Phil Nedin – Global Healthcare Leader, Arup

# Planning today's estate to meet tomorrow's needs

**Healthcare requirements are changing rapidly and these changes will have a major financial and operational impact on the existing healthcare estate. Not only are costs increasing, but there are pressures on estates to reduce costs, reduce size, become more specialised, integrate more with the community and reduce energy and carbon emissions.**

In addition, the estate also has to deal with the ongoing drivers of medical and scientific change (Fig. 1). So, the challenge faced by designers and construction professionals today is how to plan the adaptation of the healthcare estate to deal with the many changes to come and communicate these complex solutions to the clinical teams.

The only part of this equation that is fixed is the quantity and quality of the existing estate. Figure 2 illustrates the age profile of the National Health Service (NHS) estate in England. There can be as many as eight generations of building types in existence, with each generation having their own spatial, environmental and construction standards, potential for flexibility and maintenance liabilities. Many other healthcare estates in the world mirror this situation. Firstly, we must consider some of the changes that the healthcare estate will be forced to accept.

## Healthcare under financial pressure

The financial burden of an unhealthy population was recently estimated by the UK's Department of Health in a report which stated that the annual economic costs of working-age ill health could be over £100 bn. In short, a healthy population drives successful business and has a substantial overall benefit to the economy.

However, there is an enormous financial burden on countries that maintain a sophisticated healthcare system. Given the complex evolving nature of healthcare, neither the costs of illness nor the benefits of health remain static.

To maximise the benefits and minimise costs, innovative solutions are required across each of the drivers of change. At the same time, identifying healthcare costs and potential solutions is becoming more complicated.

Much of the 'low hanging fruit' has already been picked so we need to consider the opportunities for savings as a series of co-benefits that is underpinned by a whole-life cost based financial model. The potential for a single solution with a zero cost implication to significantly affect the bottom line of a healthcare system is a mirage. Applying multi-faceted, innovative solutions are the order of the day. Yet to transfer this early adopter approach to a profession steeped in evidence-based outcomes can create discomfort, resistance and delay.

In global terms, the result is that costs can vary widely even in countries of similar economic standard. Table 1 includes the cost of some healthcare systems in different parts of the world.

Table 1 reflects the cost of healthcare per person as well as the % Gross Domestic Product (GDP) for some selected countries. GDP may be an acceptable metric for economists and politicians, but it does not easily allow the consumers of healthcare to understand the cost implications of the utilisation of the system. This is important because we are now experiencing a changing global disease burden where, for the first time, more people (60%) are dying from non-communicable disease (NCD) than communicable disease. One result of this shift is that it will be more important than ever for the public to take responsibility for their own health and manage their lifestyles to reduce their reliance on the healthcare system.

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There must, therefore, be a greater understanding of the financial cost to the system of 'doing' i.e. smoking, alcohol abuse, poor diet and lack of exercise and 'treating' i.e. diagnostic scan, diabetes treatment, emergency admission and a bed day in an acute hospital etc. The changing disease burden will involve a radical shift in the approach to population screening, treatment, medication and monitoring with the inevitable changes to the healthcare estate of scale, acuity and distribution. These being underpinned by information technology systems connecting between acute centres, acute centre to community and community to home. This will undoubtedly require significant short term investment to ensure long term benefit which, at a time of global financial constraint, will be a challenge. However, the alternative is an inefficient healthcare delivery system.

**Phil Nedin**

Phil Nedin is a Chartered Engineer and a Director of Arup, responsible for its global healthcare business. This role has taken him to many regions in the world to investigate best practice solutions in healthcare engineering.

Phil has been with Arup for more than 23 years, currently based in the London office. Previously, he worked for the National Health Service in a regional health authority design group in London.

Phil is a past President of the Institute of Healthcare Engineering and Estate Management (IHEEM) and is currently on their international committee. In November 2011 he was awarded the IHEEM Lifetime Achievement Award. He is also a Fellow of the Institute of Mechanical Engineers and a member of the UK Department of Health design review panel.

## The changing nature of disease

We have touched on the changing disease burden as a major global driver of change for the healthcare estate. At a United Nations meeting in September 2011 it was noted that the rise in NCD threatens the sustainability of healthcare systems in high-income countries, as well as the expansion of healthcare systems in low and middle income countries. NCD's such as cardiovascular disease (CVD), diabetes, chronic obstructive pulmonary disease (COPD) and common cancers can often be lifestyle diseases attributed to tobacco, poor diet, physical inactivity and the harmful use of alcohol.

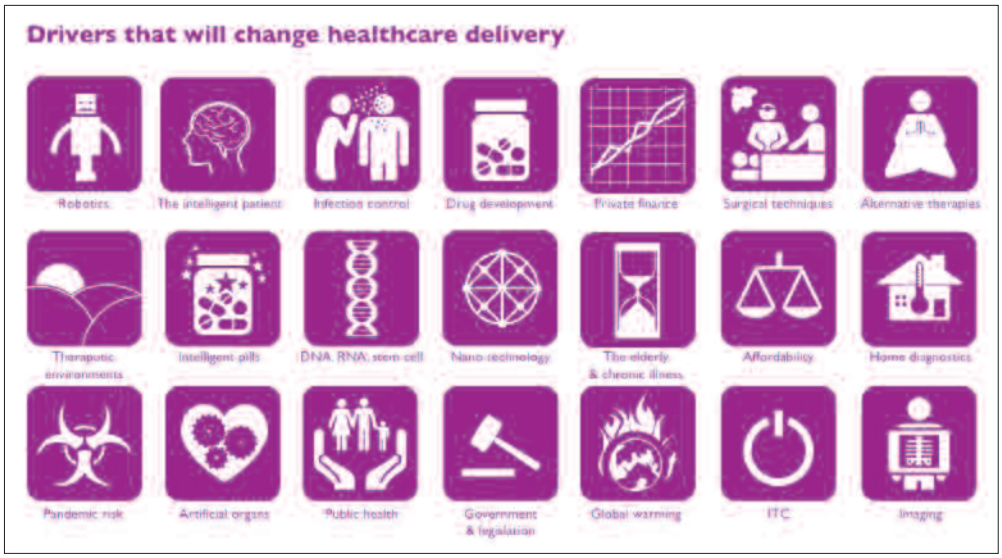


Figure 1: Healthcare drivers of change.

This, of course, begs another question – why do we as a society do things to our bodies that creates significant long-term harm? Are we just weak in the face of temptation? Are we given sufficient information about the risks involved? Are we the victims of peer pressure? Does the DNA of some have an inherent susceptibility? Are we drawn in by slick modern marketing? Government intervention was successfully implemented with the smoking ban in many countries and perhaps now we need the same approach with the price and availability of alcohol and clearer guidance on diets, particularly relating to the balance of macro nutrients (fats, proteins and carbohyrdrates).

What we do know is that the rise of NCD is going to move the goalposts in terms of the facilities we need to deliver healthcare in the years and decades to come. A study by the Harvard School of Public Health calculated that the costs of NCD plus mental health problems will total some $47 trillion over the next 25 years – about 75% of current global GDP!

Given the sheer scale of the challenge, there is widespread agreement that our current healthcare systems are not going to adapt easily to changing needs. We currently have systems that are by nature episodic, disjointed and acute hospital based. That means we have to think closely about the healthcare estates we will need as the manner of treatment shifts as shown in Table 2.

## The ageing population

Exacerbating the rise of so-called 'lifestyle diseases' is the impact of demographics. Global life expectancy at birth rose from 47 to more than 67 between 1950 and 2012. It is expected to reach 75 in 2050 as deaths become more concentrated in older age. At the same time, deaths from heart attack and stroke have been declining for more than 50 years and the screening practices for a number life threatening diseases have also improved.

The result is that in 2012 we have 800 million people over the age of 60 or around 11% of the world's population. By 2030 that number is forecast to be 1.4 billion, or 17%, and 2.0 billion by 2050 or 22%. Indeed, based on current trends, for the first time in history a higher proportion of people in the world will be aged 60 and over (21.0%) by 2047 than are aged under 15 (20.8%).

The increase in life expectancy and declining fertility has some profound implications for society. For example, the increase in older people will drive a sharp decline in the support ratio i.e. the ratio of people of working age (15-64) versus those aged 65 or over.

At the same time, those living longer are very unlikely to live free of illness. So, the incidence of chronic illness will be more prevalent in the elderly. Also people with a chronic condition usually have more than one (multi-morbidity). For example, 50% of over 65s have two or more chronic conditions and 50% of over 75s have three or more chronic conditions, such is the complexity of multi-morbidity. This means that the challenges ahead become even more complex and more expensive.

As we live longer our chances of suffering from dementia increases. Indeed, with varying levels of acuity it may even become inevitable for most people as they grow older. Worldwide, 35.6 million people live with dementia today and the numbers are set to double every 20 years. The projections are 65.7 million in 2030 and 115.4 million in 2050. Alzheimer's disease will also have a significant impact on the UK economy in the next 40 years. The projected increase in those suffering from Alzheimer's is forecast to rise from the current 700,000 to 1.7 million, while the care period for Alzheimer's sufferers runs from between 7 and 20 years.

In short, we must recognise that there is a great deal to be done as we map out the long-term relationship between increasing length and the associated quality of life.

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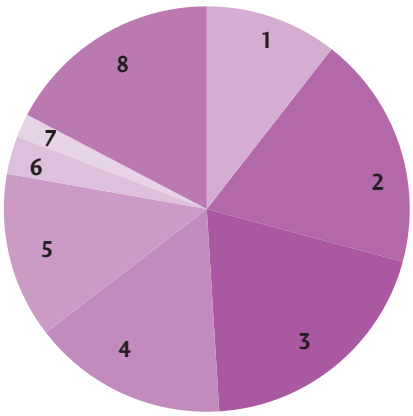
## Patients of the future

The good news is that we are at least making a start. Patient-centric or patient-centred healthcare are the new buzz phrases. This approach allows clinical planners and designers of new models of care to focus on what is important. This is an essential first step, but we must be aware that patients come in many forms, both physically and emotionally. For example, healthcare systems will soon be welcoming the first digital generation as a bulk patient group. They will have grown up on a diet of privacy and digital communications. They will be adept at searching the digital world for a diagnosis for their healthcare problems and engage with digital self help communities. They will possibly be as informed of the diagnostic and treatment options as the doctors they visit. After all, the patient may have had two weeks to research their particular problem whereas a doctor in a primary care setting will typically have 10 minutes or less to make a diagnosis and set a course of treatment.

That poses some interesting questions for patient/doctor relationships. However, in general, greater access to digital medical intelligence has to be welcomed. If individuals are going to be expected to take




| SEGMENT | YEARS | % |
|---|---|---|
| 1 | 2005–Present | 10.00 |
| 2 | 1995–2004 | 19.00 |
| 3 | 1985–1994 | 21.00 |
| 4 | 1975–1984 | 15.00 |
| 5 | 1965–1974 | 14.00 |
| 6 | 1955–1964 | 3.00 |
| 7 | 1948–1954 | 1.00 |
| 8 | Pre 1948 | 17.00 |

Figure 2: Age profile of the NHS estate 2007-2008.

**Table 1: The cost of healthcare.**

| Country | GDP/Head (US$) | Health GDP % | Healthcare cost/head | | |
|---|---|---|---|---|---|
| | | | US$ | € | £ |
| USA | 47,150 | 17.9 | 8,439.85 | 6,680.69 | 5,297.02 |
| Norway | 85,390 | 9.5 | 8,112.05 | 6,420.17 | 5,090.46 |
| Denmark | 56,240 | 11.4 | 6,411.36 | 5,076.68 | 4,023.25 |
| Netherlands | 46,900 | 11.9 | 5,581.10 | 4,418.77 | 3,502.56 |
| France | 39,450 | 11.9 | 4,694.55 | 3,719.21 | 2,946.84 |
| Sweden | 48,900 | 9.6 | 4,694.40 | 3,716.74 | 2,946.09 |
| Germany | 40,120 | 11.6 | 4,653.92 | 3,687.12 | 2,907.87 |
| Belgium | 43,080 | 10.7 | 4,609.56 | 3,649.88 | 2,893.05 |
| Australia | 50,750 | 8.7 | 4,415.25 | 3,495.23 | 2,771.29 |
| Ireland | 46,170 | 9.2 | 4,237.64 | 3,355.10 | 2,659.44 |
| Finland | 44,380 | 9.0 | 3,994.20 | 3,162.20 | 2,506.84 |
| UK | 36,340 | 9.6 | 3,488.64 | 2,763.84 | 2,189.87 |
| New Zealand | 32,370 | 10.1 | 3,269.37 | 2,587.71 | 2,052.07 |
| Italy | 34,080 | 9.5 | 3,237.60 | 2,473.42 | 1,992.88 |
| Spain | 30,550 | 9.5 | 2,902.25 | 2,299.34 | 1,821.49 |
| Greece | 26,610 | 10.2 | 2,714.22 | 2,149.98 | 1,703.77 |
| Portugal | 21,490 | 11.0 | 2,363.90 | 1,872.49 | 1,483.86 |
| Poland | 12,290 | 7.5 | 921.75 | 730.13 | 578.59 |
| SouthAfrica | 7,280 | 8.9 | 647.92 | 512.87 | 406.66 |
| China | 4,430 | 5.1 | 253.93 | 200.98 | 159.37 |
| India | 1,410 | 4.1 | 57.81 | 45.76 | 36.28 |

*(Data source – World in Figures 2013 Conversion $ to € to £ Sep 2012).*

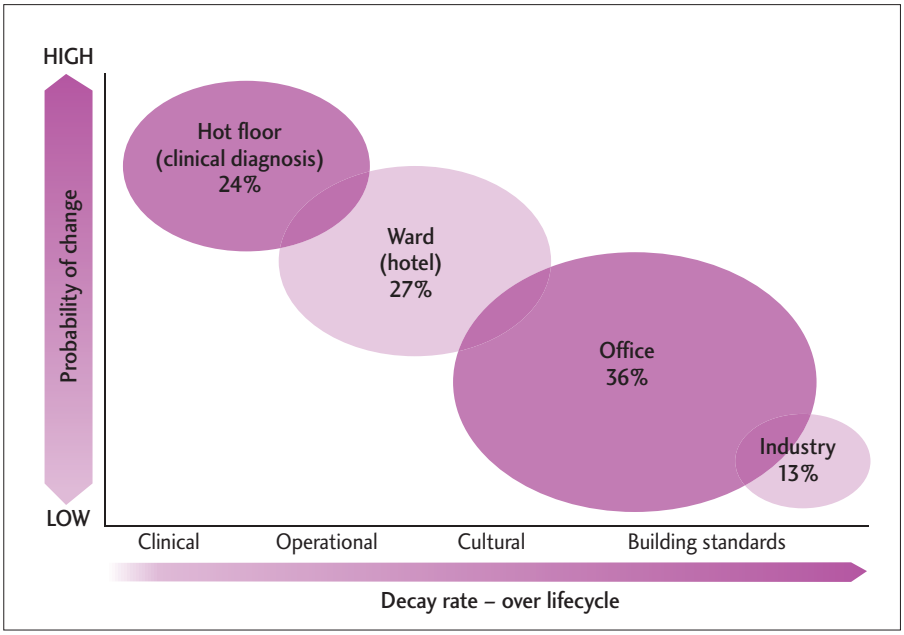
responsibility for their own health, then it is good that they have the information to do so – as long as that information is correct.

As well as being more tech savvy, this future demographic is likely to be far more demanding about their need for privacy within the acute hospital environment. This trend is already happening, with single bed units increasingly viewed as an essential requirement in hospitals and not just for reasons of privacy. Reduced spread of infection, flexibility for more bedside treatments, family and friends support, the full use of digital systems and multi-cultural acceptability are all co-benefits of this change.

There is a cost to this single bed room provision, with a new build floor area reducing the number of beds by 30% when moving from a multi bed ward to single bed rooms. This is reduced to possibly 50% when the transition takes place in a refurbishment project. This can, however, be offset by the possible reduction of in-patient accommodation in many countries, which may balance the equation.

We can therefore conclude that these trends point to some radical changes in how and where we deliver healthcare in the future. What's more, the healthcare facilities we are designing and building today, given a typical 60-year life will be in service to experience these new patient groups and the changes they will bring to bear on the system.

Figure 3: Components of a modern acute hospital and the requirements for flexibility.




## Science and technology

So far the changes we have touched on have been financial, societal, public health and demographic. There is, of course, a relentless march of science to add into the mix.

Take the relatively new science of molecular biology, which has given us a deep level of understanding of the human body through the sequencing of the human genome. Understanding how we are constructed at base level means that we not only have the chance to gauge our vulnerability to disease but also to predict how the immune system might respond to different diseases – and more crucially, to tailored therapies. This may lead to more preventative strategies and reduced attendance as in-patients.

A further scientific area of activity is nanotechnology. In terms of medical research, there are opportunities here for advanced therapies and drug delivery, innovative diagnostic imaging and structural repair. In the near future, the process of

**Table 2: How health systems need to change to be better able to prevent and manage NCD.**

| Current view | Evolving model of care |
|---|---|
| Geared towards acute conditions | Geared towards long-term conditions |
| Hospital-centred | Embedded in communities |
| Doctor-dependent | Team-based |
| Episodic care | Continuous care |
| Disjointed care | Integrated care |
| Reactive care | Preventative care |
| Patient as passive recipient | Patient as partner |
| Self-care infrequent | Self-care encouraged and facilitated |
| Carers undervalued | Carers supported as partners |
| Low-tech | High-tech |

*(Source – Report on communicable diseases Imperial College London and Qatar Foundation 2012).*

radiation and chemotherapy as cancer therapies could even be replaced through more targeted nano-therapies. At the same time, we may also see a new world in diagnostic imaging, using *in vitro* nano-cameras rather than large magnet-based devices.

The enabler for this technological change will be the advances in computer science which continues to shape the medical environment. Given that a typical mobile phone boasts computing power far in excess of the systems that carried Apollo 11 to the moon in 1969, we can easily predict that much more is to come.

What is clear is that the potential for change within the healthcare environment is enormous. The manner in which diseases are diagnosed and treated could be revolutionised within 10 years and would have a significant impact on the built environment that supports the delivery of healthcare services.

The challenge then is that the buildings that we create today have to be up to the task of meeting all these changes for the next 60 years. We even need to ask ourselves the ultimate flexibility question – if this were not a hospital then what could it be?

Clearly, the health planners, architects and engineers charged with designing healthcare facilities of the future need to understand the full scale of the potential developments on the horizon and plan sufficient flexibility into their designs to allow those changes to occur.

This long-term level of understanding will not simply be gained through discussions with local clinicians or patient user groups alone, but by interacting and collaborating with scientists and clinical researchers.

## The impact of change on the acute healthcare estate

So, what does all this mean for the day-to-day business of shaping healthcare environments that will be fit for the future? Well, first of all, we can examine the basic model of how we approach the problem now.

Modern acute hospital accommodation can be divided in four main building types – the hot areas (diagnostic and treatment); the hotel accommodation (wards); the administration (offices); and the industrial elements (laboratories, pharmacy, laundry, catering, etc). The need for change of each of these accommodation types was the subject of work carried out in the Bouwecollege in Utrecht, Netherlands in 2005 (Fig. 3). This model is very helpful in aligning functional building types with their need for flexibility, complexity of services and, ultimately, cost differences.

However, since this model was developed things have moved on and we must now consider what proportion of each of the functions will be carried out in the community or at home and what could be outsourced to local or remote third-party providers. This can only be ascertained by an analysis of the future clinical and ancillary services to be provided, the models of care associated with those services and the attitude towards public/private partnerships etc. Only then can the accommodation necessary to support the effective delivery of the service be fully considered.

In short, every healthcare estate will need a clinically led development control plan for the short, medium and long term. It will also be essential that this plan includes all the satellite facilities in the vicinity i.e. in-patient, outpatient, general practice and community care. This is critical to facilitate the future adoption of a less centralised, more dispersed service delivery model. This holistic approach will be the basis of a vertically integrated system incorporating prevention, intervention and care, enabled by a powerful digital intelligence platform.

Once we have fully considered the many complex changes that could occur over time on the estate, we can turn our attention to the condition of the building stock within the health estate at large. Given the complex nature of the problem, it is important that we have planning models to help frame our multi-discipline approach to the building stock. One such model is the AssetMap (Fig. 4). This model was originally developed to guide clients through the process of interrogating

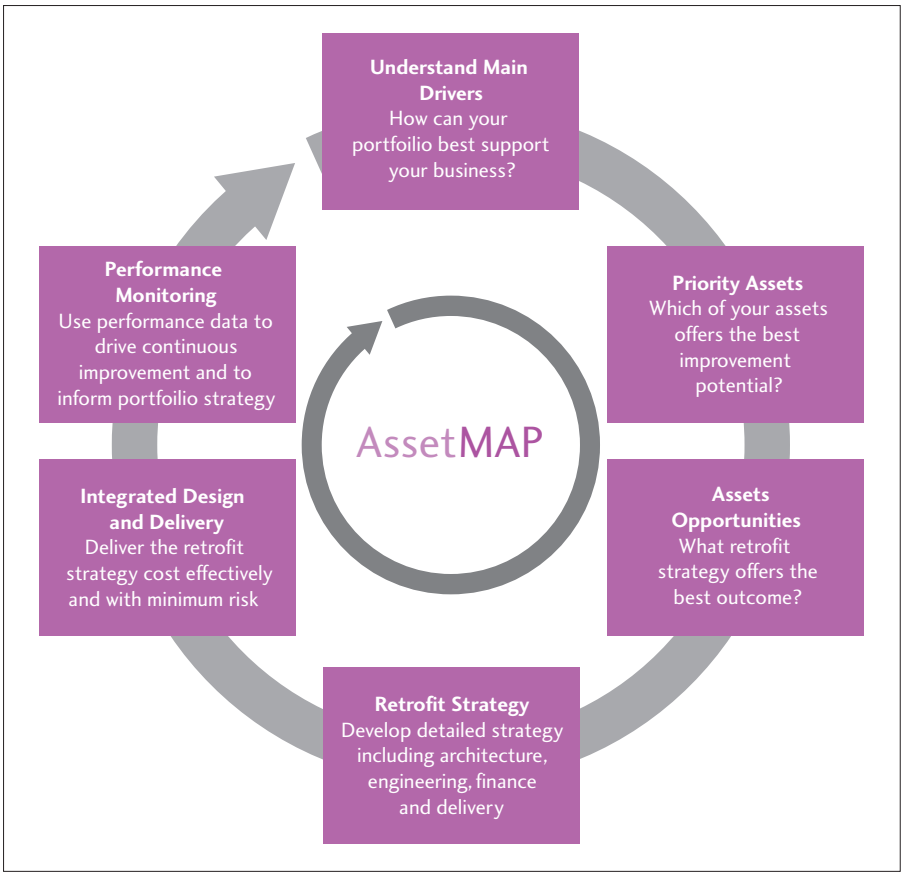



**Figure 4: AssetMap – an evaluation model to enable realisation of the potential of the existing estate.**

> 'The prize will be to future-proof our healthcare systems to enable effective economic delivery for future generations of patients.'

the existing estate to maximise its potential. This makes the model ideal for re-calculating floor area requirements and building adjacencies for a newly formed estate that fits with the new clinical requirements and reflects the inevitable shrinking of the healthcare estate.

The opportunities are significant. As the estate shrinks, so the maintenance and energy costs reduce. At the same time, land becomes available that can be used for other healthcare building developments or used to provide green spaces, healing gardens, or sold off to free up capital for investment.

The model also tells us a lot about the potential for maximising legacy and new healthcare estates. If we take the NHS in the UK, for example, we know that the healthcare estate has developed over many years into a number of distinctive types.

Figure 5 illustrates typical building arrangements and relationships that have been used over the years to develop campus sites. These forms are expressed in more detail in *Changing Hospital Architecture,* (a Royal Institute of British Architects publication). The structural frame, floor slab details, wall construction, façade composition and building services requirements are different for each form. Some of these forms and specific building types lend themselves to a reasonable level of flexibility for the adoption of new clinical functions while others do not. A further component of the 'construction form' is the effectiveness of the floor plate to accommodate a radical change of use.

Specific building types need to be analysed to ensure that cost-effective upgrading can be carried out. The extent of the refurbishment can be as simple as a redecoration or as complex as multiple floor extensions utilising new structural frame, façade and building services systems: integrating multi-bed wards into single bed accommodation or creating outpatient clinics from existing in-patient facilities. Whatever the project, it is essential that any upgrading review is considered with the potential to introduce therapeutic or healing environments.

Any revamped facility or healthcare environment should be developed to enhance the patient experience and allow

**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*

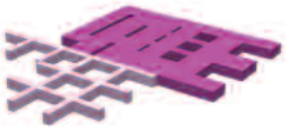
Woolwich Hospital and St Thomas's Hospital, London; Hotel Dieu, Paris; many others worldwide.

**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, Slough; Venice Hospital (unrealised design by Le Corbusier); Homerton Hospital, London.

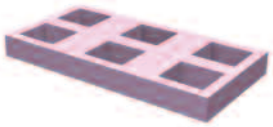


**3. Monoblock**

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.

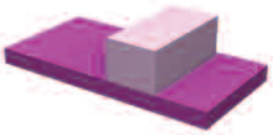


**4a. Podium and slab/tower (also 'Bundles' or 'Stacked' in US)**

The wards are generally in the tower with the clinical and technical area in the slab. This typology can be effective on urban sites with small footprinting 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.

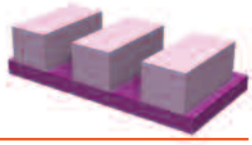


**4b. Podium with two or more towers/blocks over**

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)

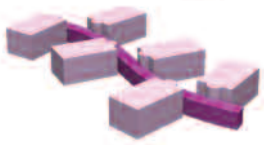


**5. Street**

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.

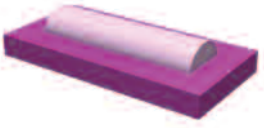


**6. Atrium/galleria**

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 hard, 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.

**Figure 5: Different configurations of the acute healthcare estate.**

> 'It is important that we have planning models to help frame our multi-discipline approach to the building stock.'

for future flexibility – but just as importantly, it has to increase the performance efficiency and effectiveness of the clinical staff. A well executed new design or refurbishment has the added benefit of enhancing the recruitment and retention of the best staff by creating improved external and internal environments. This is an important subject given that there is already a shortage of qualified clinical staff with aggressive competition for this rare commodity.

## Conclusion

There is no doubt that the planning and delivery of the future healthcare estate is an extremely complex subject. Necessarily, it has to deal with the strategic blue sky approach to future clinical and estate reconfiguration, as well as with the multi-faceted changes that are being imposed by everything from new technology to novel gene therapies. Across all of this, we need to overlay the more practical requirements of site master planning, building by building analysis and project delivery.

The jump from strategic thinking to practical planning and delivery is never easy. However, with the changing healthcare environment we must think holistically to provide the necessary cost-effective clinical facilities that future generations can rely on.

It is a multi-disciplinary approach where technological and clinical scientists, engineers, medical practitioners, healthcare planners, architects, cost consultants and constructors will be the agents of radical change.

It is a significant challenge, but the prize will be to future-proof our healthcare systems to enable effective economic delivery for future generations of patients. To do otherwise is unacceptable!

## Acknowledgements

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- Countering Non-Communicable Disease Through Innovation – Global Health Policy Summit 2012.
- The United Nations High-level Meeting on the Prevention and Control of NCD's (New York, 19-20) September 2011.
- Primary Care – The Central Functions and Main Focus – Global Health Policy Summit 2012.
- *Changing Hospital Architecture* – Royal Institute of British Architecture (RIBA Publishing 2008).