A fundamentally new approach to hospital planning & space utilisation

Professor M. Bacon RIBA FRSA
What we know...what we don’t know...

The importance of understanding the factors that drive carbon emissions...
What we do know...

Under-used or spare space across the NHS is no longer the size of the Tesco estate, but is still that of Sainsbury’s and Waitrose’s stores combined at more than 2 million m². No one anticipates all of this area could be removed, but the potential for each Trust to realign its performance and space

The NHS has one of the largest estates in Europe (National Audit Office (NAO) 2002) and many NHS facilities remain unutilised for large proportions of the week. For example, recent research (May and Price 2009) showed wide variations between NHS acute trusts and estimated that 20 per cent more space was being used than needed, at

Case Study: Utilisation

A recent case study of a Primary Care Resource Centre undertaken by revealed that the overall utilisation of this relatively new facility was in the order of only 35%, when surveyed and analysed in depth. The clinic areas were fully scheduled for use for most 1/2 day sessions but in reality the suites were only partly used with clinic rooms within the suite remaining vacant for some sessions.
What we now know...

- That we understand too little about the factors that influence space utilisation – much anecdotal evidence – but poor data.
- That we also understand too little about space for new facilities – Health Planners have to rely heavily on ‘rules of thumb’ and formulaic, out of date guidance.
- Operational Policy information is not used effectively, such that planners and designers can use it as part of the briefing process.
What we do know…

- The design of hospitals in the UK is based on assumptions concerning occupancy that lead to substantial over-design.
  - Design team projection based on Health Building Notes: 6,000
  - The Conclude Consultancy Occupancy Analytics projection based on NHS Trust forecast data: 2,300
What we now know

- That these assumptions lead to substantial over-design of the engineering systems which result in:
  - Over-provision of ventilation and cooling systems.
  - Inefficient running of these systems
  - Unnecessary carbon emissions
What we now know...

100% of ventilation plant & 88% of cooling plant was over specified.

BSRIA study of 50 buildings in 2006
In the design of air conditioning systems, the internal heat gain may contribute a significant part of the total cooling load and it is therefore important that all such gains be included. However, the plant must also be capable of operating satisfactorily at part load. Over-estimating internal heat gains may result in over-sizing of plant leading to higher capital costs of plant, poor part load performance and increased running costs.
We can conclude that...

- The NHS develops more space than is required to meet demand.
  - This waste causes substantially more carbon emissions than would otherwise be the case.
    - Operational emissions: 2.0m m^2 = approx 200,000 tonnes of carbon emissions.
    - and this does not include construction emissions
- Cost of operation:
  - £497.45 million per annum
Hardly surprising...

3. This will require innovation – new ways of working and the acquisition of knowledge and skills that will provide competitive advantage at home and internationally, building on the United Kingdom’s reputation as a world leader in sustainable design.

A 80% reduction in carbon emissions in real terms!
We can conclude that...

- We need to conserve energy and reduce carbon emissions – in absolute terms.

- A recent report from the NHS Sustainability Development Unit states that to achieve the carbon reduction commitment the NHS Estate needs to reduce emissions by 80% from the level in 2007.
The importance of understanding occupancy
Why?

• Occupancy is the major factor that needs to be understood.
  • Because it is the one factor that influences:
    • Space planning,
    • Space utilisation,
    • Major equipment availability,
    • Building plant sizing,
    • Building plant controls.
For example, between 2pm and 3pm in Oncology OP, there are approximately 4 patients on average. There is a 90% probability that at least 16 rooms will be unused and a 10% probability that all the rooms will be unoccupied. The results can also be translated as: for one out of ten days there will be 24 or 25 rooms available and for nine out of ten days the department will have at least 16 unused rooms.

Oncology Outpatients – Peak Occupancy
– Health Building Note calculation: 79 people
– Occupancy Analytics: 51
– 35% over-estimated
It also drives peak energy loads…

It enables us to correlate operational processes with the occupancy impacts. By controlling peak occupancy we can make significant impact on carbon emissions…

From this …

to this…minus 23%
...and equipment demand...
A new basis for building controls...

- Our studies show that energy consumption could be halved – IF hospital facilities are controlled in response to occupancy...
  - 22.5 GJ/100m$^3$/pa compared to 40 GJ/100m$^3$/pa

- Factors:
  - Occupancy modelled on forecast and historical data
  - Modulated systems able to respond to high level of diversity
It enables…

- Operational practices to be correlated with carbon impact.
How?

Configure the controls specification to match the occupancy profile

**ENERGY ECONOMY**

*Average electricity consumption during a working day*

*Whole building*

Source: Olof Granlund OY
How?

Manage occupancy profiles to reduce peak loads through process redesign.

- Reduced CAPEX
- Reduced OPEX

Potential benefit: Peak load smoothing

Load over time of day
Occupancy Analytics informs...

- How to manage the operational process to achieve best carbon performance associated with achieving best clinical outcomes.
- All operational processes – the resources needed to manage them – the process and resource constraints.
- The forecast flows of patients, staff and visitors, such that we can understand where people are in any part of the facility at any time of the day.
- Planning and design teams with a new kind of briefing data – it removes substantial assumptions...
Case Study:

£420m redevelopment at Brighton & Sussex University Hospitals NHS Trust
Our vision…
Key impacts…

• Some of the evidence…
  • Our analysis for the Brighton & Sussex University Hospital redevelopment showed that design team assumptions concerning occupancy, informed by Health Building Notes have been over-estimated by nearly 300%.
  • Based on forecast patient numbers we have identified over 500 m$^2$ of space that will be under utilised.
  • Based on the same forecasts we have identified areas of significant potential under-provision as well as over-provision of Imaging equipment.
What we have done...

• Space planning
  • We have modelled the relationships between staffing, space and patient demand.
    • Distinction between dynamic and static occupancy.
    • Dynamic occupancy – modelling the process and resource constraints.
    • A stochastic analysis which enable us to model random variables.
  • Study of the probability of different occupancy profiles based on different dwell times in the process.
What we have done...

Variances:

• Mean occupancy
• Upper bound percentile
• Lower bound percentile
Key impacts

We study the probability of levels of occupancy and space utilisation. A fundamentally different approach to accounting for occupancy through Room Data Sheets and Health Building Notes.

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Key impacts

- Over 500 m² of surplus space has been forecast.
  - Plan is to incorporate all Outpatient functions into the new facilities.
    - Obvious development, revenue and energy benefits.
  - To study different models of service to achieve best utilisation of accommodation. Challenge existing working practices.
  - Improve patient experience and optimise efficiency.

An evidence based, data driven approach…
What we have done...

- Engineering plant design
  - We have provided the occupancy profile for each department in the hospital. We have then correlated the results with the corresponding energy consumption for each department.
  - We are now able to establish energy targets for each department.
  - A foundation for future benchmarking
Key impacts

- Example: Assumed design team forecast of peak occupancy: 6000
- Occupancy Analytics: 2300
- Over-estimation = 3700 occupants @ 150w/pp
  - 5.5 MW of over-estimation of sensible and latent heat gains
  - 37,000 litres/sec over-provision of fresh air requirement
- Impact on scheme is currently being assessed.
Occupancy analytics

• We believe that it could be the catalyst for a major step change in the way in which hospital facilities are planned, designed and operated.
• It provides critical data where none has previously been available to inform planning, design and operation.
• It provides the means to directly correlate working practices with energy performance – translated into carbon emissions. It could be the means for a better informed dialogue between users and providers.
• It could provide the foundational data for the Premises Assurance Model.

Our vision is to provide an evidence based, data-driven approach for low carbon performance, founded in the science of Occupancy Analytics and Whole Facility Energy Modelling.
Email: matthew.bacon@conclude.org.uk

Twitter: @I_conclude