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THE LONG GAME

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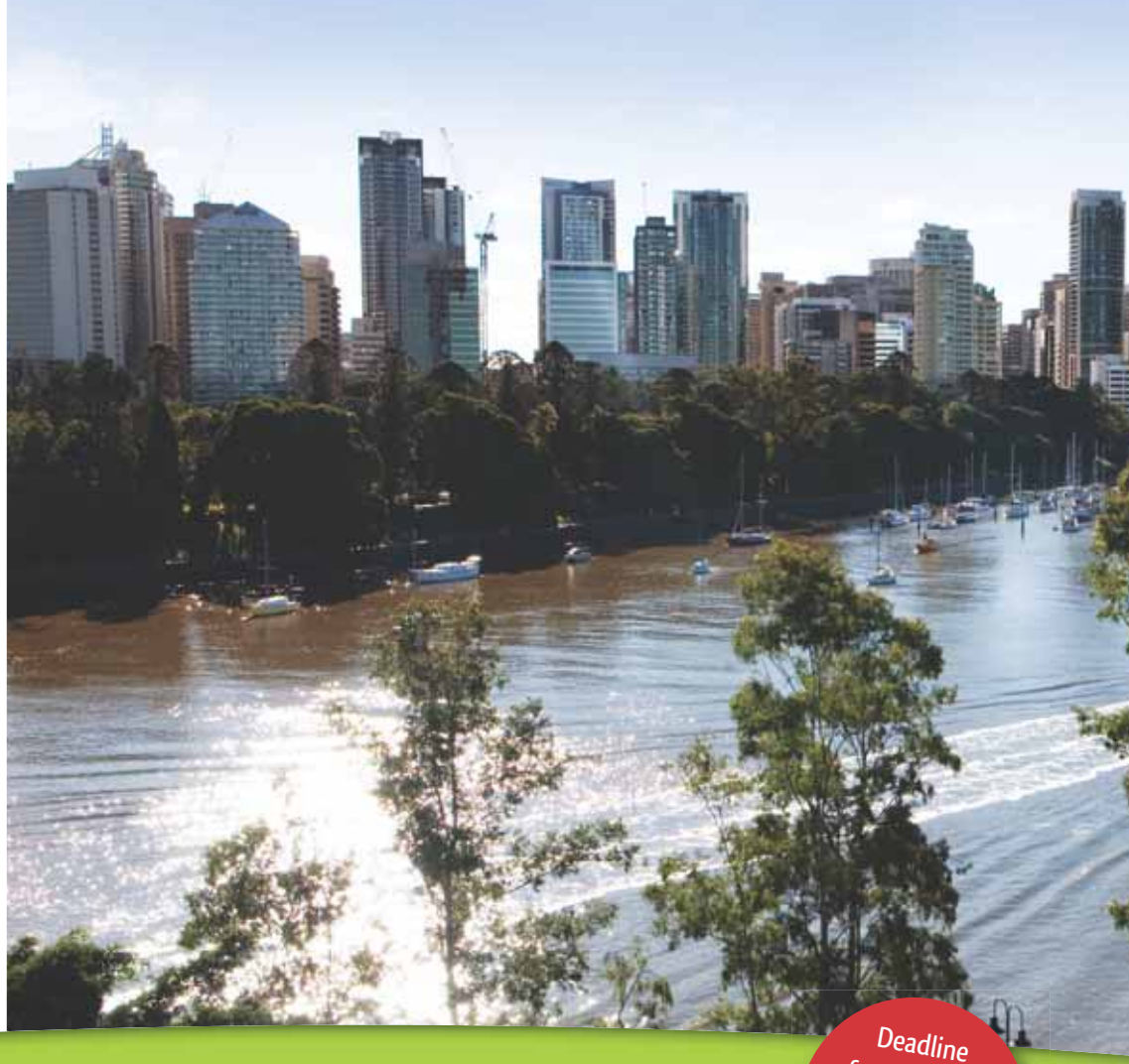
Design &Health
International Academy for Design and Health



Deadline for Abstracts 15 November 2012

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- The salutogenic hospital: The role of the hospital in health promotion
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- Wellness centres to promote individual, family and community health
- Innovation in procurement and delivery: evolving partnership models
- Indoor environmental quality that improves health and well-being
- Design for healthy lifestyle to prevent non-communicable diseases (NCDs)
- Design innovation in e-health and medical technology

Photo: Brisbane Marketing

BCEC, Brisbane, Australia, 10 - 14 July 2013

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Contributors

Ray Pentecost
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Cover Image
The London 2012 Olympic Athlete's Village Polyclinic, designed by Penoyre & Prasad. See pp 18-19. (Photo: Anthony Coleman)

Invest in the future

We have come a long way in our holistic understanding of sustainability, and the criteria by which we define it. Today we value far more than simple energy savings or carbon-reduction strategies, and cost-benefit models are being developed that will in time help us to determine more accurately the way in which a new or renovated building is not only technically sustainable in its use, recycling or even production of natural resources, but also its positive or negative impact on human resources, such as health and wellbeing. But in practice, there is still a long way to go, and in times of global economic difficulty and budget deficits, it is all too easy to take the cheaper design option and make savings on the initial capital investment, rather than invest in a more intelligent design that may cost more today, but will make significant savings off the revenue budget for operations and maintenance over the long run, not to forget improve recruitment, retention and staff morale, and reduce bed stays by improving patient recovery times. Lower construction costs have reduced the payback time for a new hospital building in terms of operational cost on average from 7 to 4 years, making the case even greater for intelligent spending now to save tomorrow. As Dr Ray Pentecost argues (p15), we need more thought leaders to make this case and others. Submit an abstract for the 9th Design & Health World Congress in Brisbane (pp10-13) next year and help to make the case on behalf of the next generation.

Marc Sansom
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Design and production:
Graphic Evidence Ltd
www.graphic-evidence.co.uk

WORLD HEALTH DESIGN
Volume 5 Number 3
ISSN 1654-9654

Subscriptions:
To receive regular copies of World Health Design please telephone +44 (0) 1277 634176 to place your order, or email WHD@designandhealth.com

Yearly subscription rates:
1 year £80; 2 years £130; Single Issue £30
World Health Design is published four times a year by the International Academy for Design and Health

Printed in the UK by
The Magazine Printing Company
using only paper from FSC/PEFC suppliers
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ARTS & CULTURE

Singapore Minister calls for innovation in infrastructure

The Singapore Minister of Health has called for urgent innovations in design, technology and infrastructure are to address healthcare challenges of growing healthcare demand, ageing populations and non-communicable diseases (NCDs)

Speaking at September's Healthcare Infrastructure Technology and Engineering (Hi-Tec 2012) conference, organised at Resorts World Sentosa by Health Infrastructure Projects (HIP), a division of the Ministry of Health Holdings, Singapore Minister of Health Mr Gan Kim Yong set a challenge to health infrastructure professionals to use their expertise in helping Singapore to meet the aims of its healthcare 2020 masterplan, "to continue to deliver accessible, quality and affordable care for all Singaporeans".

Setting out the problem, he said: "By 2030, one fifth of Singaporean residents will be 65 or over. This will lead to a significant increase in healthcare demand, since not only are the elderly four times more likely to be hospitalised but they stay in hospital much longer.

"Apart from the quantitative problem of growing demand, the rising incidence of NCDs also requires a paradigm shift in the way we deliver healthcare. We need to change our focus from one off episodic treatments in hospitals to the continuous management of chronic diseases in the community. We also need to step up our efforts to encourage more people to lead healthy lifestyles."

Mr Gan explained how through its healthcare 2020 masterplan, the Singapore Government was addressing these challenges by raising its spending capacity to meet the increasing demand, firstly by manpower. "We will increase the intake of doctors, dentists, nurses, allied health professionals, pharmacists, with the aim of growing the healthcare professional workforce by 20,000 by the year 2020."

Construction would also help Singapore to address these challenges, continued Mr Gan. "By 2020, we are planning 1,900 acute beds, 1,800 community hospital beds, and 6,600 nursing home beds. Some of the key developments include the Changi General Hospital and Community Hospital in the east, the Ng Teng Fong General Hospital and Jurong Commununity Hospital in the west, Khoo Teck Puat Hospital and Yishun Community Hospital in the north, Sengkang General Hospital and Community Hospital in the north-east, and the Singapore General Hospital and Community Hospital in the south."

Investment in health infrastructure must be focused on supporting healthcare demand growth in the future, added Mr Gan. "When it comes to health infrastructure, we have always been careful to avoid over building, which could be wasteful and increase healthcare costs unneccessarily. When demand grows we will adapt and act. We are planning carefully for future expansion and building in flexibility into the design of our new healthcare facilities, so that when necessary they can be expanded quickly.

The Ng Teng Fong General Hospital and Jurong Community Hospital, under construction

"An example are the innovations we have been engaged in to ensure our new buildings have a functional, patient-centric design. We do not want to build expensive, iconic structures with fanciful and costly features. Rather, we want healthcare facilities that put patient needs first, facilities that are functional and efficient, are also open, friendly, welcoming and easy for patients to navigate. We want designs that support healing and allow for the introduction of new models of care."

Speaking about the new Ng Teng Fong General Hospital and Jurong Community Hospital, designed by CPG Consultants, which are currently being built, Mr Gan explained how the main consideration was to incorporate the needs of the elderly and sick patients. "I was impressed by the thought that had gone into every detail, down to providing softer lighting for the elderly patients in the emergency department. The ICU and high dependency beds will be co-located to reduce the need for transfers and allow for the same care team to look after the patient. It will even have an outdoor terrace for stabilised patients to enjoy fresh air and sunshine."

Innovation, he said, can also be applied directly to the cost of healthcare. "We can design buildings that are cost-effective to manage and operate. The initial cost of construction of a healthcare facility may be a significant capital investment, but it is a one time investment. The subsequent operation and maintenance of the building on the other hand will take place over many years. High operation and maintenance costs mean higher healthcare costs, hence we should seek to capitalise in the innovations in design and technology to keep our costs low. For example, by designing healthcare facilities to make as much use as possible of natural lighting and ventilation, and embed green features and technology to realize energy savings."

The award-winning Khoo Teck Puat Hospital, Singapore

Khoo Teck Puat Hospital hosts Asian Symposium

A new international symposium and exhibition, produced by the International Academy for Design & Health is set for launch in Singapore, from 14-15 March 2013

The inaugural Design & Health Asia 2013 International will be organised over two days at the double Academy Award-winning Khoo Teck Puat Hospital (KTPH), and forms part of its regional series of symposiums already established in Europe, Australasia and Africa.

The rapid growth of Asian economies over the past half century has helped to lift billions of people out of poverty and indigence. The city state of Singapore, which was recognised by the World Health Organisation in 2000 as possessing the 6th best health system in the world, has been leading the march to raise quality and increase efficiency, despite spending just 4% of GDP on health compared to 16% in the USA.

In the 21st century, however, health systems in Asia are facing a new set of challenges, most notably ageing populations, lower fertility rates, increasing public expectations and a rise in the level of lifestyle or non-communicable diseases (NCDs), such as diabetes and obesity. By 2030, Asia (excluding Japan) will account for over half of the world's elderly population and about half of the global burden of NCDs.

By 2040, Singapore, South Korea and Hong Kong, which have the highest ageing rates in the world, will have fewer than two people of working age to support every person aged 65 or more. A steep decline in the fertility rates mean that south Korean women can now expect to give birth to only 1.39 children, whilst in Hong Kong the rate is just 1.14, and in Singapore 1.37.

Many Asian countries are restructuring their health systems, and forming the foundations for universal health coverage in response to societal demands as their economies develop. Last October, Indonesia pledged to provide health insurance to all of the country's 240m population, making it the biggest single-payer system in the world. In the Philippines, 85% of the population are now members of PhilHealth, the government-owned health insurer, compared with 62% in 2010. China's rural health-insurance scheme now covers 97.5% of the population, compared to 3% in 2003.

In Singapore, a focus on integrated care, with acute and community hospitals being strategically developed on the same site, supporting its ageing population and on the creation of a healthy society are the priorities for addressing both health status and financial inefficiencies in care provision.

International speakers from around Asia and the rest of the world will join with local speakers from Singapore's health administration and from its architect and design communities to debate how the public, social and healthcare infrastructure can play a role through the salutogenic perspective in meeting these challenges.

Providing an ideal location, the KTPH, which opened in 2010, is a 550-bed general and acute care hospital, managed by Alexandra Health, that has won accolades for its highly sustainable approach, as well as measures taken around health promotion, both in the environment through the application of nature and in its service provision through education. The new Yishun Community Hospital next to KTPH will be ready by 2015 to provide step down facilities and integrated care.

More details on registering for the conference and viewing the speakers and the programme agenda, which will be launched in November, will be available at www.designandhealth.com. Sponsors or exhibitors interested in taking part should contact info@designandhealth.com

The Gardens by the Bay in Singapore, which opened in June 2012, supports healthy living

Towards a Healthy Society

The Scientific Programme for the 9th Design & Health World Congress & Exhibition in Brisbane will explore the global application of salutogenic perspectives on improving human health and wellbeing by design, reports ***Alan Dilani***

The International Academy for Design and Health (IADH) will be organising the 9th Design & Health World Congress & Exhibition (WCDH 2013) in partnership with the Australian Government and State Health Departments, and supported by world-renowned academic institutions and healthcare industries worldwide.

Following Australia's successful bid, the WCDH 2013 will be held from 10-14th July 2013 in Brisbane, considered to be one of the most livable cities in the world and the capital of Queensland, famously known as Australia's "Sunshine Sate".

The health status of people living in Australasia is one of the highest in the world, with rising life expectancies and falling mortality and morbidity rates. But the region's healthcare systems face similar challenges to the rest of the developed world, characterised by increasing cost pressures, an ageing population and a rise in the level of lifestyle diseases, most notably diabetes and obesity. In addition, Australasia faces the challenge of addressing the inequities in health outcomes of its indigenous population and those living in more remote and rural areas.

In recognition that a healthy population is the foundation for social development and economic growth, Australasia is undergoing a policy shift that is addressing the need to redesign its health systems to embrace health promotion and embed a preventative approach based on better education and research. At the same time, the region continues to enjoy one of its most prolific periods of health capital investment, with many new benchmark facilities recently opening or due for completion.

The challenge of non-communicable disease (NCDs) was discussed for the first time at the General Assembly of the United Nations in September 2011, and was determined to be a more significant socio-economic threat to modern society than poverty, giving global recognition to the urgent need to reshape our built environment to tackle the 21st-century challenge of lifestyle diseases.

A salutogenic approach to health and public infrastructure development embedded at the core of a preventative health strategy meets this challenge by focusing on a more holistic understanding of healthy built environments. Following nearly two decades of dialogue and interdisciplinary research-based design undertaken by the IADH to promote understanding of the value of salutogenic design, there are, however, still inadequacies in implementation.

One of the most pressing subjects is the rehabilitation of our existing infrastructure into more livable eco-cities. A new generation of designers, architects and engineers need to learn how to apply ecological and salutogenic design principles in their work, supported by world governments to develop understanding of the value of a healthy and sustainable society.

The WCDH 2013 will provide an opportunity to engage with the world's foremost interdisciplinary network of thinkers in the field of design and health. Participants will join with architects, psychologists, physicians, nurses, health planners, environmental designers, health administrators, policy makers and other researchers, practitioners and key decision makers and influencers to discuss how to improve human health and wellbeing by creating stimulating and sustainable environments.

The Minister of Health, Malaysia opens the World Congress in Kuala Lumpur in June 2012

Keynote: Dr Ken Yeang calls for authentic ecological design

Call for Papers

The IADH is committed to developing knowledge amongst the design and health professions in an effort to reduce the prevalence of lifestyle diseases and improve quality of life, and invites you to participate in the 9th Design & Health World Congress & Exhibition 2013 in Brisbane in Queensland, Australia from 10-14th July, 2013 by submitting abstracts on the following themes:

- The salutogenic hospital: The role of the hospital in health promotion
- Case studies of successful healthy built environments
- Salutogenic design for healthy communities and urban planning
- Improving health by design for indigenous communities
- Wellness centres to promote individual, family and community health
- Innovation in procurement and delivery: evolving partnership models
- Indoor environmental quality that improves health and well-being
- Design for healthy lifestyle to prevent non-communicable diseases (NCDs)
- Design innovation in e-health and medical technology

Each abstract should be no more than 400 words in English. The abstract should clearly state the objectives, methods used, results and conclusions. The paper will be presented to an audience with diverse interests and disciplines. Consequently, we are seeking presentations that focus on the practical importance of environmental design qualities that promote health and wellbeing. Papers addressing more than one of the congress themes will be given preference.

All abstracts will be subject to a rigorous blind peer review process by the WCDH 2013 Scientific Committee and a select number will be chosen for oral presentation with a wider number presented as posters. Abstracts and enquiries should be submitted by e-mail to the WCDH 2013 Secretariat at the following address by no later than 15 November, 2012.

WCDH 2013 Secretariat, International Academy for Design & Health E-mail: info@designandhealth.com Tel: + 46 70 453 90 70 Fax: + 46 8 745 00 02

Proposals must include a title, author(s), organisational affiliation, and three keywords. Papers chosen for presentation will be published in the Final Programme and Book of Abstracts, with selected papers published in full in World Health Design in 2013-14.

The author(s) or co-author(s) should register and pay the registration fee in order to present the paper at the conference. The official language of the WCDH 2013 is English. Further information on the conference venue, hotel accommodation and registration fee will be provided in the Preliminary Programme in February 2013.

Timetable

01 September 2012
Publication of First Announcement and Call for Papers

15 November 2012
Deadline for Abstracts of Papers

1-20 December 2012
Evaluation of Abstracts by Scientific Committee

15 January 2013
Authors notified of decision of Paper acceptance

01 February 2013
Preliminary Programme and Registration

15 May 2013
Deadline for Early Bird and Speaker Registration and completed manuscript

01 June 2013
Final Programme and Book of Abstracts published

July 2013-2014
Selected papers will be published in World Health Design

Congress dates and schedule

The WCDH 2013 is a five day event, which will be held from 10-14 July, 2013 at the Brisbane Convention Centre, Queensland, Australia.

Wednesday 10 July
Registration from 14.00-18.00 Pre-congress symposium Opening Ceremony and Welcome Dinner from 19.30

Thursday 11 July Congress & Exhibition
Late registration from 08.00-09.00. Congress and exhibition from 09.00-18.00. Social program to be advised

Friday 12 July Congress & Exhibition
Congress and exhibition from 09.00-18.00 Advisory Board Meeting of the International Academy for Design & Health from 19.30

Saturday 13 July Congress, Exhibition & Academy Awards Gala Dinner Congress and exhibition from 09.00-18.00 Academy Awards Gala Dinner from 19.30

Sunday 14 July Architectural Study Tours
Site tours and visits to local landmarks and health facilities

14-15th March 2013

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Invest and grow

The Design & Health World Congress 2013 in Brisbane offers a myriad of opportunities for international organisations to develop their presence in the Asia Pacific

In a challenging global economy, opportunities for growth and investment in Australasia and the Asia Pacific region continue to grow at impressive rates.

With a thousand delegates expected to attend from all across the globe, the 9th Design & Health World Congress & Exhibition (WCDH 2013) in Brisbane provides an ideal gateway to the Asia Pacific markets.

With a wide range of sponsorship and exhibition opportunities available to suit all budgets, WCDH 2013 offers a knowledge-led platform for industry to network with leaders in the field, develop research collaborations, reach senior decision makers, and grow their international business.

This global audience will comprise delegates from all continents of the world and from a variety of interdisciplinary backgrounds – architects, health planners, designers, health administrators, researchers, clinicians, estates & facilities managers, and from related industries, such as building/construction, banking, legal, private equity, medical equipment, furniture/furnishings and technology.

Opportunities

Sponsorship of the Design & Health World Congress will provide Australian and international organisations with unparalleled exposure before, during and after the event with thought leaders and decisions makers from across the globe. Associating their name with the International Academy for Design and Health on this stage, at this scale, will cement or establish the position of firms as innovative leaders in the marketplace.

For organisations interested in exhibiting, a prominent location and an attractive booth presence throughout the congress are essential to attract visitors, meet potential clients, develop new relationships and generate business. Booths are available in a variety of sizes to suit individual requirements and budgets. A combination of a booth with sponsorship of a conference session or a corporate showcase can ensure maximum exposure and value for money. A range of specialist sponsorship opportunities are also available for organisations wishing to create a unique impression and ensure a strong brand presence. Sponsorship of the delegate bags, the Scientific Poster Gallery, the Welcome Dinner and Academy Awards Gala dinner, and the Study Tours all provide opportunities for your organisation to be seen to be making a special contribution to the success of the Congress. The Academy is also seeking additional sponsors for a special book on Australian Healthcare Design, which will be published in time for the congress, and provided to all delegates attending complimentary, as well as being available for purchase.

Another popular feature of the congress is the corporate showcase programme, which runs during the lunch and coffee intervals on each day of the World Congress. Each showcase is scheduled and promoted in the programme and comprises a 25 minute presentation aimed at generating profile and real business interest. This gives organisations the perfect stage to demonstrate their services, hand-out materials and answer questions from a dedicated audience.

Limited opportunities are also available to sponsor the Design & Health International Academy Awards programme, which is the world's leading advocacy programme, recognising excellence in the research and practice of designing healthy environments.

The awards are open to international organisations in both the private and public sectors. Each award provides a valuable sponsorship platform, associating organisations with best practice, winning projects and the Academy, as well as providing significant publicity before, during and after the awards ceremony on the final evening of the congress. The Awards will open for entry in November 2012.

To discuss or receive information on how to sponsor or exhibit, contact Marc Sansom at: info@designandhealth.com

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Thought **leadership**

The true potential of a research-based approach to design can only be achieved if knowledge is pooled for the good of all, writes ***Ray Pentecost***

A seemingly unquenchable passion for research is transforming design worldwide. We are now trying to ask the right question (as opposed to the easy one, or the funded one) and endeavouring to ask it in the right way (as opposed to the convenient or expedient way). It has challenged members of the design world to use research for the right purpose – better design – and not to cheapen it by turning it into a marketing cliché.

Research reveals answers that are rarely one-dimensional, and it is only when it is shared, and compared to other studies, that its true value is known. Some practitioners and researchers keep the findings to themselves, however, believing that those insights are the key to winning the next client interview by revealing what nobody else knows.

How real is this advantage? Research findings generally have a half-life that is no respecter of discoverer or owner; findings age quickly and, especially if linked to the more popular or visible projects, move rapidly toward the realm of common knowledge. They can also be very narrow in scope, making them less valuable in a general marketing strategy. And finally, research findings can be real and predictable, or they can be anomalies, but one can't be sure until they are replicated. The most exciting and potentially valuable discoveries have very limited actual value until another research team can achieve the same results in the same research environment, or until the original team can repeat the study and generate the same results.

In the world of research, all findings are valuable – even those that are not supportive of a hypothesis, or deemed useful to the private sector – because they contribute to the broader understanding of a topic, as well as the tools and approaches for studying it. To really claim an research-based approach, one must, eventually, turn to the work of colleagues, and even competitors, to assemble a portfolio of current research findings for the design concepts. The proprietary mindset is, in that moment, diluted.

Quickly replacing the "proprietary" view of individual research efforts is something known as "thought leadership". A thought leader acknowledges the intellect and creativity that led a research effort and birthed a significant finding, but also recognises that almost never can one research finding, or individual researcher, or single research team, possibly ever represent enough value all by itself to justify the proprietary view of research findings.

A thought leader freely shares individual research findings, and recognises and celebrates the discoveries of others They are known not just as someone who discovers, but someone who uses and presents new knowledge to the greatest possible value proposition for all concerned.

A thought leader shares individual research findings, and celebrates the discoveries of others

Will you join the ranks of the thought leaders and freely share your research findings? Will you help clients recognise the value of thought leaders? Will you trade in the limited value of a proprietary view of individual research and pursue, instead, the much broader, and the significantly more valuable, reputation as a "thought leader"?

Dr Ray Pentecost III, DrPH, FAIA, FACHA, LEED AP, is the president of the International Academy for Design & Health

Once in a lifetime

Redevelopment plans for many of Finland's ageing healthcare facilities is an opportunity to embed new models of care. ***Marc Sansom*** reports from Design & Health Europe 2012 International Symposium in Helsinki

Whilst every health system has its own particular characteristics, resulting from historical, structural, cultural and socio-economic differences, the pressures of a modern global society in the 21st century are creating similar cost burdens on health economies that are threatening the quality, accessibility and affordability of care.

Speaking at the Design & Health Europe 2012 International Symposium in Helsinki, organised by the International Academy for Design & Health from 20-21 September, Prof Carola Grönhagen-Riska, chief physician, Hospital District of Helsinki and Uusimaa, Finland, explains how the pressures on the healthcare system in Finland are increasing. "Rising levels of urbanisation, an ageing population, a decreasing workforce and a weakening economy are creating pressures for new models of care and new health facilities to support a more integrated healthcare system."

With a population of just over 5m, Finland's health economy is relatively small compared to its larger European neighbours, but its challenges are similar. Across the world, from the USA to Singapore, Australia, Canada, the UK and Sweden, more integrated care, says Prof Grönhagen-Riska, that promotes healthy living, supports prevention and early intervention, and develops a well-functioning primary health system in conjunction with social care, is seen as the new model of care that will improve quality at the same time as creating efficiencies.

She warns however that there is "no 'one-size-fits-all' model" or "any empirical foundation for specific integration strategies" that Finland is attempting to adopt, but that is has drawn many principles from the research that it will use to guide implementation, including the need for: comprehensive services across the care continuum; patient focus; geographic coverage; information systems and management; holistic financial management; appropriate implementation in high density metropolitan areas versus less dense rural areas; and clinical engagement and advocacy.

Is Finland's current healthcare infrastructure capable of supporting a new integrated model of care? According to Dr Aki Lindén, chief executive of the Hospital District of Helsinki and Uusimaa, many of the hospitals that had served Finland so well in the 20th Century are not only ageing, but are no longer fit for purpose. "Technically, the old hospitals no longer meet the needs of the present or the future and its focus on specialised care with its growing high technology that needs more and more space. They are increasingly unsafe in respect of fire safety and work safety. They were planned for yesterday's quiet and easy patients and their lower expectations and they were not designed for modern patient processes or today's severe infections."

Additional challenges, explains Dr Lindén are: rising problems with indoor air quality problems; hospital real estates are too small or too large; square-metres are in wrong departments; location is not optimal; new energy efficiency demands and national building code regulations are difficult and expensive to complete; some of the hospital buildings are of high architectural heritage and they are officially protected as a part of our designed environment.

A recent study by Inspira, a financial advisory organisation in Finland, explained Dr Lindén shows that the requirement for renovation is high and acute all over the country, with interest being shown in alternative models of designing, contracting and

Dr Aki Lindén, ceo, Hospital District of Helsinki and Uusimaa: "Technically, the old hospitals no longer meet the needs of the present or future"

Prof Carola Grönhagen-Riska, chief physician, Hospital District of Helsinki and Uusimaa: "There is no 'one-size fits all model"

Mikael Paatela of Paatela & Co Architects, Finland, Mark Johnson of Civitas, USA and Mikko Sinervo of Architect Group Reino Kolvula Oy, Finland

financing new renovation or new build projects. In addition, there are opportunities to look at ways that the 20 different hospital districts in Finland served by five university hospitals can collaborate better in the planning phase and by introducing new technical innovations as well as new finance models.

Although, says Dr Lindén, the challenge is less about the municipalities being able to fund the initial capital cost of a project investment and more concerned with the annual operational and maintenance costs of the healthcare facility. "How do we compare and prioritise the advantages and disadvantages of building new hospitals versus renovating old ones, in alignment with our political shareholders?"

With a new children's hospital in the advanced planning stage within the Hospital District of Helsinki and Uusimaa, presented during the symposium by Dr Jari Petaja, director of the Department for Women and Children at Helsinki University Hospital, and many other facilities being considered for redevelopment, the symposium provided an opportunity to learn about benchmark international projects and design approaches.

These included a presentation by Prof Alan Dilani on behalf of Inge Fottland, project director for the innovative St Olavs Hospital in Trondheim, Norway; a paper from Stéphane Vermeulen, director of healthcare for VK in Belgium on the masterplan of the Saint Petersburg Educational and Scientific Clinical University Campus; and a number of examples of projects from Australia, where considerable capital investment over recent years has been made to modernise the health estate. These projects were presented by James Grose of BVN Architecture, Kate Copeland of Queensland Health, and Jeff Menkens of Hassell.

As governments and health providers around the world invest in either building new or in renovating old healthcare infrastructure, there are many international examples to learn from. As Prof Grönhagen-Riska reminded delegates, "you are not the first person to build a hospital, there are models, norms, standards and experts to guide you."

Politicians need more courage

Governments need to do more to embrace new theories and perspectives on health promotion, agreed speakers at the International Health Promotion Research Forum, held from 6-9 August in Trondheim Norway in conjunction with the 5th International Research Seminar on Salutogenesis.

A keynote speaker and world-renowned expert on health promotion, Professor Dennis Raphael from Canada, raised concerns about how Canadian society, which until recently was world leading in the field of health promotion, had taken a step back.

In a comparison of the development of health promotion practices in different modern societies, Prof Raphael explained how this was the result of more conservative and conventional politicians taking office in Canada that lacked the courage of the previous government to embed new and brave health promotion initiatives in Canada.

Professor Geir Arild Espnes, director of the Norwegian host organisation, the Research Center for Health Promotion and Resource (RCHPR), expressed similar concerns that the Norwegian Government still lacked the sufficient maturity to adopt and embrace the new thinking, remaining stuck in old paradigms and showing limited openness to new health theories, despite increased knowledge and understanding amongst professionals in the Norwegian Health Directorate.

Professor Espnes explained the theoretical as well as the practical foundations for the centre using the new legislation of health in Norway as a departure point for the discussion. He pointed to the urgent need for theoretical foundation in public health work and the development of legislation, stressing the important role of organisations like the RCHPR to join forces with practitioners to knock on the doors of Government Ministries to demonstrate how the new health theories can develop into practical applications to meet the 21st century health challenges.

Prof Geir Arild Espnes

A panel of top international researchers at the conference, also included the founder of the International Academy for Design & Health, Professor Alan Dilani who spoke on how to design salutogenic work and living environments and Professor Bengt Lindström, who is the leader of the Global Working Group on Salutogenesis and spoke on the theoretical foundations of salutogenesis and its practical implications.

In it together

The integration of health facilities and other related community services has multiple benefits: apart from the obvious economies of scale, it can enable the cross-fertilisation of ideas between the different resident groups. And when fitness and clinical facilities are combined, it can help to foster a more holistic view of health for patients – wellness, as well as illness.

Nightingale Associates' Bolton One in Greater Manchester is such a facility. Part of the University of Bolton's Deane Road Campus, it services the university as well as NHS Bolton and Bolton Council. Each has their own specified areas, but they are interlinked to enable shared facilities and easy access; the building has been designed around its integrated nature, to ensure the maximum benefit of co-location. On the clinical side, a new Out Patients Centre, spread over three floors, includes a GP practice, a range of Out Patient clinics, diagnostics (X-ray), rheumatology and orthopaedics. Leisure facilities open to the local community include a swimming pool and hydrotherapy pool, a gym and dance studio; this is complemented by the university's sports facilities, including a four-court sports hall, climbing wall and the Sports Science and Health Sciences departments. Some future flexibility has been built in – should the clinical spaces need to expand in future, the service trenches have already been extended into non-clinical areas. Bolton One is convenient for public transport and cycle routes, and there is on-site cycle storage along with shower and changing facilities. The building has been designed to achieve a BREEAM Excellent rating; thermal modelling was used to achieve a 20% reduction in CO_2 emissions, and 80% of the roof and external cladding achieved an A/A+ BRE Green Guide Rating. This is complemented by day-to-day energy-saving features such as energy-efficient lifts, rainwater reuse and low-flush WCs.

Bolton One, Lancashire, UK

Completion date: 2012
Clients: NHS Bolton/University of Bolton/Bolton Council
Cost: £31m
Size: 13,250sqm
Architect: Nightingale Associates
Main contractor: Eric Wright Construction
Structural Engineer: Booth King Partnership
Mechanical Engineer: JRB Environmental

David Millington

Brisbane Marketing

Brisbane, which will host the 9th Design & Health World Congress, 10-14 July 2013, has invested AUS$100m on cycling infrastructure over the last four years

Harnessing health in cities

The healthiest cities are socially cohesive, walkable, attractive, environmentally friendly cities – and we need them now far more than at any point in our history, writes ***Veronica Simpson***

As far back as 2007, a UN report declared: "The battle for sustainable development, for delivering a more environmentally stable, just, and healthier world, is going to be largely won or lost in our cities."[1] Somehow the message of hope contained within this statement – and some of the intelligence that informed it – seems to have got lost in the recent outpourings of global concern at the relentless population drift towards our already overloaded urban centres, and the negative impact that this is predicted to have on individual as well as planetary health. With the current urban population of 3.3 billion exceeding the total world population in the 1960s, and set to exceed 5 billion by 2030, there is certainly cause for concern – especially in the light of escalating levels of obesity, diabetes, heart disease and depression caused in no small part by the design of our cities and suburbs and the sedentary lifestyles they promote.

But if cities are part of the disease, they also contain all the ingredients for a cure. A report by David Satterthwaite, senior fellow at the International Institute for Environment and Development (IIED), indicates that where cities had been believed to be the biggest environmental blight on the planet, responsible for up to 80% of greenhouse gas emissions, the actual figure is likely to be nearer 30-40%. Satterthwaite found that rural areas tend to have higher CO_2 emissions per person, due to people living in larger, detached houses, and travelling longer distances by car (cars are responsible for 12% of greenhouse gas emissions in Europe and up to 50% in parts of the US). "Blaming cities for greenhouse gas emissions misses the point that cities are a large part of the solution," he concludes. "Well-planned, well-governed cities can provide high living standards that do not require high consumption levels and high greenhouse gas emissions."

Redressing current models

Already, there is evidence of significant civic investment all around the globe in redressing the prevailing urban and suburban models of the past 50 years – clogged, car-centric, demographically disconnected and socially and environmentally toxic. One of the most visionary examples has to be Singapore's Gardens by the Bay initiative (*WHD* July 2012). This 101 hectare, S$1bn (£500m) superpark is an exemplar for sustainable construction as well as ambitious

> **More than half the homebuyers in the US now want a place that's in a walkable community**

landscape design. Grant Associates and Gustafson Porter were master planners for the Bay South and Bay East Gardens, which opened in June 2012 (with Bay Central yet to come in the next phase), complete with giant eco trees clad in solar panels, and Wilkinson Eyre designed biodomes filled with exotic plant life. Singapore-based CPG Corporation, a building and infrastructure management consultancy created from the privatisation of Singapore's Public Works Department, played a major role in the vision and implementation for this scheme.

CPG is now working with China to help develop greener, more sustainable approaches to city planning. China – facing the prospect of over half its population moving from the country to the city over the next few years – is already on the case, developing a prototype eco-city in the ¥250bn (£25bn) Tianjin Eco City (see case study), a joint Sino-Singaporean venture. Tianjin region is next to Beijing, and the Eco City site is about 40km from Tianjin city centre, comprising a 30sq km coastal area that was previously mainly saltpans, barren land and polluted water. Construction is well under way, with the aim to transform it into a "socially harmonious, environmentally friendly, resource-efficient" city for around 350,000 residents by 2020.

CPG has been involved in various projects within Tianjin Eco City, including designing the city's International School. CPG's executive director for urban planning Nina Yang offered these insights into the project: "Two of the key planning principles of Tianjin Eco City are the notion of compact development and smaller land parcellation, to allow the inclusion of more green corridors and the provision of a future 'people mover system' to reduce the usage of cars. All the city's buildings must achieve minimum green criteria which includes: meeting energy conservation standards, usage of renewable energy, harvesting and recycling of rainwater. A pneumatic refuse system is also being implemented city-wide by the developer."

Yang has reservations about other so-called eco cities: "There are many cities and developments in China that claim to be planned as eco development, but few have seen the masterplan to realisation. I will hesitate to say if there are other good examples following in Tianjin's footsteps."

Even Tianjin's intention is not to be an exemplar in terms of sustainable building design or construction, or even energy use. The aim is only for 20% renewable energy overall – though 90% green transport. The idea is to make this city affordable for a wide cross-section of worker residents and their families, and easily replicable. Buildings are designed to harness natural daylight and ventilation, and there are solar panels on tower block roofs, though some go further: government-owned buildings will collect their own rainwater for reuse and are powered by geothermal energy, with light-sensitive window shutters and solar heating systems. Environmental, social and health benefits largely come from the low level of car use, and high levels of outdoor activity encouraged by closely connected homes, businesses and neighbourhoods, combined with outstanding outdoor recreational facilities.

People-centric environments

Creating healthy cities isn't just about eco-technology, car-use and levels of connectivity. It's also about maximising opportunities for resource sharing and local sustainability, and using local cultural insights in ways that can improve the fabric and experience of living in a city. As Maximo Martinez, associate director at UK-based consultancy Space Syntax, says: "It's about not designing a city from a transport engineering point of view. We'd rather put people first."

Investing in urbanism: Singapore's Gardens by the Bay, a visionary civic project

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Space Syntax was founded in the 1980s to promote a more rigorous understanding of urban design and its social and economic impacts, using analytical tools developed at the Bartlett School of Architecture, University College London, by Professor Bill Hillier and his colleagues. It currently has consultants working on projects all over the world, including on Foster + Partners' Masdar project in Dubai (allegedly an eco city but at present coming across more like an exclusive, zero-carbon, supertechnology-driven business park). It has also collaborated with Edward Cullinan Architects (ECA) on a plan for a new Libyan eco city developed some time before the fall of Colonel Gaddafi's regime in 2011 (see case study), and which may well be revived under the region's new government.

Since the onset of global recession, the practice has seen less demand for new city plans in favour of fine-tuning what already exists – which, in itself, is a vastly greener and more economically sustainable trend. For example, Ed Parham, associate director Space Syntax, has been working on a scheme in Jeddah to try and turn its thriving slum areas (there are around 60 of them, spread across the city) into healthier and more sustainable neighbourhoods. "When we first started looking at Jeddah they wanted to demolish the slums completely and rebuild," says Parham. "We suggested that was hugely expensive and a high-risk investment as well as a legislative nightmare. We know that there's an underlying spatial connection that leads to economic and social decline." What they discovered on closer examination of these "unplanned settlements" was that these neighbourhoods had evolved organically into far more connective and supportive communities for their residents than anything that could be designed for them. Unlike the slums of Mumbai, the settlements have access to clean water (delivered in trucks every two days) and are made of reasonably well-constructed blockwork. What they don't have is access to infrastructure – schools, health centres – and any connection to Jeddah's wider civic life. Space Syntax's proposal is to address these issues as efficiently as possible while minimising disruption to the vibrant communities within them.

Top: Jeddah's slums have much worth saving. Above: Charleston, overlooked by 20th-century developers

China's problems are in some ways similar, says Parham, caused by "the practicalities of managing rapid growth". However, in China the priority is "to house [people] in places that have adequate sanitation and access to facilities", which means swathes of new housing, built in hastily carved-out areas on the edge of existing cities, and designed by an assortment of private developers that generally create self-sustaining city blocks that are completely isolated from one another. "You end up with inward-looking communities with no pedestrian access, whose margins are defined by big roads," says Parham. "You don't have a pedestrian network in these blocks and people tend to get in their cars to visit other blocks. Unless you have a spatial structure that works across lots of different scales, then things get very difficult."

Retrofitting car-centric cities

Australia and the US – both riddled with unwalkable cities and suburbs – have been working hard to find the best ways to retrofit (or reverse-engineer) car-centric, disconnected urban conglomerations. Dr Richard Jackson is one of the US's leading healthy city evangelists, grabbing a welcome chunk of US TV airtime earlier this year with his four-episode series and accompanying book, *Designing Healthy Communities*.[2] A medical practitioner, ten years ago he was director of the US Center for Environmental Health and wrote and spoke widely on the contribution that sprawling suburbs and car-centric cities were making to obesity, diabetes, heart disease, depression and asthma. At the time, he says, "I was roundly

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Florence Nightingale.
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criticised by the home-building industry. That idea has gone from being seen as just bizarre to common sense."

Though the scale and cost of retrofitting US cities would seem daunting, many initiatives have been undertaken over the last few years, primarily driven by people-power – local communities, town councils and concerned individuals have rallied to the cause of improving health and connectivity. As Richard Register, president of Ecocity Builders said on an inspiring BBC World News programme[3] recently: "An eco city is a city for people powered by breakfast, not a city for cars powered by gasoline." Resulting schemes include: grassroots projects to create walking routes in built-up cities such as Atlanta; local businesses transforming a near-derelict suburban shopping arcade and parking lot into a vibrant independent grocery, restaurant and recreational hub in Arizona; and major civic investment programmes such as the proposed $5bn plan to revive 55 miles of LA's natural riverbed (currently buried under concrete) to create a walkable, cyclable and sailable leisure and residential community in the heart of the city.

Public transport – and transit oriented development (TOD) – has suddenly become fashionable, with schemes combining cars, trams, buses and walkways with river routes and cycle routes currently under way both in America and Australia. The city of Brisbane, for example, has invested AUS$100m on bikeway infrastructure over the last four years to create 1,000km of cycle and shared path routes for inner city and suburban cyclists.

What's driving these initiatives is people power, but its momentum is building thanks to the commercial imperative. "When people vote with their pocket books, the business community listens," says Jackson. "Homes that are in walkable communities are selling at a premium. More than half the homebuyers in the US now want a place that's in a walkable community. Large numbers of baby boomers who moved to the suburbs are tired of needing a car for everything and they don't want to tend the yard any more."

There is no longer talk of eliminating cars, however. Co-presence is generally seen as the desirable state – ideally, a city that accommodates cars while prioritising pedestrians, cycling and public transport. Considered landscaping, architecture and quality public space is also a key part of the new healthy cities recipe. "We need to build places that are just as good as somewhere people want to visit," says Jackson, quoting the mayor of Charleston, an elegant, colonial city in South Carolina which, in Jackson's words "luckily wasn't affluent enough to interest the developers in the 50s, 60s and 70s." Equally vital is providing access to these health-giving walkways, cycleways and facilities across

Shahat Garden City, Libya

Libya's Shahat Garden City (Madinat Hadaek Shahat) is a proposed 1,500-hectare masterplan by Edward Cullinan Architects (ECA) and Space Syntax for a pioneering, carbon-neutral development for 60,000 people in the fertile and temperate Green Mountain region. Zoning and grid-based development are rejected in favour of a city plan evolving around an existing network of thriving smallholdings; residential neighbourhoods are arranged around these green areas, with buildings occupying the less fertile rocky outcrops. Each neighbourhood will have sustainably designed houses, and flexible and adaptable arrangements of schools, businesses and utilities. ECA senior director Roddy Langmuir says: "In Libya, public open space is not looked after or valued in the same way that it might be in the West. The public space between houses and the pavement is often left as a dusty margin, collecting rubbish, so we brought the houses up to the road edge and allowed them to look inwards to shaded courts for privacy." Cars have not been banished, since strong transport connections to neighbouring towns are crucial to the city's economic success.

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Penrith Health Campus Redevelopment Stage 3, New South Wales, Australia Photography by Ethan Rohloff

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Tianjin Eco City, China

The high rise tower blocks of Tianjin Eco City are already rising, with completion set for 2020. With a population of 350,000, it is China's main testbed for social, economic and environmentally sustainable city living. Designed around a single axis – the valley cutting across the site – with three centres (one main city centre and two sub-centres) and four residential districts, each neighbourhood has its own business area, with adjacent residential blocks broken down into "eco-cells" of 400m by 400m – the ideal walkable distance. Four cells make up a neighbourhood, served by shops, schools and utilities. The ample provision of low-impact public transport as well as walking or cycling opportunities is a central part of the plan, with 90% green transport being the goal. Water transport, pedestrian paths, trams and hybrid or electric buses will link neighbourhoods to districts. Its developers are pitching the city as a live experiment for future-forward corporations, and over 600 companies have already signed up to a presence here; General Motors is using Tianjin to work out how electric driverless cars can function in a normal traffic system, for example, and Philips is trialling a new low-energy lighting system.

all demographics and incomes (one criticism of India's current surge in eco housing developments is that only wealthy professionals can afford to live in them).

In terms of future engagement and empowerment with healthy living schemes, a dialogue between residents and politicians, planners, developers and construction companies is crucial. This is what typifies the most successful schemes revealed in Jackson's research and also that in the excellent book Retrofitting Suburbia, by Ellen Dunham-Jones and June Williamson.[4] Says Jackson: "It's so important for people to really engage the community and really talk with them – they are the folks that have 'ground truth' in military terms. Designers have their wisdom and intelligence. The community has its own. When you harness the two, wonderful things happen."

Veronica Simpson is an architectural writer

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The long **game**

Penoyre & Prasad's Athletes' Village Health Centre, part of London's Olympic Park, hopes to have a direct impact on the health of an an-yet-unformed new neighbourhood. ***Veronica Simpson*** reports

Winning an Olympic project has to be a high point in any architect's career. However, with the excitement at being required to deliver a landmark building comes the tightest imaginable security conditions, the fierce and unforgiving glare of the world's media, and the harpies of civic accountability ready to descend at the slightest provocation. It is always going to be a mixed blessing.

For Penoyre & Prasad, to design and build a 5,000sqm mixed healthcare and community facility on the Olympic construction site in just under two years, with limited end-user engagement, was challenge enough: the practice has made its name on the considered and inclusive nature of its process as well as its buildings. It also had to create a building that would suit both private developer looking for headline-grabbing architecture – Lend Lease was holding the purse strings – and the East London NHS Trust, which wanted a highly efficient and future-proof facility that would become a beacon for wellbeing for a community that doesn't yet exist. Throw in the need to handle the infamous branding/legacy control-freakery of the IOC (the International Olympic Committee), LOCOG (London Organising Committee for the Olympic Games) and the Olympic Delivery Authority, and the need to process more than 200 Olympic and Paralympic athletes a day, and you'd expect a few sleepless nights.

For Penoyre & Prasad partner and lead architect Mark Rowe, the issue of Olympics usage versus the building's legacy was never a problem: "In every decision it was always the legacy that won out." Interestingly, some of the potential constraints – the requirement for speed and the lack of time for consultation – may have proved a bonus in that it helped to clarify the solution very quickly. "We had to rely on accumulated knowledge from 20 years of deep engagement," says Rowe. Though the practice went through extensive modelling and experimentation with designs for the tight, awkward site, right on the edge of the Olympic village, ultimately "the client team wanted a model we knew would work," says Rowe. Lincoln Avenue, one of the practice's award-winning cluster of community health centres in Northern Ireland, was similar in scale and aspect, so it was this building that formed the basis of the design.

Glazed brickwork and matching mortar creates a monolithic appearance

Visual dynamic

As with the Northern Ireland health buildings, at the centre of the Athlete's Village Health Clinic is a bright and welcoming, four-storey atrium, with timber balustrades and balconies leading off a wide central staircase. This means that each department can be identified and accessed easily from the reception desk, located just inside the entrance. On each floor, double-loaded corridors offer a continuous allocation of standardised rooms, which can be reconfigured to suit their eventual NHS use. Walls are white, and clinical areas are floored in bespoke lime-green rubber, providing a zesty dominant colour and unified identity.

The building itself has a handsome and striking presence. Its exterior cladding of pale German brick with a ceramic finish and matching mortar creates a monolithic appearance, though the west elevation also features substantial glazed aluminium curtain walling. Its triangular aspect – with corners raised in strategic locations – creates a strong visual dynamic.

The way it slices through the grid form of the surrounding blocks, stacked with bland new high-rise residential buildings, also creates a strong visual axis with the new Chobham Academy school, designed by Allford Hall Monaghan Morris. These two buildings, far from the architectural gymnastics of Hopkins Architects' Velodrome and Zaha Hadid's Aquatics Centre, bring a much needed civic quality to this part of the Olympic Park – "like a little church amongst Manhattan's skyscrapers", as the architects have quipped.

Future communities

Newham Primary Care Trust (NPCT) provided as clear as possible a brief for the space, including GP and physiotherapy rooms, dentistry, scanning rooms and offices. The design allows for any spare capacity to be transformed into additional clinical space, or vice versa. The shallow floorplate of around 13m is key, with the pattern of tall, thin windows easily accommodating the reconfiguration of internal walls without any loss of daylight. Services run down the middle of the corridor on each floorplate and can easily be moved if usage or layout changes.

Anthony Coleman

Tim Soar

The Sir Ludwig Guttman Health Centre (Athletes' Village Polyclinic, London, UK)

Completion date: 2011
Size: 5,300sqm
Client: Lend Lease
Architect: Penoyre & Prasad
Structural engineer: WSP
M&E consultant: Wallace Whittle
Quantity surveyor: Gardiner & Theobald
Landscaping: Applied Landscape Design
Main contractor: Willmott Dixon

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Sustainability is part of the Olympic legacy, of course, and the building exceeds its target emissions rate by 31%, achieving a BREEAM Excellent rating. The presence of railway lines on two sides means that natural ventilation would have been too noisy, but energy-efficient cooling is achieved through propane (R290) gas chillers. Other environmental measures include a sedum roof and rainwater harvesting for toilet flushing. The building feeds off a district heating system, which brings its annual CO_2 emissions down to 18.5g/km^2 – lower than the building regulation's standard 25kg/m^2 for similar-sized health buildings.

The space to deliver

The environment for staff is also considered, with a high-quality staff club offering indoor and outdoor dining, food preparation and relaxation. This was one of the areas that was nearly value-engineered out of the proposal, until Rowe and his team explained the benefits of knowledge-sharing and team-building that the similarly blessed Northern Ireland centres enjoy.

Rowe has commented in a recent *Architects Journal* feature that a commitment to design quality throughout the project team ensured that any political wrangling was kept to a minimum – the ODA, its own planning authority, LOCOG, Lend Lease and advisers Lifschutz Davidson Sandilands "all brought a commercial-sector zeal for excellence that we do not always see in public-sector procurement. So, in that sense, we were given the room to deliver quality without having to fight as hard as is sometimes required."

It was certainly interesting to construct a building under stringent security supervision. As it flanks the local public realm, key areas of the building have been designed to resist bomb blasts, and there was airport-style security every time the architects went on site – including sniffer dogs. "A whole programme was designed just for this building. The police were having to sign off on every partition before it was closed off," says Rowe. But the fact that the plans had been rubber-stamped by the security team meant that there could be no back-tracking or corner cutting once construction began.

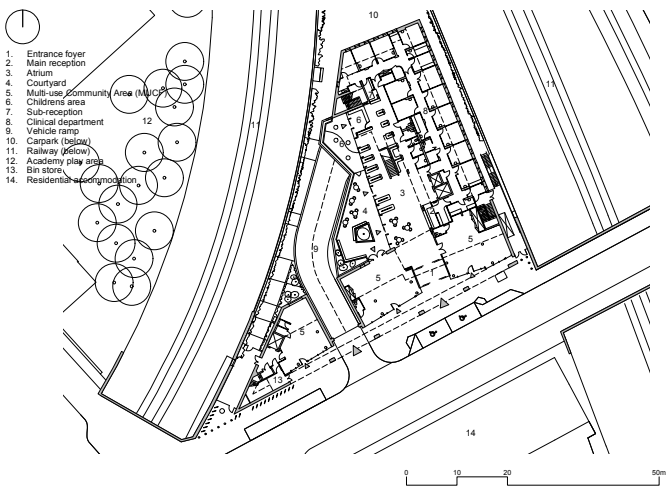
But otherwise, few modifications were required for operation during the Olympics and Paralympics. Additional container units sat alongside the building for MRI scanning, and also for the legendary ice baths for cooling down overstrained muscles, all of which were accessible through a secure zone. Extra sinks and toilets were installed in the ground-floor consulting area, for doping control. Toilets had to accommodate Paralympic athletes in wheelchairs.

What was more difficult, says Rowe, was designing for a community that doesn't exist yet: "We have a limited knowledge of who the patient population will be," he says. Though the residents of nearby Leyton will make up half of its catchment, it is hoped that the Athletes' Village flats will attract a diverse and permanent population, including families, to turn this into a thriving community health centre. But it all depends on the developers, the Qatari ruling family, which bought the Olympic Village last year, together with a private British company. Given the depressed state of the UK housing market, only 20% of the properties will be sold, and the rest will be rented. What Rowe doesn't want is for it to "turn into a student ghetto". But if they get it right, "there's hope that it could be a model for the rest of London." Now that would be a legacy to be proud of.

Veronica Simpson is an architectural writer

Tim Soar

Lime-green rubber flooring, offset by white walls and timber cladding, provides a welcome in reception



The clinic sits on a tight, awkward site, right on the edge of the Olympic village, and flanked by two railway cuttings

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CAPE TOWN, SOUTH AFRICA
COMPLETED 2000

PRIMARY HEALTH CARE FACILITIES

PROJECT: OPOLLO HOSPITAL
BAYELSA, NIGERIA
COMPLETED 2009

TERTIARY HEALTH CARE FACILITIES

PROJECT: CHRIS HANI BARAGWANATH HOSPITAL
JOHANNESBURG, SOUTH AFRICA
COMPLETED 2009

Equal **measure**

Latin America's greatest barrier to economic growth – and by extension, the good health of its people – is the gap between rich and poor, writes ***Emily Brooks***

Latin America is the region with the highest inequality in the world, a situation that has remained unchanged over the past 40 years, and the single largest factor that retards its economic growth. The disparity between rich and poor is reflected in the accessibility of healthcare. A Christian Aid report[1] published in April stated that this is a region "where geographic location and ethnic group are hugely important in determining life chances… there are large gaps in education provision, in areas such as nutrition, health, access to water and electricity, and in standard social protections such as social security coverage and pensions." Although poverty has decreased overall in Latin America, the report criticises governments for not properly designing their public policies around such extremes of rich and poor; it also points the finger at the top tier of society, who are resistant to tax reforms that would see them cede significant parts on their wealth in the wider interest of alleviating poverty.

Health spend for the region as a whole averages out at 2.8% of GDP, but spending is often concentrated in urban areas, and does not reach the poorest rural sections of the population. The divide between rich and poor has contributed to a typical pattern: communicable diseases, malnutrition and poor maternal health on the one

hand, with an accompanying rise in non-communicable diseases (NCDs) in the rising middle classes. Non-communicable diseases account for 62% of deaths in Latin America (for comparison, the figure is 85% in OECD countries, and 21% in sub-Saharan Africa), and demographic change over the next few decades will be dominated by an ageing population, and the associated increase in demand for healthcare.

Pró-Saúde Profissionais Associados' new hospital for Porto Velho will serve 1.5m people

A 2011 report by the World Bank focusing on this change of demographic[2] questions Latin America's preparedness for this additional burden – and states that it will be particularly difficult for low- and middle-income countries to meet the elderly's health needs. It recommends that healthcare systems be strengthened to provide better primary services, as well as "develop healthcare policies to expand across the prevention and treatment of NCDs, especially among the poor. In many countries, health insurance is restricted to the higher-income population, while public health services provide subsidised access to services focused on communicable diseases and maternal and child services, while treatment of NCDs is paid largely out of pocket and becomes the main cause of financial hardship related to health events."

Catching up with change

All of this seems a long way from discussions about how healthcare design can help improve patient experience and health outcomes. Is Latin America just too busy fire-fighting? Ana Carolina Potier Mendes, partner at Brazilian specialist healthcare architects Pró-Saúde Profissionais Associados, says that her major challenges are "how to attend to the needs of the client – related to short schedules and, most of the time, lack of money – as well as a lot of bureaucracy in the country, and the high speed of change in the world." More holistic philosophies are not at the forefront because "most of the facilities are still investing in basic issues that have to be resolved. But there is a rapid and growing discussion on those sorts of matters and we can already see the application of that discussion in most of the biggest projects in Brazil." She adds that "although the country has been passing through a boom of investment in construction, there is still

Hospital Unversitario San Vicente de Paul, Rio Negro, Colombia

As Hospital San Vicente de Paul approaches its centenary, it has its eyes set on the future. Perkins+Will, together with Colombian firm Condisegno, unveiled a new hospital here at the end of last year that reflects the culture and history of the original facility, but incorporates technological advances and a strong sustainability agenda (it is the first LEED-certified healthcare facility in Latin America). A circular public lobby connects all functions of the hospital, while the three clinic buildings use a clear colour-coding system to aid with wayfinding. Patient rooms are all single-handed, with an attached family area in every ICU recovery room. The hospital's clean, contemporary interior has a sense of quality that is intended to give patients a reassuring experience; it makes the most of local building materials, including warm red brickwork and dark wood veneer.

Completion date: 2011
Number of beds: 260
Size: 50,000sqm
Architects: Perkins+Will, Condisegno

a big gap dividing the hospitals with huge investments and the hospitals with lack of resources – but this distance has been reduced more nowadays." The firm's new R$73m (£22.5m) hospital in Porto Velho, capital of the state of Rondônia, will start to be built at the beginning of next year. It is hoped that the 17,000sqm, 254-bed facility will relieve severe overcrowding in the city's existing João Paulo II hospital, whose emergency department currently serves the state's entire population, some 1.5 million people.

Flagship facilities

Several international architectural firms are making their presence felt with projects in Latin America. HKS, which has an office in São Paulo, has formed a strategic partnership with Texas's Methodist International, with aim of offering a broad package of services to Latin American healthcare professionals – business development, clinical operations and care delivery models from Methodist International, and world-class facility design from HKS. Further examples of hospitals looking north for design inspiration include Clinica las Condes, RTKL's collaboration with MOBIL Architects in Santiago, Chile, and Gresham, Smith & Partners' Clinica Delgado in Lima, Peru, a scheme for insurance group Grupo Salud (see case studies).

There is still a big gap dividing hospitals with huge investments and hospitals with lack of resources

Brazil's first healthcare PPP, Hospital do Subúrbio, is being used as a model for further facilities

These projects reflect a rise in demand for private healthcare and have in common enlightened clients that want to create flagship facilities with a strong sense of community integration. "They wanted something that would be an iconic building – something that would be recognisable not only in the community, but in their country as well," says Greg Wieland, project designer for Gresham, Smith & Partners. For Clinica Delgado, the practice envisaged the integration of local cultural pointers – and local building materials – with high-quality, patient-centric spaces and American-style hospital management. These include a four-storey atrium that Wieland describes as "something really special", with local-granite-clad walls, an indoor waterfall and suspended stairway; there's also a rooftop garden. The jagged shape of the facade's glass curtain wall is a complex design and one that certainly offers the distinctiveness that Grupo Salud were searching for: as Wieland puts it: "They needed strong architecture as well as strong human experience."

Clinica Delgado will be managed by the American Hospital Management Company, further indication that facilities are looking to North America not just for architectural services but for the business, procurement and operations side, too. The IFC has loaned $25m to the project, seeing Grupo Salud as a "reputable sponsor" and recognising the opportunity of the company creating vertically integrated insurance and healthcare provider systems, also commonly found in the US. In Santiago, RTKL and MOBIL are working on the former's first Latin American healthcare project, a bed-tower extension to Clinica Las Condes, expected to open late 2013. The hospital is affiliated to Johns Hopkins International (JHI), and RTKL's Scott Rawlings says that

Completion date: Estimated April 2015
Client: Grupo Salud
Number of beds: 144
Size: 35,000sqm
Architect: Gresham, Smith & Partners

Clinica Delgado, Lima, Peru

Gresham, Smith & Partners says its aim for this building is to be the best hospital in Latin America – and certainly a beacon of excellence for Peru. The tone is set with the building's facade, a complex, angular curtain wall of transparent and fritted glass that soars upwards at the corner where two streets meet, its form inspired by the rocky outcrops of Machu Pichu. The fritted glass, made locally, will provide solar shading and is set off by swathes of greenish local granite. These fractured surfaces and building materials are repeated inside, in a four-storey atrium space. A tight site means there are five storeys below grade, and ten above (all parking is underground); patient rooms are finished in natural materials and the positioning of the beds orientates the patient towards the natural light, with views to an adjacent archeological site and the surrounding community. The hospital will be strong on cardiology and oncology, reflecting the region's increasing burden of non-communicable diseases, as well as a desire to attract medical tourists from elsewhere in Latin America, and further afield in North America (it is being built in partnership with an international operator, American Hospital Management Company).

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Clinica Las Condes, Santiago, Chile

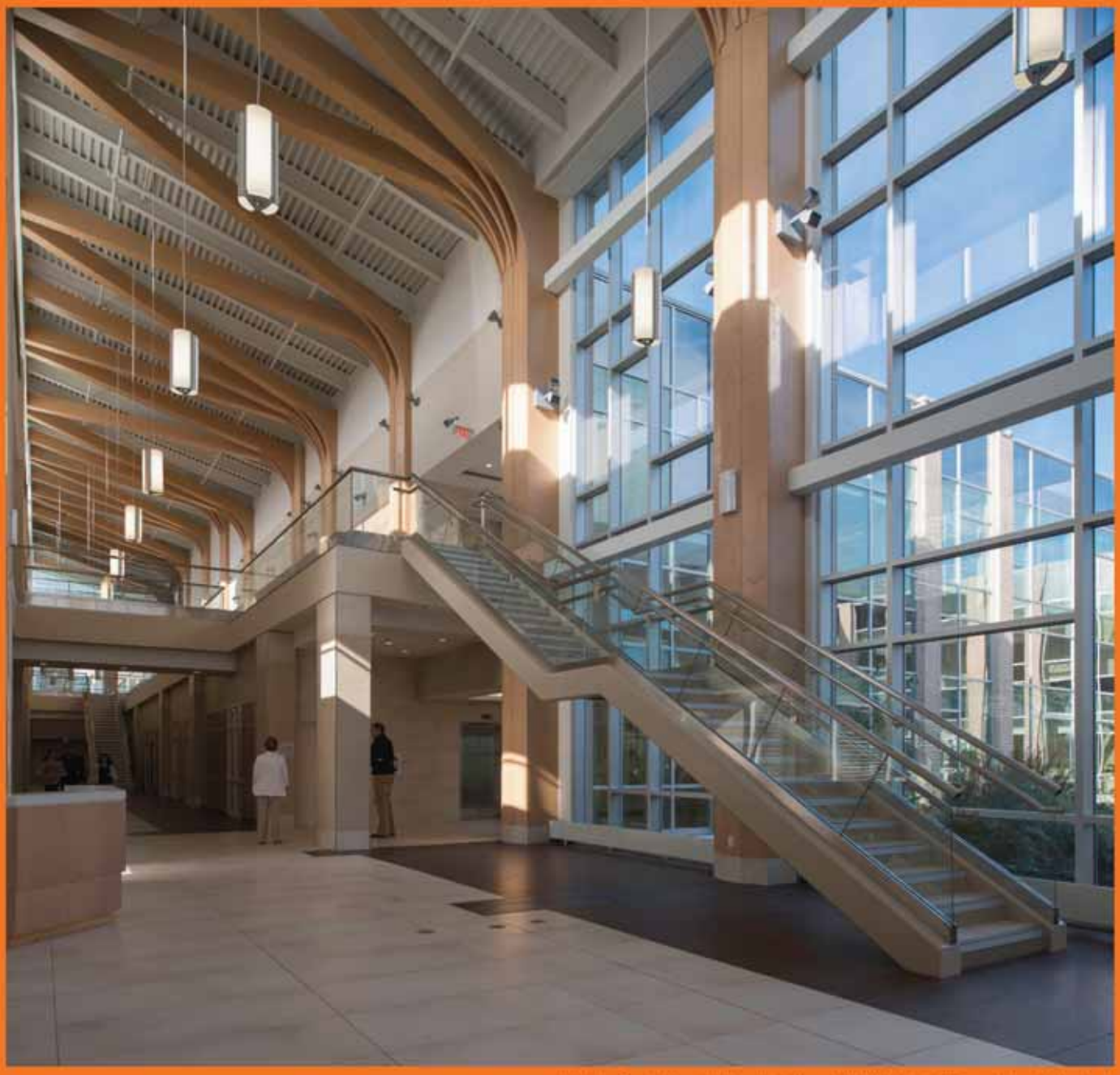
RTKL's first healthcare project in Latin America is a private hospital in Santiago; RTKL's Scott Rawlings says that the project "is an opportunity to combine state-of-the-art healthcare planning concepts with a real love of design and the environment". The hospital, in need of expansion, created a masterplan with Johns Hopkins International, which in turn recommended RTKL to design this 292-bed extension. The two bed-towers will more than double capacity, with state-of-art patient care units (both medical and ICU) and a new surgical suite. Its facilities will incorporate advanced technologies and hotel-like environments with plazas, gardens, water features and artwork. The expanded hospital will also have a stronger focus on accommodating the needs of patients' families – visiting groups tends to be large, so there is more generous waiting space. Lastly, this is a hospital that tries to "give back" to the community: the ground and first floors are set back from the walkway, with the remaining floors cantilevered over them, encouraging pedestrian use; and there are many reasons for the wider community to visit, with public and education space, a cafe and a local art programme.

Completion date: Estimated late 2013
Client: Clinica Las Condes
Number of beds: 292
Size: 120,000sqm
Architects: RTKL, MOBIL Architects

the commission came about through its recommendation: "I think the client here was looking for cutting-edge healthcare planning and had confidence in Johns Hopkins' recommendation. Also, the collaboration between RTKL and JHI was seamless. We enjoy joining forces to bring clients a wider platform of services." He adds that MOBIL, which acted as local partner on the project, "brought significant talent to the table. Their insight into the client and the region was critical."

Sustainability issues

The IFC has also supported several public-private partnerships in Latin America, including Brazil's first healthcare PPP, Hospital do Subúrbio, which opened in 2010. For Tlalnepantla Hospital in Mexico, a 120-bed facility, the IFC is using its financial muscle to push the sustainability agenda – it will be required to have a LEED Silver certificate for both the hospital's construction and operations. In August, the IFC announced $12m of financing for Hospitaria, an energy-efficient 50-bed hospital in northern Monterrey, Mexico, that will improve access to health services for low- and middle-income communities; it opens this October.



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Hospitaria, a new energy-efficient 50-bed hospital in northern Monterrey, Mexico, has received $12m of IFC investment

Rawlings says that, in Chile at least, "they are very sensitive to sustainability and the human experience," although it is perhaps telling that there is no LEED equivalent for Latin America (or its individual countries). The World Bank has said that public institutions such as hospitals should be acting as flagship projects to promote the long-term savings opportunities that sustainable procurement can provide, and this ought to naturally extend to the fabric of the buildings themselves. The first LEED-certified hospital in Latin America is the Hospital Universitario San Vicente de Paul in Rionegro, Colombia, designed by Condisegno and Perkins+Will (see case study). It uses vernacular building materials, including local brick (used inside and out), Colombian marble and wood veneer from nearby forests. Approximately 80% of the building is naturally ventilated; rainwater harvesting and an on-site wastewater treatment plant conserve water.

RTKL and GS&P both paint a picture of Latin America as family focused, which is reflected in how hospitals are arranged. "In Peru, and Latin America, family is very important, so waiting rooms have to be a little larger. The LDRs [labour, delivery and recovery room] needed adjacent VIP rooms," says GS&P's Alba Lopez-Isa, project architect for Clinca Delgado. The firm's Frank Swaans, vice-president of global healthcare services, also mentions a different approach to infection control, "more like how the US was doing it in the 50s," but explains the delicate balancing act of taking the best of "western" design ideals and merging them with local concerns: "On one hand we've been hired to design an American-style hospital but you can't just plop that down with no regard to local cultures and standards." Swaans says that senior hospital staff were surprised by their level of clinical knowledge – "good communication with physicians was really important. They weren't used to architects being able to communicate in a technical way" – and, on their side, GS&P was surprised by the local availability of high-quality materials, such as the glass that will be used for Clinical Delgado's complex facade.

Both GS&P and RTKL say that they are seeking further business in Latin America, but Rawlings says that "they simply are not building as much healthcare as you might think". When finished, their projects will undoubtedly attract attention for their cause, however, and it will be up to enlightened governments, insurance groups and private developers to take forward the ideas that they contain.

Physicians weren't used to architects being able to communicate with them in a technical way

Emily Brooks is an architectural writer

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Better bedroom for mental health

A new model for an adult mental health bedroom is being launched by the Design in Mental Health Network (DIMHN). Intended to stimulate debate among commissioners, clinicians, designers, manufacturers and service users, the Better Bedroom initiative brings together current best practice to design a modern, homely bedroom that is a therapeutic and safe place, balancing the demands of an anti-ligature environment with user-friendliness, risk management and efficiency.

Britplas, makers of security windows and doors, will be unveiling a sample bedroom at its Warrington headquarters. DIMNH has also worked with the Building Research Establishment (BRE) on the initiative, and a second bedroom is planned at the BRE Innovation Park in Watford; additionally, the concept is being officially launched at the UK's annual Healthcare Estates conference in Manchester on 9-10 October. "We hope that people will come along to see the bedroom and say 'I've got a better solution for that'," says DIMNH's Jenny Gill. "We certainly don't see the Better Bedroom as a finished product; our aim is to stimulate innovation. It incorporates products which may be considered to be some of the best presently available."

Living landscape

Opened in June by HM The Queen, Stantec Anshen + Allen's South West Acute Hospital is Northern Ireland's first all-single-room hospital. It is also a facility that sits easily within its environment, a 21-hectare greenfield site one mile north of Enniskillen, surrounded by open countryside. Great care has been taken to ensure that the 300-bed hospital complements the site: the masterplan preserves and enhances existing site drainage patterns and surrounding ecosystems, while the buildings' organic forms, locally sourced timber and stone, green roofs and extensive landscaping results in a hospital that feels at one with the natural environment. The 69,000sqm facility is "human scale" – split into three buildings, separated by long linear gardens and courtyards to maximise natural light and create optimum outdoor views. This is Northern Ireland's first PPP healthcare project; it is also the first foray into the UK market for its Spanish builders, FCC.

David Barbour

Visionary Victoria

A state-of the-art new wing for Victoria Hospital in Kirkcaldy, Fife, is now open. The 500-bed extension to the existing hospital, designed by BDP, contains 11 operating theatres and a new accident and emergency department as well other services including maternity, paediatric, renal and critical care. The building's stepped form attempts to bridge the change in scale from the existing hospital down to the adjoining residential area. Diagnostic and treatment space is located in a two-storey podium, offering maximum flexibility to accommodate future changes in clinical practice and technology. The podium is subdivided by wide landscaped courtyards, assisting orientation and providing daylight and long views. Wards are accommodated in contrasting straight or wave form elements located in the upper four storeys above the podium, providing a variety of ward sizes. The £170m hospital was delivered by Balfour Beatty for NHS Fife through a Public Private Partnership. White Young Green was the structural engineer, and Hulley Kirkwood was the building services engineer.

Made good

A welcoming amphitheatre-style garden is just one of the patient-friendly features of a new Nebraskan hospital designed by AECOM. Good Samaritan Hospital's West Tower extension, which opened in September, follows patient-centric Planetree principles, using natural and low-noise materials, a soothing colour palette, access to natural light and intuitive wayfinding. The sunken garden is accessed off a two-storey cafeteria, the balcony floor of which features rotating art exhibits; the gallery has now become the largest space in the community to see local art. A new heart centre on the site consolidates many of the cardiac services offered at the hospital, including outpatient testing, catheterisations and open-heart surgery. New surgical suites and endoscopy suites are also located in the building. The project was delivered on time, and under its $65m budget.

Robb Williamson

Home-like rehab for South Yorkshire

Plans for a new rehabilitation unit in South Yorkshire have been announced by Capita Symonds. The facility, part of Montagu Hospital in Mexborough, is due to open next summer, and will transform the care of local people recovering from serious illness or injury, including stroke and other neurological disorders, amputations or complex orthopaedic problems. Initial artist's impressions of the unit depict a bright and welcoming environment with plenty of home-like design elements and a design that encourages independent living. "The centre will be designed so the physical environment aids clinicians in delivering rehabilitative care," says Capita Symonds' project manager Tom Myers. "The plans include a domestic-style staircase and a courtyard with varied paving styles to help people re-learn the ability to walk on different surfaces. The design team's brief was to create an environment that is non-clinical and pleasing, which will help lift spirits and motivate patients." The project is currently seeking planning permission and expects to break ground in November.

British company seizing a window of opportunity overseas

Britplas Commercial Windows are enjoying continued growth on a global scale.
With more new projects confirmed in Australia off the back of a number of new build mental health facilities for Queensland Health, Britplas are capitalising on the reputation their multi award winning Safevent window has built from NHS Trusts across the UK. The company's new office in Brisbane is receiving enquiries from clients architects and contractors alike.

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"One stop" transplantation facility

Serving more than 3.3 million UK residents and receiving patients from around the world, the Institute of Transplantation (IOT) at the Freeman Hospital, Newcastle upon Tyne, is a holistic transplantation centre at the forefront of international best practice. Opened last year, Ryder Architecture's 10,000sqm building is one of only four similar transplant centres worldwide; its clinical accommodation includes oversized theatres, which enable simultaneous transplant surgery; a 22-bed ICU; single-bed patient rooms with en-suite facilities; and a dedicated outpatient suite for pre- and post-transplantation assessment. This is complemented by a 100-seat lecture theatre, seminar and meeting rooms. Designed with the patient journey in mind, the facility brings together all aspects of transplantation under one roof, offering a "one stop shop" approach wherever possible so that patients can access all the services they need in one location.

Geoffrey Lyon

Dental school at the cutting edge

An integrated building for research, clinical care and teaching in the field of dentistry has opened in Houston, Texas. The University of Texas Health Science Center at Houston School of Dentistry is a 27,500sqm brick and glass six-storey building designed by WHR Architects. It contains dental clinics, simulation and pre-clinical labs, clinical support labs, a clinical research lab, classrooms, a learning resource centre, a student centre and administrative space. The building is divided into three zones, with patient and public areas on the lower floors, followed by student areas, then faculty and staff areas. Patient areas feature a neutral backdrop with soft colours used for the furnishings to create a quiet soothing environment, while a brighter palette enlivens the student classroom and labs. The $98m building, completed in April, forms part of a wider 45,000sqm development of the university's South Campus, which has seen the creation of five new buildings, set around an attractive central courtyard.

Korean hospital breaks ground

Dongbaek Severance Hospital, a 93,000sqm facility in Yongin, South Korea, has broken ground. The building is situated on a steep site, a challenge for architects AECOM and Korean practice BAUM, co-designers on the project. The hospital, AECOM's third major healthcare facility in the country, will contain a diagnostic and treatment base, clinic, atrium and the bed tower. It has been planned to enhance functionality, while at the same time capitalising on the site's attributes. Access to daylight and nature will promote healing, while also helping to fulfil the aim of creating a sustainable healthcare environment. The hospital is due to be completed in 2015.

Healing Environments

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Design & Health Scientific Review
Antidotes to environmental determinism

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

Fewer medical errors, healthier brains, less post-disaster trauma, and fewer malnourished children – all by design. Like everyone else, I wish this were possible. But environmental determinism – the seductive belief that environments can lead to predictable behaviour change – has been on the ropes for decades ever since researchers and designers began crafting ways to work together. We know that the physical environments in which we live, work, and play influence us – but how this is accomplished must remain a lively subject of environment-behaviour (E-B) research and design discussion if the professional connection between research and design, between the sciences and the arts, is to remain vibrant. Environmental determinism along with its antidotes lies at the critical juncture between research and design – it might even be the reason the two joined forces nearly half a century ago. The antidotes to environmental deterministic thinking are evidence-based design, neuroscience, and post-occupancy evaluation.

Design decisions that faithfully build on evidence – established knowledge, established methods, and established data analysis – have a higher likelihood of influencing (never determining) perceptions, attitudes, and behaviours designers hope to affect. Selection of the evidence, agreement between professionals from different disciplines as to what constitutes sufficient evidence, and thorough analysis of those data require teams working together to achieve evidence-based design.

Understanding the way the mediator that lies between environment and action – our brains – is essential to linking environmental design intentions to actual outcomes. The neurosciences are increasingly developing theory and research helpful to designers who want to get a handle on the tenuous connection between environment, the brain, and behaviour. The Academy of Neuroscience for Architecture (ANFA) which just held its first highly successful annual conference at the Salk Institute in La Jolla, California (www.ANFArch.org) is dedicated to in-depth interdisciplinary research to contribute to this discussion.

And finally we arrive at the standard and often overlooked mainstay of E-B research – post occupancy evaluation (POE). This is the main antidote to environmental determinism – returning to what is actually built after people have occupied it to find out if the predicted effects actually occurred. What a profound idea! What a simple solution! But how often do we actually do this anymore? How often do we patiently wait until after a POE is conducted to announce the wonderful effects of design? Not often enough.

I suggest we re-dedicate ourselves as individuals and professionals to this fundamental and wonderful systematic practice of finding out if we are actually correct when we link our design intentions to predictions of the future.

Designing Out Medical Error (DOME):
Establishing an evidence base to design products and equipment that better support surgical wards

A three-year project by the Royal College of Art's Helen Hamlyn Centre for Design and Imperial College, London, researched the most error-prone healthcare processes in surgical wards, and suggested new ways to reduce those errors

Jonathan West, Helen Hamlyn Centre for Design, Royal College of Art, London; Grace Davey, Helen Hamlyn Centre for Design, Royal College of Art, London; Oliver Anderson, Imperial College, London; Ed Matthews, Helen Hamlyn Centre for Design, Royal College of Art, London; Jeremy Myerson, Helen Hamlyn Centre for Design, Royal College of Art, London

Evidence suggests that something goes wrong in one out of every ten hospital admissions. The causes of medical error are many, but rather than point the finger of blame, we need to understand why they happen, identify those that can be avoided and develop ways to design them out of the system. This is easier said than done, as the causes of error are complex and the variables many.

Three crucial and interlocking elements lie at the heart of modern healthcare – team, process and equipment. Change one element and we change the others. That means design interventions must change behaviour and be welcomed by hard-pressed hospital staff, as a way of delivering better, safer care to patients.

That was the challenge undertaken in planning the DOME (Designing Out Medical Error) project. To meet that challenge a team of hospital staff, safety experts and process analysts from Imperial College London and St Mary's Hospital, Paddington were joined with a team of designer-researchers from the Royal College of Art. The hypothesis was that to enable better, safer care for patients, all three elements should be tackled together in a way that empowers the clinical partners.

The exemplar designs that resulted are the proof of that hypothesis, but the real outcome of DOME is more than a set

Figure 1: A typical busy NHS ward in the UK

Figure 2: Failure Mode and Effects Analysis (FMEA) group session

Figure 3: Site visits for analogous industries research showed an open safety culture

of design concepts – it is the validation of a collaborative research and design process that really can deliver better, safer healthcare. We believe the process is robust and repeatable, and this will be confirmed once full evaluation by simulation and clinical trial is complete.

The DOME project was set up with the aim to better understand and map healthcare processes on surgical wards – and establish an evidence base to design equipment and products that better support these processes and therefore reduce instances of medical error.

A single multidisciplinary team was assembled from among research staff at the Helen Hamlyn Centre for Design at the Royal College of Art, Imperial College London and St. Mary's Hospital, Paddington – bringing together designers, engineers, clinicians, ergonomists, psychologists and business academics in the fields of design, patient safety and management as one team. This is in line with the recommendations from the UK Department of Health's *Design For Patient Safety Report.*

Problem definition

A fundamental part of the Hippocratic Oath is *Primum non nocere*: "above all, do no harm." Modern medicine is ever advancing, but no individual, system or environment is perfect, and mistakes are made.

This issue of medical error in hospitals is high on the political agenda and is rarely out of the news. Human errors and systemic failures lead to preventable harm and unnecessary suffering for patients. In the UK, research suggests that as many as one in ten patients in hospital may suffer the effects of error in care, resulting in costs of £2bn annually. It is estimated that more than half of these cases may have been avoidable.

A key aspect of the problem is that healthcare processes continue to evolve whereas the design of much ward-based equipment remains largely unchanged. Daily patient care involves a complicated interaction of many tasks and processes (Figure 1), supported by products that co-exist within the patient's bed space. However, these products are often designed with little thought for safe integration and context of use.

This is often because design skills are engaged late in the stage of development of hospital equipment, and as a consequence the designs may show little regard for the systems in which they work. In short, current treatments are not effectively supported by available equipment.

A multidisciplinary approach

The DOME study took the view that no single discipline could effectively tackle the complex systemic nature of medical error on surgical wards – a multidisciplinary approach was necessary to gain a more thorough understanding of these systems and healthcare processes in order to develop more appropriate products and services. DOME therefore developed a collaborative methodology to allow systems and products to be considered concurrently, paving the way for process reforms as well as new designs.

Project overview

The team immersed itself in the surgical ward environment and engaged with patients and frontline staff throughout the project, gaining their trust and encouraging open conversation and shared insights. These lasting relationships allowed valuable user input into the subsequent co-design and feedback stages of the project.

Through a systematic process of reviewing published literature, incident reports, observations and questionnaires, the most error-prone processes were revealed. These were crystallised into design briefs, which gave focus to the innovation phase of the project.

The interaction between the multidisciplinary DOME team and the growing network of patients and healthcare staff supporting the project was a key strength in generating ideas. This phase included brainstorms, expert groups, workshops and site visits to observe analogous industries. Ideas were developed through sketching, computer models and prototypes, which were subjected to continuous critical feedback from patients and healthcare staff.

Figure 4: Current typical locations for equipment used at the bedside

Figure 5: The Carecentre, which houses everything needed to care for a patient in the bed space

Allowing end-users to try out the new designs in a simulated ward environment enabled their safety and usability to be checked. This also permitted the designs to be refined and built as clinical prototypes, which are currently undergoing trials in the real healthcare environment.

The DOME project benefited from taking a holistic approach to designing out medical error and the resulting design outputs are broad in their range – from physical products, communication and diagnostic tools, to service and environmental recommendations.

Research

Initial observations and mapping: Members of the DOME team, including designers, clinicians, psychologists and ergonomists, carried out several hundred hours of initial observations in three hospitals in order to observe all activities that patients and staff participate in. Immersing themselves in the hospital environment meant they were able to investigate the full range of factors contributing to medical errors. The research team began by observing the surgical patient journey through the hospital and visualised this using mapping techniques.

Exploring the problem: Addressing every potential medical error in surgical wards was beyond the scope of the DOME project. A comprehensive literature review of all published adverse events revealed that the surgical ward was indeed as hazardous as the operating theatre, but the review did not identify the most important sources of error or explain why harm was occurring. Therefore, patients and staff participated in a risk assessment survey to determine which healthcare activities were most hazardous.

The five most hazardous healthcare activities on surgical wards were identified and prioritised. Detailed observations and in-depth interviews with patients and healthcare staff allowed these five healthcare activities to be fully understood and mapped. The five highest risk processes that occur in and around the patient's bed were identified as: hand hygiene; information hand-over; vital signs monitoring; isolation of infection; and medication delivery.

Prioritisation of risks: These five high-risk healthcare processes identified from the survey were subjected to an engineering design technique called Failure Mode and Effects Analysis (FMEA). Expert groups – consisting of doctors, nurses, patients and researchers, all with experience of the subject matter – were organised by the DOME team to validate the healthcare process maps and then rate the risk associated with each step in the processes (Figure 2). Steps in each process that were associated with the most risk were carried forward to the next stage.

Cause analysis: The riskiest steps in each healthcare process were assessed using the framework for analysing risk and safety in clinical medicine. The expert groups were asked to give the reasons why each type of failure may occur and continue giving reasons until the systemic weaknesses of the system were identified. This allowed the causes associated with the highest risk failures in the entire surgical ward environment to be identified and targeted for patient safety improvement.

Figure 6: Multiple hand hygiene signs on a ward

Figure 7: Clear safety signage on a construction site

Figure 8: The proposed hand hygiene mirror sign

Analogous industries: Concurrent with the research on surgical wards, the DOME project investigated how risk is managed and safety considered in other industries. Members of the team visited international sites in the mining, chemical, oil exploration, shipping and construction industries (Figure 3) to draw lessons on ways to reduce systemic error. Process maps were created for analogous industry processes to sit alongside the surgical pathway maps.

Task design, reminders, equipment and space were identified as the generic components in any design-led approach to improving safety. This work was also combined with a review of operations management literature in the field, including key models for managing complexity such as Reason's Swiss Cheese Model, which was expanded to develop a Healthcare Error Proliferation Model.

Design briefs

The understanding of errors, their causes and methods to manage risk, were central in shaping the design briefs that would direct the eventual project results. A rich and detailed picture of where and why errors occur was built up during the research, and major systemic weaknesses became apparent.

These underlying weaknesses alone, however, could not provide the basis of a design brief. It was not possible to design around a brief that was as broad as "reminders" or "equipment"; instead, this learning was combined with the original focus on healthcare processes. Each process formed the centrepiece of a brief.

The detailed findings of the research were centred on the five most error-prone healthcare processes that occur on a typical elective surgery ward:

- Infection control
- Hand hygiene
- Medication
- Vital signs
- Handover

These briefs were an important focal point. In each case they were validated by a process expert to ensure that the essence of the research was captured. It was also important to inspire a breadth of creative thinking by the team. The brief, insights and design solutions are considered in turn:

1) Infection control – the Carecentre. The brief was to design a way to improve staff use of the apron and gloves for patients with a known infection, and encourage the use of alcohol hand gel. Staff do not always adhere to infection control rules, because the apron and gloves are not always handy, and it is easy to forget to use the alcohol hand gel. From spending time shadowing nurses and immersing themselves in the ward environment, the team noticed that most equipment needed for patient care at the bedside was scattered all around the ward (Figure 4). This not only meant that common tasks took longer to complete, it also made it difficult for staff to adhere to procedure as the equipment they needed was not easily accessible.

The proposed "Carecentre" (Figure 5) houses all the equipment needed to care for a patient in the bed space. It contains gloves, aprons, hand gel, a medication locker and a bin, and has a flat surface for reading and writing documents. It is located at the end of every bed. The staff workflow is channelled past it, and the gloves, apron and gel become much more readily accessible. It also contains other items such as medication, streamlining the work and improving efficiency and compliance.

2) Hand hygiene – a communications campaign. Here, the detailed brief was to improve hand hygiene by designing a way of effectively reminding and educating staff to clean their hands at the right time, when entering and exiting the bed space. The role of hand hygiene in preventing the spread of infection is well known, but the lack of effective reminders means people still do not wash their hands at the right time. There is a plethora of hand hygiene reminders on the ward (Figure 6), mainly positioned at the entrance to wards or bays, but there is a lack of focus at the point of care – in the bed space.

The team visited a construction site where there was a different approach to signage. Instead of posters or homemade laminated signs, every sign was official, clear, and instantly recognisable (Figure 7). This insight inspired the development of a single hand hygiene symbol for use on hospital wards. The hand hygiene symbol (Figure 8) was developed to standardise the visual reminders on the ward; the communications campaign raises awareness and educates staff about the new initiative. The mirrored signs catch people's attention as it emphasises movement in the bed space. The supporting campaign uses novel ways to raise awareness, and educate staff about the new initiative.

3) Medication – a new pill pot. The brief was to design a way of improving the safety of the drugs round on a ward by reducing omissions (nurses missing a drug off a patient's round) and interruptions. Failure to administer medication can have severe

Figure 9: A nurse on a medication round

Figure 10: The new blister pack design

Figure 11: The tray used to keep medications in order

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Figure 12: Tangled cables on a vital signs trolley

Figure 13: Transcription of vital signs results

consequences: missed doses, repeated doses, wrong drug or wrong strength are potential errors. It is not only the staff who are responsible – some patients refuse to take their medication. The process is badly supported by equipment, with many systems evident, depending on the ward.

The team observed medication rounds (Figure 9) and were surprised at how many times the nurses were interrupted while performing such an important task. When they did get interrupted, there was no safety net in place to catch an error if one occurred. If the patient was given more information and was more involved in their medication regime, it could act as a "double check" to reduce errors.

A new blister pack design (Figure 10) takes the form of single dose "spoons" with patient-friendly information printed on the handle. Each patient also has a tray to manage their different medications. The nurse tears off a blister "spoon" from each pack and places it in the tray (Figure 11). For each round, the patient receives a complete tray with information about each drug. If a drug needs to be ordered from pharmacy, a reminder "spoon" is placed on the tray, reminding both patient and nurse that the order still needs to be completed.

4) Vital signs – a new trolley. The team aimed to redesign the way vital signs (eg blood pressure and temperature) are measured, making the recording of results, and the cleaning of the equipment, easier. A patient's deterioration may be missed if vital signs are not measured at the right time, if they are not documented properly, and if they are not correctly interpreted. One of the most important indicators – respiratory rate – is often not measured at all. The vital signs equipment has the potential to spread infection as it is wheeled from patient to patient; the cables are often tangled and it is difficult to clean (Figure 12).

From carrying out a short audit of the charts, the team saw that plotting was inconsistent (Figure 13) and it was not surprising that the results were incorrectly interpreted. It was clear that an electronic system would remove transcription errors. A simple redesign of the trolley, introducing easy-clean surfaces and a cable management solution, was also necessary.

The easy-clean design and improved cable management system of the trolley (Figure 14) reduces the risk of infection. The new interface facilitates easy collection of results including respiratory rate, which is often overlooked, while the automatic plotting (Figure 15) removes transcription errors. The screen guides the nurse through the correct procedure, captures all the data and automatically displays the figures on a chart. The screen also helps nurses to accurately measure respiratory rate, which is a crucial but often neglected vital sign. When finished, the cables are retracted back into the trolley, keeping it tidy and making it easier to clean.

5) Handover – a new environment. Handover is vital to the continuity of patient care. A successful handover needs to be supported by a well-designed environment with all the necessary information at hand. It usually takes place in a room that is ill-equipped, too small and prone to interruption (Figure 16).

The team surveyed 50 "handover rooms" in three hospitals. This revealed that there was actually no such thing as a dedicated handover room, and handover usually took place in a staff room, nurses' station or office. Because space is at a premium it is not possible to have a room solely for handover. Therefore the suggested design for the room is intended to be flexible and has two modes: when in handover mode, there is bright lighting, formal seating, writing surfaces and signage to reduce interruptions (Figure 17); when in staff-room mode there is relaxing lighting, comfortable seating and kitchen facilities for staff to take their breaks (Figure 18).

Testing and evaluation

The development of the DOME concepts has had the ongoing input of frontline hospital staff and patients. As the designs became more resolved, more extensive testing was carried out in a simulated ward environment at St Mary's Hospital, London. Various clinical scenarios were played out by nurses using the new designs, which were improved as a result.

The Carecentre and an iPhone app to measure respiratory rate (part of the vital signs trolley design) have undergone formal trials. Results will be published as they emerge and used to improve the designs.

Manufacturers Bristol Maid (UK) and Humanscale (USA) have been involved in the development of the Carecentre and vital signs trolley respectively; the designs are being refined in partnership with them.

Figures 14 and 15: The new vital signs trolley design (above left) and the screen close up (above right)

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Figure 17: A mock-up of the new room, in handover mode

Figure 18: The new room in staff room mode

Conclusion

These design outcomes are rooted in extensive clinical research, spanning the full three years of the project. This time span not only enabled an in-depth analysis of typical ward processes and errors, but also allowed enough space for genuine co-design and co-research to take place.

By placing designers in the clinical environment for an extended period, and involving clinicians in the design throughout the innovation process as genuine partners, the design outputs are true to the needs of frontline hospital staff.

The five briefs were considered in parallel, in keeping with the research aim of looking at the broader context of use whenever a new design is developed. This ensured that the concepts would be fit for purpose in the complex system of a hospital ward, and also that designs such as the Carecentre would incorporate features that were of benefit beyond their specific brief.

Beyond the designs, the larger lesson from the project is the benefit of time and space for a true collaborative working methodology to emerge. It is only by forging these methods of working together that the complex multidisciplinary problem of medical error can be tackled effectively.

Acknowledgements

The DOME research team would like to thank the following organisations for supporting the project: the Engineering and Physical Sciences Research Council (EPSRC); Bristol Maid and Humanscale, industrial collaborators on the Carecentre and the Vital Signs trolley; Clinical Safety Research Unit, part of the Centre for Patient Safety & Service Quality in the Department of Surgery and Cancer at Imperial College London; and the European Commission Representation in the UK.

We would also like to thank the following people for their advice and insights: members of the Advisory Board; staff and patients at Imperial College Healthcare NHS Trust, in particular Helen Edgar (ward manager) and staff and patients on Charles Pannett Ward; and also the subject matter experts – Maisse Farhan, Katie Scales, Ian McCabe, Monsey McLeod and Susanna Walker.

This project was completed with the help of BrainBakery, Emma Stanton, Chiara Bello, Emilia Serra, Daniel Becerra, Maja Kecman, Jaakko Tuomivaara and Peter Woods.

For more details, see www.domeproject.org.uk

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Figure 16: A crowded staff room being used for handover

Rapid-response architecture: **Redeployable trauma centres for post-disaster response**

In the wake of global disaster, there is a strong need for post-trauma emergency structures. A research project from South Carolina's Clemson University seeks to inject some architectural integrity into current models

Stephen Verderber, Arch.D, NCARB

Globally, the rhythms of everyday life are being upturned by unplanned major events. These events may appear to be random occurrences but are increasingly difficult to respond to effectively. Effective, compassionate responses are often unattainable. Geopolitical conflicts, earthquakes, intense hurricanes, flooding, famine, tsunamis, acts of terrorism and cross-cultural ethnic strife over finite, nonrenewable resources are becoming commonplace. With each passing year, in both developed and in less developed societies, citizens are at greater risk. In the US alone in 2011, there were 12 disasters that each caused over $1bn in damages, causing the loss of many hundreds of lives. In Bangladesh in 2011, more than 60,000 internally displaced persons (IDPs) became permanently homeless due to rising seas and corresponding widespread inland flooding that overwhelmed the region's healthcare infrastructure. By 2050, it is predicted that nearly 80% of the world's population will reside in coastal regions and this alone, coupled with increased rises in mean sea levels, warming ambient temperature levels and coastal subsidence, is a recipe for innumerable future disasters.

The need is becoming urgent for rapidly operationalised healthcare facilities able to be quickly deployed to disaster strike zones and set up within hours.[1] In this regard, the World Health Organization (WHO) advocates research and development in innovative, sustainable responses to disasters, including rapid-response architecture. This, in a world where more communities and regions are now increasingly susceptible to the deleterious outcomes of life-altering events of cataclysmic scale and intensity.

US Library of Congress

Figure 1: First world war surgical field hospital, France

Figure 2a

Figure 2b

Figure 2c

Figure 2d

Medcoach Corp.

Figure 2a-d: Vehicular clinics-on-wheels, 1950s-80s

Background and recent history

The earliest portable building is generally considered to be the yurt, an ancient thatched hut that could be assembled/disassembled and transported from place to place using carts drawn by mules, oxen or horses. Variants on this basic freestanding building type evolved through the centuries in response to local culture as well as climatic factors, locally available materials, fabrication techniques and site conditions such as mountainous terrain versus low-lying coastal sites.[2]

Currently, modern redeployable trauma centres, or RTCs, are called for, able to be transported and operationalised quickly in the aftermath of man-made and natural disasters globally. Effective, sustainable RTCs can fill a critical void in a community or region's damaged or destroyed healthcare infrastructure. During the first world war, innovations in military hospitals were introduced on the battlefield. New, nomadic systems for healthcare delivery were highly efficient, mobile and relatively lightweight. Lessons had been learned from the American Civil War tent hospitals in this regard. By the first world war, soldiers were sustaining more severe wounds than ever before in combat due to the use of increasingly lethal weaponry. One Mobile Field Hospital, no.353 of the 80th Division,

US Army, was deployed in France in 1917; it consisted of 20 tents, and was transported in 40 trucks with convoys stretching as far as a quarter mile in length (Figure 1).

Infirmary trains were another type of RTC utilised in the first world war. These British units were highly elaborate and were transported across conventional rail lines up near to the battlefront. A single rail car housed 33 beds for "inpatients". A typical unit consisted of eight types of rail cars with each fitted for a specialised function. Up to 50 cars were deployed in a single train. An allied nomadic type, modern hospital wooden barge RTCs, dated from the American Civil War and were used on canal and rivers: most of these infirmaries had been adapted from agricultural or merchant marine uses. The patient was typically carried on a stretcher across a gangplank to topside and then brought down below deck. These portable vessels, at best, had small portal windows and poor ventilation. Later, massive US hospital ships would be developed, such as the USS Hope. This RTC ship-hospital was deployed in the Persian Gulf and Iraq wars and in 2005 was deployed on the Mississippi River at the New Orleans riverfront in the aftermath of Hurricane Katrina.

During the second world war and throughout the US Korean War, numerous MASH (Medical Army Surgical Hospital) RTCs were implemented in the field near the battlefront. In the Vietnam War, MASH units, together with inflatable MUST (Medical Units Self-Contained and Transportable) were developed for the field. The latter featured a double-walled fabric membrane skin that was inflated by turbine U-packs. These supplied critical HVAC support. While innovative on a tectonic level, they would unfortunately fall victim to collapse from being hit by a single mortar shell; furthermore, they required concrete pads to keep from floating away in tropical rainstorms.

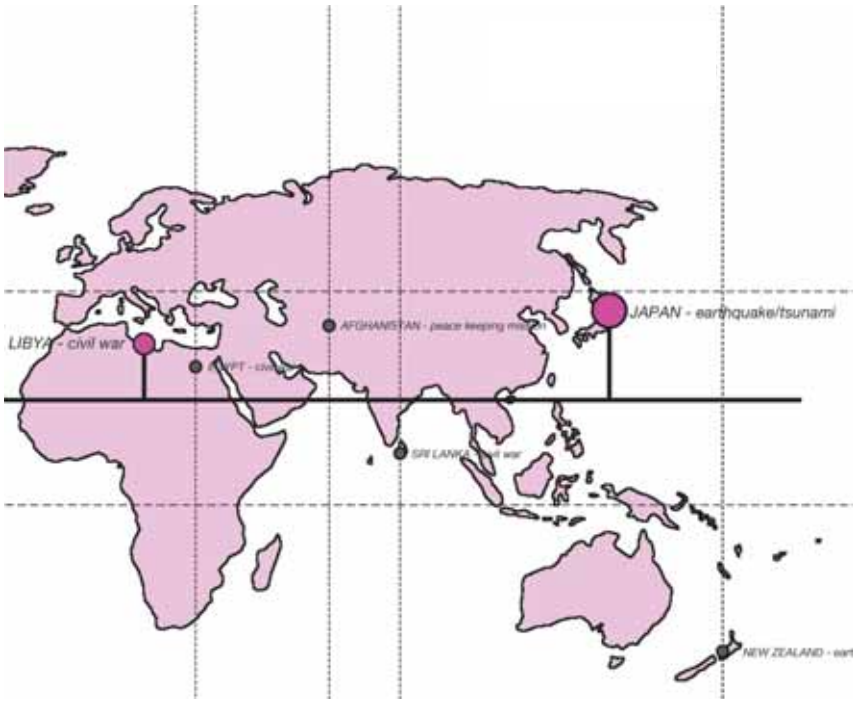
More recently, the US military developed its DEPMED (Deployable Medical) centre transportable system, whose modules were conceived to replicate as closely as possible the functional amenity and stability of a standard brick-and-mortar hospital. DEPMED RTCs employ a variant on standard intermodal shipping containers, and these containers house critical components such as labs, radiology, pharmacy, sterilisation units and surgical suites. The US DEPMED units are interconnected to TEMPER (Tent, Expandable, Modular, Personnel) units consisting of inpatient wards and related support operations. Collectively, these CSH (Compact Support Hospital) units are deployable in a 16- to 256-bed capacity. DEPMEDS, however, are far less mobile than their MASH precursors. For this reason, they are not positioned in direct proximity to frontline combat zones. DEPMED/CSH RTCs have performed rather admirably during the Iraq and Afghanistan Wars, saving thousands of lives.

Figure 3: Land/amphibious RTC prototype (2012)

Mobile vehicles developed during this period include advanced ambulances, and mobile vehicular clinics-on-wheels in large-scale screening and vaccination campaigns waged against TB in the 1950s and 60s.[3] Numerous corporations in recent decades have manufactured nomadic "clinics-on-wheels" for use by governmental and NGO healthcare organisations, and a wide array public health agencies. These include Ian M Smith's CARE Mobile Medical Clinics, deployed in India in the late 1950s and early 1960s (Figures 2a and 2b), the government of Cuba's deployment of 36 multi-phasic mobile medical units (Figure 2c), and a fleet of 42 mobile health screening units deployed throughout the Republic of Congo in the 1980s (Figure 2d). Not ironically, the hospital bed itself remains that most mobile of devices, and this portability alone provides enticing opportunities for innovative applications in RTC settings.

Recent disasters and RTCs

At the present time, a complex and often contradictory set of six superordinate dimensions generally shape current



Ryan Ramsey/S Verderber

Figure 4: Recent global disaster mapping

design theories, strategies, and principles, which govern the manufacture of RTCs globally. Each of these broad-based factors manifest in a pre-disaster versus a post-disaster condition, as in the case of *Socio-cultural* factors (demographics, migrational diasporas, religious cycles and traditions, activities of daily living, and quality of life factors as these correlate with human health outcomes).

Political factors include legislation, political systems and their governance models, events of unrest and/or insurgency, issues surrounding political control, the role of capitalist disaster-interest lobbying groups, the role of non-governmental organisations (NGOs), as well as the sense of hope versus apathy, or despair, among the victim populations.

Economic factors include the exchange and control of capital, goods and services, supply and demand issues at the macro and local level, production and distribution systems and their efficacy, and land valuation and demolition trade offs within disaster strike zones.

Climatic factors include local weather, seasonal cycles, and the effects of global climate change. Geographic factors include local geology and soil conditions, topography, plate tectonics, especially in coastal zones, and the influences of hydrological systems. Ecological factors include environmental health, mediation issues, site resilience, and interdependency, diversity, and wellbeing of crops and animal species and their availability as local food sources in the aftermath of disaster.

Hurricane Katrina in 2005 stands as the costliest natural disaster and one of the five deadliest hurricanes in the history of the US, having inflicted the loss of 1,837 lives in subsequent massive floods in New Orleans and along the US Gulf Coast, and incurring over $200bn in property damages. Among recorded Atlantic hurricanes it is the sixth strongest overall. The most deaths occurred in New Orleans, which flooded up to 80% as the city's federally built and maintained levee system catastrophically failed. Large tracts of neighbouring parishes also became flooded, and the toxic floodwaters lingered for weeks. Massive governmental incompetency characterised the entire response to Katrina from top to bottom. RTCs set up in Katrina's strike zone included two massive hospital ships, including one deployed from Canada, and another ship deployed by the US Navy, and the Carolina MED-1 vehicular-based trauma treatment centres, as well as half a dozen US Red Cross open-air tent clinics.

The Haitian earthquake of 2010 was a catastrophic magnitude 7.0 disaster event, with an epicentre near the town of Léogâne, approximately 25km (16 miles) west of Port-au-Prince, Haiti's capital city. An estimated three million people were impacted by the quake; 316,000 lives were lost, 300,000 were injured and more than one million persons instantly became homeless IDPs. The Haitian government estimated that 250,000 residences and 30,000 commercial buildings collapsed or were severely damaged.

Makeshift, zombie-like tent cities sprang up literally overnight everywhere in the days and weeks following the catastrophe. Golf courses, vacant lots, parking lots – in short, anywhere with open space became encampments.[4] They each ranged in size from a few dozen families to thousands of families each. One of the hundreds of temporary-permanent encampments was set up in Corail, eight miles north of the centre of Port-au-Prince. Within days of the earthquake, thousands of refugees had agreed to relocate to this formerly remote, barren place. RTCs set up in the aftermath of the earthquake included an advanced portable hospital sent over by the Israeli government (The Israel Defense Forces Medical Corps IDF-MC Field Hospital), International Red Cross open-air tent hospitals, the ad hoc conversion of schools and residences into makeshift trauma treatment centres, and various container clinics set up by a handful of NGOs deployed from various countries.

The earthquake and tsunami off the Pacific coast of Tohoku in 2011 was a magnitude 9.0 undersea mega-thrust event. It was the most powerful known earthquakes to have ever hit Japan, and one of the five most powerful earthquakes in the world overall since modern record keeping began in 1900. It triggered powerful tsunami waves that reached heights of 40.5 metres in Iwate Prefecture, and which travelled 10km (six miles) inland in the Sendai Region.

In 2011, the NHK News Service in Japan reported that in addition to the loss of 15,800 lives, 5,900 injuries, 3,600 missing persons, and the total destruction of 45,000 buildings, damage to an additional 144,000 buildings, and massive destruction of infrastructural amenities, the tsunami itself inflicted multiple nuclear accidents. These

accidents centred on an ongoing Level 7 meltdown at three reactors within the Fukushima I Nuclear Power Plant complex, with associated evacuation zones uprooting the lives of 300,000 IDPs. With remediation and reconstruction exceeding US$300bn, this is at this writing the most costly global disaster on record.

Right after the earthquake, one Japanese architectural firm, Yasutaka Yoshimura Architects, developed a prototype container-shelter, the Ex-Container Project, for persons and families displaced by the disaster. These modular units were extremely generic and minimalist and are adaptable for use as clinics. Their proportions were virtually identical to standard intermodal shipping containers. They are all white on the exterior, with windows and openings sparingly carved out from these "shoeboxes". The modular units can be stacked on top on one another up to four levels in height. They are currently in mass production and a total of 50,000 have been purchased by the Japanese government to date, for deployment across the post-disaster strike zone on newly acquired land parcels. RTCs deployed in this strike zone have to date consisted of International Red Cross and Red Crescent tent hospitals, airlifts to urban medical centres, and Japanese defence force portable field clinics.

Global prototyping

On the evening of 20 April 2010, a massive explosion occurred in the Gulf of Mexico 60 miles off the coast of Louisiana. An immense ball of fire erupted high into the clear night sky as 11 men lost their lives. An over-budget, problem-plagued deepwater oil exploration platform had imploded – the BP Deepwater Horizon.

The limitations of extreme engineering technology were laid bare for the world to witness as the rig fell 150 metres to the ocean floor, in ruins. For three months thereafter, its ruptured wellbore spewed more than 200m barrels of crude oil directly into the ocean. The unprecedented damage inflicted upon the region's delicate aquatic ecosystems, its seafood industry, tourism, and the communities directly impacted, garnered extensive media attention and scrutiny by global environmental advocacy organisations. Governmental agencies with supposed regulatory oversight of the US deepwater drilling industry were caught completely unprepared.

In response to this and other on-shore and offshore disasters, a prototype RTC was developed within the Graduate Program in Architecture + Health at Clemson University in the US, by Team 896. This system is modular and can be set up on water within a buoyant aperture, configured up to 75 modules, or on dry land. It was developed in response to the specific scenarios of the recent BP disaster, the Tohoku earthquake, and recent strife in the Mediterranean off the coast of Libya (Figures 3-7). This system's modules feature photovoltaic panels, lightweight shell fabrication based on techniques perfected by the automobile industry, and a thermoplastic polymer exterior "skin" (Figure 7). Ryan Ramsey co-lead the design of this innovative prototype (with the author).

The RTC's configurations can be pre-set to be expandable from a single modular unit to as many as 75 or more modules on a single site. (Figure 5). The most anticipatory of these systems afford a high degree of flexibility from a site-planning standpoint. Reconfigurability options yield pinpoint response modalities in settings that can range from dense urban, open shoreline, irregularly shaped sites, to remote rural sites. In terms of design/tectonic and installation factors, modular systems, lift-pack systems, and hybrid systems combining elements of both, are most feasible at this time. Hybrid pneumatic combined with hybrid fixed container systems likely afford the most amenity and flexibility in most field settings. In Israel, two large urban

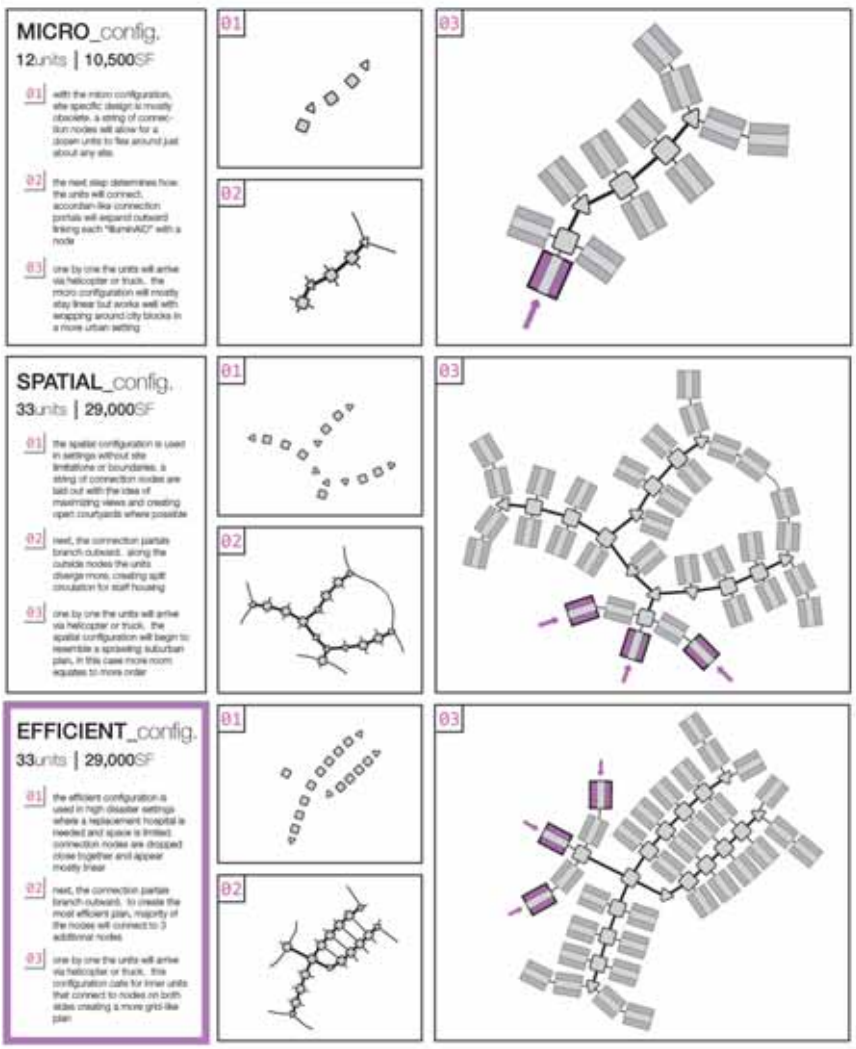


Figure 5: Suggested configurations for the prototype, according to site limitations and level of disaster

Ryan Ramsey/S Verderber

Figure 6: Internal configurations can be adjusted according to need – from surgery space to staff housing

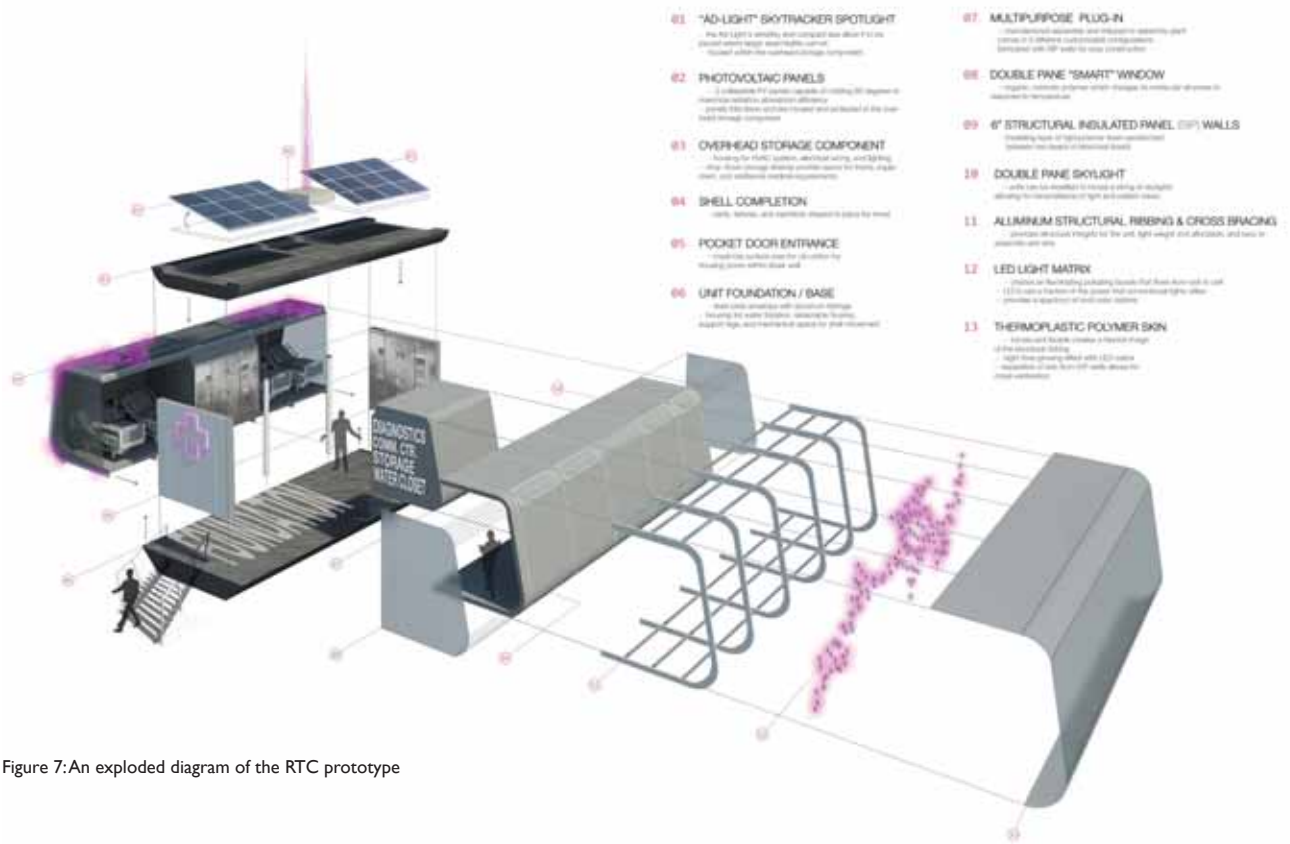
hospitals recently opened, each with a below-grade parking deck that can rapidly be re-deployed/reconfigured to house pop-up portable trauma centres (Figure 8). This strategy is one that warrants significant further research and field testing.[5]

It would appear logical to surmise that the global demand for ecologically sustainable and health-promoting RTCs has never been greater. Of course, challenges and opportunities associated with RTCs are many, as are the various methods available for their funding, designing, prototyping and manufacture. An RTC can function as a freestanding entity, or as an adjunct to a fixed, immobile healthcare infrastructure, including as kit-of-parts, highly flexible appendages to conventional, fixed-site clinics, hospitals and medical centres.

Why aren't more architects engaged in responding to the challenge? Why is it that so few off-the-shelf prototypes of genuine architectural integrity are readily available for first-responder implementation? Where is private industry? Why have most healthcare architects remained indifferent to this call for action? The following are perhaps a few reasons why significant architectural design/tectonic advancements in this field remain so few and far between:

The dominance of the engineers: Transnational engineering firms dominate the industry as the provider of first choice in emergency and offshore shelter. An emphasis on bare bones functionality and logistical expediency has usurped any attention to anything that might be equated with the broader, classically based Vitruvian principles of architecture (commodity, firmness and delight). The largest US federal contracts are held by a relatively small handful of very large engineering corporations.[6] These politically connected corporations tend to dismiss anything that aspires to achieve more than bare functionality: "We don't have time for architects (or architecture) and they are (it is) a needless expense anyway that just slows us down."

Architects' traditional disdain for bureaucracy: Many architects are disinclined to communicate with engineers and politicians in a truly collaborative spirit. It is this fact that perhaps holds the profession back from making further inroads in achieving higher healthcare design



Ryan Ramsey/S Verderber

Figure 7: An exploded diagram of the RTC prototype

quality with respect to pre-manufactured RTCs. This might account for the disaster industry's unfortunate yet continued overreliance on prosaic, uncreative and excessively minimalist shipping-container-based systems, nearly all of which are placeless, inflexible and wholly generic in relation to the timeless Vitruvian principles of commodity, firmness and delight.

Lack of professional training and preparation: The culture within most academic schools of architecture does not foster a genuine appreciation for or attitude of social engagement among the students – in terms of inculcating the personal initiative, sense of compassion and indefatigable perseverance so necessary to respond quickly and adroitly to healthcare needs in the aftermath of disaster. It is not an overstatement to say that, while in school, most architects are not trained to communicate with NGOs, with civil engineers or the aforementioned for-profit mega-corporations that specialise in disaster mitigation, nor with governmental ministries of health. The status quo in this regard must change, and change quickly.

Sharyn Mittelman

Figure 8: Israeli RTC deployment within medical centre parking deck

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Salutogenic Design: **The neurological basis of health-promoting environments**

All architecture embodies narratives that may either support or work against a state of good health. Neurological theory can be used to explain why salutogenic environments work, and how they can improve health outcomes

Jan Golembiewski BfA BArch MArch PhD

Architecture mediates almost all experience and moderates a great deal of behaviour. For the best part, the moderative effect that architecture plays is qualitatively even. The ubiquity of vertical walls and orthogonal layouts with very similar features for similar typologies guarantees this. Is there a qualitative difference in a right turn over a left one? Does it mater whether a window is a sash-cord or a casement? Either way, the actions these decisions prescribe are radically different, but on a qualitative level, the experiences are nearly identical.

But architecture can be genuinely manipulative, and herein lies the qualitative differences in the phenomenology of architectural experience. Sudjic[1] describes how architecture is used as a weapon, to defeat an enemy before a shot has ever been fired; Snodgrass[2] describes architecture that is used as a vehicle for religious and spiritual revelation; and Jencks[3] makes a solid attempt to relate how architecture can thrill its visitors. But when it comes to healthcare design, architecture is rarely so focused on psychology. Somehow architecture all too often loses its considerable manipulative power as it becomes subservient to its parts: future expansion, structure, models of care, functional programme, efficiencies, sightlines, infection control and the needs of a diverse group of users. All these things are critical, but to let functional and structural issues lead design is to let the cart lead the horse. So is it possible to harness the considerable manipulative power of architecture for better health outcomes?

Architecture – a building, or better still, an entire environment – can amplify emotions, especially when they are already vulnerable. Sudjic[1] proposes that the endless gallery leading to Hitler's chambers in Albert Speer's Neuen Reichskanzlei, and the grandiosity and sheer scale of his suite so amplified the helplessness of the 1939 president of Czechoslovakia, Dr Emil Hácha, that he not only surrendered his nation, but also suffered a cardiac arrest in Hitler's presence.

From a medico-legal paradigm, it seems impossible to prove that the Neuen Reichskanzlei (Figure 1) had anything to do with the state of Dr Hácha's heart, but from a salutogenic perspective, the relationship is unmissable. The same can be said for architectural interventions that are designed to improve health outcomes – correlations don't mean causation. But architects and healthcare planners should not be dismissed so easily. Reviews of healthcare design research show there are now thousands of relevant studies, many of which have been shown to make a substantial difference in health outcomes.[4] But these studies invariably focus on single details, frequently drawing on abstract aetiological mechanisms such as the general concept of "stress". The salutogenic methodology is both more holistic and more specific: for Antonovsky[5] the stimulation we call stress isn't just noise, it's information. And our ability to cope with the flood of information – be it good or bad – is ultimately what determines our generalised state of health.

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Figure 1: The Neuen Reichskanzlei; most of the building is taken up by a grandiose gallery leading to Hitler's chamber. Did its foreboding nature contribute to Czech president Dr Emil Hácha's heart attack in 1939?

The theory of salutogenics

The theory of salutogenics has a basis in the empirical testing and ideas of Antonovsky.[5] which find that *health outcomes improve when a sense of coherence is fostered.* A sense of coherence (SOC) in turn, depends on the net resources that support *meaning,*

comprehensibility or manageability. Put simply, all of these things help us make the best of life's circumstances. They help us cope.

Almost all healthcare interventions (medicine, care, architecture) focus on *manageability*: the physical resources needed to keep on going. It's paradigmatic that this is virtually all healthcare is obliged to do: to treat the sick and keep them warm, fed and dry while they recover from a point of critical illness or injury.

Comprehensibility is a function of knowledge. Information about the life situations that people find themselves in builds a sense of comprehensibility. Healthcare information will include facts about the nature of the illness, how long a stay will be, what treatments are available, who will be involved and how, information about side effects and what resources will assist in recovery. In the healthcare sector, things are improving for comprehensibility and there are a few "islands in the sun", but information communication is something which health facilities have traditionally been bad at.[6,7]

Meaningfulness enriches and gives quality to life. It is the sum of all the best reasons people have to keep on living.[5,8-10] Generally speaking, hospitals don't consider the fostering of meaning to be their role, but when people are beleaguered with anxiety about their state of health and about the future, it's hard to imagine that any other psychological interventions could be more significant than developing reasons to hang in there and believe that everything is going to be okay in the long run.[5,8-11]

A caveat is due here; salutogenic needs do change with the intensity of pathology – comprehensibility is more important (in the short term) than meaningfulness whenever "things are not looking good" for a patient, and they are aware of it – in cases such as primary myocardial infarction (cardiac arrest), for instance[12].

The neurology of salutogenic healthcare design

The reason that manageability is important for health is obvious and doesn't need further elaboration here, but why abstractions like meaning and comprehensibility are so important can be difficult to understand.

The brain can be seen as an organ that perceives, creates and manages meaning. The most basic level of this is *manageability*. Even the most simple of creatures need to manage the needs of survival: sustenance, protection and reproduction. The bulk of the relevant processes to manage these needs are automatic in most creatures. The areas of the brain that are wired for manageability are within the reptilian complex; a simple system that implements a simple formula; if it's food, eat it, if it's danger, flee and if it secretes sex hormones, mate it.[13]

Comprehensibility is a step more complicated because it involves perception, that is, a cognitive, interpretive step. And this presents a problem: how is sense-data interpreted? The internal representations we have of external objects cannot be true to reality. This is firstly because reality offers a richness that humans simply cannot experience: humans don't even share the same sensory range as one another (some have better high frequency hearing, others are colour blind etc), and certainly we have very different sensory ranges to other animals. Bats can hear pitches of up to 115kHz, and humans only about 17kHz; humans can feel light of 300-400tHz range as heat, but poecilia reticulata (the common freshwater guppy) can see and taste the same spectrum.

But what humans lack in terms of sensory ability, we make up for in cognitive ability. We have an extraordinary ability to identify the differences between just about everything, and this information is stored in vast lexical ontologies. At a glance we can tell the difference between a Nokia and an iPhone, between a painting by Modigliani and one by Picasso or a song by Jimi Hendrix and a religious hymn. Not all this information is immediately relevant, but it is our nature to store and use such information as needed. Information becomes critical only when required: "I need medical attention – where's Emergency?" Or "If I take this medicine will I get side effects?"

The cerebral cortex is used for associations – in other words, the links between pieces of information; the basis of comprehensibility. Learning is the generation of these links, and knowledge is their retrieval. Although learning takes place over a globally distributed network,[14] the main place that somatic (sensual, physical) associations are paired with meanings is in the primary perceptual cortices.[15] A paleomammalian (limbic) organ called the thalamus mediates the somatic nervous and sympathetic nerve impulses and distributes them to the appropriate perceptual areas of the brain. These are then associated with one another and more abstract meanings in the higher perceptual association cortices and with actions in the motor cortex (all are subsections of the cerebral cortex).

Comprehensibility doesn't have to reflect "truth". Comprehension can be delusional. Delusional subjects generally have relatively low SOC scores, due to poor manageability and meaningfulness scores. But recovery from delusional states only

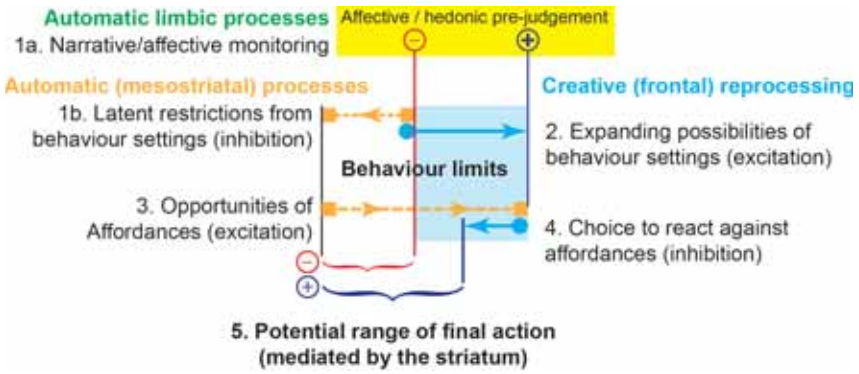

Figure 2: The reptilian complex (orange) mediates instinctive "event management" responses – there is either instinctive/learned action or none. Paleomammalian organs (the hippocampi and amygdalae) monitor experience for narratives that impart an affective or hedonic value (ie, "it's good or bad for me") the sense of "where I am in this story" roughly corresponds to the salutogenic notion of comprehensibility (green). In positive circumstances, the neomammalian complex (blue) is engaged and is able to expand the possibilities of action or restrict them according to a person's own sensibilities and context. (Image from[22]). Behaviour settings are pre-set expectations of behaviour in a given environmental setting. Affordances are perceived opportunities to act[21,23,24]

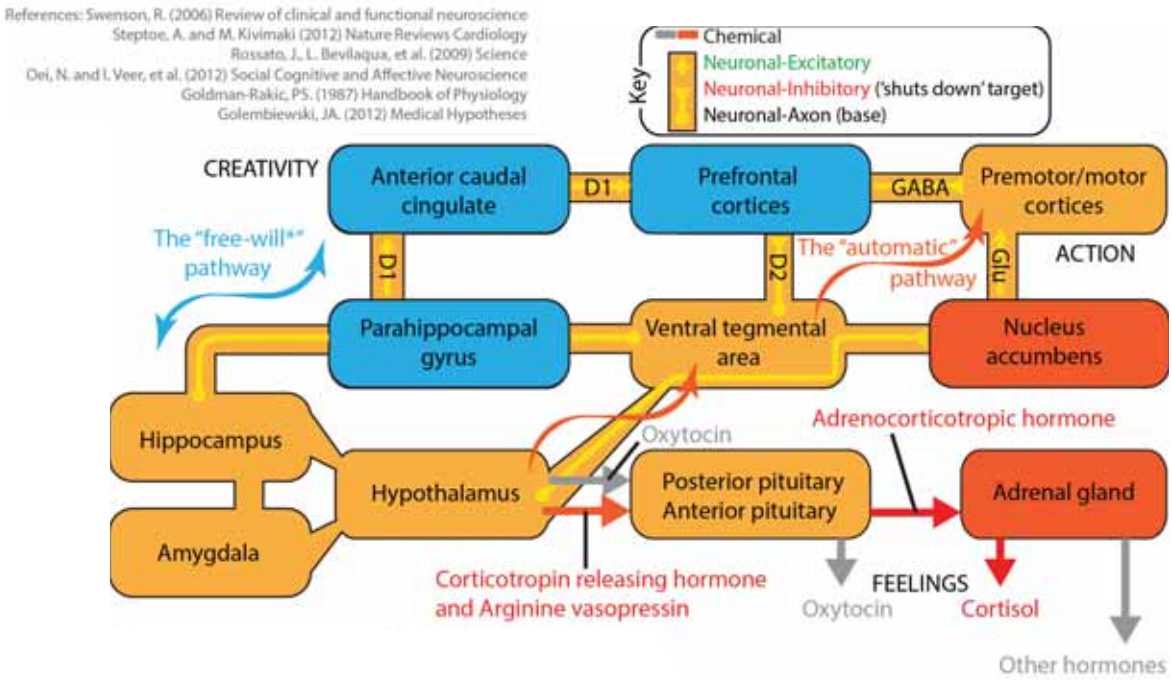

Figure 3: The automatic versus creative action pathways – the thresholds for conscious choice and deliberate behaviour are moderated by the combined amygdalae and the hippocampi in the limbic region of the brain. If circumstances are perceived as going beyond a reasonable threshold of control, these organs trigger the hypothalamus to override neomammalian processes. Associated feelings occur in parallel – negative events triggering cortisol, a hormone associated with non-specific anxiety. Cortisol bypasses normal hormonal regulation. Drawn from many sources: for more information, please contact author

reduces SOC scores further – particularly for comprehension, implying that the underlying SOC is challenged by having to comprehend the world afresh.[16]

Meaning is an order more complex again, and in this evolutionary step, the anterior hemisphere of the cerebral cortex swells to make a distinctly neomammalian shape, one that is far more defined in humans than in any other species – it is the neomammalian complex, incorporating a highly developed anterior cingulate cortex (ACC) and prefrontal cortex (PFC). These organs process choice, insight, creativity, the sense of self and other complex cognitive processes to establish appropriate actions for situations for which there are no ready responses.[17,18] The use of the neomammalian complex definitively separates humans from all other animals, and makes us what we are: more human.

Like other advanced mammals, the folds of the neomammalian complex contain a thick network of dopamine neurons. What differentiates ours from those of all other animals is that most of the neural receptors in the human frontal cortex are of the D1 type with higher densities of D2 type receptors deeper, in the paleomammalian regions (see the top section of Figure 3). In contrast, D2 receptors remain ubiquitous throughout the entire mesofrontal region in other mammals – from the reptilian middle brain right through to the prefrontal cortex.[19,20] The difference is not subtle. The D1 receptor is excitatory, meaning that when it fires, it activates the neomammalian complex. This means that some perceptions will activate the centre of consideration, thoughtfulness and creativity. D2 is inhibitory, so when it fires, it restricts activations in the same region. This enables faster judgements, but at the expense of consideration, thoughtfulness and creativity. This explains what we all know already; that humans are naturally more considered in their actions than any other animals. Animals, on the other hand, are more instinctive.

Each evolutionary iteration of the brain must process increasingly complex information, but like a computer the more complex information is, the slower it is to work through. Unfortunately evolutionary theory doesn't favour slow reactions, so to maintain quick reflexes, the more evolved areas don't replace the primitive ones. The more developed layers of the brain fold around the more primitive, and mechanisms have been developed that allow the primitive/instinctive areas to spring back into action whenever speed is required. In advanced mammals, reflexes are regulated by the amygdalae (used to monitor emotional context) and the hippocampi (to monitor schemata and narrative context). Together these set up thresholds for automatic inhibitory responses and excitatory overrides, so if a surprise occurs, appropriate instincts will be already approximately set for appropriate action in a given situation[21] (see Figure 2).

Sometimes surprises are good and welcome – jokes for instance, and the automatic reactions include laughter, smiles and happy feelings. These are good and don't need to be managed. But a negative shock will solicit screaming (sounding an alarm to others) and even more basic self-protection instincts: the release of stored energy to enable flight, and the defensive withdrawal of blood from the periphery of the body (to prevent certain death, should a snake or bear bite a limb). All of these reactions commence in the reptilian complex, and their activation inhibits the activation of the neomammalian complex.[25]

The withdrawal of peripheral circulation protects the body from physical shocks. It is a primary function of the hypothalamus, the pineal gland and adrenal cortex. Together,

these secrete hormones, which inhibit peripheral circulation by metabolising quickly to cortisol.[26] It's fast, but not an ideal solution because cortisol has a number of undesirable side effects: It overrides healthy limits on blood sugar, blood pressure and heart rate (the tip of the iceberg: there are other negative side effects also). In non-emergencies, cortisol synthesis doesn't occur and essential hormones are produced from the same primary compound (cholesterol) instead. These maintain happiness and appropriate healthy bodily function; they include progesterone, dihydrotestosterone (DHEA) "the joie de vivre hormone",[27] testosterone and oestrogen, to name only a few (see lower section of Figure 3).

It is important to note that cortisol is not stress and stress is not cortisol, although the two are commonly confused. Cortisol can be a useful medicine when used wisely. Cortisone (synthesised cortisol) is used to suppress the immune system (during allergies or asthma attacks, for instance). But in natural circumstances, cortisol is a by-product of automatic self-preservation systems that only kick in when:

a) The neomammalian complex is bypassed. This area is used to process the primary salutogenic resource: meaning.
b) People find themselves in situations, which they associate with lurking danger (a hippocampal function, which correlates to another salutogenic resource: comprehensibility).
c) The environment is perceived as being aversive (a function of the amygdalae, which also correlates to comprehensibility). Note that amygdalae don't have a neutral function. Neutral stimuli are emotionally ambiguous, so they are polarised into negative or positive following narrative cues from the hippocampi.
d) Automatic behaviours commence before cortisol even reaches the bloodstream. These include instinctive and learned behaviours, but the problematic ones are only noticed in negative circumstances: they are stereotypical behaviours, screaming, fleeing, sudden violence, confused thinking patterns and perseverance (when in excess, all of these are associated with mental illness).[25]

It begins to become clear that the failure of comprehensibility triggers the reflexes in the reptilian brain to produce cortisol and other unwanted reactions. This is apparently a last-ditch effort to maintain the last and most primitive of the salutogenic resources: manageability.

Powerful design

If asked if Dr Hácha's experience in the Neuen Reichskanzlei could have caused a heart attack, there is no doubt that the building was an essential factor in rapidly increasing his vulnerability. The design of the Neuen Reichskanzlei worked (as intended) to defeat adversaries. The narrative of immense power was written into the masonry. And when this was combined with the generalised negativity that Dr Hácha must have sensed as he approached his nemesis, his creative and adaptive resources would have been reduced. Instead of using his neomammalian brain to test creative solutions, the negativity inherent in his situation (reinforced by the architecture and social milieu) must have triggered alternative automatic behaviour pathways, thereby reducing his thoughts to testing established fears for himself and his country. It's easy to imagine Dr Hácha thinking thoughts along the lines of: "Perhaps they have invaded already, and they are

Credit: CPG Consultants

Figure 4: A patient reads the morning paper on one of the many abundantly green spaces of the Khoo Teck Puat Hospital in Singapore, designed by CPG Consultants and landscaped by Peridian Asia

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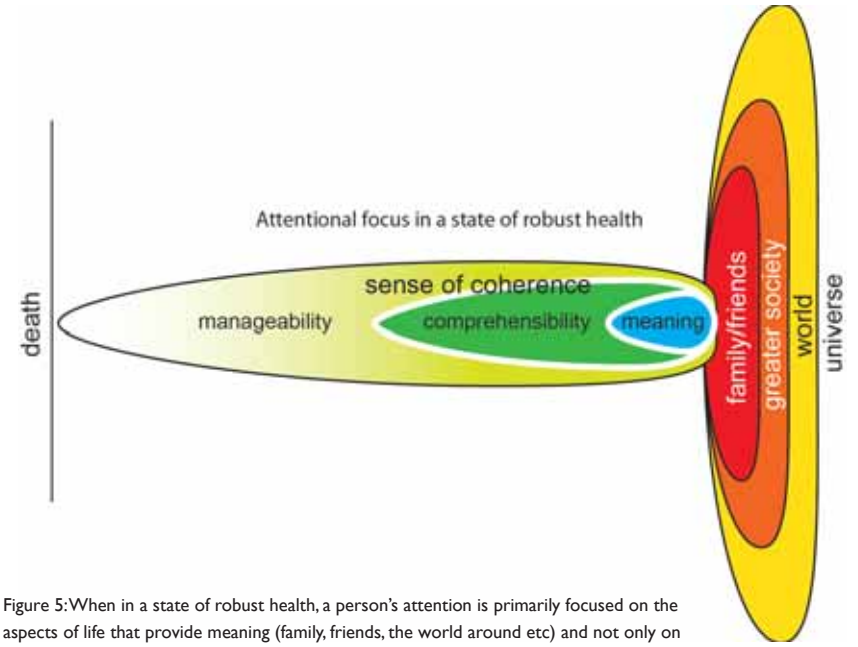

Figure 5: When in a state of robust health, a person's attention is primarily focused on the aspects of life that provide meaning (family, friends, the world around etc) and not only on survival. In this diagram, blue represents the locus of attention, and green peripheral attention

keeping me here so I'm not there to rule my country in its hour of need?" (Note the paranoid thinking.) Meanwhile, on a physiological level, Dr Hácha's cortisol levels will have soared, causing his blood pressure to increase. When extreme this reaction can cause transient myocardial ischemia, an atypical cause of cardiac arrest: the heart stops because of the sudden swelling of the heart tissues.[26]

Comprehensibility and meaning

Thus architecture can be a powerful weapon. But can it be an equally powerful ally? The hippocampi/amygdalae coupling sets up automatic response thresholds that are already likely to be low for people entering a healthcare setting, so as healthcare designers, our first task is to maintain comprehensibility.[12]

To do this, the embedded narratives within the environment must be managed. That means taking great care that the typology and patient experience is recognisably and indisputably positive. The first step is to distance the style of the new facility from those ubiquitously seen in medical dramas. That means design teams should look for functional alternatives to white walls, vinyl floors, strip lighting, typical services and even the design of surgical scrubs and nurses' uniforms.[28] Bring in masses of glorious plants and fresh air like in the Khoo Teck Puat Hospital in Singapore (Figure 4), and consciously design the soundscapes, lighting, and patient experience. Perhaps the most alarming features of modern hospitals are the monitors, which set off alarms when a patient's vital signs are irregular. There is no question that these machines are essential, but the alarms no longer need to sound right by a patient's bedside. Current technology allows the alarms to be routed directly to communications devices that are carried by medical staff. Healthcare lighting should be natural and electric light should be low-glare, and be of a "warm" temperature.[29] Windows should look out to gardens and plants and art should adorn patient rooms. Many interventions of this kind have already been studied and found to be useful, even on their own (once again, see[4,30] for handy reviews).

The next step is to enrich meaning. Meaning is to be found whenever humans engage in concerns beyond their own (even if these are very abstract); the wellbeing of family and friends, in the greater good of society, in protecting animals and the environment, even in protecting the security of the cosmos (Figure 5). Designing environments that foster meaning is not easy because what makes life worth living is intrinsically personal, but by the same token, design decisions that should be avoided are more universal. At the top of this list of things to be avoided is, unsurprisingly,, meaninglessness. Meaninglessness causes bizarre and frightening expressions such as mutism, emotional shutdown or severe mental illness.[10,31-33] As mentioned earlier, it can also be traced to physiological breakdown as demonstrated by Dr Hácha's heart attack. Meaninglessness must be avoided in all scales from typology to detail. Yet meaninglessness is ubiquitous in traditional hospitals: Kafkaesque corridors that go on and on, rooms without windows, machines that make alarming sounds and have flashing lights (the staff appear to ignore them and never explain what they are for). Large wards, where patients may feel like objects not people. More important still are the subtleties of approaches to care: members of staff that don't look you in the eye, don't seem to care, or have mean dismissive or haughty attitudes are measurably deleterious.[34] Unsurprisingly, evidence suggests that the same innovations that improve health outcomes can also improve social relations.[35] It doesn't always take much to change these details, and the differences will be very profound.

The healthcare designer's role

It seems ironic, but hospital stays are shortened by better hospital experiences. Thus, designers are wise to concentrate on making a patient want to stay. The "care" in "healthcare" is axiomatic for better health because care supports the amygdaloid/hippocampal coupling. If the environment says, "everything possible is being done to help and it's all going to be okay," then the scene is set for the ideal health-building behaviour and thought patterns to kick in. Furthermore, unhelpful by-products such as cortisol will be reduced, meaning the endocrine system can naturally regularise.

Ultimately, the healthcare designer has to juggle two narrative concerns. On one hand, vigilance is needed to avoid any typologies, symbols and settings that may be associated with negative outcomes. On the other hand, the team should look for opportunities to imbed positive experiences for all the facility users. Not only are all good things expected to improve the outcomes for patients, but to improve the environment for the entire facility including the staff and guests.

Already some international industry leaders are pushing far beyond the statutes and guidelines to make exceptional hospitals by focusing on the patient and staff

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experience. Simple concepts like comfort, cosines, joy and aesthetics have had no place in the traditional hospitals of the 20th-century, yet they are the psychological bricks and mortar of all healthy buildings, whether or not they are healthcare facilities. The architects who designed the Royal Children's Hospital in Melbourne, Billard Leece Partnership and Bates Smart, with HKS, put in a giant touch-screen, like a huge iPod, for kids to play with. There's a multi-level aquarium, an adventure playground and even a meerkat enclosure courtesy of the nearby Melbourne Zoo. Meanwhile, in Singapore, CPG Consultants, directed by a visionary chief executive, ensured that Khoo Teck Puat Hospital departed from the 20th-century hospital paradigm by introducing an abundance of greenery, fresh air and a hundred varieties of butterfly. The payoff is that patients feel that things are going to be better than expected.

Figure 6: The meerkat enclosure at the Royal Children's Hospital, Melbourne. In this project, the architects (Bates Smart and Billard Leece, with HKS) up the ante: hospitals can be places to be enjoyed

Acknowledgements

This work was supported by the Schizophrenia Research Institute, utilising infrastructure funding from New South Wales Department of Health.

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Design for social empowerment: **A low-tech, cost-effective approach to tackle malnutrition**

Malnutrition is a complex societal challenge that affects around 150 million children. Philips Design's Philanthropy by Design initiative has been seeking a low-tech solution that empowers non-professional caregivers to help children under five years old

Simona Rocchi, Research Design & Innovation, Philips Design Consultancy

The World Health Organization estimates that, in countries with developing economies, approximately 150 million children under five are malnourished. This article illustrates how Philips Design has channelled socio-cultural expertise and design capabilities into its Philanthropy by Design Initiative to help tackle this global problem. The approach was grounded in two major guiding principles: the use of a low-tech, low-cost approach; and the use of a people-focused qualitative approach to consider needs and requirements of caregivers and care receivers.

The intention was to come up with cost-effective tools to detect, monitor and educate about malnutrition. A few propositions were designed to empower (non-professional) caregivers in their tasks. Others were aimed at making families more aware about the causes and consequences of malnutrition, or helping them monitor and diagnose their own children.

Project background

An increasing number of companies are using social investment budgets to tackle societal issues affecting "undeserved" people. They choose to help low-income communities by creating and donating solutions for specific projects, rather than providing financial support. Humanitarian projects, if conducted with a businesslike approach, can support socio-economic and environmental causes while serving as laboratories to develop sustainable solutions, and new insights into resolving societal problems. In doing so, they bring together companies' philanthropic actions with capacity building, organisational learning and long-term business strategies.

The link between corporate social responsibility and the opportunity to create competitive advantages has been broadly investigated by M Porter in a series of articles published in Harvard Business Review.[1,2] This "strategic philanthropy" is driven by the desire to combine social responsibility with the company's objectives to enhance brand image, strengthen employee engagement and increase trust and customer loyalty. This approach can be used as a source of innovation and as a competitive asset.

Figure 1: Mothers and babies waiting for health checks at a local health centre in rural India

In the same spirit, Philips Design's Philanthropy by Design Initiative aims to donate creativity and socio-cultural expertise to empower the most fragile categories of society. Philanthropy by Design channels design expertise to develop sustainable solutions, in collaboration with NGOs, that have an impact in developing markets where Philips operates, and/or of strategic business interest. Malnutrition is one of these challenges to be addressed.

A complex challenge

According to the World Health Organization, malnutrition was already affecting one in three people worldwide in 2000. It affects all age groups, but it is especially common among children in low-income communities and those with inadequate access to health education, clean water or good sanitation. According to the FAO (The United Nations Food and Agriculture Organization), poor nutrition plays a role in 50% of the 10.9 million child deaths each year.[3] The World Hunger Education Service says that "Children who are poorly nourished suffer up to 160 days of illness each year. Poor nutrition plays a role in at least half of the 10.9 million child deaths each year – five million deaths."[4]

Malnutrition essentially means "bad nourishment". Clinically, malnutrition is characterised by inadequate or excess intake of vitamins, minerals and other nutrients necessary to maintain healthy tissues and organ function. Since it is not classified as a disease, doctors are not always taught how to deal with it. Yet malnutrition is the single most important risk factor for frequent infections and health disorders.[5] People on a low-income may eat and absorb too little nutritious food, making them more disease-prone. Inadequate or inappropriate food leads to stunted development and/or premature death. The effects are more than medical; malnutrition is also a social disorder rooted in poverty and discrimination, and it has economic ripple effects that can jeopardise a country's development.[6]

The goal that we defined in 2011 to face this complex challenge was to empower "non-professional" caregivers and families (especially people in rural areas) to take appropriate actions by better informing and equipping them to recognise the symptoms of malnutrition. We worked closely with experts from knowledgeable organisations in the field of malnutrition, such as Save the Children and the Real Medicine Foundation. With their help we gathered information from the field and real-life experiences, and we selected problems and target audience to focus on by considering opportunities for design interventions.

Figure 2: A chart to raise awareness on balanced meal and children's required nutritional values in the context of Indian eating patterns

It was decided to target children under five, as they are particularly vulnerable to the effects of malnutrition in infancy and early childhood. Specifically, the first two years of life is the critical period in which to act. If not treated in time, malnutrition can be fatal. Even those who survive can face devastating long-term consequences such as blindness and impaired mental development.

In the light of the emerging research findings, two major areas of problems reserved our attention.

Problems in diagnosing malnutrition

Local health centres arrange checks where families can come and have their children's growth monitored. However, some families cannot go to these health checks because they have to work, because they have to look after young children, or because they can't afford the cost of transportation to the health centre. As a result, "mobile" healthcare workers try to visit families in their homes. One drawback of this approach is that not all measurement tools are intended to be used on the move. Furthermore, some of the caregivers have a basic level of literacy and/or healthcare training. Problems can also arise during health checks. Measurements aren't correctly taken because the child is anxious and doesn't keep still long enough. Even a deviation of a centimetre can lead to an incorrect diagnosis. There may not be sufficient numbers of staff present to keep the child in the right position for the measurement, measuring tools may break, and children wearing too many clothes also lead to inaccurate results.

"Keeping the child in the right position is often challenging, especially when it is anxious." Malu Begum, healthcare worker, India (2011).

Difficulty in establishing root cause

Diagnosing a child as being malnourished isn't the end of the story. Very often it is not possible to identify the root cause. The child could be suffering the effects of diarrhoea or poor hygiene, but on the other hand it may not be fed properly. Another reason for the weight loss could be tuberculosis.

Not knowing why a child has become malnourished makes it impossible to define the right treatment or prevent it from happening again. The challenge is to target parents – and especially mothers – to make them more aware of the effects and causes of malnutrition. This can involve a considerable shift in perception; parents

What are the body parameters considered in detecting and assessing malnutrition?

- Weight
- Height
- Age
- Upper arm circumference

often don't think their child is sick when it is malnourished because everyone else is skinny as well, so they believe it is normal.

"It would break the cycle of malnutrition if you could get the mothers to understand the causes." Child in Need Institute (2011).

The design brief

It was decided to select three specific areas to focus on design interventions: *detection*, *monitoring* and *creating awareness* of malnutrition. Our ambition was to develop solutions that would be bundled together in two toolkits:

- A toolkit to empower "non-professional" healthcare workers to detect and measure malnutrition;
- A toolkit to help families address key aspects of monitoring and educating about malnutrition.

It was also decided to conceive concepts to make easy-to-use measurement tools, growth charts and home monitoring.

Measuring tools: The objective is to empower mobile healthcare workers in the local communities to take precise, efficient growth measurements (height, weight, age and upper arm circumference) with simple, portable tools. It is also to create a solution that gives a quick reliable result so the child only spends a minimum of time being measured. All this is to empower non-trained users by making the procedure simple while ensuring the results are reliable.

Easy-to-use growth chart: The objective is to empower healthcare workers to detect and monitor abnormal growth in children by means of simple and intuitive growth charts. These growth charts should make it easier to plot results (height, weight, age and upper arm circumference) and should also be easier to read and interpret. This is vital, because the different measurement results are related to one another, and human errors when plotting the measurements can lead to incorrect diagnosis.

Domestic monitoring: The objective is to empower family members to regularly monitor and diagnose their children at home. It is also to make them more aware of the causes and effects of malnutrition.

Basic functional requirements in assessing and measuring malnutrition-related aspects were also stated as the following:

- Measuring height/length and upper arm circumference (of children standing or lying down);
- Measuring weight (the scales should read the weight quickly and precisely, and also be able to weigh the mother and the child together in a way that the mother's weight can then be subtracted automatically);
- Defining as precisely as possible the age of children up to 2 years old;
- Linking this information together to get an overall picture of the child's condition.

Design requirements were grounded on the fact that all tools should be designed for mobile healthcare workers; therefore they should be light, time-efficient, reliable, easy to transport and easy to calibrate. In addition, the design brief asked also for:

- Solutions that were simple to use without the need for written instructions. When instruction is necessary, it is advised to use locally relevant icons so even illiterate or semi-literate people can interpret them;
- Solutions that were able to give a quick result so the child spends a minimum of time being measured;
- Results that can align with the graphics of the current growth chart;
- Solutions that were ideally locally produced (by the NGOs or users) using easily available materials like paper, textile, wood or other recycled items;
- Solutions to not be made in a way that

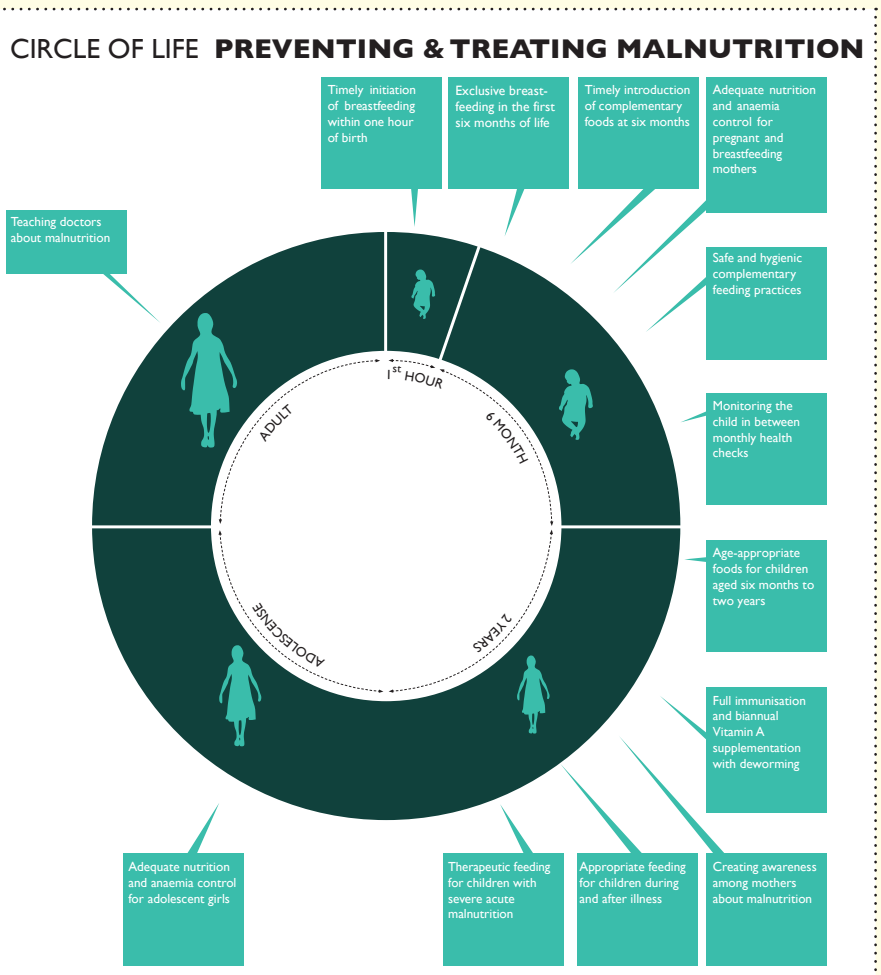

Figure 3: Design tools used in the co-creation process to explain the context, issues and activities surrounding malnutrition at a specific time

would make them a target for theft;
- Solutions to be sturdy, so they can be used for as long as possible, or be easily recyclable/biodegradable.

"Measuring height and weight is not a simple task because the kid is moving. This causes the scale to bounce, and it takes a long time until they are still again. Often the health worker just makes an assumption of the weight. A kilo or even a centimetre of approximation can lead to a wrong result." Paige Harrigan, Save the Children (2011).

Methodological approach

To develop appropriate solutions for a variety of challenging, underserved contexts-of-use it was necessary to adopt an outside-in approach. When dealing with non-familiar territories of innovation, a company's internal competencies and technological know-how are not sufficient assets. External complementary expertise is required to generate a deep understanding of issues related to the diagnosis of malnutrition, as well as of the general level of awareness among people who are most affected by it, and of the surrounding infrastructural and socio-economic conditions. Therefore, we worked closely with specialists from organisations such as Save the Children and the Real Medicine Foundation, able to bring knowledgeable contextual insights, real-life-experiences and local networks around the challenge of malnutrition. We co-created the design briefs, and together envisioned solutions that were simple ways to empower local people to act.

This collaboration with such experienced and knowledgeable NGO representatives brought a wealth of insight into the realities of dealing with malnutrition in multiple underserved contexts, from Africa to India. They could give first-hand accounts of family activities and routines, local diet and nutrition in their specific contexts of life. They could provide a comprehensive view of the availability of resources, infrastructure shortcomings, technological constraints, solutions currently used to diagnosis malnutrition and their limitations, relevant social issues like religion, societal hierarchies, language, literacy and cultural taboos, and even the level of trust in medical services and outside agencies. During the creative workshop, they were also on-hand to immediately offer their opinions during discussions and to provide input on initial concepts, which helped steer the design process in the right direction.

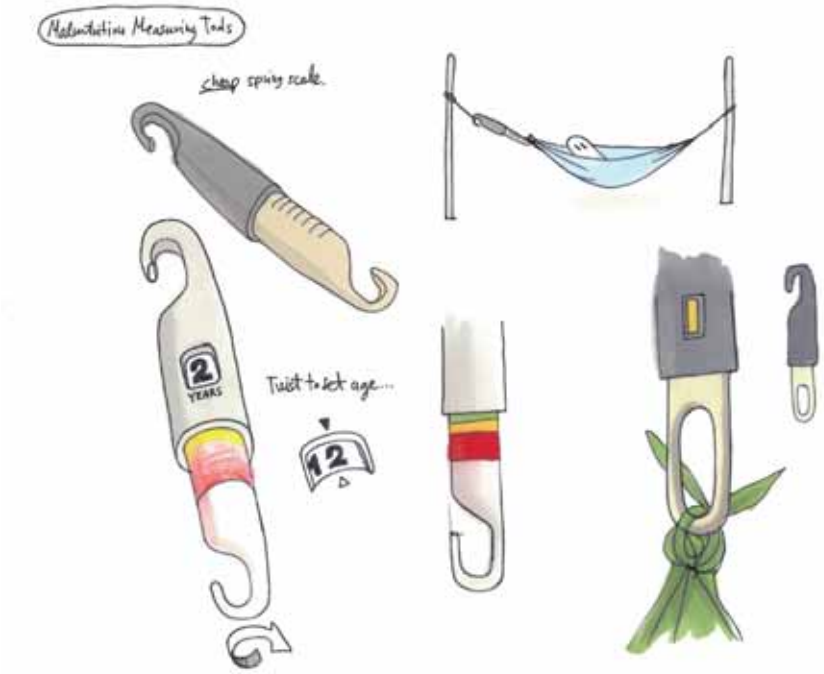

Figure 4: A few concepts to measure weight and height envisioned during the two-day ideation workshop

Contextual insights were consolidated into common digestible, informative and inspirational formats shared in the central event of the design process: a two-day session held at in July 2011 that brought together various disciplines from Philips Design as well as two invaluable experts from the Real Medicine Foundation and Save the Children. A "Design Times" newsletter was made to explain the context and main issues surrounding malnutrition. It included three descriptions of people living in India ("personas" type tools) who were forced to deal with malnutrition – two healthcare workers, and a mother who herself suffered from malnutrition and whose five children are likely to as well.

To help inform and inspire participants, a number of "circle of life" posters were also created. These posters dealt with preventing, detecting and treating malnutrition: they illustrated the most important issues to address in the first hour of a baby's life, in the subsequent six months and two years, during adolescence and when in adulthood. They also described health checks, showing what is important for the child, parent, health worker and doctor/nurse.

In the workshop, these tools were key in thinking of people-focused solutions. They helped participants to experience the main issues faced by their protagonists (healthcare workers, mothers and children) in certain geographical and socio-cultural conditions, and they stimulated the imagination of designers when it came to forming possible answers to such issues.

Looking for design answers

Many design concepts were generated during the two-day workshop. The ambition was to provide meaningful and effective solutions in the light of the constraints of the contexts of their potential application. Low-tech and low-cost became two guiding principles of the creative process. The most promising concepts have been posted on a website (www.philanthropybydesign.org/fightmalnutrition) together with the original design briefs. In the spirit of co-creation, NGOs, designers and other stakeholders are invited to give their opinions and continue the design process providing their input. Approximately 20 concepts are currently listed on the website.

Two concepts were selected for further development and field trials as part of malnutrition measuring tools: the "Trunky and Monkey" mid-upper arm circumference (MUAC) measuring straps. MUAC is routinely used as an immediate indicator of whether a child is malnourished or not. Trunky and Monkey are the first concepts that came alive to support this indication, and are intended for detecting malnutrition

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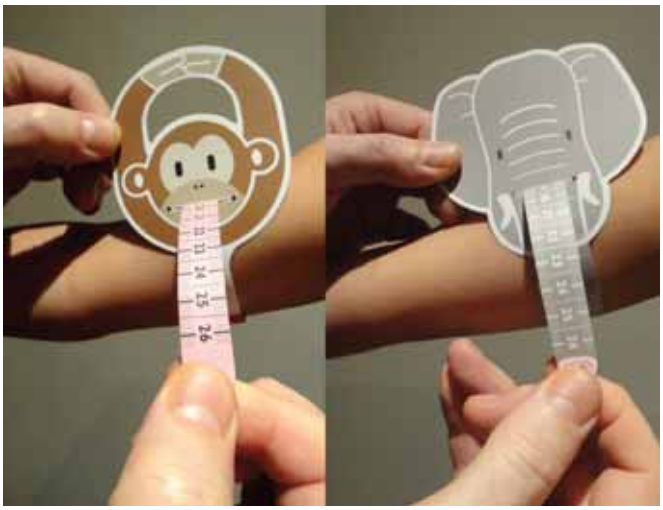

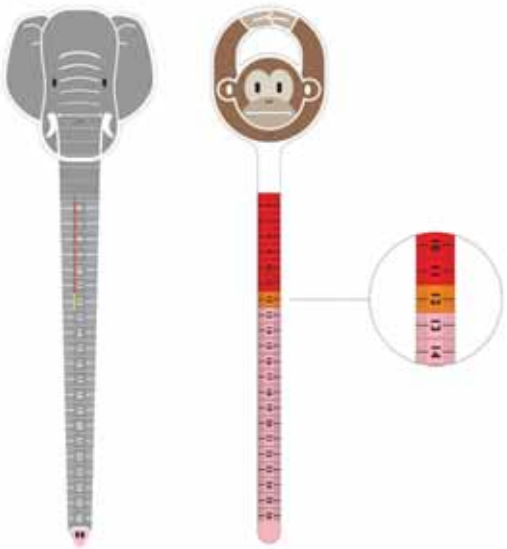

Figures 5 & 6: Monkey and Trunky mid-upper arm circumference (MUAC) measuring straps

in children under five living in underserved areas. Because children are the main focus of these concepts, they were designed to appeal to them. The straps are designed as animal heads. By sticking through the trunk/tongue of the animal through its mouth, you create a circle in which the child's arm can be measured. Trunky and Monkey are part of a series of envisioned easy-to-use solutions to empower even non-professional healthcare workers in examining children, without scaring them and therefore speeding up the measurement, and increasing the throughput of the procedure.

The thinking behind it was that, by coming up with something playful and non-medical-looking, it would encourage the children to co-operate with the care givers. Indeed, children are often anxious during measurement, which can lead to inaccurate results and can also slow down the healthcare worker activity. Both the Trunky and Monkey designs are intuitive; it is immediately obvious how to use them. They could even be used by parents to quickly check their children at home. They can be locally produced by standard printing methods, and since they are cheap (€0.50 printing cost), they can be given to the child to play with, so that they can become more familiar with the examination procedure.

"I love Trunky and Monkey measuring straps. They could empower parents to see if their child falls under the malnutrition threat (red or yellow) or whether they have improved." Caitlin McQuilling, Real Medicine Foundation (2011).

Field trials and next steps

In April 2012, 1,200 Trunky and Monkey MUAC measuring straps were sent to the NGOs that participated in the kick-off workshop and other humanitarian organisations for field trials. The aim is to collect feedback to evaluate response on the tools, and for their further improvements. These propositions are also digitally available via the FightingMalnutrition website, so in effect anyone can download them and try them out.

This year we will continue to work out some of the most promising concepts generated during the workshop held in 2011, and we will post the progress on the website to make both the healthcare worker toolbox and the family toolbox more complete. In the spirit of co-creation, we are looking for constructive feedback on an ongoing basis, which can be used to refine and enrich concepts still further. The FightingMalnutrition website will remain an important platform for continuing this value co-creation experiment. In line with the open innovation thinking inherent to our Philanthropy by Design Initiative, we encourage NGOs to freely make use of the concepts, to try them out and to evaluate their functional, emotional and social value.

Acknowledgements

I am grateful to Helle Ullerup for the content coordination of the research and design activities of this project, and to the entire design team: Andrew Benson, Peter Gal, Patray Lui, Tom Delaey, Jiska de Wit, Manfred Nitsch, Vanessa Sattele, Gary Nudds, Nicole de Klein, Paige Harrigan, Christian Richard, Lilian Marijnissen, Caitlin McQuilling, Marko Macura.

Special thanks go to Caitlin McQuilling of Real Medicine Foundation and Paige Harrigan of Save the Children, whose invaluable input before, during and after the concept generation workshop has helped shape and refine the outcome.

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Leonardo da Vinci: Anatomist

The Queen's Gallery, Buckingham Palace, London
4 May 2012 to 7 October 2012

Leonardo da Vinci was the archetypal 'Renaissance man', accomplished in both the arts and the sciences, including painting, sculpture, architecture, music, anatomy, engineering, cartography, geology and botany.

Only a small proportion of the drawings that survive are connected directly with his paintings, or his sculptural, architectural and engineering projects, many of which were never realised. The remainder were Leonardo's attempt to record and understand the infinite variety of experience.

Leonardo always maintained that an image transmitted knowledge more accurately and more concisely than words. The sheets by Leonardo in the Royal Library at Windsor Castle, England covering all aspects of his activity, are deemed by many to be the library's greatest treasures.

All the drawings and manuscripts in Leonardo's studio at his death were bequeathed to his pupil Francesco Melzi, who took them back to his family villa near Milan. After Melzi's death, around 1570, the collection was sold to the sculptor Pompeo Leoni (c.1533-1608), who pasted the drawings into the pages of several albums. These were dispersed some time after Leoni's death in Madrid, and one was brought to England, probably through the agency of Thomas Howard, 2nd Earl of Arundel, who owned the album by 1630.

During the Civil War, Arundel left England, and there is no further trace of the Leonardo volume until 1690, when it was recorded at Whitehall Palace. How the album entered the Royal Collection is unknown, though it is most likely that it was acquired by Charles II. Although the binding of the album survives, the drawings have been removed in the course of the last two centuries. They are now housed in individual mounts, and kept in solander boxes in the Print Room in the Royal Library at Windsor Castle. Today, a selection of drawings by Leonardo can be seen in the Drawings Gallery, which is on the public route at Windsor Castle.

A nude man from behind, c.1504-6

The bones, muscles and tendons of the hand, c.1510

Lost science

The exhibition at the Queen's Gallery focuses on his anatomical drawings, and is the largest ever of Leonardo da Vinci's studies of the human body. Leonardo has long been recognised as one of the great artists of the Renaissance, but he was also a pioneer in the understanding of human anatomy. He intended to publish his ground-breaking work in a treatise on anatomy, and had he done so his discoveries would have transformed European knowledge of the subject. But on Leonardo's death in 1519 the drawings remained a mass of undigested material among his private papers and their significance was effectively lost to the world for almost 400 years.

According to Martin Clayton and Rio Philo, editors of the book *Leonardo de Vinci. Anatomist*, which accompanies the exhibition, Leonardo would not have recognised the image of himself as a painter who also happened to practice in the sciences. "From the 1480s onwards his scientific studies were at least as important to him as his artistic activity. During the last decade of his life, he seems not to have begun a single new painting, and in the years from 1508-

1513, he worked as a scientist who occasionally put his hand to paintings that he had begun in earlier years. And of all of his scientific endeavours – optics, geology, botany, hydrodynamics – the field that engaged him most fully, was that of human anatomy."

In the book, Clayton, who is the senior curator of prints and drawings at the Royal Library, and Ron Philo, who is adjunct professor in the Graduate School of Biomedical Sciences, University of Texas Health Science Centre at San Antonia provide an essential work of reference and accompanying body of material to the exhibition, displaying 87 of Leonardo's finest and most important anatomical studies with full scientific and art-historical explanations and discussion.

The muscles of the shoulder and arm, and the bones of the foot, c.1510

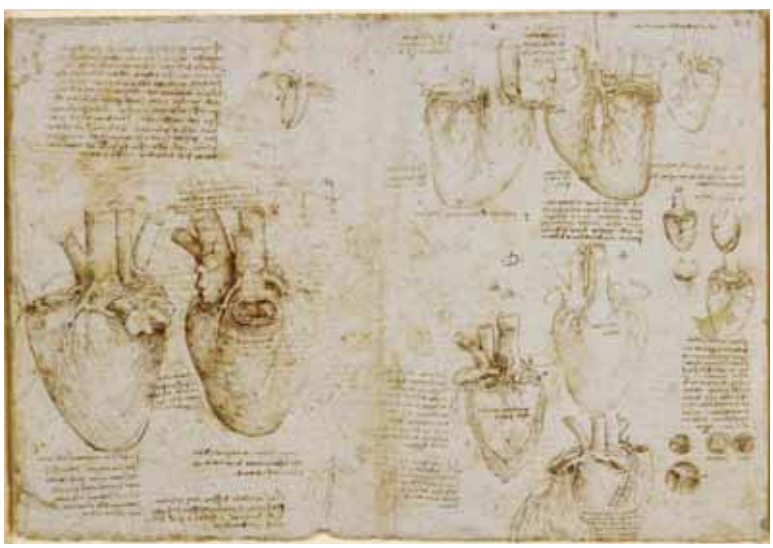
A skull sectioned, c.1489

Together, the exhibition and the publication provide a unique exploration of the anatomy of the human body. The history of anatomical study has been traditionally divided into pre- and post-Vesalian periods, following publication of Andreas Vesalius's groundbreaking *De humani corporis fabrica* in 1543, but as Clayton and Philo suggest, such is the brilliance and accuracy of Leonardo's anatomical drawings that had his treatise been published, we would today refer to pre-Leonardian and post-Leonardian periods.

Many of Leonardo's early anatomical observations were based on a blend of traditional or even ancient beliefs, animal dissection, proportional analysis and mere speculation, although as his skill as a draughtsman increased, explains Clayton and Philo, so he also became more adept at illustrating structures that he had only inferred and not seen.

After a number of years when he returned to Florence and focused on re-establishing himself as one of the city's great artists, which he also developed through his attention to the study of physical structures of horses and males nudes, both in action and at rest, he returned to his anatomical investigations, devoting time to studying the existing literature, before eventually returning to Milan where he embarked on his most sustained period of anatomical work between 1507-1512.

In a few intense years, Leonardo dissected around thirty human corpses, combining manual dexterity in dissection with an acute understanding of physical structure, great skill as a draughtsman and an eloquent literary style to produce some of the finest anatomical studies ever made. The description of a post-mortem on a man thought to be 100 years old, explain Clayton and Philo, which details for the first time in the history of medicine the vascular occlusion, arteriosclerosis and cirrhosis of the liver, is the first sign of this activity, and suggests that Leonardo was already sufficiently experienced in human dissection to identify the human pathology of this case.



Studies of the coronary vessels and valves of the heart, c.1511-13

His studies however remain relatively unfocused and arbitrary in both subject and depth of analysis, remark Clayton and Philo, until 1510, when a marked shift in the basis of Leonardo's investigations is detected. During the winter of 1510-11, he compiled a series of 18 double-sided sheets, known as Anatomical Manuscript A, in which he included more than 240 individual drawings and notes running to over 13,000 words. The bones and muscles were the focus of these

investigations, and although the nerves and vessels were occasionally included, it was the mechanics of the body, rather than the biochemical or spiritual considerations that Leonardo was primarily interested in. Clayton and Philo suggest that the key to the success of Manuscript A was Leonardo's willingness to put aside spiritual matters, which allowed him to analyse the muscles and bones in purely physical terms. They also remark that this methodological shift may have been the consequence of his increasing experience, resulting from greater access to human material. "The efficacy of his dissections increased exponentially: as he became familiar with the body, so he was better able to formulate his questions, dissect the relevant part accurately and efficiently, understand what he uncovered and synthesise his discoveries in drawings of a clarity rarely matched to the present day."

Tools of the trade

Central to the development of Leonardo's anatomical work was his ability to draw upon his knowledge of and skills in other disciplines. Clayton and Philo point out that anatomical illustration is not a simple matter of depicting what is found upon conducting a dissection. Other than the bones which can be shown undiagrammatically, any representation of a part of the body requires a degree of stylization to be legible. There is no space in the musculoskeletal system to convey the structure of a system clearly, some space must be introduced, the muscles must be differentiated and the nerves and vessels separated to some degree. Leonardo therefore adopted and developed a wide range of illustrative techniques, including the principles of elevation, plan and section from architecture, insisting that structures should be shown from multiple directions to convey complete spatial information.

From engineering, explain Clayton and Philo, he took the device of the 'exploded' view, depicting the elements pulled apart to show their articular surfaces and how they connect. He tried to analyse 'complex movements' as composed of 'simple' elements, combining the engineer's or architect's orthogonal analysis of space and form with the physiologist's attempt to isolate the movements caused by each individual muscle. Having analysed the full complexity of a structure in a sequence of drawings, Leonardo would then convey the whole structure in a single diagram, reducing the muscles to threads so that the interrelationship of every muscle and bone could be seen, explain Clayton and Philo.

All of Leonardo's anatomical papers were finally published in a series of facsimile editions between 1898 and 1916, and in 1979, a complete facsimile edition of his anatomical studies was published, such that his drawings have now been seen by millions of people around the world. As Clayton and Philo remark however, "He is an oddity – a scientist who made great strides in his field and yet had no perceptible influence on its wider development."

We will never know if Leonardo's anatomical work, if it had been published as intended at the time, would have altered the path of European anatomical study and arguably medicine, but we do know that there has never been a more convincing case for the marriage of art and science than the work of Leonardo de Vinci.

"Though you may have a love for such things, you will perhaps be impeded by your stomach; and if this does not impede you, you will perhaps be impeded by the fear of living through the night hours in the company of quartered and flayed corpses, fearful to behold. And if this does not impede you, perhaps you will lack the good draughtmanship which such a depiction requires; and even if you have skill in drawing, it may not be accompanies by a knowledge of perspective; and if it were so accompanied, you may lack the methods of geometrical demonstration and of calculating the forces and strengths of the muscles; or perhaps you will lack patience so that you will not be diligent. Whether all these things were found in me or not, the 120 books composed by me will give the verdict, yes or no. In these I have been impeded neither by avarice nor negligence but only by time."

Leonardo de Vinci (circa 1508-10)

Studies of the foetus in the womb, c.1510-13

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