).

The questionnaires were anonymous and the only information requested was hospital name, specialty and personal profile (age, weight, height).

The first part of the questionnaire addressed the use of OR clothing and information about the medical and personal items that staff carry. The second part examined staff

preferences regarding the design of OR clothing. In order to assist the respondents in defining their preferences and design choices, we used one-dimensional figures (produced together with a professional image-maker), presenting the different clothing alternatives. Altogether we presented respondents with six different shirt necklines (Figure 1), four types of trouser waistbands (Figure 2) and six alternatives for pockets at different locations on shirt and trousers. Respondents were asked to circle on the pictures the design solutions they preferred. Colour preferences for OR clothing were represented by the full Microsoft Office colour hexagon and grey palette (a total of 137 colours, including 10 grey shades). Most questions in the questionnaire were multiple choice or yes-and-no options, followed by open questions and room for adding comments.

Field observations

Our multi-centre survey verified that most OR personnel wear a unisex outfit, consisting of a loose, short-sleeved shirt (mostly with a V-neck) and trousers (with an elastic band or string waist) made of 50% polyester/50% cotton, a cap and a mask. The most common colours of OR outfits found in the different healthcare centres (and even within the same hospital) were shades of green, grey, blue and purple. Our observation has strengthened the common knowledge that OR staff, while still in their OR clothing, move outside the immediate operating room to various wards and even go outside the hospital¹⁸. Recently, Weinbroum *et al*¹⁸ showed that 82% of their study's OR population did not bother changing into regular clothing when leaving

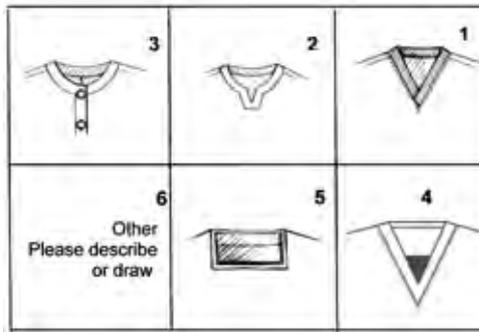


Figure 1: Examples of the necklines to select in the questionnaire. 1. V-neck, 2. heart shaped, 3. round with buttons, 4. keystone squared, 5. square

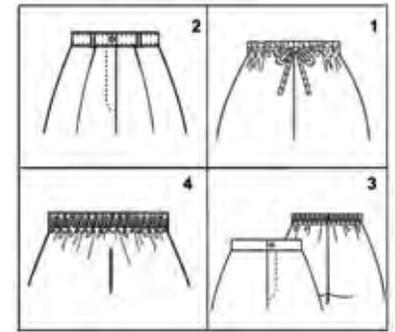


Figure 2: Examples of the types of trousers to select in the questionnaire



Today's surgical staff wear ceil blue scrubs, pictured here in the Olympus ENDOALPHA suite in Hamburg

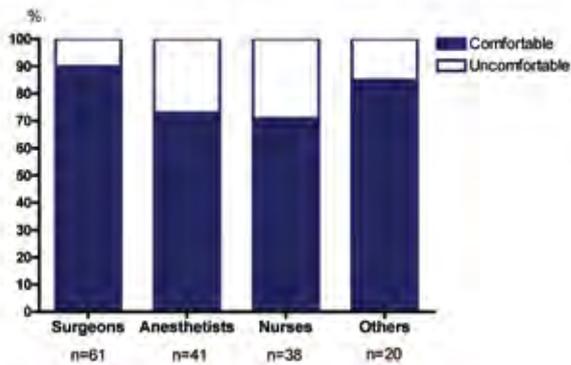


Figure 3: Results of the questionnaire about degree of comfortableness of operating room clothing by the different professions (N=160)

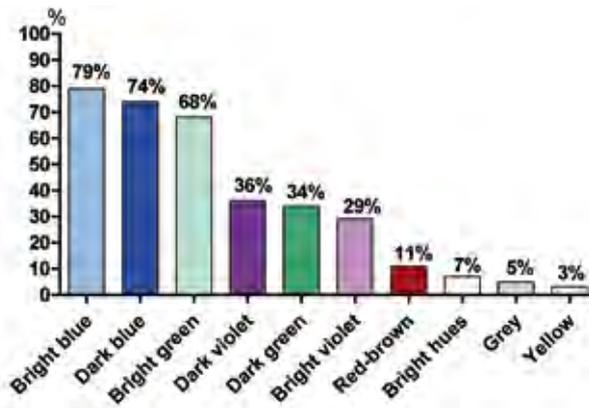


Figure 4: The distribution of preferred colours for operating room clothing (N=160)

OR areas to see patients in their offices, the emergency department or other wards and hospital zones. Note that different countries have different regulations regarding wearing surgical attire outside the perioperative environment, putting on a new set of clothing on return to the OR or, alternatively, putting on a cover, lab coat or jacket on exiting. Moreover, no conclusive scientific literature exists on the relative effectiveness in reducing rates of contamination when scrubs are worn outside the OR or in putting on a cover when exiting the OR^{14,16,18}.

Common findings in our observations were the frequent untidy appearance of surgical staff, over-packed pockets, hanging items fastened with safety pins or other improvisations, creative female solutions for narrowing the V-neck of the shirt, various techniques for fastening the ID card, items protruding from holes in the pockets due to inadequate care of the clothing and packed untidy pouches, etc. We occasionally asked staff members to empty their pockets and documented their contents. This information helped us in drawing up the list for the questionnaire of carried items.

Current use of OR clothing

Eighty-one percent of the respondents (N=160) claimed that their OR garments were by and large comfortable (see Figure 3). Ninety percent of the surgeons expressed a significantly high comfort rating with regard to their current clothing, compared to 71% of the nurses and 73% of anaesthetists, with no significant differences between genders in comfort level.

Thirty-six percent of respondents reported that they 'always' or 'very frequently' wore a top-dress over OR scrubs when in the OR zone. Breaking this response down by gender,

we see that 60% of the female staff responded that they 'always' or 'very frequently' wear a second layer of clothing, compared to only 16% of the male OR staff. The most common reason for donning a second layer was thermal protection against the low temperatures in the OR zone (80%). While surgeons and anaesthetists claimed they wore covering gowns (73% and 53%, respectively), nurses noted that they preferred sweatshirt jackets (66%). More than half of the female staff (57%) preferred wearing an overdress when leaving the OR zone.

Eighty-seven percent of the respondents changed their OR clothing during the work shift. The most common reasons for doing so were soiled (93%), wet (58%) or torn (50%) clothing.

Preferences for OR clothing design

The majority of OR staff respondents (81%) would prefer that OR clothing continue to be unisex in style. This preference was similar for both feminine and masculine staff, with no significant difference between specialties (surgeons, anaesthetists and nurses). By and large, the staff did not show a great interest in having OR clothing change in style or colour.

The future colour preferences of the OR personnel revealed a conservative approach, approximating the current inventory.

The colours most preferred for OR clothing (out of the 137 colours presented), were bright blues (79%), dark blues (74%) and bright greens (68%) (see Figure 4). No gender differences were found in colour preferences, although only females selected the red-brown shades. Significant differences were found among specialties. Seventy-nine percent of the surgeons preferred dark blues, 80% of anaesthetists chose bright green, 98% of the nurses opted for bright blue and 94%

preferred dark blue. A correlation was found between age and the preferred colour for OR clothing. While 100% of the younger staff (up to 35 years) favoured dark blue shades, 59% of the middle-aged personnel preferred bright blue and green and 88% of the older respondents preferred bright blues.

Only 25% of the respondents would like to have two-tone or multicoloured OR clothing, with no significant difference between genders or age groups. Significant differences were found among specialties in their approach to colour in the clothing design; 35% of the nurses and 34% of anaesthetists were willing to consider changes in pattern and multicolour design compared to only 13% of the surgeons. The respondents were even less enthusiastic (only 14% of the respondents) about a combination of printed patterns (e.g. stripes, dots), with no difference between genders.

Shirt design preferences

Five different shirt openings were presented in the questionnaire (see Figure 1). Optimally, the shirt opening should be wide enough to enable easy and fast removal in case of contamination or getting wet and, on the other hand, it should supply adequate covering of the front chest for both genders. As seen from our observations, several methods are presently used by wearers to compensate for inappropriate shirt openings. Given that OR clothing is subjected to massive and frequent aggressive washing in industrial laundries (to eliminate contamination), stylish finishing that includes buttons and zippers or a knitted opening will be damaged and distorted in a short time. Even Velcro will become nonfunctional due to cotton fibres attaching to it in the washing process, not to mention what all these accessories will add

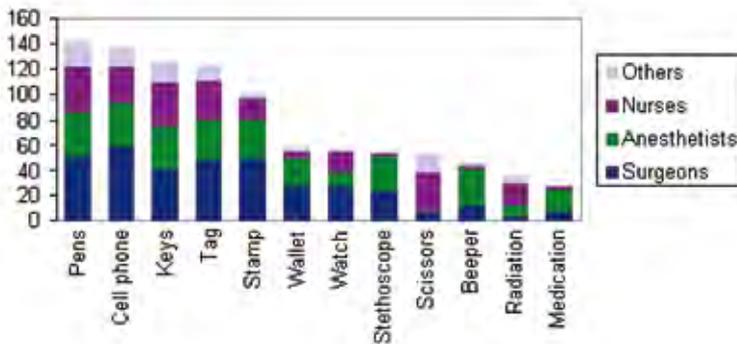


Figure 5: Most common items carried by operating staff (N=160 people)

articles. However, in light of today's extensive use of electronic devices (such as iPods or electronic diaries), the need for continuous connectivity (beepers, mobile phones), the modern culture of gadgets, security issues (electronic ID cards) and increasing distances between ORs and hospital wards, the number and diversity of items that surgical personnel carry has multiplied.

In the absence of any other solution, the pockets on OR uniforms have become a main storage site. Thus, pockets are over-packed^{7,8,19} and various means are used to connect, hang, pin and attach belongings to the clothing. This results in a risk to hygiene and sterility, inconvenience in changing soiled or wet dress during work, constraints in putting on or removing the covering gowns and tops, risks to patient safety due to falling items (mostly upon bending over the OR table) – and creates a sloppy, negligent and disheveled image for OR staff.

Indeed, the respondents' greatest interest in changes concerns the number and position of pockets in the OR shirt and trousers.

We suggest an external, independent carrying solution rather than pockets for this function (Figure 6). We believe that storing staff belongings outside of their clothing will promote a tidy appearance, increase safety and sterility, and facilitate clothing maintenance.

An external carrying and storage solution positioned at the waist or hips will not interfere with normal activities such as changing soiled or wet garments during the work shift, as it will eliminate the need to empty pockets or detach items. Our concept is a wide adjustable

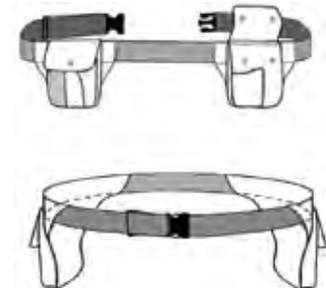


Figure 6: Concept for external carrying and storage object positioned at the waist or hips with different compartments. Above: opened buckle, back view. Below: closed buckle, front view

to the cost of the clothing.

The preferred neckline for pullover OR shirts were V-necks (34%), heart-shaped (25%) and closed V-necks (keystone squared) (25%). Round openings with buttons (Chanel style) were favoured only by female OR staff (25%). No significant differences were found among specialties, age groups or weight groups in terms of opening preferences.

Six different pocket options were presented in the questionnaire, placed at different spots on the shirts. The flat open pockets positioned on both sides of the shirt and top open pockets were the most preferred alternatives (64% and 45%, respectively). No significant differences were found among genders, specialties or weight groups in terms of shirt pocket preferences.

Trouser design preferences

An elastic waistband (51%) and a string waistband (49%) were the preferred waistbands for OR trousers (out of four options), with no significant differences between genders and specialties. Not surprisingly, these two options were chosen as they enable fast and easy dressing and undressing, maximum comfort through long operations and night shifts, and maximum versatility and adjustment for both genders and a wide variety of body measures and figures. Moreover, they are highly resistant to massive washings.

Closed side pockets and side pockets with diagonal openings were chosen from seven types of trouser pockets (42% and 34%, respectively), with no significant difference among genders, specialties or weight groups. Interestingly, closed back pockets were favoured twice as much by male OR staff while no female staff member chose an open back pocket.

Carried belongings

Participants were asked to report what items they carry with them, using a detailed list that included 24 articles (defined after our preliminary field study). On average, staff carry 8.3 ± 3.6 (mean \pm standard deviation) items (median 8 and range 2–21). This corresponded, on average, to about 1 kg in weight. We saw a trend, although it did not reach a significant level, toward a positive correlation between the size and distribution of hospital units and number of carried items. No significant difference was found between women and men in the number (8.7 ± 3.7 vs. 8.1 ± 3.6 , respectively) and characteristics of carried belongings.

Pens, cell phones, keys, employee name tags, stamps, wallets and watches were the seven most commonly carried items (see Figure 5). There was no significant difference among members of different specialties in terms of carried items.

Specific items that were carried exclusively by individual subgroups were scissors (79%) and x-ray pass keys (45%) carried by nurses, and beepers (70%) and medication carried mainly by anaesthetists (43%). OR nurses in our study did not carry stethoscopes and beepers.

Seventy-six percent of respondents answered that they were open to considering alternative options for carrying items instead of in their clothing pockets.

Carrying solutions

Our observations and the questionnaire revealed a major inconvenience not related to the OR clothing itself but to the need to carry different medical and personal belongings. OR garments were designed to provide a protective layer between patients and staff, not to carry or store personal and medical

belt with an easily opened and closed buckle, with an option for holding several external pockets. The pockets would be worn on the side or back of the hips, in a similar manner as a pistol belt, to allow proximity to the OR table. The belt design should be ergonomic, offering easy access to belongings, with no need to search or empty the pockets.

Variable numbers and configurations of external storage pockets and division into dedicated compartments would allow maximum flexibility and personal customisation for every OR team member. The independent external storage units would allow also maximum flexibility to accommodate schedules and planned tasks.

The external containers should be made of washable material. Current technology and advanced textiles²⁰ enable developing compact, light and 'smart, intelligent' pockets (e.g. containing a power supply for electronic equipment, embedded computing, changeable and adjustable compartment dimensions and even tactile paging).

Electronic employee ID tags

Electronic ID tags have become commonly required accessories⁹ for hospital staff in general and especially for staff needing to enter restricted areas such as the OR. Our observations revealed that staff members find the ID card annoying – and therefore, may not wear it or invent different means to carry it, thus impairing safety and/or visibility.

Ideally, ID tags must be placed high enough to be visible by other OR personnel and by electronic recognition devices such as door beam detectors. They should adhere firmly

to the OR dress, yet be easy to remove, preferably without having to be touched to avoid contamination. We suggest a patch pocket concept, covered with transparent mesh, to hold the ID card stable and visible, placed at chest height, with a side opening for easy insertion and removal (Figure 7).

The future

Most likely, in the near future, some of the inconvenience and awkwardness imposed by the items and accessories carried by the staff will be eliminated. The number and size of electronic items will be reduced; they will be encapsulated into all-purpose multifunctional units (such as seen today with the iPhone), embedded into wearable computers and replaced by intelligent systems for biological identification. Nonetheless, personal tangible items ranging from scissors to candy, tissues and pens will still need appropriate carrying solutions.

Moreover, innovative technologies linked to nanotechnology will probably bring in aseptic solutions that will be more efficient than current scrubs and surgical teams will not need a special dedicated dress. This may include solutions such as anti-contamination and dirt spray to be dispersed over regular dress prior to entering the operating room. Additional thought should be given to the benefits and the need for OR-dedicated clothing as a uniform and symbol in organisational culture.

Summary

Operating room clothing, although having hardly changed for more than a decade,

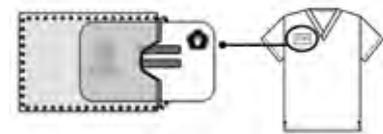


Figure 7: Prototype of a pocket with side opening for storing the magnetic employee ID card

represents a relatively convenient and comfortable option for multitasking OR staff, in spite of its old-fashioned look. Today's scrubs are by and large not too expensive and are also a popular item that is favoured even outside the OR territory.

Nevertheless, based on our observations and questionnaires, we propose a carrying solution that may reduce the burden on OR staff, decrease the risk of work accidents and help maintain a high standard of hygiene and a professional, tidy appearance.

We suggest using our picture and colour palette methodology for introducing the evidence-based design of OR clothing at each health facility according to local preferences, tradition and cultural background.

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Access to Daylight and Outdoor Views:

A comparative study for therapeutic daylighting design

This study compares the impact of access to daylight and the provision of outdoor views and their relationship to patients' recovery time in an open-heart surgery environment

Md Ashikur Rahman Joarder, Prof Andrew Price, Dr Monjur Mourshed

A well-balanced and good visual environment is of major importance to patients' health. But information about the impact of daylight on clinical recovery is necessary in order to effectively assess the need for the modernisation of existing hospitals or to evaluate alternative strategies for new hospital design.

In the search for a relationship between daylight and clinical recovery, an individual's preference to daylight over artificial light has been well established^{1,2}. In addition, the relationship between daylight and the psychological benefit³ for hospital patients, as well as the impact of daylight on specific physical diseases related to bones and cancers (e.g. rickets and skin cancer) are also well researched⁴.

However, defined knowledge about the impact of daylight on general diseases, such as diseases originating from the malfunction of organs such as the heart, lungs, stomach and kidneys and not generated from psychological pressure, is weak and studies are few in number⁵, provide controversial findings⁶ and are debated^{7,8}. To implement daylight strategies within the therapeutic design of hospital buildings, the impact of daylight on general diseases needs to be better established with sound evidence.

The objective of this paper is to find an evidence-based relationship between daylight, outdoor view and patients' recovery rate in a general hospital environment.

Methodology

While the effects of daylight on different diseases and patients in the therapeutic



Square Hospital, Dhaka, Bangladesh

environment have been analysed in previous research, the more intensive studies appear to have focused on surgical patients⁹⁻¹¹. In most cases, surgical patients have to undergo a standard procedure of treatment before and after surgery and are in a near equal state of physical condition after the same surgery when they come back to the ward from post-operative care units.

Therefore, it was decided that a number of patients who had undergone a major open-heart surgery would be used as samples for this study. After surgery, patients are moved to a bed in the cardiac surgical intensive

care unit. Once they have improved to a satisfactory level and were moved to rooms in the cardiac surgery unit, they were used for the observational study.

To build a reliable model for this study, the following criteria for sample selection were fixed:

- Selection of a uniform patient population for sampling (e.g. patients undergoing a particular type of surgery/procedure or very specific patient group).
- The sample should not consist of a particular disease or a whole ward, where the physical problem is the same but complication levels

mean that clinical recovery or patients' length of stay may differ.

- Selected samples should be in an equal or nearly equal stage of the disease at the beginning of the study.
- The patients should be free from other major complexities.
- It should be a non-psychological disease and not be related to bones or cancer (as the relationships with these diseases have already been established).
- The disease should cause both physical and psychological stress to patients.
- To recover, all patients should undergo a standard procedure of treatment.
- The patients must have to stay in hospital for several days to undergo treatment, so that the investigator has enough time to observe their progress before release.

In general, variables can be grouped into four major classes: environmental, physiological/clinical, demographic and psychological. Clinicians tend to focus more on clinical variables while non-clinicians focus on environmental or architectural variables. However, there are some common variables selected by both groups. Reviewing past works on variable selection, the following variables are recommended for further research for this study:

- environmental variables: illuminance (average daylight intensity in lux), temperature, relative humidity (RH), room type (single/double bed) and provision of outdoor view (POV);
- clinical variables: length of hospitalisation, blood pressure, temperature, heart rate, respiratory rate. Following discussion with hospital medical staff, a number of other variables were also identified: smoking habits, hypertension, dyslipidaemia, myocardial infarction (MI), transient ischaemic attack (TIA), stroke, bronchial asthma, cerebral vascular diseases (CVD), diabetes mellitus (DM), chronic renal failure (CRF), ejection fraction value (EF), pulse oximeter arterial haemoglobin oxygen saturation (SPO2), fasting blood sugar (FBS) and fluid balance;
- demographic variables: gender, age, weight, body mass index (BMI), etc;
- psychological variables: as psychological variables are correlated with clinical variables, the direct and indirect psychological impact of daylight on patients' physical health can be observed by analysing the clinical variables mentioned above. To make the research

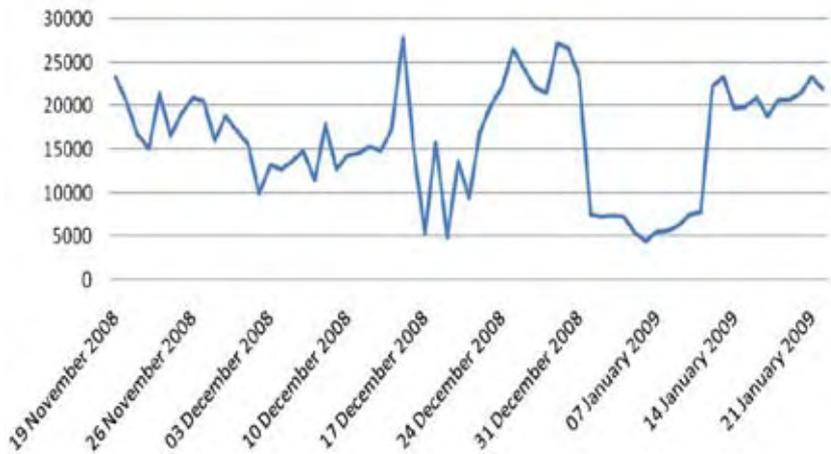


Figure 1: Average horizontal exterior illuminance (HEI) for Dhaka

more objective and avoid multicollinearity between variables, emphasis was given to the parameters of patients' physical health indicators and no psychological variables were recommended separately.

Statistical model

To fill the research gap, an evidence-based relationship needs to be developed which can correlate daylight intensity with clinical variables (blood pressure, temperature, heart rate, respiratory rate, etc) to predict patients' stay time.

Based on a critical review of key pieces of research relating to the therapeutic effects of hospital building and lighting^{2,9,10,12,13}, a multiple linear regression model (MLR) was developed using stepwise regression to finalise the environmental and clinical variables, and to correlate these two groups of variables. MLR attempts to model the relationship between two or more explanatory (independent) variables and a response (dependent) variable by fitting a linear equation to observed data. Every value of the independent variable 'x' is associated with a value of the dependent variable 'y'. Formally, the model for multiple linear regression for 'n' observations, is:

$$y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + \dots + b_nx_n + e$$

where, y is the true dependent, 'a' is the constant or intercept, the 'b's' are the regression coefficients for the corresponding 'x' (independent) terms, and 'e' is the error

term reflected in the residuals. It should be noted that, whether it is for a single variable or for multiple variables, the relationship predicted is always linear. In the least-squares model, the best-fitting line for the observed data is calculated by minimising the sum of the squares of the vertical deviations from each data point to the line (if a point lies on the fitted line exactly, then its vertical deviation is 0). Because the deviations are first squared, then summed, there are no cancellations between positive and negative values. The ordinary least-squares estimates $b_1, b_2, b_3, \dots, b_n$, are usually computed by statistical software packages (e.g. SPSS).

For this study, the dependent variable of the model (y) was the recovery time of each patient in the hospital room in hour and the explanatory variables (x's) were comprised of the rest of the environmental, clinical and demographic variables. The number of explanatory variables could then be eliminated step by step to develop a suitable statistical model.

Measurement of daylight

One of the constraints of daylight research is the estimation of daylight levels which change rapidly with the change of cloud cover in the sky over time^{14,15}. In Walch et al's research⁹, the measurements of sunlight intensity were taken by a light meter twice daily in the observed patients' rooms at approximately 9:30am and 3:30pm. These were multiplied by the number of AM and PM daylight



Figure 2: Location of outdoor data logger

exposure hours and summed to determine the cumulative daily sunlight exposure in lux-hours. However, the measurement of sunlight intensity twice daily does not adequately represent the actual daylight levels that the patients experienced during their stay time in hospital because of the rapid change of daylight intensity throughout the day. A more continuous measurement of sunlight intensity for patients' rooms is necessary for reliable results. This can be done by either installing several data loggers in each patient room or using simulation software to find out the average daylight levels. As it is not possible and practical to fix several data loggers on the work plane of the each patient's room to measure illumination in a running hospital environment, the application of a daylight simulation programme was recommended for the study.

To analyse the daylighting environment Choi² used a lighting simulation program, 'Radiance', to test the illuminance level in his study. To verify the output data from Radiance, the calculated data produced by Radiance were compared with the data from measurements taken at the site and using the scale model. The discrepancy between Radiance and the on-site measurements was 2% to 47% and Radiance and the scale model was 9% to 50%. Choi suggested that, as daylight is very much sensitive to sky conditions, it can result

in large discrepancies, due to the differences between CIE sky conditions (defined by International Commission on Illumination (CIE)) and the actual sky conditions. For example, CIE's intermediate sky condition does not cover varying amounts of cloud in the sky and is therefore not the same as actual sky condition. Thus, the horizontal exterior

illuminance (HEI) of Radiance is not identical to actual HEI values. One HEI value cannot cover the diversity of the intermediate sky which has 30% to 70% of the sky covered with clouds.

Figure 1 shows the variation of average HEI from 19 November 2008 to 21 January 2009 for Dhaka, Bangladesh. For this study, one outdoor data logger (UA-002-64, pendant logger temp/light, 64k memory) was installed at the top of the helipad, above the hospital roof, about 66 metres from ground level (Figure 2) to measure HEI at five-minute intervals. The output of the data logger was used to simulate the average interior daylight intensity of the room used in the case study, considering the CIE standard overcast sky model with a full progressive radiosity inter-reflection method using the FlucsDL module of the IES <Virtual Environment 5.5> software package.

Data collection and analysis

The study started on 18 November 2008 and ended on 22 January 2009. Compliance with the Data Protection Act 1998 was ensured and the research was checked by an ethical advisory committee. The hospital authority was informed of the objectives of the research and approval received before the work was started. Participating patients

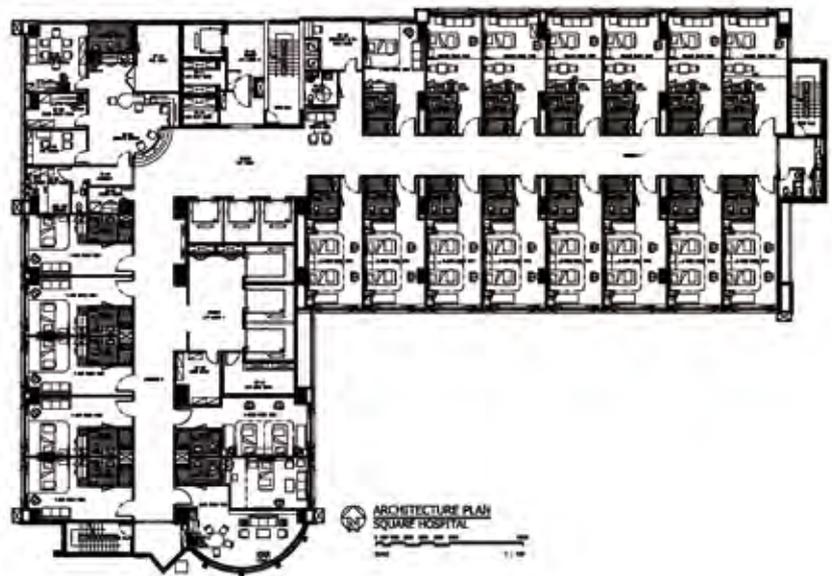


Figure 3: Architectural plan of 10th floor

signed informed consent forms before being discharged from hospital.

The cardiac inpatient unit, which is located on the tenth floor of the 15-storey Square Hospital building in Dhaka was selected for the observational study. In the layout of the floor plan, the toilets are placed on the corridor side of the patient's room rather than on the façade side, thus providing scope for ample daylight inclusion from outside (Figure 3). As the location of the unit is on the tenth floor and the majority of the surrounding buildings are six-storey or less (Figure 4), there were few obstructions to daylight from the surroundings. But the actual built surroundings were incorporated during simulation modelling (Figure 6). All rooms were painted in the same colour and were equipped with similar furniture and facilities.

The floor consists of both single- and double-bed rooms. In the double-bed rooms, a 1.8m-high movable screen is used for privacy. As a result, the outdoor view was restricted for the patients who stayed in the inner side beds.

As the focus of the study was to compare patients who had experienced varying daylight intensity during their stay in hospital rooms which also provided outdoor views, the architectural layout and arrangement of

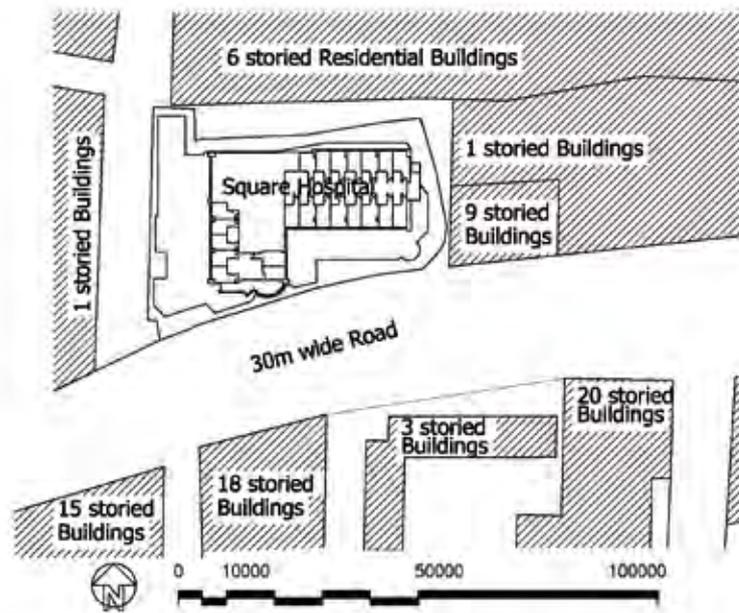


Figure 4: Site and surroundings of Square Hospital building

the floor was appropriate for the study.

A total number of 278 patients were treated during the study period. They could be grouped in three categories: open-heart surgery patients, patients treated with only medicine and patients who had undergone minor surgery. In line with the criteria set out

for the study, 41 open-heart surgery patients were initially selected for observation, as they were considered to be the most uniform patient group of the three categories.

To eliminate bias, the experiment was run double-blind; that is, neither the patients nor the doctors knew about the lighting status of the rooms and the researchers never met the observed patients. During this time, further tests were conducted to assess and monitor the patient's physical development.

The researchers used the test results for statistical analysis to understand the development of clinical recovery process. Patients' stay in the cardiac unit usually lasted from two days to a week or longer after they were transferred from the cardiac surgical intensive care unit. The focus of this research was the influence of daylight and POV on patients' stay time and recovery process.

Of the 41 patients, 33 were coronary artery bypass graft (CABG) surgery patients and the other eight had other types of surgery, such as for coarctation repair, valve replacement, atrial septal defect (ASD) or patch closure. The operations were successful for all 41 patients. One patient who stayed less than 48 hours in the cardiac surgery unit after transfer from the cardiac surgical intensive care unit was excluded from study. The 40 remaining patients, each of whom



Figure 5: Location of indoor data logger

Design & Health Scientific Review

stayed at least 48 hours in the inpatient rooms, were used as the sample for statistical analysis.

For each observation, a total of 32 possible explanatory variables were first considered

(Table 1). Patients' clinical and demographic information was collected from hospital records. The environmental variables of the rooms (light, temperature, RH) were collected by installing three indoor data loggers (U12-

012, temp/RH/light/ext data logger, 12 bit) in three representative rooms oriented in the north, south and east. Data loggers were fixed on the back wall of patient's bed above the patient's head at a 2-metre height from floor level to avoid shadows on the sensor from the movement of patient and hospital staff (Figure 6).

Greater variation was found in lighting intensity for different orientations at the specific point where the data loggers were fixed. However, the variation in temperature and RH was not significant, as the building was centrally air-conditioned. Average illumination values for each patient's room with respect to the patient's time in the cardiac surgery unit after surgery were obtained by daylight simulation. Readings of the outdoor data logger were used as the HEI to simulate the average daylight intensity. As-built drawings, specifications and information based on a physical survey of the hospital building were used to generate the 3D-model for the simulation study, as described earlier (Figure 7).

Table 1 presents a sample summary of the statistics of the variables. Column one of the table shows the list of provisional variables for the model. In the sample group there was no case of CRF and TIA, and there was only one case of stroke and bronchial asthma and two cases of CVD. The maximum body temperature of the patients was recorded 99°F (37.22°C) and minimum 98°F (36.67°C) with a mean of 98.05°F (36.69°C) and 0.22 standard deviation. Due to the lack of significant difference in CRF, TIA, stroke, bronchial asthma and body temperature in the sample group, these variables were excluded from the model at the beginning of the analysis.

To determine the multicollinearity between variables that may bias the standard error or generate wrong signs and implausible magnitudes in the coefficients¹⁶, the Pearson correlation for the rest of the variables was analysed. The most significant variables of the correlated variables in the model were selected. For instance, mean arterial pressure (MAP) was significantly correlated with weight, height, BMI, age, gender, systolic blood pressure, diastolic blood pressure, respiratory rate, fluid balance, smoking habits and hypertension and all were dropped from the model. In the next stage, a stepwise regression

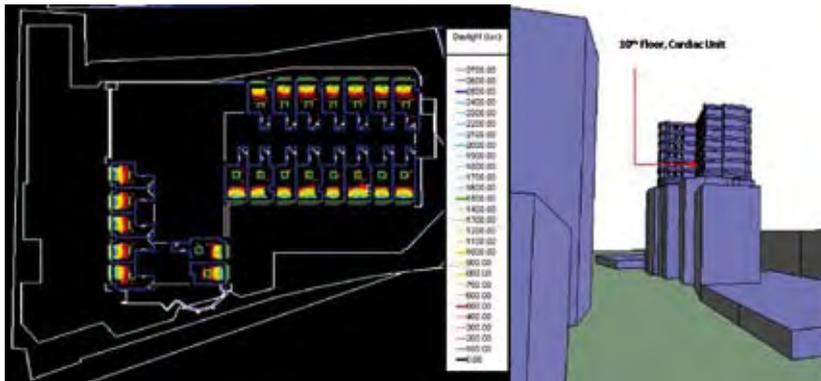


Figure 6 (above): Daylight simulation with a full progressive radiosity inter-reflection method

Variables (unit/number)	Minimum	Maximum	Mean	Standard deviation
Patients' stay time in hours (dependent variable)	48.00	178.00	88.43	29.88
Systolic blood pressure (mm Hg)	83.00	153.00	117.43	14.26
Diastolic blood pressure (mm Hg)	49.00	90.00	74.48	7.71
Mean arterial pressure (mm Hg)	60.00	106.00	88.83	9.45
Heart rate (beats/ min)	78.00	102.00	87.95	6.90
Respiratory rate (resp/min)	16.00	30.00	19.95	2.73
Body temperature (°F)	98.00	99.00	98.05	0.22
Pulse oximeter arterial hemoglobin oxygen saturation (%)	93.00	99.00	96.33	1.87
Fasting blood sugar (mmol/l)	5.00	11.40	7.49	1.85
Fluid balance (ml)	-1800.00	195.00	642.50	419.72
Ejection fraction value (%)	35.00	65.00	52.89	7.87
Smoker (17)	0.00	1.00	0.43	0.50
Hypertension (30)	0.00	1.00	0.75	0.44
Dyslipidaemia (21)	0.00	1.00	0.53	0.51
Diabetes mellitus (15)	0.00	1.00	0.38	0.49
Myocardial infarction (13)	0.00	1.00	0.30	0.46
Transient ischaemic attack (0)	0.00	0.00	0.00	0.00
Bronchial asthma (1)	0.00	1.00	0.03	0.16
Stroke (1)	0.00	1.00	0.03	0.16
Cerebral vascular diseases (2)	0.00	1.00	0.05	0.22
Chronic renal failure (0)	0.00	0.00	0.00	0.00
Gender(33 male, 7 female)	0.00	1.00	0.80	0.41
Age (years)	5.00	70.00	50.70	16.60
Weight (kg)	22.00	92.00	60.05	14.95
Height (cm)	99.00	180.00	155.10	15.92
Body mass index	15.40	34.70	24.80	3.91
Room type (15 single & 25 double)	0.00	1.00	0.63	0.49
Provision of outdoor view (30 with outdoor view)	0.00	1.00	0.75	0.44
Room temperature (°C)	19.28	27.28	24.12	1.14
Relative humidity (%)	47.84	82.60	64.83	5.44
Point illumination of combined lighting (lux)	3.90	668.80	61.67	94.15
Average daylight intensity of the rooms (lux)	200.24	1080.45	598.43	185.32

Table 1: A sample summary of the statistics of the variables initially considered in the model

analysis was conducted to select the 'best' set of explanatory variables and insignificant variables, such as gender, MI, EF, dyslipidaemia, room type, etc, were eliminated from the model. Finally, two environmental variables and five clinical variables were selected for the MLR model. The final set of variables, their coefficients (B), standardised coefficients (Beta) t-statistics, together with the P-values are shown in Table 2.

Model interpretation

As illustrated in Table 2, using the multiple regression model, it was shown that six variables decrease patients' length of stay in inpatient unit and only one variable is responsible for increasing stay time (diabetes mellitus). All the selected variables are highly significant in the MLR model (P value range from 0.0 to 0.1). Six variables are equal to or less than a 5% level of significance and one variable (POV) has a 10% level of significance. The column of unstandardised coefficients (B) provides the values for the explanatory variables for the final MLR equation. Expressed in terms of the variables used, the final MLR equation can be written as EQ [1] (see Figure 7).

Therapeutic and intuitive judgment confirmed the validity and practicality of mathematical signs in the model (EQ [1]). A view to the outdoors may help to reduce patients' length of stay (t=-1.636, P value=.112). And the reduction of patients' length of stay with an increase in daylight (t=-1.995, P value=.055) is in line with the findings of previous research from Ulrich¹¹ and Choi². It is evident from the model that daylight is more significant (t=-1.995, P value=.055) between two room variables: daylight and POV. The coefficient estimates show that, while holding the other explanatory variables constant, POV reduces patients' length of stay by 13.5 hours on average and by four hours per 100 lux increase in daylight (multiplying B with 100 lux).

One of the objectives of the research was to identify whether daylight or POV

has a more significant impact on patients' recovery time. Comparing the standardised coefficients (Beta) of two room variables, it can be concluded that daylight is more important than POV in relation to the recovery process (Beta -1.995 for daylight to Beta -1.636 for POV). The reason may be that daylight has both a psychological and a physical impact on patients but outer views only have psychological effects.

Therefore, based on the estimated MLR model, it can be concluded from an architectural decision-making perspective that a room with more daylight but a reduced view to the outside is better than a room with a better view but less daylight. Providing high windows and skylights for more daylight in a deep-planned, single-storey hospital building or on the top floors of a multi-storeyed hospital building can be an effective solution in a dense urban context, from a therapeutic point of view.

Medical judgments have also confirmed the validity and practicality of the mathematics of the clinical variables in the model (EQ [1]). During and after open-heart surgery, as a result of the anaesthesia, blood pressure and heart rate is usually reduced from its normal state¹⁷ – and the patient's recovery process accelerates with an increase in

blood pressure (t=-5.218, P value=0.0) and heart rate (t=-2.626, P value=0.013) to its normal state. As a result, length of stay in hospital is reduced. It is logical that diabetic patients will take more time than non-diabetic patients to recover (t=4.441, P value=0.0) and an increase in patients' FBS (t=-4.989, P value=0.0) and SPO2 (t=-1.636, P value=0.112) will accelerate recovery after surgery^{18,19}.

Conclusion

In this paper a methodology was developed to establish an evidence-based relationship between the availability of daylight and patients' recovery rate in a general hospital environment with the help of a MLR model. A case study involving a limited sample group was used to reach a decision about daylight and outdoor view. The limitations of this study, given the time and other resources required for such a systematic investigation, meant the study population was restricted to patients who had undergone open-heart surgery and the sample size was small. However, the most uniform patient group in the unit was selected as a sample for this study and the number of insignificant variables was reduced to overcome the limitations of the sample number.

With an increase in sample size and with a variety of surgical patients, it may be possible to generate a statistically more significant model with greater confidence in the impact of other therapeutic elements on hospital patients. According to Pechacek et al²⁰, predicting actual daylight intensity by

Explanatory variables	Un-standardised coefficients(B)	Standardise d coefficients (Beta)	t- statistics	P- values
Constant	1086.209		5.029	0.00
Average daylight intensity of the rooms (lux)	-0.040	-0.245	-1.995	0.055
Provision of outdoor view (POV)	-13.495	-0.198	-1.636	0.112
Mean arterial pressure (MAP)	-2.365	-0.748	-5.218	0.00
Heart rate (HR)	-1.444	-0.333	-2.626	0.013
Diabetes mellitus (DM)	38.049	0.624	4.441	0.00
Pulse oximeter arterial haemoglobin oxygen saturation (SPO2)	-5.839	-0.366	-3.052	0.005
Fasting blood sugar (FBS)	-10.517	-0.651	-4.989	0.00

Table 2: Multiple regression model for patients' stay time in cardiac unit. Dependent variables: patients' stay time in hours; R square=0.591; adjusted R square=0.502; F=6.617(sig=0.0)

$$\text{Patients' stay time (hours)} = 1086.209 - 0.04 \text{ Daylight} - 13.495 \text{ POV} - 2.365 \text{ MAP} - 1.444 \text{ HR} + 38.049 \text{ DM} - 5.839 \text{ SPO2} - 10.517 \dots \text{EQ}[1]$$

Figure 7: Final MLR equation, expressed in the terms of the variables used

simulation is beyond the capabilities of all but the most advanced computer modelling software. The researchers chose to use FlucsDL (from the IES software package) to measure the average lighting intensity of the inpatients' room. Actual outdoor horizontal exterior illuminance measured by an outdoor data logger from site was used to overcome the unpredictable nature of outdoor daylight intensity due to the rapid change of cloud cover in the sky.

The researchers tried to not only establish the impact of daylight and outdoor view on hospital patients but also to illustrate how this knowledge of outdoor view and daylight potentiality can be incorporated in the architectural decision-making process in critical situations. It is expected that the findings from the evidence-based methodology and the relationship established between daylight, outdoor view and recovery time will help to develop a more robust model to support the evidence-based design of therapeutic daylight hospital buildings.

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Arts and Culture



Transforming the Healthcare Experience through the Arts

Blair L. Sadler and Annette Ridenour
Aesthetics Inc, 2009
Price: US\$69.95

Art and science have polarised loyalties since before the Enlightenment, so we should not be surprised that many clinicians still view artistic intervention in healthcare as no more than a harmless adjunct to their work. But they should be reminded of Le Bon's observation that: "Science has promised us truth...it has never promised peace or happiness." Yet, peace of mind and a scrap of happiness are just what the sick need when they are in distress.

In *Transforming the Healthcare Experience through the Arts*, Blair Sadler, a highly experienced and influential administrator, and Annette Ridenour, president of Aesthetics Inc, have produced a sumptuous volume which contains, in addition to a number of informed overviews, no less than 36 well-illustrated case studies, where sensitive and sensible application of the arts, in their many forms have measurably improved the patient experience – and, in many cases, produced significant clinical and financial benefits.

The authors have written an attractive and accessible handbook rather than an academic treatise and readers should not be put off by that fact that its format resembles a promotional compendium for the artists and institutions whose works are illustrated. In fact, this arrangement makes it user friendly at an informed, lay level where it is most needed.

Its scope is wider than many people would have thought possible – it includes post-Katrina shelter art and Milwaukee

Night and day

Artwork by Michele Angelo Petrone, MAP Foundation

"As time goes by, night follows day, and day follows night – a natural cycle without beginning, without end and without gaps. Life's cycle continues without interruption, or at least it should. I found myself caught between life and death, light and dark, banished to an unknown place – between night and day. The illness forced itself into my life where there was no place for it. The arrival of illness stole a place and time that should have been destined for better things."



So much love

Artwork and quote by Michele Angelo Petrone, MAP Foundation

"A serious illness does for your appetite for love what steroids do for your appetite for food. When feeling low and vulnerable, your appetite for love can become insatiable. Fortunately, love came to me from so many different sources, some friends, from my lover – well that goes without saying, doesn't it. The nurses and counsellors and even the cleaners gave so much love. It means so much to me even now. Some of the doctors also expressed love. Is a doctor a better doctor if he (or she) is loving? Undoubtedly, no question of it."

multigenerational interface on a shoestring – and compels interest through lively narrative. If the book doesn't say anything particularly new, one must not forget there are multitudes out there for whom it will be both new and topical. Early names who blazed a trail a quarter of a century ago – Roger Ulrich in the US, Susan Loppert in the UK and Marilyn Cintra in Australia – would all agree that this trumpet call to administrators, clinicians and architects needs to be repeated at every opportunity.

The book contains rather too many one-liners to bolster the case studies introduced, not all of which are apposite and, again, some of the laudatory observations about the schemes described are repetitive and maybe too saccharine-coated for some

The journey
Artwork by Michele
Angelo Petrone,
MAP Foundation



tastes. Nonetheless, in one sense it doesn't matter, as the book is all about selling ideas and enthusiasms and such emphatic enthusiasm no doubt helps to spread the message.

Mental health is touched upon, mostly covering dementia, and the lack of more numerous examples probably reflects the fact that successful applications are hard to find.

The correlation of arts with the recognised quality benchmarks of safety, efficiency, timeliness, equitability and patient-contentedness is rightly stressed in the observation that, as well as recording proven successes in arts interventions, it is equally important to focus research on the perceived experiences of patients in care. This cannot be overstated.

Strong emphasis is also placed on the role that creative arts, both visual and performance, have in the area of public health, encouraging self-awareness in an ever busy, preoccupied population who could do a lot more to prevent themselves becoming ill in the first place.

Perhaps the most important message is contained in Roger Ulrich's afterword when he says: "I applaud the book's call to action for more research on the effectiveness of various types of arts interventions in different care settings." This is the next area of research in a nutshell, albeit a pretty substantial nutshell.

It is all very well for those of us working in the field to say that colour, light, control of noise, external view, animation, privacy and spatial continuity all have a positive role to play, but we are years away from demonstrating which of these factors is the more important in any given setting. And following that, some new brave souls will have to tackle head-on the topic of distraction as therapy. If that one is cracked, then we will all be motoring very fast indeed, with happier patients at our side.

Transforming the Healthcare Experience through the Arts is available for purchase through www.artandhealthcare.com or at Amazon.com.



John Wells-Thorpe is an architect, a former NHS trust chairman and co-author of *The architectural healthcare environment and its effects on patient health outcomes*

Such emphatic enthusiasm no doubt helps to spread the message

TRANSFORMING the HEALTHCARE EXPERIENCE THROUGH the Arts
BEATE L. SÆVI
ANNETTE SJÖSTRÖM