The long game - Future hospitals - investing in sustainable healthcare facilities
Philip A. Nedin, Director, Global Healthcare Business Leader
Arup
United Kingdom

The 5th Concept Symposium on Project Governance
Valuing the Future - Public Investments and Social Return
20. – 21. September 2012

Symposium web-site: http://www.conceptsymposium.no/
Concept Research Programme: http://www.concept.ntnu.no/english/
“A design team which produces a total, balanced, efficient design can help to produce a better environment.”

Sir Ove Arup, November 1968

“Valuing the Future”
Losby Gods – Oslo

Future hospitals – Investing in sustainable healthcare facilities
Phil Nedin
Wednesday 20th September 2012
10,000 people in more than 90 offices around the world
Our Business Goal

Transform our clients healthcare outcomes

Place

People

Performance

and quality

Your Buildings and Assets

Leadership and Workforce

Operational and Financial Performance

Clinical and Business Services

Sustainability - Research - Development - Innovation - Knowledge transfer
Shaping our business through design
Adding value to the process through consulting advice

Clinical Leaders Network

DH – 18 weeks
Action Learning Sets

Patient Safety - Single Bed Wards

Developing Sustainability Guidance

Lean Process Improvement

Asset Management – Life cycle funds
Arup research project involvement

**Project 1**
The Centre for Health Design
An Open-Source Searchable Database to Assess the Impact of Environmental Strategies on Health Outcomes

**Project 2**
Practical Resilience to Climate Change

**Project 3**
The Effect of Phase Change Materials on Building Thermal Performance

**Project 4**
Reinforce links with the Pathogen Control Engineering Institute (PaCE) based at Leed University

**Project 5**
Reducing the risk of infection through the introduction of single patient bedrooms

**Project 6**
Application of air disinfectant devices to enhance the respiratory transmission protection in hospital wards

**Project 7**
Areas of infection risk in healthcare facilities.

**Project 8**
Beyond Master Planning Beyond Estate strategy

**Project 9**
The impact of environmental space on delirium in ICU departments
European gradation in health – and health facilities

- Cost trend
- Public expectation
- Widening gap
- Sustainability - social
- Sustainability - economic
- Policy aim - reduce cost spiral
- Macro-economic need for the 15

Social development needs
For new and transition member States - increased investment in healthcare

Public expectation

Time line
<table>
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<td>$3,994.20</td>
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<td>Greece</td>
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<td>$2,714.22</td>
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Source – The world in Figures 2013. Conversion $ to € to £ Sept 2012
Facilitating reform in the mature healthcare markets
whole systems efficiency – extending the provision of care

A recognition that most future efficiency gain will come from improving systems coherence

Most countries are at the cross over point
Drivers for change – The changing face of healthcare

- Changing workforce
- Building design
- Impact of technology
- New Clinical models
- Whole system configuration
- Synchronised procurement
- Public/private partnerships
- Inside hospitals
- Outside hospitals
Design adds value

100

Maintenance cost

1

Capital cost

0.1

Design costs

400

Running cost of the business

By the time a building is completed up to 90% of its life cycle economic and ecological costs have been made inevitable.

More for less – design council 1997
### Hospital Geometry – generic options

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<td><strong>Total Floor Area</strong></td>
<td>14,795m²</td>
<td>14,663m²</td>
<td>14,775m²</td>
<td>13,956m²</td>
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<tr>
<td><strong>Number of Floors</strong></td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>Façade Length</strong></td>
<td>1886m</td>
<td>1863m</td>
<td>2051m</td>
<td>1840m</td>
</tr>
<tr>
<td><strong>% Façade</strong></td>
<td>34.41%</td>
<td>34.31%</td>
<td>37.48%</td>
<td>35.60%</td>
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<tr>
<td><strong>External Length of foundation</strong></td>
<td>1008m</td>
<td>686m</td>
<td>681m</td>
<td>482m</td>
</tr>
<tr>
<td><strong>Area of Foundation</strong></td>
<td>8127m²</td>
<td>5830m²</td>
<td>5210m²</td>
<td>3680m²</td>
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<td><strong>% glazing</strong></td>
<td>60.20%</td>
<td>60.35%</td>
<td>56.27%</td>
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<td><strong>Ventilation strategy</strong></td>
<td>Predominantly Natural Ventilation</td>
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<td>Mixed mode</td>
<td>Predominantly Air conditioned</td>
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## Capital Cost Breakdown

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## Whole life costing

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<td>£28,128,205</td>
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<tr>
<td><strong>Financial cost at Year 1</strong></td>
<td>£2,258,348</td>
<td>£2,236,854</td>
<td>£2,396,193</td>
<td>£2,447,218</td>
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<td><strong>Financial cost at Year 10</strong></td>
<td>£23,915,483</td>
<td>£23,574,025</td>
<td>£25,293,023</td>
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<td><strong>Financial cost at Year 30</strong></td>
<td>£92,87,066</td>
<td>£91,040,351</td>
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<td><strong>Financial cost at Year 60</strong></td>
<td>£196,828,900</td>
<td>£192,524,507</td>
<td>£198,863,388</td>
<td>£196,488,271</td>
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<td><strong>Annual social cost of carbon (£70/ton)</strong></td>
<td>£20,567</td>
<td>£20,266</td>
<td>£22,001</td>
<td>£36,440</td>
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</table>

Financial cost includes: Operation and maintenance, social cost of carbon and energy.
Narrow plan v’s deep plan – Whole life costing

- Departmental adjacencies = Clinical efficiencies
- Construction efficiency = Capital cost economies
Sustainable planning – Narrow plan v’s deep plan
Healthcare drivers that shape our business

- Robotics
- The intelligent patient
- Infection control
- Drug development
- Private finance
- Surgical techniques
- Alternatives
- Therapeutic environments
- Intelligent pills
- DNA, RNA, Stem cell
- Photo acoustics
- The elderly & chronic illness
- Affordability
- Home diagnostics
- Pandemic risk
- Artificial organs
- Public health
- Government & Legislation
- Global warming
- ITC
- Imaging
Flexibility in design

- Hot floor (clinical diagnostic) 24%
- Ward (hotel) 27%
- Office 36%
- Industry 13%

Probability of change:
- high
- low

Decay rate - over lifecycle

Ref: Bouwcollege
The changing face of healthcare provision

- Hot floor (clinical diagnostic): 24%
- Ward (hotel): 27%
- Office: 36%
- Industry: 13%
- Central: ?%
- Community: ?%
- Outsourcing: ?%
- Home: ?%

Probability of change:

- High
- Low

Decay rate - over lifecycle:

- Clinical
- Operational
- Cultural
- Building standards

Ref: Bouwcollege
lifestyle developments!

- If eating habits met nutritional standards, 70,000 lives a year would be saved in the UK.

- Domino pizza & Kentucky fried chicken profits rose by 25% and 14% respectively in 2008 while McDonalds had their best trading ever year in the UK.

- Anorexia in girls under 16 in the UK has risen by 80% in the past decade.

- 23% of liver transplants in UK 2008 went to people with alcohol related disease – an increase from 14% in 2007.

- Smoking ban in public places – benefits apparent!

- Danish place a tax on saturated fats Oct 2011 – governments are watching!

- Mayor Bloomberg (NY) action on Fizzy drinks, smoking, fast food chain calorie counts and banned trans fats in restaurants.
1930’s adverts promoting lifestyle

Legislation v’s the nanny state
Genetic developments!
The completed human genome is only 5 years old but genetic pathways have already been successful:

- Age related macular degeneration
- Inflammatory bowel disease
- Cardiovascular disease
- Type 2 diabetes
- Obesity
- Cancer therapies
- Stroke therapies

- Major genome centres are now able to sequence 1 human genome every day – the first one took many years
Drug developments
• The development of the Poly-pill to postpone cardio-vascular disease!

Surgical developments
• Tumours to be illuminated with targeted dye to ensure first time removal!

Technical developments
• Proton beam for targeted radiation treatment – large scale
• Iphone apps – small scale

Diagnostic developments
• Early CDT testing
The internet, social networking sites & wireless devices

The catalyst for new healthcare business models

Smart phones (Apple Apps store)

Access to medical records

Health monitoring – exercise, diet and vital signs

Health advice by phone (developing countries)

Medical education by phone and networking sites

Magic carpets for the elderly

Medication reminders

Personal health coaching by phone

Social networks organised for common ailment support
The available APPS technology
Technology developments

Gamma knife

CT/MRI

Proton Beam

Where next
Smaller.................smarter.................swifter
ECG development

Experimental c1888

GE MAC 400 ECG - 2008
Barn theatre incorporating laminar flow units

Nightingale Architects
Alzheimer’s Disease – UK trend

- 700,000  ............................................................... now
- 940,000  ............................................................... 2021
- 1,700,000 ............................................................. 2051
- 154% INCREASE OVER THE NEXT 45 YEARS!
## NCD - Prevalence of Diabetes

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<td><strong>Worldwide</strong></td>
<td>171,000,000</td>
<td>366,000,000</td>
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<tr>
<td><strong>China</strong></td>
<td>20,757,000</td>
<td>42,321,000</td>
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<tr>
<td><strong>United States of America</strong></td>
<td>17,702,000</td>
<td>30,312,000</td>
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<tr>
<td><strong>United Kingdom of Great Britain &amp; Northern Ireland</strong></td>
<td>1,765,000</td>
<td>2,668,000</td>
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*Source: World Health Organization*
The Impact on the existing estate
The Age Profile of the NHS Estate in England, by date of construction

- Pre 1948: 17%
- 1948 to 1954: 1%
- 1955 to 1964: 3%
- 1965 to 1974: 14%
- 1975 to 1984: 15%
- 1985 to 1994: 21%
- 1995 to 2004: 19%
- 2005 to present: 10%

Source: ERIC (Estates Returns Information Collection) 2007-08 returns from the NHS

50% of the Estate pre-dates 1985
The existing estate – our starting position!
The existing estate – building generations!
Refurbishment – Multiple contracts
Guy’s Hospital tower London

constructed 1974

Comm’s tower
User link
Patient tower

Proposed solution

Space
Links
Facade
Typical models of the built estate

1. Linked pavilion or finger plan
   The oldest typology and still in common use. The pavilions would often have clinical spaces on lower levels with wards above.
   **Examples**
   Woolwich Hospital and St Thomas’s Hospital, London; Hotel Dieu, Paris; many others worldwide

2. Low-rise multi-courtyard or checkerboard
   This typology can offer a human scale in contrast to the institutional character that tends to overwhelm most hospital design. However it will tend to apply to the larger, non-urban sites or smaller hospitals.
   **Examples**
   Wexham Park Hospital; Venice Hospital (unrealized design by Le Corbusier); Homerton Hospital, London

3. Monoblock
   The classic compact and circulation efficient type. The small atria/lightwells can take many forms and the lower floors may have fewer, with deep planning for non-patient areas or operating theatres. There is a need for artificial ventilation and the opportunity to incorporate Interstitial Service Floors.
   **Examples**
   Greenwich Hospital, London (demolished); Boston City Hospital; McMaster University Hospital, Ontario
Typical models of the built estate

4a. Podium and slab/tower
(also ‘Bundled’ or ‘Stacked’ in US)

The wards are generally in the tower with the clinical and technical areas in the slab. This typology can be effective on urban sites with small footprints but the upper floors can be problematic in terms of travelling distance.

Examples
Bridgeport Hospital, Connecticut; Prince of Wales Hospital, Sydney; Royal Free Hospital, London; UCL Hospital (PFI), London

4b. Podium with two or more towers/ blocks over

This typology avoids some of the potential travel distance and scale problems of no. 4a above but will require a larger site.

Examples
Birmingham Hospitals (PFI)

5. Street

The attraction of this type has lain in its flexibility and extendibility as well as the legibility that the street itself offers to patients.

Examples
Wythenshawe Hospital, Manchester; Northwick Park Hospital, London; Westmead Hospital, Sydney, Rikshospitalet, Oslo
Typical models of the built estate

6. Atrium/galleria

Atria have become extremely common in open plan office buildings where daylight can penetrate working floors from both sides. The cellular character of hospital buildings make atria a less obvious solution but there are a number of successful uses of this typology.

**Examples**
- New Children’s Hospital, Sydney; Chelsea and Westminster Hospital, London; Hospital for Sick Children, Toronto;
- University of Maryland Homer Gudelsky Building

7. Unbundled

Unbundled is a pattern of segregation of the diagnostic and treatment functions on the one hand, and on the other the nursing functions along a shared circulation/support spine. ‘Unbundled’ is a North American term and the typology is dominant in current design there; but it is also used worldwide.

**Examples**
- Norfolk and Norwich Hospital; many US examples

8. Campus

Individual buildings disposed around the site with or without enclosed circulation network.

**Examples**
- Hospital sites that have been built up over the years with successive additions.
Refurbishments – flexible engineering services?
**single room vs multi bed.**

- Effective isolation
- Specific cleaning regime
- Privacy & dignity
- Improved patient environment
- Reduced patient travel
- Individual room stores/supplies

- Patient interaction
- Capital cost
- Staffing cost
Modelling Sustainability

Multi bed room

Single bed room
CFD Analysis – window and door leakage

No wind LL Vent

Leeward LL Vent

Windward LL Vent

No wind HL Vent

No wind HL Vent

Windward HL Vent window curtain
Single room of the future
## The real cost of refurbishment?

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<td>Electrical Services (incl. lifts)</td>
<td>£4,150,357</td>
<td>£4,048,077</td>
<td>£4,106,319</td>
<td>£3,939,734</td>
</tr>
<tr>
<td>BWIC</td>
<td>£720,261</td>
<td>£617,680</td>
<td>£642,500</td>
<td>£617,680</td>
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<tr>
<td>Preliminaries and contingencies</td>
<td>£6,835,712</td>
<td>£5942,914</td>
<td>£6,367,686</td>
<td>£5,999,323</td>
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<tr>
<td>Total</td>
<td>£31,447,315</td>
<td>£29,229,253</td>
<td>£30,243,696</td>
<td>28,128,205</td>
</tr>
</tbody>
</table>

**Approx 13% saving due to a refurbishment!!**
Optimising flexibility - #3 Planning in advance

If this were not a hospital then what could it be?
ORIGIN | HISTORICAL PERSPECTIVE – BRIGHAM AND WOMEN’S

The Hospital covers about 10 acres of land.
225 beds.

Fire-proof throughout.

Some of the chief objects have been to furnish the patients with the optimum amount of light and sunshine, and to make it possible for every patient to be easily moved out of doors.

By several systems, according to the requirements:
1. By the ordinary use of wall windows.
2. By windows in monitor roofs.
3. By accelerating heating coils in stacks.
4. By inlet fans.
5. By outlet fans.

GENERAL FACTS

Air Space in Typical Positions
2,400 cubic feet per patient.
This air can be changed five times each hour.

Flooring
Largely battleship linoleum cemented to granolithic, except the outside marginal eight feet of open wards on main floor, which space is wholly granolithic to allow of heating by hot water pipes in an enclosed space below this part of the floor.

Heating Wards
1. Hot water direct.
2. By warmed granolithic floors in bed space.
3. By fanning filtered air over hot water pipes into wards.

Plumbing
Single pipe system used throughout.
New and expanded fields of knowledge created space needs that were difficult for the hospital to meet. “The character of the work done within the walls of an institution is vastly more important than the walls themselves. Even so, it must not be overlooked that if the work is good, it grows, and the time comes when walls must expand in correspondence.” – BWH 1937 Second Master Plan Report
HOSPITAL GROWTH | A HOSPITAL MUST CHANGE IN ORDER TO REMAIN RELEVANT

Hospital Growth Milestones:

- 1911 Hospital Opens
- 1937 Second Master Plan
- 1950’s Research spurs New Construction
- 1969 to 1986 BWH triples in size.
- 1978 New 500 Bed Patient Tower opens
- 1994 Ctr for Women and Newborns opens
- 2008, Shapiro Cardiovascular Building opens.

Today, over 2.4 million square feet on main hospital campus.

2008, The Hospital Today
THICK & THIN | HORIZONTAL INTEGRATION - VERTICAL FINGERS

- Centers of Excellence
  - Service Line / Disease Centric
  - Discrete Institutions

- Accommodations
  - Thematic Centers
  - Institutional Identity
  - Mixed Acuity
  - Bidirectional Bench to Bedside
Refurbishment – A wise sustainable investment

- Refurbished in a phased manner whilst in occupation
- Single phase with decant – original use
- Single phase with decant - change of use
- Structural integrity – extended floor-plate
- Building engineering systems – impact on space and use
- Consider low energy/carbon solutions
- Consider the requirements for privacy and dignity
- Consider the needs of resilience due to climate change
- Non-viable spatial solution for future models of care - Demolish

All healthcare estate sites to have a development control plan clearly defining the future for the building stock given the likely changes in the provision of healthcare – this is wise sustainable investment!
Design Audit to achieve a Low Carbon Buildings

- Building form and orientation
- Passive ventilation strategy
- Lighting Controls
- Reduced Air Leakage
- Exposed Mass
- Glazing Spec
- Increased Shading
- Increased Insulation
- Biomass boilers
- Solar Hot Water Generators
- CHP
- Ground Source Heat Pump
- Wind Turbines
- Small Scale Hydro
- PV
- Fuel Cells

Kg Carbon saved per £ spent

Carbon Neutral Building
Annual Mean Daily Average Temperature

Degrees Fahrenheit
- < 32.0
- 32.0 - 40.0
- 40.1 - 45.0
- 45.1 - 50.0
- 50.1 - 55.0
- 55.1 - 60.0
- 60.1 - 65.0
- 65.1 - 70.0
- > 70.0

ARUP
3 - NHS England CF: Total consumption emissions

NHS England (2004): 18.6MtCO₂
3 - NHS England CF: Procurement emissions breakdown
Energy Breakdown of 45 GJ/m³

- **Air Heating**: 20%
- **Heating**: 11%
- **Hot Water**: 14%
- **Humidification**: 1%
- **Pumps and Fans**: 15%
- **Small Power**: 13%
- **Lighting**: 14%
- **Cooling**: 5%
- **Catering**: 2%
- **Lifts**: 3%
- **Sundries**: 2%

**Acute hospital energy breakdown – May 20th 2008**
Energy Calculations for targeting and monitoring energy use

<table>
<thead>
<tr>
<th></th>
<th>Total Wards + D&amp;T + Theatres</th>
<th>D&amp;T only</th>
<th>theatres</th>
<th>Nat Vent Wards</th>
<th>Mech Vent Offices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>kWh/m²/annum</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>736</td>
<td>593</td>
<td>2237</td>
<td>229</td>
<td>221</td>
</tr>
<tr>
<td><strong>GJ/100m³/annum</strong></td>
<td>48</td>
<td>38</td>
<td>192</td>
<td>26</td>
<td>25</td>
</tr>
</tbody>
</table>
Reducing the use of natural resources through new technology

- Photovoltaic Panels
- Wind Turbines
- Combined Heat and Power Generation
- Biomass boiler systems
- Ground water heat pumps
- Water saving technology
- Rainwater Collection
Proposed sustainable energy strategy

- PV cells for Car park lighting
- Ground water to A&E entrance underfloor htg.
- Solar panels. Summer DHWS
- PIR water sensors on all basins
- Solar chimney moves air from north side openings via simple labyrinth through atrium for summer cooling
- Car park ground source heat pump
- Small scale wind turbines for window control gear or extract fans in wards
- Rainwater harvesting Feeding WC’s or irrigation
- CHP Tri generation - Cooling for theatres 300KW refrigeration effect (cooling capacity)
- Bio-mass boiler installation 2MW base load

Rainwater monitoring unit
Industrial logistics in healthcare

Small bore Pneumatic tube

Movement of people and supplies

Large bore Pneumatic tube

Alttagelvin Hospital
Site wide large bore pneumatic tube system
Influencing Standards & guides

- Natural lighting
- Natural ventilation
- View
- Weather tightness
- Energy conservation
- Sound insulation
- Security
- Safety
- Fire spread
- Cleaning

Soaring hospital fuel costs could hit patient care

Jonathon Carr-Brown and Sarah-Kate Templeton

The energy bills of some NHS hospitals have almost doubled as multinational oil and gas companies increase their prices to the health service by £120m a year.

The Department of Health said this weekend that, which represents health trusts, said: “These price increases could amount to several hundred thousand pounds for each hospital trust, which could be difficult to find in the middle of the year, given all the other financial commitments such as pay rises.

“Hospital trusts do not have a lot of money in reserve. They tend to spend money as they get...
Exemplar window design

**Note:** Dimension of external solar shading device depends on building orientation, etc

**Note:** Care to be taken on façade material selection. Thermal capacity, heat absorption and emissivity to be taken into consideration.
The window – the most important system in the building

The sash v’s the casement!
1999 summer analysis showing warmest days (exceeds 27degC in room) without blinds
Ward design – solar shading concept & Leeward-windward effect
Ward cluster – day light and air flow across the floor plate – climate resilience.
## Future Overheating Risk (Room)

<table>
<thead>
<tr>
<th>Location</th>
<th>Months</th>
<th>Temperature (°C)</th>
<th>25</th>
<th>26</th>
<th>27</th>
<th>28</th>
<th>29</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>London</td>
<td>July</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hours exceeded</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>July</td>
<td>291</td>
<td>189</td>
<td>129</td>
<td>77</td>
<td>50</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>June to Aug</td>
<td>543</td>
<td>310</td>
<td>170</td>
<td>78</td>
<td>50</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td>574</td>
<td>322</td>
<td>172</td>
<td>78</td>
<td>50</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Swindon</td>
<td>July</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hours exceeded</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>July</td>
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<tr>
<td></td>
<td>June to Aug</td>
<td>96</td>
<td>34</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td>97</td>
<td>34</td>
<td>10</td>
<td>0</td>
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<td>0</td>
<td></td>
</tr>
<tr>
<td>Cardiff</td>
<td>July</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hours exceeded</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>July</td>
<td>43</td>
<td>10</td>
<td>0</td>
<td>0</td>
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<td></td>
<td>June to Aug</td>
<td>57</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td>57</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**ARUP**
MICROBES AND LIGHT SPECTRA

The spectra of light microbes are exposed to many influences that may influence their growth rates and viability. In many instances, light wavelengths that may kill microbes can be screened or heavily filtered through colored glazing systems. Serotonin released by the patient may be reduced in the same way.

Isaac Jamieson – Imperial College London
Caring for our elderly

- Lives alone
- Has diabetes and arthritis
- Fiercely independent
- Poor vision and hearing
- Low income
- Own home
- Family lives 200 miles away
- Does not qualify for L.A. home care assistance
<table>
<thead>
<tr>
<th>TMS DATA</th>
<th>COPD</th>
<th>CHF</th>
<th>Diabetes</th>
<th>Totals</th>
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</thead>
<tbody>
<tr>
<td>Total Patients</td>
<td>790</td>
<td>113</td>
<td>159</td>
<td>1,062</td>
</tr>
<tr>
<td>Total number of Clinical Alerts</td>
<td>15,451</td>
<td>1,663</td>
<td>3,006</td>
<td>20,120</td>
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<tr>
<td>Total number of Clinical Escalations</td>
<td>2,420</td>
<td>238</td>
<td>189</td>
<td>2,847</td>
</tr>
<tr>
<td>Total Unplanned Admissions Prevented</td>
<td>472</td>
<td>37</td>
<td>23</td>
<td>532</td>
</tr>
<tr>
<td>Total Emergency Admissions to Hospital as a result of an Escalation</td>
<td>94</td>
<td>8</td>
<td>5</td>
<td>107</td>
</tr>
</tbody>
</table>

Ref: Data based on >1,062 NHS LTC patients monitored over 3 years
Estimated savings

Ref: Data based on >1,000 NHS LTC patients monitored over 3 years

david.muxworthy@alere.com

<table>
<thead>
<tr>
<th>Area of Savings</th>
<th>Total</th>
<th>NHS Tariff</th>
<th>Gross Saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>COPD Admissions Prevented</td>
<td>472</td>
<td>£2,793.00</td>
<td>£1,318,296.00</td>
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<tr>
<td>Nurse Visits Saved</td>
<td>1,758</td>
<td>£30.00</td>
<td>£52,740.00</td>
</tr>
<tr>
<td>Mileage Saved</td>
<td>1,758</td>
<td>£8.00</td>
<td>£14,064.00</td>
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<tr>
<td>CHF Admissions Prevented</td>
<td>37</td>
<td>£2,987.00</td>
<td>£110,519.00</td>
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<tr>
<td>Nurse Visits Saved</td>
<td>205</td>
<td>£30.00</td>
<td>£6,150.00</td>
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<tr>
<td>Mileage Saved</td>
<td>205</td>
<td>£8.00</td>
<td>£1,640.00</td>
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<tr>
<td>Diabetes Admissions Saved</td>
<td>23</td>
<td>£2,112.00</td>
<td>£48,576.00</td>
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<tr>
<td>Nurse Visits Saved</td>
<td>160</td>
<td>£8.00</td>
<td>£1,280.00</td>
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<tr>
<td>Mileage Saved</td>
<td>160</td>
<td>£30.00</td>
<td>£4,800.00</td>
</tr>
</tbody>
</table>

**Totals Gross Savings**

£1,558,065.00

*Formula: 20 Miles per journey @ £0.40 per mile
Nursing Time: 1.5 hours @ £20 per hour*
Therapeutic environment

‘The first requirement of a hospital should be that it should do the sick no harm.

Little as we know about the way in which we are affected by form, colour, by light, we do know this, that they have a physical effect.

Variety of form and brilliancy of colour in the objects presented to patients is the actual means of recovery.’

Florence Nightingale Notes on Hospitals 1885
Therapeutic environment and Clinical efficiency

Cardiff Royal Infirmary c1880
Components of the therapeutic environment

- Sufficient car parking
- Clear way-finding
- Privacy & dignity
- Appropriate acoustics
- Natural daylight
- Interesting/relaxing views
- Low risk of hospital acquired infection
- Thermal comfort
- Environmental control
- Artificial lighting
- Art
- Entertainment systems
Transmission of Infection

- Contact transmission
- Droplet transmission
- Airborne transmission
- Common vehicle transmission
- Vector borne transmission

Bug’s delight
Estimated prevalence of hospital-acquired infection among patients, %

- Britain
- Denmark
- Spain
- Netherlands
- Australia
- Germany

Source: National Audit Office
Infection control – A holistic design process

Operational

Design

Maintenance

Product

Validation

Function

Research

ZERO TOLERANCE STRATEGY

ARUP
### MRSA 2001 – 10, UK NHS

<table>
<thead>
<tr>
<th>Year</th>
<th>Number</th>
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</thead>
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<tr>
<td>2001/2</td>
<td>7291</td>
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<tr>
<td>2002/3</td>
<td>7426</td>
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<tr>
<td><strong>2003/4</strong></td>
<td><strong>7700</strong></td>
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<tr>
<td>2004/5</td>
<td>7212</td>
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<td>2005/6</td>
<td>7097</td>
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<td>2006/7</td>
<td>6383</td>
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<tr>
<td>2007/8</td>
<td>4451</td>
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<tr>
<td><strong>2008/9</strong></td>
<td><strong>2932</strong></td>
</tr>
<tr>
<td><strong>2009/10</strong></td>
<td><strong>1898</strong></td>
</tr>
</tbody>
</table>
Conclusions

• Healthcare is the most complex sector
• Different countries have different priorities & funds
• Future developments must be clinically driven
• Understanding the role of the existing estate must be a key element for future planning
• Long term planning is essential
• A WLC model is essential to deliver clear value
• “Future needs” sensitivity analysis is required on all solutions – what if............!
• The wider carbon agenda must be recognised
• Innovation and best practice must be introduced
• The therapeutic environment needs a greater evidence base
• We must be holistic in our development of solutions
“A design team which produces a total, balanced, efficient design can help to produce a better environment.”

Sir Ove Arup, November 1968

Thank you