CREATING COMPLETE HOSPITALS

FROM FACTORIES FOR FIXING TO PLACES FOR HEALING

NEUROSCIENCE IS TEACHING US THAT FULLY FLOURISHING HUMANS NEED: BEAUTY, CONNECTEDNESS, GREENERY AND A SENSE OF PURPOSE JUST AS MUCH AS THEY NEED CLEAN AIR AND SUFFICIENT FOOD

The main court at the Defence and National Rehabilitation Centre, (DNRC), Loughborough, completed 2018 [1]

NON- TECHNICAL SUMMARY

A place for healing or a factory for fixing? [2]

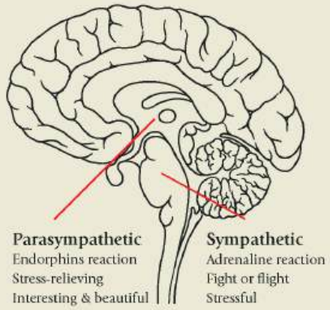
1. Context

Too much twentieth century science, design, management and medicine treated problems as simplistic time and motion studies, as machines where inputs could be directly related to outputs and where efficiency was about size and avoiding extraneous distractions. Across nearly all spheres of human endeavour bigger was better and the local and the natural, the charming and the idiosyncratic needed to be swept cleanly away in the name of scientific progress.

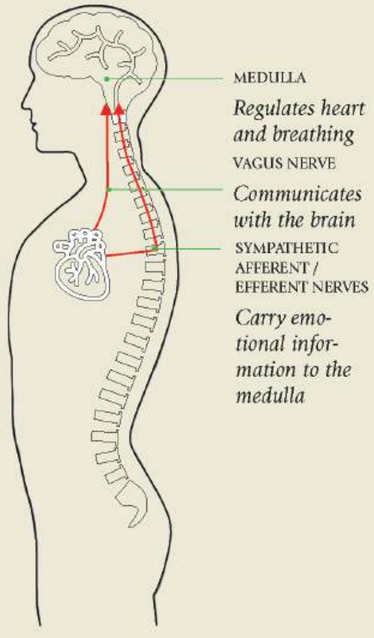
This approach had many strengths: hospitals got cleaner; food got cheaper; lives got longer. But it had weaknesses as well. We failed to understand how complex and interlinked were the ecosystems which keep us alive or indeed the chemical and biological process within our own bodies. We started to build disposably for the short term not enduringly for the long term.

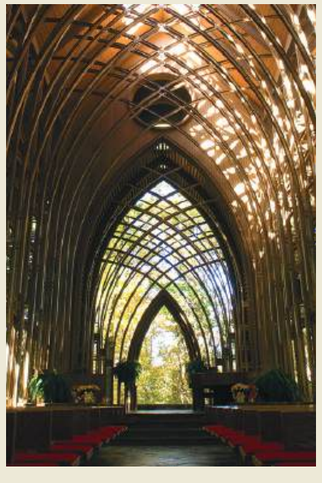
Dahlia Flower [3]/ Alhambra Macabre, Spain [4]

Neuroscience: the autonomic nervous system [5]



In attempting to be strictly functional, we ripped out the soulful and the beautiful which our minds need. In transporting crops from one continent to another, in dousing fields with synthetic chemicals, in exposing our bodies and brains to stresses and strains unknown in all evolution we also did much harm (to ourselves and to the planet) and undermined our own capacity to do good. Over the last generation, with dramatically enhanced computer-aided systems modelling, we are re-learning what our distant forebearers knew innately: 'no man is an island.' Our planet's, and our own, health and wellbeing are influenced by an infinitely more complex array of factors than once we realised. Neuroscience is teaching us that fully flourishing humans need connectedness, beauty, greenery and a sense of purpose just as much as they need clean air and sufficient food.





Humankind intuitively responds to patterns rooted in nature with a Pleasure response

Tree Arcade [6]/ Mildred B Cooper Chapel [7]

We are complex emotional systems not simple mechanistic tools. Our theoretical appreciation of this complexity is growing. However, too many of the environments we actually create remain ignorant of this broader understanding. They are mechanistic and ultimately bad for us.

This submission to the Wolfson Prize is written in the spirit of moving hospital design from the twentieth century to the twenty first, from 'factories for fixing' to 'places for healing'. It responds to the overwhelming professional belief which our research has unearthed that hospitals need to be better places for patients and for staff. (Only 8% of respondents to our indicative survey felt that current hospitals' physical environments had a positive effect on patient service.) And it is obviously written in the aftermath of the COVID pandemic with awareness of the importance of our physical environment perhaps greater than ever before.

Our submission builds on our team's deliberately diverse backgrounds in clinical care and hospital management, in practical hospital design and academic research into the correlations between design and wellbeing. Based in the real-world experience of building and running hospitals, it is intended to be a practical blueprint for a CEO or COO but a blueprint informed by the best available research into one of the most profound of all questions: what types of places make us whole, healthy and happy?

Gardening as therapy at Horatio's garden [8]

We should create gardens which are easy for patients to use and which feel safely enclosed [9]

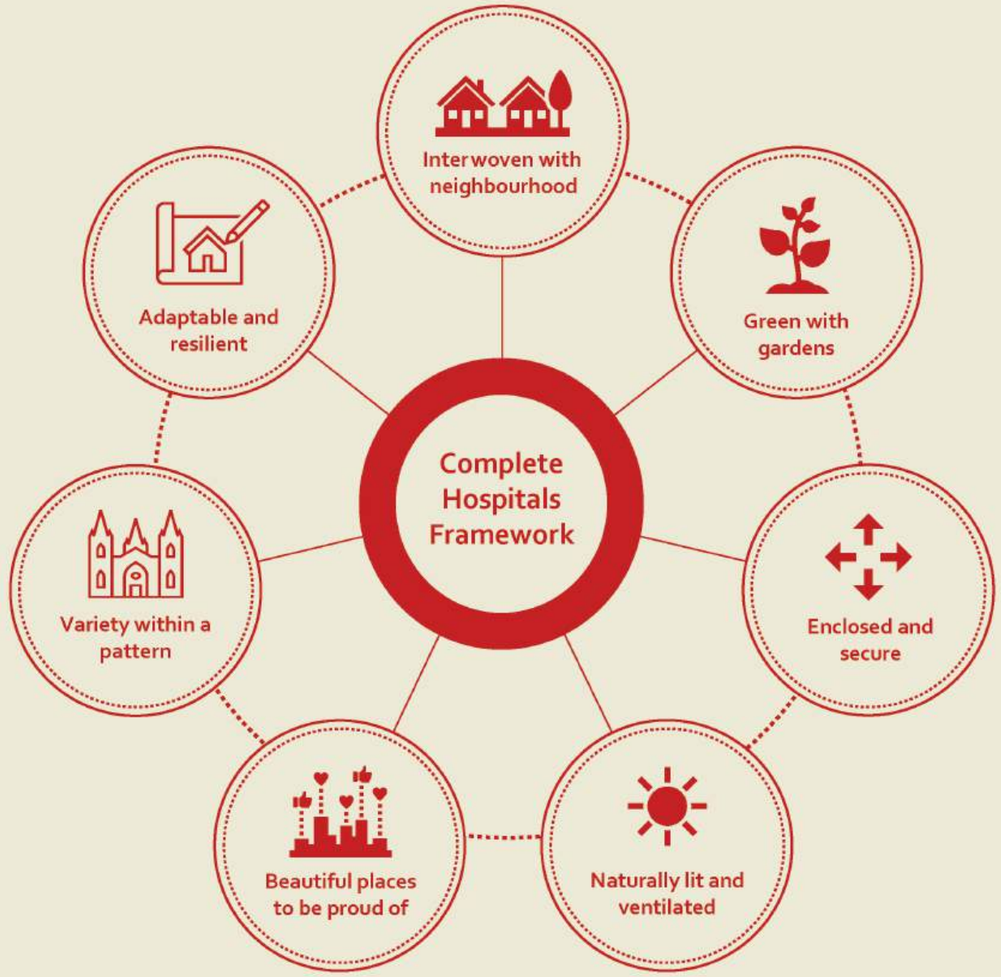
2. The Complete Hospitals Framework

The Complete Hospitals Framework is not one single design but a series of six management tools. These are intended to give a CEO or COO tasked with developing or managing a hospital the right framework, questions, process, KPIs and cost benefit analysis tools to 'set the design brief' for a hospital and then later to measure their own success or to find opportunities to improve. These tools are:

Tool	Purpose
1. The Complete Hospitals Framework	• Setting the overall requirements and metrics for hospitals that improve well-being
2. The Complete Hospitals Governance board	• Suggested board members nationally and locally for hospital delivery
3. The Complete Hospitals KPIs	• KPIs by which to manage a Complete Hospital
4. The Complete Hospitals five-step process	• A process of five key question types to 'set the brief' for a new hospital
5. The Complete Hospitals 'pattern book'	• A detailed series of 36 patterns which should be emphasised, included or not used in a design brief as the situation dictates
6. The Complete Hospitals Green Book Cost Benefit Analysis tool	• A model which, with further functionality, can serves a basis for making design decisions trading off present costs for long term gains

Underpinning this suite of tools is the now very robust evidence about the types of places that are good, or bad, for us. This evidence is now too clear to be ignored. Hospitals for humans which are more completely able to improve patient experiences, clinical outcomes and staff wellbeing whilst also integrating with wider civic society and health and social care will need to have seven key components. These seven components will also help deliver new hospitals more sustainably by suggesting the right approach on the critical (but too often overlooked) issues of embodied carbon and longevity and how staff and patients arrive at and interact with hospitals.

HOSPITALS SHOULD BE:



1. Interwoven with neighbourhood.

2. Beautiful places to be proud of.

3. Variety within a pattern.

4. Naturally lit and ventilated spaces.

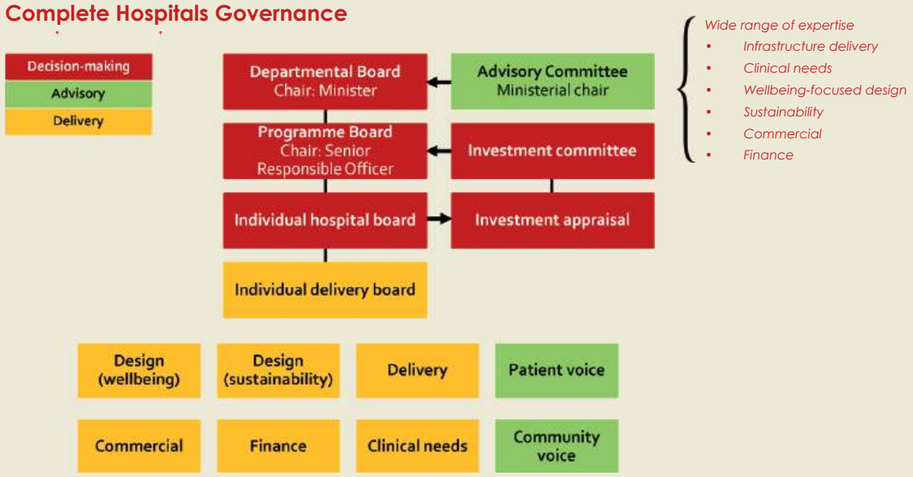
5. Enclosed and secure.

6. Green with garden.

7. Adaptable and resilient.

We also suggest a governance framework for creating new Complete Hospitals and KPIs for managing them so that hospitals leaders' eyes are kept targeted on the main prize of healthy and happy patients and staff.

Complete Hospitals Governance



Wide range of expertise

- *Infrastructure delivery*
- *Clinical needs*
- *Wellbeing-focused design*
- *Sustainability*
- *Commercial*
- *Finance*

Complete Hospitals KPIs

- Self-reported patient wellbeing
- Self-reported patient satisfaction
- Patient admission and discharge times

- Length of stay
- Adverse incidents
- Mortality rates
- Infection rates

- Self-reported happiness of hospital staff
- Staff sickness rates
- Operative success rates
- Being up to date with training

- Self-reported happiness of hospital visitors
- Proportion of visits to hospital made by active travel
- Annual use of images of hospital in media about the wider area

View looking into the arcaded main entrance court at DNRC, Stanford Hall. This is a practical space as well, used to provide a garden to enjoy, with steps, ramps and greenery and different floor finishes for amputees to practice using their new prosthetic limbs [10]

CREATING A COMPLETE HOSPITAL

We have set out a five-step process of questions that a leader charged with delivering a hospital can pose in order to 'set the brief.' These are intended to be supremely practical and to lead to specific answers which can be recorded. Key questions are:

Process and key question for setting the brief for a Complete Hospital

- How wide is hospital's catchment area?
- How will staff and visitors travel to the hospital?
- What opportunities are there for re-greened active and public transport? Can we create greenways, trams with trees? Can we plant trees?
- How can the required carparking be economically and sympathetically incorporated?
- How much interaction will/ should there be with the local neighborhood and community?
- Does it have any overriding unique requirements such as access to countryside or proximity to specialist facilities?

- How can we maintain permeability through the site for users and visitors and at different grades?
- How can we relate the building to existing site and its imitate surroundings?
- How can the hospital brief be subdivided to relate to surrounding building scale and urban grain?
- How will it use and create public space?
- How will hospital both stand out and fit in?
- How will hospital express community identity and pride?
- How will hospitals feel familiar and healing?

- Which spaces do & don't require natural light and/or ventilation?
- How many private rooms will we need?
- What different privacy levels are needed and how do we ensure they are achieved?
- Where can we create alternative external circulations routes?
- How much external space would benefit the hospital and where would it be best located in relation to other facilities?
- How do we create a variety of outdoor green spaces with differing privacy levels?
- How we connect upper floors with gardens?
- Where should prominent continuous stairs be placed?
- How do we avoid noise and light pollution?

- What is the right hierarchy of construction for different elements of the facility?
- How do we avoid short term technological obsolescence?
- How can we use public funds efficiently?
- How do we create buildings that people want to keep?
- What materials with low embodied carbon would be suitable for your hospital?
- What materials will have longevity appropriate to the different levels of hierarchy?
- How can we use materials and architecture to ensure minimized requirements for long term maintenance?

- How do we ensure ongoing focus on building maintenance for long term sustainability?
- How do we ensure ongoing opportunities for patients to garden?
- How do we support surrounding community?

CREATING A COMPLETE HOSPITAL

Answering these questions, and the more detailed questions which underpin them, will identify how to use our Complete Hospitals pattern book. We have a created a list of 36 specific 'patterns' which collectively define the possible design parameters of a Complete Hospital. Formally using the five-step process should identify which of these patterns should be emphasised, included or excluded and how to approach them.

1 Interwoven with neighbourhood

- 1a Catchment
- 1b Public transport
- 1c Car parking
- 1d Urban grain
- 1e Block sizes
- 1f Scale & frontage
- 1g Connectivity
- 1h Public realm

2 Beautiful places to be proud of

- 2a Landmarks
- 2b Reflecting comunity
- 2c Celebrating pride

3 Variety within a pattern

- 3a Symmetry
- 3b Biophilia
- 3c Variety

4 Naturally lit and ventilated

- 4a Building Depth
- 4b Windows
- 4c Views
- 4d Connectivity

5 Enclosed and secure

- 5a Secure
- 5b Public space
- 5c Privacy levels
- 5d Circulation
- 5e S tairs
- 5f Light & Noise

6 Green with gardens

- 6a Greenways
- 6b Trees
- 6c Greenery
- 6d Biodiversity
- 6e Gardening
- 6f Upper Floors

7 Adaptable and resilient

- 7a Hierarchy
- 7b Technology
- 7c Economic
- 7d Attractive
- 7e Sustainable
- 7f Well detailed
- 7g Maintained
- 7h Community

Patient enjoying nature through gardening [11]

3. This submission

This submission has two main parts.

- The first part (The problem – humans are not machines) sets out the issues that our work has uncovered. In a nutshell, hospital design has forgotten that humans are complex emotional beings.

- A foreword, written by Dr Hervey Wilcox, a senior clinician and former hospital manager, sets out the profound problems for patients and staff that our 'patients as machines approach' is creating in real life. Hervey's experience has been mirrored by the dozens of health professionals to whom we have now spoken or who have completed our indicative survey. (57% believed that hospitals' physical environment had a negative or very negative effect on their personal productivity or health. Only 12% believe the opposite.)

- Chapter one: Treating the complete human explores the profound changes in our understanding of the links between place and emotional wellbeing. This is highly relevant for the health and wellbeing of patients, staff, visitors and indeed for wider civic society in which a hospital must sit.

- Chapter two: How to create complete hospitals for humans sets out the specific evidence associating different elements of hospital design with better patient, staff and civic wellbeing.

- Chapter three: Deep green not thin green asks how hospitals can be sustainable over their lifetimes. As well as considering thermal efficiency there are critical issues of behaviour, the buildings' form, longevity of design, materials and location that will crucially influence their lifelong carbon footprint.

- The second part of our submission (From factories for fixing to places for healing) outlines our Complete Hospital Framework and a partial Green Book cost benefit analysis of this approach vs. 'business as usual'.

- Chapter four: Governance outlines our Complete Hospitals Framework, Governance and KPIs for hospitals to be more completely able to improve patient experiences, clinical outcomes and staff wellbeing.

- Chapter five: Delivery – the right questions outlines our five-Step process and a list of 36 'patterns' which a project manager can use to 'set the brief' for a new hospital and to help them put this theoretical understanding of place and wellbeing into practical application.

- Chapter six: Delivery – creating Complete Hospitals shows how following the five-step process can set a design brief very different to the status quo. Two case studies (one rural tertiary hospital and one urban acute hospital) show how the Complete Hospitals Framework can lead to very different design approaches in different circumstances.

- Chapter seven: Evaluation examines the financial deliverability and sustainability of the Complete Hospitals Framework using a partial Green book methodology. In

present value. Even with a highly pessimistic set of assumptions, it has a modestly net positive value over 120 years and only has a very modestly negative value (-£9m) over 60 years. In all other scenarios, this approach is highly value positive, up to +£319m over 120 years.

- Chapter 8: What next is drafted as a letter to the COO of a district hospital development project advising them how to take forward this approach. It suggests how the programme could be expanded via a Compete Hospitals accreditation programme.

- Our conclusion finishes by encouraging those charged with leading our hospitals to rediscover the older meaning of hospital (as a place of hospitality) alongside the modern

Garden for neurology patients at the DMRC [12]

Finally, three appendices collate all our Complete Hospitals Framework in one place for ease of use and provide more detail on our indicative staff survey and on the detailed assumptions and methodologies underpinning our cost benefit modelling.

A father visiting a major new children's hospital as we were completing our first-round submission told us that he found the inside 'harsh, confusing and intimidating.' The team behind the Complete Hospitals Framework think we understand why he had this natural response. We wish to change this. To do so, an understanding of the power of place needs to be allied to a practical experience of creating new buildings cost-effectively, to responding flexibly to complex briefs and to evaluating public benefit over three generations not just a project build cost over 36 months. We dare to believe that our team combines these attributes. And we hope that our submission sets out how to do this.

And we believe we can. Our submission sets out why and how.

Internal courtyard with greenery and pool at Weihai Hospital of Traditional Chinese Medicine, Shandong, China

CREATING COMPLETE HOSPITALS

FROM FACTORIES FOR FIXING
TO PLACES FOR HEALING

Hospital (noun)

(1) an institution for the medical treatment of patients

(2) A charitable home, hospice or school

From the Latin, *hospitalis* - relating to a guest

"We shape our buildings;
thereafter they shape us"

Sir Winston Churchill

"All the hospitals I have worked in have different problems.
The thing they all have in common is that they are not places where
you would want to spend time."

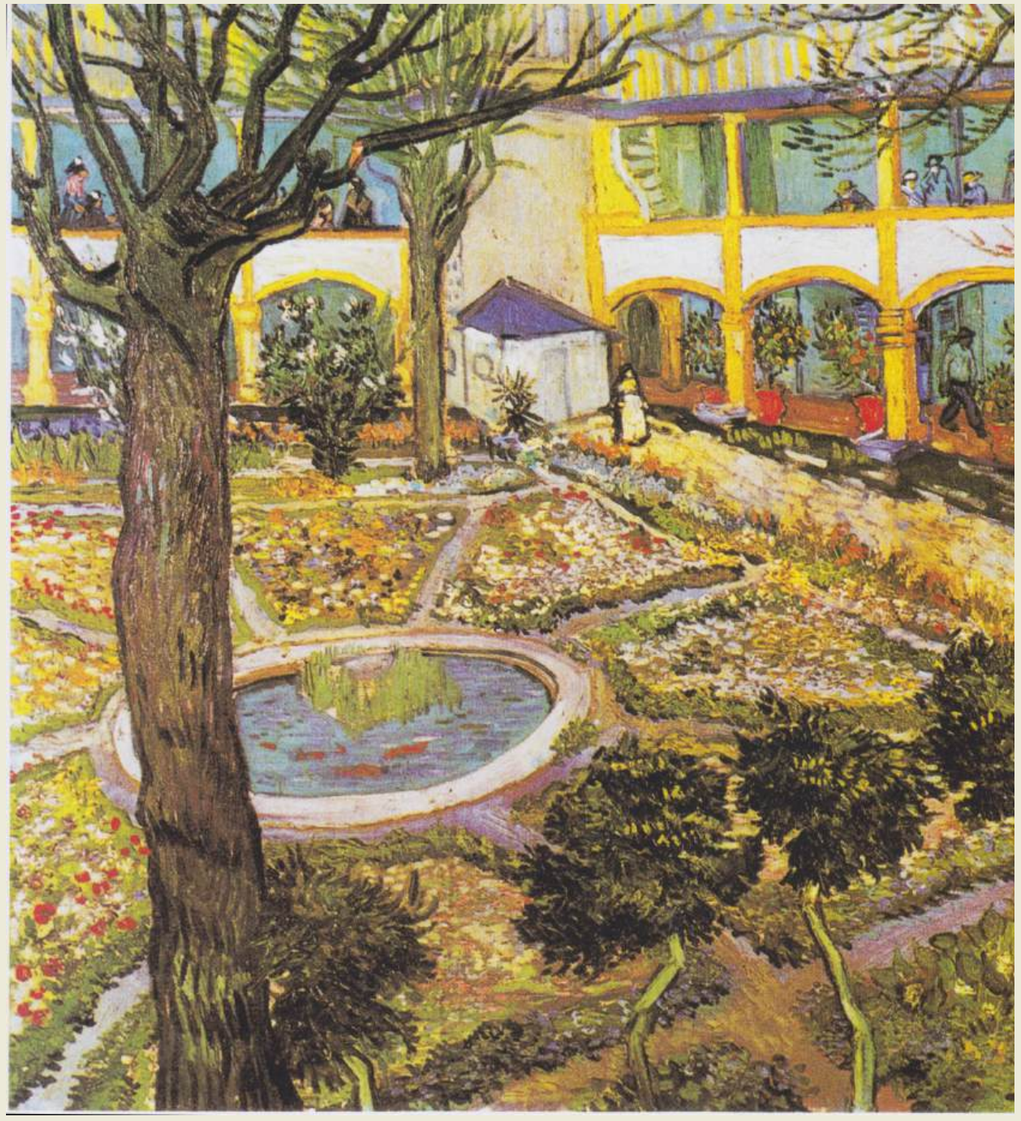
A hospital Clinical Director and senior manager, 2021

"Ugly inefficient health units and hospitals inhibit good health and health care"

Biomedical scientist, UCL Hospital , 2021

"That light and space and beauty and functionality should exist in the places where we do our work healing each other seems so fundamental and yet … it is a deviation from the way we are accustomed to thinking."

A nurse speaking in 2007



Van Gogh painting of hospital in Arles [A]

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CREATING COMPLETE HOSPITALS

FROM FACTORIES FOR FIXING TO PLACES FOR HEALING

A place for healing or a factory for fixing? [B]

Foreword: the patient journey

I have worked as a Consultant in the NHS for 31 years. During this time I had added responsibilities as Trustwide Director of Clinical Risk for 14 years and a Clinical Director for 12 years. I chaired a regional Research Ethics Committee for 16 years and have an MBA with distinction and an LLM in Legal Aspects of Medical Practice. I have also had my own experiences as both an outpatient and an inpatient. I write this with these experiences and hope that they can pave a way forward to improve radically patient experiences, clinical outcomes, staff wellbeing and the integration of hospitals with wider health and social care. A way forward that is rooted in science but lived in human experience and intuition. A way forward that connects the dots between our environment, our lives and our health and wellbeing.

A typical experience for an outpatient in a UK hospital begins when they are waiting for consultations or tests: in corridors, watching patients being wheeled past by hurrying staff or in rooms without natural light or even a hint of the world outside, with a disorientating feeling that they are in a temporary space or a building designed for storage and machines rather than people. When they finally get to see the clinician, often accompanied by the second or third apology of their visit, they find themselves in a room that feels just as unfriendly as the corridor: a small space where poor building materials and a lack of appropriate soundproofing can make confidential conversations a lot less than confidential. Each of these issues would probably be accepted with a wry smile if they were the exception. But they are not. It is disconcerting, indeed shocking, to find that there are hospitals where this applies nearly everywhere. There must be a better way.

For an inpatient, and speaking as a recent one myself, the experience can leave you feeling much the same or worse. I recently spent eight days in a major hospital. A single room. A window that was screwed shut and a venetian blind fixed to obscure the view. My primal instinct was to run. Instead, I peeled back one of the slats over the window and was greeted by a dirty concrete wall. I left it shut. I wondered who had designed my featureless room. A physiotherapist encouraged me to leave that room every day and to go for a walk. The nearest place was the hospital car park. Still, a welcome relief from the eight days which I spent in that room. There must be a better way.

Recently, a neighbour told me of a similar experience. He was visiting his mother at another large hospital, where she was an inpatient on a ward for the elderly. He told me of the harsh unnatural ward light that remained on all day, every day, in the absence of natural light. He told me how there was nowhere for clinicians to talk to relatives except in a small unattractive sitting room in front of other patients. Again, there is the thought: 'am I somewhere that was designed for something else?' There must be a better way.

This is the patient's view. It is often worse for the clinical staff, who are already exhausted from the pressures of work. There has been a perception that clinical staff should share open spaces, forgetting about the need for confidentiality for meetings, dictating letters or being on the phone. Belatedly they are then 'shoehorned' into tiny airless offices.

Where I worked, there were senior clinical staff whose offices were converted storerooms, and one whose office was formerly a lavatory. A non-clinical area had been converted to a ward with no natural light, and a room for special tests had a corridor too narrow for patients' trolleys to pass. Our literature review has revealed that these issues are widespread in Britain's hospitals and that this matters A 2014 systematic review concluded that patients in rooms with natural light and a more pleasing design experienced significantly reduced anxiety and pain, while healthcare costs were reduced.[1] Increased natural light in hospitals improves physiological and psychological states for staff as well as reducing the cost of lighting and heating.[2] Natural lighting increases the production of serotonin, a chemical in the brain which lifts people's mood and alertness.[3] It really is hard to overstate the potential. Our indicative staff survey found that only 8% of our respondents felt that we are currently providing physical environment for patients which is positive or very positive. This is more than an opportunity. We have an obligation to improve our hospital design for better patient outcomes.

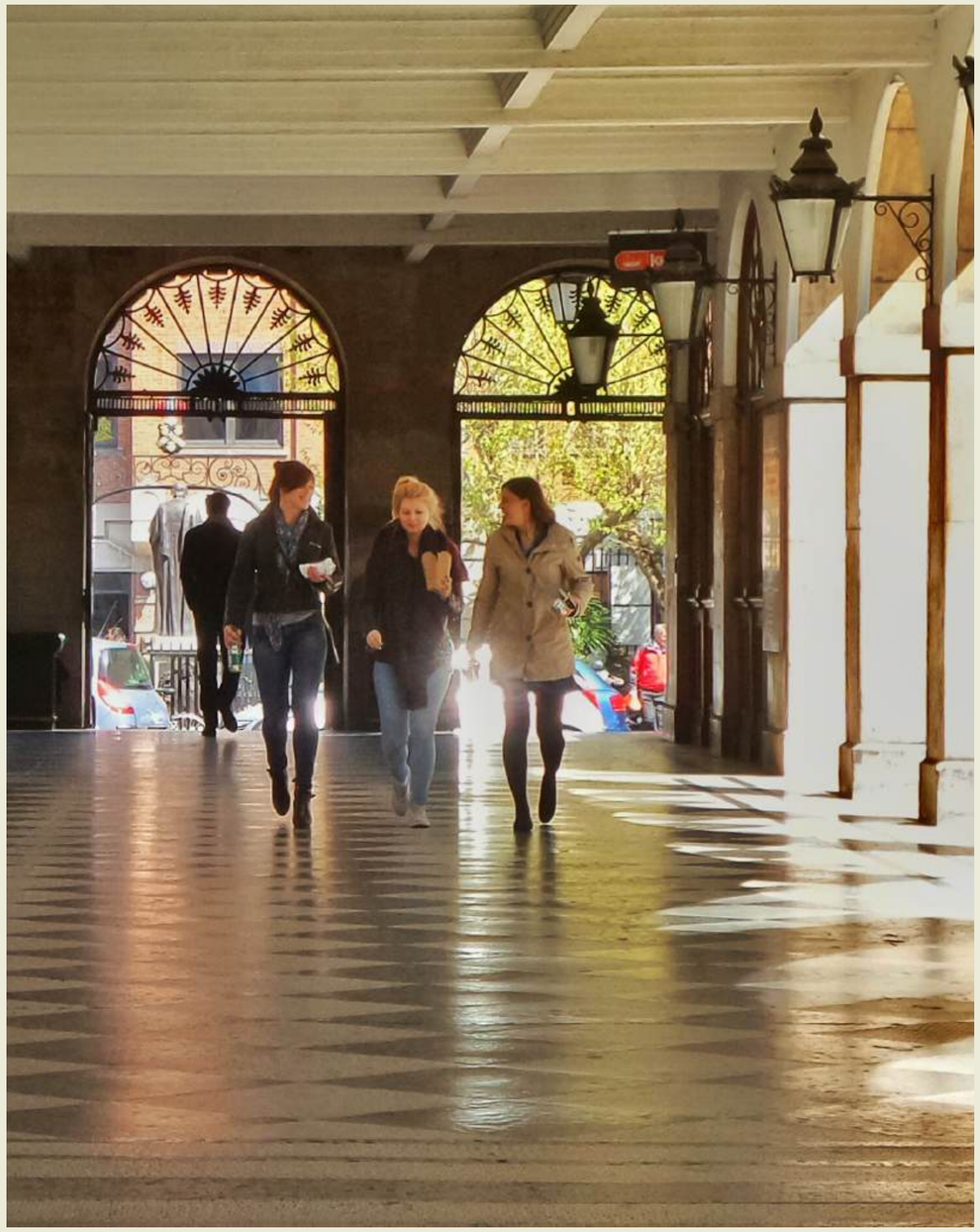
A typical waiting area [C]

Functionality is problematic too. I have seen operating theatres installed in spaces where the ceilings were too low to accommodate normal operating theatre lights, and pharmacy storage areas where pillars have prevented the (now standard) modern robotic dispensing systems from

being installed. All of these issues were partially resolved, but always with more expense involved, which took money away from patient care. One major inspection by the Care Quality Commission congratulated us on what we had managed to achieve despite our unsuitable buildings and spaces. We portrayed our teams as working with high morale in a 'war situation.' But we need a better way. So much more could be achieved if our hospitals were designed for people rather than for processes and for the full gamut of human needs, not just the dictates of apparent procedural efficiency.

It is these instincts of creating hospitals which respond to humans as they really are, not just as a twentieth century time and motion study would like them to be, which underpin this submission. There is a better way to create hospitals for humans. Here's how:

Dr Hervey Wilcox MA, MB, BChir, MSc, MRCP, FRCPath, MBA, LLM



Sunlit corridor in Guy's Hospital [D]

PART I

THE PROBLEM

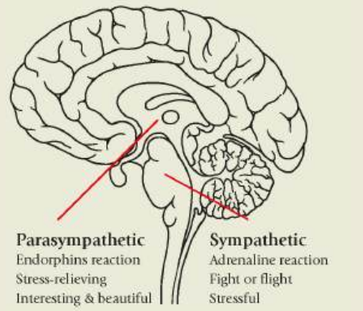
HUMANS ARE NOT MACHINES

CHAPTER 1

TREATING THE COMPLETE HUMAN- THE REVOLUTION IN UNDERSTANDING OF PLACES AND WELLBEING

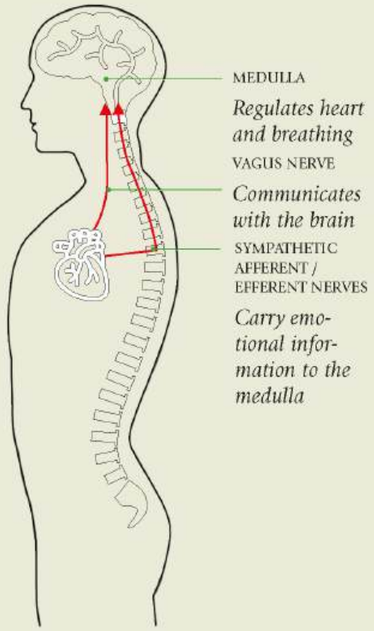
"Architects and designers have a greater ability to improve public health than medical professionals"

Dr. Claudia Miller



Above: The Autonomic Nervous System [E]

Below: Autonomic Nervous System Pathways [F]



Neuroscience has opened the door to a new frontier in which designers are at the forefront of preventative, wellness-centred design. There is extensive research demonstrating that good architectural design has clear psychological and physiological benefits which transcend the mere sense of an aesthetically pleasing appearance. Research has similarly demonstrated a link between poor design and negative physical and mental health. This relationship between design and psychological wellbeing is consequential.

Understanding the benefit of good places on psychological wellbeing, and its physiologic basis, is critical so that we can employ the technological tools we have available to create places that are not only profoundly beautiful but also psychologically beneficial. With health problems such as chronic stress-induced heart attacks, obesity, high blood pressure, depression and anxiety increasingly plaguing the modern world, this has proved unavoidably necessary.[4]

1. Background

A basic knowledge of the central nervous system's structure and function is essential to understanding the physiological basis of psychological wellbeing. During the course of evolution the human forebrain, the centre of executive thinking, planning and emotion, developed to be disproportionately larger than those of other mammals. The forebrain processes information from external stimuli, classifies it as dangerous or harmless, and triggers the proper response which, in the setting of danger, is generated by the more primal portions of the human brain and brainstem.

When mammals experience danger, the sympathetic nervous system (SNS) jumps into action releasing adrenaline, noradrenaline and cortisol, raising the heart rate and blood pressure, opening airways to improve breathing, and slowing non-essential bodily functions.[5] This fight or flight response to threats developed evolutionarily to increase our chances of survival when we're in danger. Once the threat has been neutralised through fight or flight, the parasympathetic nervous system (PNS) starts working to return the body to homeostasis. [6]

THE "BROAD VIEW" PATTERN ELICITS A REST-RELAXATION RESPONSE. THE PICNIC TABLE NEXT TO A CALM BODY OF WATER IS A REST-RELAXATION VIEW/ PATTERN [G]

Threats experienced by our ancestors were episodic coming from factors beyond their control such as predators and inclement weather. Activation of the SNS in those situations was short-lived. For modern day humans, an absence of natural predators and readily available shelter means stressors have shifted radically (work or traffic). While they are not typically life or death situations, our bodies still respond as if they were. Furthermore, many modern stressors never go away, leaving our bodies in prolonged "survival mode", preventing the return to homeostasis. This chronic stress not only leads to the aforementioned physical and mental illnesses, it also causes sustained cortisol release which can prevent cell repair after division, directly accelerating the aging process and shortening life spans.

In contrast to the body's response to stress or threats, when the forebrain identifies pleasurable stimuli, it signals the pleasure centres scattered throughout the brain and brainstem to release a variety of neurochemicals including dopamine, oxytocin, glutamate and endorphins.

Evolutionarily, human brains have been encoded to associate a sense of pleasure with objects and places that increased the chances for survival.[7] For the earliest humans that meant food, water and shelter, all found within the savannah from which we originated.[8] Although most humans no longer live in such pure natural environments, these characteristics have been encoded in our brains.[9] As a result, modern humans still associate shelter and the natural environment with pleasure, albeit in a more subjective manner.

THE REST-RELAXATION VIEW/PATTERN AS SEEN PREVIOUSLY IS OVER-RIDDEN BY THE DANGER PATTERN OF THE LIGHTNING. THIS IS EVIDENCE OF HOW POWERFUL OUR SURVIVAL INSTINCTS ARE [H]

In 1984, Edward Wilson published Biophilia, an in-depth exploration of a concept originally introduced by Erich Fromm. It described modern humans' need to be in contact with nature. Wilson proposed that this necessity was a vestige of the attraction experienced by our human ancestors for all living things, an attraction to which we were genetically predisposed.[10] Eventually, as we became sufficiently cognitively aware to discern a difference between humans and other species, a more specific attraction to our own human species emerged. Nonetheless, remnants of that former attraction to all living organisms remain and continue to elicit positive psychological responses.

Finally, it's essential to understand the importance of patterns created through symmetry in which elements of a similar size and shape are aligned, rotated, reflected, or scaled. When observing an object, we subconsciously compare its intrinsic geometrical components to see if they match (like-object grouping). This is our brain's best effort to analyse something in its holistic form given our inability to scrutinise every detail individually which would result in cognitive overload.[11] Our human "cognitive limit" for analysis is seven components, after which it becomes stressful for our brain to try and remember more. [12]

Patterns in life and in architecture represent consistency and organisation, a lack of chaos. By identifying a pattern our ancestors were better able to predict what came next, thereby improving their chances of survival. Seeing advantageous patterns today evokes a similar physiological 'pleasure' reaction.[13] In contrast, chaos or unpredictability, can cause a negative physiological reaction and even affect our brains' processing capabilities.

Above:Sunflower/Mosta Dome, Malta [I]

Below: Dahlia Flower/ Alhambra Macabre, Spain [J]

2. The Application of Physiology, Psychology and Patterns to Design

The ancient Roman architect Marcus Vitruvius Pollio felt successful architecture was contingent upon "firmitas, utilitas, and venustas" or, in modern terms, "form, use, and beauty." Although individual conceptions of "beauty" vary, the feeling, and physiological response associated with it is universal. Seeing something we define as beautiful causes us to feel a sense of pleasure. Physiologically, this results from the release of dopamine, oxytocin and endorphins.[14] Buildings that provide us with a sense of pleasure are those that incorporate natural and architectural elements our brain recognises as having similar characteristics or patterns to locations that helped our ancestors survive.

We find buildings that incorporate positive symmetries, patterns and the fundamental properties of good design to be more beautiful because our brains have been physiologically conditioned by evolution to associate those components with safety, security, wellbeing and survival. As noted previously, that perception results in the release of oxytocin and endorphins, resulting in a sense of pleasure. This in turn throttles back the negative aspects of the SNS (accelerated heart rate and raised blood pressure), working to restore our body and immune system and return us to homeostasis. This is all beneficial for mental and physical health.

Above: Tree Arcade [K]

Above: Mildred B Cooper Chapel [L]

Above: King's College Chapel, Cambridge [M]

Many critically acclaimed buildings throughout time included patterns that mimic the natural environment from which we came. Nature is one element so crucial that when absent can derail the effectiveness of good design. These positive effects from biophilia are made possible by two distinct factors: a) proximity and visual connection with plants, animals and people; and b) built environments that successfully mimic that natural environment through proper symmetries and patterns.[15]

Antoni Gaudi's La Sagrada Familia, in Barcelona, Spain and Nicholas Grimshaw's Eden Project in Cornwall, England are two such projects that have successfully employed pattens that mimic nature.

Facial recognition is one of the paramount survival adaptations of humanity. It is so critical that 65% of the brain's neuronal structure in a newborn is devoted to facial recognition mechanisms.[16] Clinical studies of facial recognition have found that the brain recognises certain patterns or features that make faces more easily distinguishable.[17]

While architecture can produce positive psychological and physiological responses, poorly designed architecture can do the opposite. Professor Salingaros has noted, "Our bodies signal the absence of natural geometries and structural balance with anxiety and illness".[18] Just as cognitive overload induces stress, so too do environments devoid of information to process. As applied to the built environment, buildings that lack patterns and symmetries either don't register or actively repel us.[19] Facial patterns are bilateral 3-part symmetric compositions. New-borns relax and, through learning and the bonding process, associate this pattern with pleasure. When the pattern appears later in life, the same relaxation, stress-reducing, pleasure reaction occurs as a subliminal response.

The post war baby boom brought an increased demand for residential and commercial buildings requiring rapid construction.[20] This led to the proliferation of small, unstimulating hospitals (i.e., they lacked characteristics that activate our pleasure response) that were thoughtless in terms of floor plan, use of space, or aesthetics. The modern hospital's medical advancements focused much more on diagnostics, treatments and research, and notably required more room.[21] Where medicine evolved, hospital architecture did not, and newfound technologies were thoughtlessly crammed into old floor plans leaving less space for patients.

An increase in material production capabilities yielded cheap, new building products produced in the factories previously dedicated to the war effort. These materials set in motion the post-war aesthetic that characterised many industrial buildings built in the 1950s-1990s. Glass, concrete, aluminium,

synthetics and steel, combined with monochromatic colours, poorly placed windows and an absence of architectural detail produced a unique form of sensory deprivation.[22] Not only did this result in less intellectual stimulation, it also reduced the positive aspects of human touch, creating a cold, unwelcoming environment that lacked the ability to foster wellbeing.

ARCHITECTURE HAS ALWAYS BEEN PREOCCUPIED WITH ITS PRIMEVAL CONNECTION WITH NATURE AS EXEMPLIFIED IN THE ILLUSTRATION TO THE FRONTISPIECE TO "ESSAI SUR L'ARCHTECTURE" BY MARC-ANTOINE LAUGIER 1755 KNOWN AS "THE PRIMITIVE HUT". DESIGN BY CHARLES EISEN [N]

Such inadequately constructed buildings and poorly designed settings have had a significant negative societal impact. In 1926 the U.S. Supreme Court declared public (physical) health to be a fundamental responsibility of local governments, thus allowing governments to legally regulate land use. The World Health Organization (WHO) later expanded the concept of public health to encompass mental and social wellbeing in addition to physical health and the absence of disease.[23]

Sagrada Familia, Barcelona, Spain ©

Both city planning and the architecture of individual buildings that comprise the urban built environment are essential to the protection of public health. Studies have shown that battered neighbourhoods with dilapidated buildings make us feel unsafe, creating a sense of anxiety by activating our SNS.

In Cognitive Architecture: Designing for How We Respond to the Built Environment, Sussman and Hollander argue that humans are generally healthier when their built environment contains a variety of independent shops and unique spaces rather than concrete buildings and repetitive chain stores.[24]

Neuroscientist Colin Ellard's research went further. He monitored skin conductance and electrodermal responses to emotional excitement in participants led down two city streets. The first included a large, generic Whole Foods building; the other included a plethora of unique shops and lively restaurants. He found the former environment resulted in the lowest arousal level of the study, while the latter produced a high level of excitement.[25] The kind of disengagement Ellard found is undesirable from a psychological perspective. Studies conducted by Merrifield and Danckert suggest that even small amounts of boredom can induce stress.[26] These results led Ellard to conclude: "The holy grail in urban design is to produce some kind of novelty or change every few seconds, otherwise, we become cognitively disengaged."[27]

Despite our ingrained affinity for natural environments, too much nature can evoke a stress-type response similar to our response to too much uniformity in buildings. Russell and Lanius developed a model to identify the preferred balance of built and natural environments through positive physiological responses. Their model breaks down the possible emotional reactions to environments into four categories: arousing versus not arousing, and pleasant versus unpleasant.[28]

Russell and Lanius found that when an environment is arousing but unpleasant, we feel tense; when the environment is unpleasant but not arousing, we feel unstimulated and bored. Both cases cause stress and SNS activation. When environments are pleasant, they can either be arousing (making us feel excited and stimulated, causing chemicals like oxytocin to be released), or not arousing (making us feel pleasantly relaxed and at peace, helping our PNS to run smoothly). Being too extreme on either side of the arousal spectrum is uncomfortable. This generates a physiological response that causes us to seek either arousal reduction or sensory enhancement. Humans therefore seek out built environments that they find to be most pleasant and least stressful.

3. The Restorative Impact of Architecture

As noted, good architectural design finds much of its influence in the symmetries and patterns of nature. The stress-reducing capabilities of those designs are a direct result of our brain recognising visual similarities to nature and to patterns that allow smooth information processing through like object grouping. But the beneficial impact of natural design elements goes deeper than an improved sense of psychological wellbeing.

Restorative environments are those that foster restorative processes.[29] Merely being in contact with nature and these environments is enough to set this process in motion. Such

restorative effects were clinically demonstrated in several studies conducted by Roger Ulrich. In one, Ulrich demonstrated that simply viewing pictures of nature can lessen the effects of exam-induced stress.[30] In another, Ulrich demonstrated shorter post-surgical recovery times for patients in hospital rooms with a window overlooking a small stand of trees compared to patients recovering in a room with a brick wall in place of the window.[31]

A third study analysed the physiological effects of a stress-inducing 10-minute black and white video displaying industrial accidents. Following the initial video, one subject group viewed a 10-minute colour video displaying everyday nature, while the second watched a 10-minute colour video of urban areas. The participants exposed to the nature video experienced an increase in positive feelings and were found to have lower blood pressure, muscle tension, and skin conductance levels; the urban scenes failed to produce any of these positive physiologic effects. [32]

Typcial cloistered courtyard in Venice [P]

Knowing the restorative effects that come from human interaction with nature, it follows that places that incorporate the natural environment can facilitate similar restorative effects. Turning our personal shelter into a natural environment provides us with refuge (a safe sheltered place) and prospect (an unobstructed view of the surrounding environment).[33] Similarly, tamed nature appears to be reassuring to many of us: avenues rather than wild forest, parkland with a folly in it.

Incorporating findings such as Ulrich's into the building process today is simple, although the degree to which this incorporation

is possible will depend on space and available resources. In the most basic form, having windows with a view of nature is easily done. When unattainable, in a city for example, simply adding pictures of nature to one's environment can produce similar effects. When resources are bountiful, buildings that have large windows or glass walls permitting an unobstructed view of nature or indoor plants will be the most beneficial at producing the desired psychological benefits.

4. Implications for hospital design

Our lived environment, good and bad, has a substantial psychological impact on humans. Well-designed places that have greenery and that use successful geometry, symmetry and patterns are an infallible method of evoking a pleasure response, activating our PNS, returning us towards homeostasis and thus having a positive psychological and physiological impact. Poorly maintained places make us nervous and fearful, while dull repetitive places bore us; both cause a physiological stress response and take us out of homeostasis.

Fortunately, this growing body of cognitive research regarding the positive and negative impacts of design make "bad design" avoidable and correctable. The creation of new hospitals should not simply avoid these negative attributes but should both:

- Work to counteract them by incorporating the elements of restorative design; and
- Test their effectiveness prior to using limited resources.[34]

Amongst the patterns which researchers associate with nature are:

- Light. Natural sunlight is not just essential to perceive and evaluate our surroundings:
  a. Our skin requires sunlight;
  b. Various organs require sunlight (eyes and skin); and
  c. Circadian rhythms are regulated by sunlight.
- Colour. Harmonious pigmentation generates a healthy effect:
  a. Harmonies in colour affect people's psychological mood; and
  b. Colourless surroundings are associated with illness, decomposition and death.
- Gravity. All objects in nature exist in gravitational equilibrium. We feel and relate to balance through gravity:
  a. Our brains naturally compute gravitational balance of forms; and
  b. Reducing scale in objects as your gaze rises, reassures our body of the gravitational balance around us thus reducing neurological stress.

- Fractals. Geometrically linked structures being linked at various levels of scale. Self-similar geometries are present in trees, bushes, animals and human beings, linking us cognitively to nature's structures. This in turn creates a relaxed neurological processing state.
- Curves. Curved forms are found everywhere naturally. One of the primary forms that humankind evolved with is curvature in the human body. We know these as non-threatening, pleasure-inducing forms that lower stress.
- Detail. At arm's length or closer.
  a. Highly organised complex detail is visible and touchable throughout nature;
  b. Our sense of touch is important to recover information about materials;
  c. Subliminal communication depends on reading of details to help determine if it is safe and pleasurable; and
  d. Detail allows neurological processing that is innate in humans bringing improved relaxed processing and lower levels of stress.
- Water. Most of us find the presence of water to be pleasing, relaxing and healing.

Similarly, the human preference for bilateral 3-part symmetry implies the use of various patterns at difference scales within a structure. These include:

- Long view symmetry longer than an arm's length such as at the end of corridor, upon entering a room, lift or lobby, across a courtyard or upon entering a building
- Medium view symmetry at arm's length such as wall, floor or tile patterns, placement of artwork, bath fixtures, furniture layout, windows and door deign and cabinet design
- Short views at less than an arm's length such as wall and floor tiles, furniture design, accessory arrangement and door details.

* * *

The next chapter explores the practical implications of this evidence for wellbeing-maximising hospital design. It examines peer-reviewed research of the benefits of using some of these patterns in actual hospitals. Sadly, too much of this evidence is still being routinely ignored. A twentieth century 'factory for fixing' approach continues to dominate hospital design.

CHAPTER 2

HOW TO CREATE COMPLETE HOSPITALS FOR HUMANS - A REVIEW OF THE EVIDENCE

'You get caught in bad traffic, then you need to find a parking place, then you need to rattle around finding change as you don't want to get a ticket, then you get lost in the hospital, then you need to stand in the waiting room and then the first thing the doctor or nurse says is "Let's take your blood pressure.'

Daniel Leveson, Buckinghamshire Healthcare NHS Trust

'The building's structure itself must be healing if it is not to induce anxiety.'

Professor Nikos Salingaros

AL MANSUR QALAWUN COMPLEX, CAIRO, 1284-8. THE COMPLEX, WHICH INCLUDED A HOSPITAL, REFLECTED ITS IMPORTANCE THROUGH VISUAL DISPLAYS OF BEAUTY [Q]

Plan of Al Mansur, Qalawun Complex Cairo with integrated Courtyards [R]

1. Historical and staff survey context

Although they lacked the knowledge of scientific medicine, historically hospitals by culture and continent instinctively reflected many of the components of wellbeing enhancing design whilst also reflecting their important purpose through public displays of architectural quality

These cultural tenets held during the nineteenth century as, slowly and painfully, modern scientific medicine based on empirical observation was born. During the twentieth century, however, this principle was gradually abandoned. Instead of proclaiming their high moral purpose to their surroundings,

St Thomas Hospital, Lambeth. After [S] and Before [T]

hospitals' measurable functionality and, above all, cost became an architectural feature in itself, transforming the hospital as a building type.

Not only did this change profoundly affect the physical nature of the buildings, it also impeded the quality of care, despite wider advances made in scientific healthcare. In striving for readily provable efficacy, we forgot that humans are not machines. We threw out the baby with the bathwater. As one of the pioneers of the study of hospital's effect on their patients' health, Professor Roger Ulrich, put it; *'This desire for functional efficiency, together with the pathogenic conception of disease and health, has helped to produce healthcare facilities with environments starkly institutional, stressful, and detrimental to care quality.'*[35]

Royal London Hospital, Whitechapel. After [U] and Before [V]

Our indicative hospital stuff survey (see appendix 2) discovered very high levels of concern about hospital design and functionality:

•Only 8% of staff surveyed felt that the physical environment of hospitals had a positive effect on patients. 53% felt it had a negative effect.

•Only 12% of staff surveyed felt that the physical environment of hospitals had a positive effect on their personal productivity or mental or physical health. 57% felt that it had a negative effect.

This is clearly not good enough. New hospitals need to move from a 'factory for fixing' to a 'places for healing' approach. Here's how:

2. Create hospitals for clinical outcomes and patient experiences

What does the evidence suggest makes for healthier and happier patients?

Create gardens that patients cannot just see but use. The evidence suggests overwhelmingly that hospitals should integrate gardens and greenery into their design. Evidence is mounting that nature (be it gardens, water, a fountain, even the rhythm of natural light) is an especially effective and beneficial setting for fostering restoration for patients, family members, and staff.

Little Cloister, Westminster Abbey [W]

- Clare Marcus and Marni Barnes 1995 research into four healthcare gardens in the San Francisco Bay area found a clear correlation between stress and gardens. Interviewing 143 users they found that 78% of respondents felt calmer and less stressed when exposed to a pleasant garden.[36]

- A carefully controlled study of 46 patients in two hospital wards found that gallbladder surgery patients assigned to a room with a window view of a natural setting had shorter postoperative hospital stays compared to patients in similar rooms with windows facing a brick building wall (7.96 days, compared with 8.70 days).[37]

The walled garden at the new DMRC at Stanford Hall near Loughborough is not there only to be seen, patients and staff can spend time there enjoying nature and gardening. [X]

Patients also self-report the same phenomenon.

- A 2001 San Diego study found that users of a children's hospital garden disliked and avoided areas having a high percentage of concrete ground surface and starkly built features.[38]
- A 2005 San Francisco study found 59% of the 143 patients that used the hospital's garden found trees and plants were the most important factors in improving wellbeing and calming senses.[39]
- The Horatio Garden at the Duke of Cornwall spinal treatment centre at Salisbury District Hospital offers an exemplary facility. In a recent survey about the flower rich rooftop garden, 100% of participants said that it improved their sense of wellbeing. "You can see the earth, and you can see sky overhead, and just all these things are so much part of the life that I had before".[40] One doctor told us in our staff survey, 'We are so lucky at Salisbury to have Horatio's Garden, it's a beautiful tranquil space.'

Bayezid II Health Museum Hosptial Courtyard [Y]

Hospital de Santa Cruz, Toledo [Z]

They may not have had modern carefully controlled studies. Over many centuries those who create hospitals have instinctively known this to be true. In the Middle East, South America and North Africa, the traditional design of a central courtyard, provided not only shade from the harsh sun but also a calm and relaxing environment for patients to enjoy. In the UK, during the first world war, the important function of gardens was recognised in the rehabilitation of patients. Greenery was an essential feature for many auxiliary hospitals and convalescent homes providing injured soldiers with a sense of place and serenity after the horrors of the war.

Steps have been taken recently in Britain to improve access to greenery. However, efforts still appear to fall behind best practice elsewhere. The Khoo Teck Puat Hospital in Singapore integrates greenery into design at a monumental level. In total, there are 15 gardens across the site, with planters offering over 700 species of native plant and a continuous green view for patients and staff. "I felt so relaxed' said one patient".[41]

Create wards with windows and natural light not just piped air. According to the architectural historian Jeanne Kisacky, until the 20th century, every single room within a hospital typically had access to the outdoors.[42] By the late 19th century this changed. Advances in germ theories and technological advances of artificial ventilation models and later air conditioning systems, meant that windows no longer played the irreplaceable role they once did.[43]

Khoo Teck Puat Hospital, Singapore [AA]

However, there is a growing body of work to suggest that these artificial systems are worse for patients.

- In 2012, research at Oregon University found that although keeping a window open increased the range of bacteria in a room, the level of harmful bacteria was actually higher in hospital rooms where windows remained sealed.[44]
- A 2007 Peruvian study also found that wards built more than 50 years ago, with large windows and high ceilings, had better ventilation than modern rooms. When analysing the spread of Tuberculosis (TB) within hospitals, the study estimated that in mechanically ventilated rooms, 39% of susceptible people would become infected after 24 hours of exposure to an untreated TB patient. This compared to a 33% infection rate in modern rooms with windows open and 11 percent in a pre-1950-style room.[45]

- Twentieth century thinking also failed to recognise the wider benefits windows offer. Research at the Department of Neuropsychiatric Sciences at Milan University found that patients with bipolar disorder assigned to brighter, east-facing rooms with morning sunlight had hospital stays nearly four days shorter than those with west-facing rooms.[46]
- By controlling the body's circadian system, exposure to natural light reduces patients' depression, decreasing length of stay, improving sleep and lessening agitation. At least 11 robust studies have found this. In one comparative study of a cardiac intensive-care unit, patients stayed a shorter time (2.3 days) in sunny rooms than in dull rooms (3.3 days). Astonishingly, mortality was also 60% higher in dull rooms (12% or 39 out of 335) than in sunny rooms (7% or 21 out of 293).[47]

St Bart's Hospital, London [AB]

Create attractive variety in a pattern. Too many modern hospital layouts are bland and sterile. Not only are all the rooms the same but the corridors that lead to them and the doorways that enter them are normally undifferentiated. The sensory and aesthetic experiences of patients are not held to be crucial to their treatment and recovery. However, the evidence suggests that this is a mistake.

Studies suggest that environments that lack positive distractions cause patients to focus increasingly on their own worries, fears or pain.[48] 'Positive' distractions can take different forms from art, internal layout, furniture and even the use of colour on walls. For example, research at the Chelsea and Westminster Hospital found that over four fifths of 50 women undertaking colposcopy examinations said that having visual art present "greatly improved their anxiety and experience." [49]

- A 2000 study by Romedi Passini from the Montreal University found links between the local environment and the behaviour of patients with Alzheimer's disease. Four of the six participants experienced difficulties in finding their room, when corridors and doors all looked similar. The research highlighted that monotonous interiors reduced patients' ability to navigate a space, increasing anxiety. In contrast, a simple, yet 'articulated' environment, with frequent visual reference points, improved their navigational abilities. [50]

- However, complexity can go too far. Though not in a hospital setting, a 1981 study into the relationship between humans and their environments is instructive. It compared 73 students' ability to navigate in two buildings at Michigan University. Participants' ability to comprehend and navigate interior spaces was enhanced by regular geometric shapes. 40% got lost in the chaotic and unstructured Chemistry Building. Only 13% did in the Modern Languages Building which was more structured without being sterile. [51]

- Hospital environments which inpatients find attractive will also encourage more physical activity which will aid recovery. In one study, following environmental changes, men who reported increased perception of neighbourhood aesthetics were 2.25 times more likely to walk more than those who did not. Each additional neighbourhood feature perceived to have changed favourably was associated with increased walking for transport by 3.0 minutes per week and increased recreational walking by 2.2 minutes per week.[52]

Health workers we have spoken to have agreed that we need to do better. As one experienced hospital doctor put it to us: "*Why would you want to go into a hospital. They are such depressing places.*" We should create attractive hospital interiors with variety in a pattern. Maggie's Cancer Care Centres, for example, have been designed to be as un-institutional as possible, with light, art, space and warmth. The heart of the centre is always the informal kitchen area.[53]

Temple of Flora, Stourhead [AC]

Create calmer and quieter environments. In the UK, 40% of hospital patients are bothered by noise at night, according to in-patient surveys.[54] This is too high. A doctor at the Royal Hampshire told us in our staff survey, 'the sleep of patients is always poor due to noise. To ensure this is improved would be great.'

- Most findings suggest that noise detrimentally affects us, for example producing sleeplessness and elevating heart rate. Several studies have focused on infants in intensive care units, finding that higher noise levels elevate blood pressure, increase heart and respiration rate, and worsen sleep. [55]

- Similarly, there is growing evidence to suggest that private rooms save more money than they cost. They reduce noise, decrease bacterial infections by half and reduce the length of patients' stays in hospital by 10%.[56]

Maggie's Centre, Edinburgh, designed by Richard Murphy [AD]

- Furthermore, studies suggest that the increased cost of single-occupancy rooms is more than offset by the money saved due to fewer infections. The Department of Design and Environmental Analysis at Cornell University evaluated the financial feasibility of this type of investment, calculating the net financial gain (or loss), taking into account all resources invested and amounts gained over the five-year analysis period. Invested resources included the money for building the single-bed rooms, along with their annual operating expenses. The amounts gained included the costs avoided each year by reducing nosocomial infections. The research found that cost savings from the reduction of nosocomial infections in single-bed rooms in this case substantially outweighed additional construction and operation expenses. The mean value of internal rate of return over a five-year analysis period was 56.18%. [57]

- Single rooms with movable walls will also permit more privacy in doctor-patient conversations and greater adaptability.

3. Create hospitals in which staff love to work

It is easy to focus too heavily on patients' needs, forgetting the people that actually use the space on a daily basis. Doctors, nurses and other health professionals need to be healthy and upbeat too. Better staff engagement, which can be influenced by physical environments, has been associated with reduced staff absenteeism and turnover, higher patient satisfaction and lower mortality and infection rates.[58] This is clearly a major problem at present, particularly after the travails of the COVID pandemic. One doctor in Oxford told us that her department only has 20% of the staff they had two years ago due to poor working conditions, frequent resignations and an inability to recruit.[59] A senior doctor added, 'We rely heavily on temporary staff of variable quality and at high expense.' Clearly improving staff retention and engagement is important. Physical environment is part of this.

Too many hospitals do not optimise their staff's wellbeing. What does the evidence suggest makes for healthier and happier staff? The good news is that the type of environment which is good for patients seems to be pretty good for those who work in the hospital as well.

Staff need greenery and natural light too. The need for greenery is just as relevant for a staff member as for a patient.

- Evidence has begun to appear showing that hospital gardens increase staff satisfaction with the workplace, and may help hospital administrators in hiring and retaining qualified personnel. [60]

- One Norwegian study, undertaken in an X-ray ward, reported the effect of installing 25 groups of green plants along with full spectrum daylight bulbs. This intervention was associated with reductions in sick leave (25%), tiredness (32%), headaches (45%) and sore throats (31%.)[61]

- Natural light is also good for hospital staff. As one young doctor at Northwick Park hospital put it to us in our staff survey, 'please can we have some windows, preferably ones that open!' A hospital administrator in Truro urged the importance of 'good ventilation.' They are quite right.

- One study of 141 Turkish nurses found that exposure to more natural light reduced stress. Those with more than three hours of daylight exposure during their shift had higher job satisfaction and less stress than staff with less daylight exposure.[62] In another study, 70% of staff reported that more natural light had a very positive or positive impact on their work life.[63]

- Good lighting can also reduce errors. One American study found that medicine dispensing error rates fell from 3.8% at 450 lux to 2.6% at 1,500 lux.[64]

- The good news is that we are starting to do this. At Great Ormond Street Hospital for example, gardens have been specifically designated for staff members in order to reduce stress.

Create calmer and quieter environments. Just as patients respond to natural conditions, so do staff. It is not uncommon for doctors and nurses to have to work 12-hour shifts. This highly pressured role means therapeutic environments are crucial. Sadly, the evidence is that too many of the hospitals that we have built over the last few generations have not provided this. As one doctor working in Charing Cross Hospital (built in 1973) told us: *"There were some days when I felt physically unwell just from being in the hot stuffy doctors' room with no window, no air, and horrible smells."*

Charing Cross Hospital, London [AE]

This is supported by increasing evidence. Noise levels have been shown to be a distraction and stressor for staff, resulting in reduced productivity. One study of 100 nurses within a critical care unit revealed that noise-induced stress could account for 6% of headaches at work. The results indicated that telephones, alarms in equipment, and the beeping of monitors for patients were identified as annoying.[65] In one study nurses whose duties moved to a new hospital wing with more private rooms, more staff areas, more natural light and better views of nature experience 17% less stress, 16% more job satisfaction and a 34% higher perceived service quality to patients.[66]

wIn short, whether it's a garden or comfortable break room, staff should have somewhere where they can escape briefly from the demands and stresses of the workplace. This is certainly something respondents to our staff survey suggested. 'Improved staff facilities have a positive impact on staff wellbeing' advised one nurse at the Buckinghamshire Healthcare NHS Trust.

Create environments for physical health – permit stairs as well as lifts. Hospitals' internal arrangements are also important in promoting health. Lifts are clearly necessary in hospitals for speed and for the many unable to use stairs. However, their confined space and their reliance on buttons present a clear risk of cross-infection. One Canadian study found that there was a greater bacterial prevalence near lift buttons (61%) than on lavatory surfaces (43%).[67] One experienced hospital doctor has observed, "I always worry about lifts and infection." By contrast, for those who can use them, stairs are provably good for you. Their frequent use is associated with improved physical health. Multiple studies show this in office buildings.[68] This has also been shown to be true for the elderly, for whom, like patients, their use is normally discouraged. A remarkable three-year longitudinal study of older residents in Miami found that:

"Elders who resided on blocks with more front porches, stoops [a small staircase leading to platform and front door] and buildings built above ground had significantly better physical functioning at 24-month follow-up than did elders who resided on blocks with fewer of these architectural features." [69]

As well as large lifts for those who need them, hospitals should have prominent staircases in the same place in each storey. Their frequent use will aid staff's physical health, probably retard infection and also help those recovering patients who are able to use them.

Architecture matters. The physical environment around us plays a role in our behaviour and wellbeing whose importance is increasingly being recognised by academics and in public debate.[70] This matters in hospital design as well. As one NHS doctor put it to us: *"The building I currently work in is really run down and depressing …. It would definitely help with happiness and wellbeing if it were nicer"*

Former Buxton Hospital, Derbyshire [AF]

Another very experienced clinician and hospital manager said: '*All the buildings I have worked in have different problems. The thing they all have in common is that they are not places where you would want to spend time.*'

The wider evidence suggests he is not alone in feeling this. In 2004, the Commission for Architecture and the Built Environment (CABE) conducted a research project into the role of hospital design in recruitment, retention and performance. The survey of 265 directors of nursing, across the UK, found that 35% of respondents regarded the reputation and design of a hospital as a major consideration (very important or important) for nursing staff when deciding where to work. During this review some thought that low-rise hospitals were better than high-rise ones. While nurses also discussed the concept of the 'village atmosphere' in which nurses felt part of the bigger corporate body rather than just a unit within the body.[71]

Productivity and retention. What might be the cumulative effects of these improvements in their environment upon staff productivity and retention? It's hard to be certain but studies estimate anything up to 15%. The best sourced and most credible study is a little more cautious finding a range of between 0.5% to 5%. Even at the lowest end of this range, these are material productivity improvements across the total of hospital staff.[72]

4. Create hospitals that support wider health and of which communities can be proud

How can hospitals support the provision of wider health and social care? What does the evidence suggest on what type of hospitals communities prefer and on what hospitals should mean to their town or neighbourhood? And how should we work with neighbourhoods to create them?

Above: University College Hospital old building [AG] *and new building* [AH]

Below: The new Royal Liverpool Hospital, Liverpool [AI]

Carve hospitals with civic pride. *"Why can't they make them like this anymore?"* one NHS professional told us, talking about Warneford Hospital, East Oxford, built in 1826.

Somehow, somewhere, we have lost not just the ability but even the desire to create public buildings of beauty and moral worth. The issue was starkly highlighted by the evidence that Anna Mansfield gave the Building Better Building Beautiful Commission in 2019. [73]

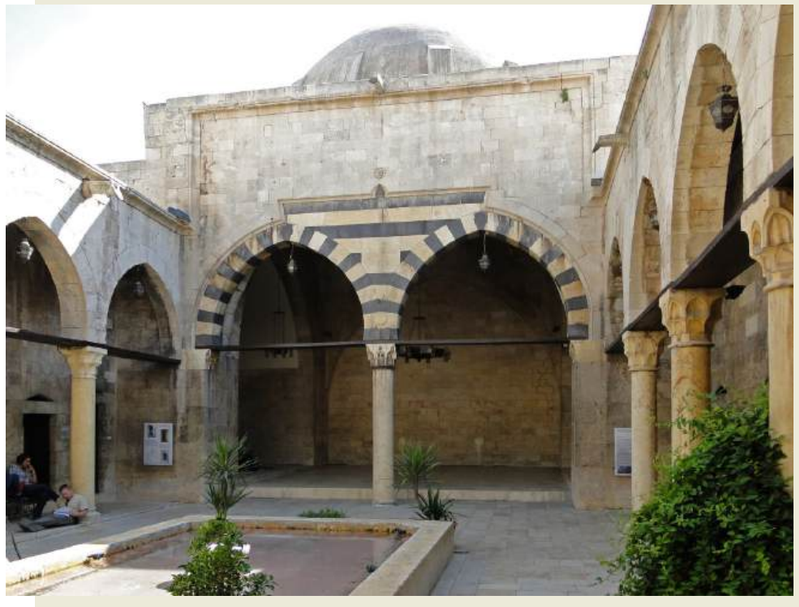
"I was working on a PFI project ten years ago, and we were told by the contractor to put in a more expensive material that looked cheaper, because there was real sensitivity about anything in the NHS looking expensive."

This is ridiculous, Kafkaesque. A hospital is a noble building built for a noble purpose. It should not be built to look disposable and cheap. It should be built to last. (This will also be more sustainable – see chapter 3). We should rediscover the confidence and ability to create hospitals, indeed all public buildings, of popular beauty and civic pride. This is why *Living with Beauty* found consistent praise for the quality of Victorian as opposed to more recent civic buildings. Medieval churches

or Victorian town halls were normally the tallest and the most elaborate buildings in their towns or parishes. The NHS plays a similar cultural role today. Our aspirations should be equally high.

- Deborah Davidson in her research into the community value of hospitals states that they 'engendered a deep sense of ownership and connectedness, because they were embedded in community history, civic pride, family values and personal significance: *"I was born on this land here where the hospital is now sited [. . .] and I've lived here ever since".*[74]

- These places are highly important not only for their personal significance but what that actually means to us as human beings. Neurotheological research by Dr Andy Myers on behalf of the National Trust has established that people's brains respond positively to places that have personal meaning to them. Of 20 participants tested 78% reacted strongly under a functional MRI scanner to such places. 65% of those surveyed said these places made them feel calm, providing an escape from everyday life. [75]



Bimaristan Arghun Al-Kamili Hospital, Aleppo [AJ]

Why is it therefore that we fail to recognise this significance in contemporary hospital design? Older designs such as the former Exe Vale Hospital embody this immense importance through outward displays of architectural quality, creating both a sense of place and an institution of which communities can be proud.

How, then, should we design hospitals? Research by Elizabeth Bromley, for the University of California, into hospitals in the US exposed some key fundamentals, "the beauty of the architecture is, there's nothing "hospital" about it". A hospital should be an "impressive and prestigious building" on a "human scale" to "project hope, healing and human-ness."[76] This should be the mantra for any new hospital. Instead of merely copying cheap and disposable design models developed for cheap hotels and shopping malls, the architectural quality should reflect the highly prized community asset that it is.

Design places with human scale, coherence and complexity, variety in a pattern and some symmetry. Too many contemporary hospitals are bland and monotonous. However, as we have seen, there is a growing body of neuroscientific work to help us understand exactly what type of environments we prefer – and why. This has direct consequences for hospital design. We prefer engaging and varied buildings that are recognisable, have some level of symmetry, meaning and coherent complexity. We need variety but not chaos, structure but not obsessive repetition – variety in a pattern. To cite just a few studies:

Weihai Hospital of Traditional Chinese Medicine, China, [AK]

Create engaging facades. Research by Colin Ellard and the BMW Guggenheim Laboratory in 2011 established a link between engaging architecture and excitement levels. When testing 134 participants, through 'galvanic skin response', the research found that people were, on average, more excited around engaging with varied facades (2.8 out of 5) in comparison to long blank facades (2.1 out of 5).[77]

Create symmetry. As human beings, we are naturally drawn to symmetry. A 2006 study by Michigan State University, in cognitive science and neurology, used functional MRI to investigate the relationship between symmetry and aesthetic preferences. Both metabolic and behavioural findings showed that 66% of the symmetric items were judged to be beautiful compared to 42% for non-symmetric items.[78] This idea of symmetry was a hallmark of much 18th and 19th century hospital design. Architectural features were designed to be symmetrical offering engaging and pleasant environment at a human scale.

Above: Guy's Hospital, London [AL]

Maggie's Centre, West London, designed by Richard Rogers [AM]

The power of colour. The importance of colour should also play a role in the design of buildings both externally and internally. Professors Adams and Osgood conducted a study on 23 groups of 40 secondary school students, from 20 different cities around the world, to assess the 'mood music' of colour. It found that, on a scale from 0 (low) to 7 (high), blue was preferred and associated with positive feelings (such as familiarity). Blue had an average rating of 5 while red and yellow had average ratings of 0.1 and 0 respectively. By contrast, red was the highest rated in terms of activity, with an average rating of 4. Our brains find red exciting and arousing and blue relaxing, generating strong emotional reactions that can be related to our built environment.[79] A senior doctor at Oxford University Hospital replying to our survey recognised the importance of this: 'even nice coloured walls and some art would improve things a lot!'

Create reassuring enclosures. Enclosed courtyards are a popular design feature in Middle Eastern and African hospital design and there is evidence to suggest why. More enclosed spaces tend to be more popular then less enclosed spaces. We also tend to feel safer and find them more attractive. Cognitive researchers have shown why. The parahippocampal cortex (an area of the brain) is extremely responsive to enclosure. For example, in one study, seven adults were asked to look at the image of a checkerboard, with edges that were either clear or obscure. People were measurably more stimulated when they were looking at images with clearer edges, which they found more pleasant.[80]

Above: The Cloister at St John of Jerusalem Eye Hospital, in Jerusalem, built 1965 by J. E. Simpson [AN]

In principle, we know what to do. However, we appear to struggle to carry it out. As the architect John Weeks concluded *"physically a human hospital should be architecturally familiar, nicely decorated, and made of brick with a lot of flowers and wood inside and lawns and trees outside. It has a pitched roof and ordinary sized windows."*[81] He was right.

Above and below: Co-design new places and buildings with communities, not at them [AO]

Design with communities not at them. Consistent research shows that residents are more likely to support development if they can influence it. People's involvement in design makes for better places which are better anchored in and supported by their neighbourhoods.[82]

We should therefore re-discover civic pride in public architecture not just as an outcome but as a *process*. New hospitals, particularly Primary and Secondary Care hospitals which will normally need to be more embedded in their communities, should be popular, and beautiful sources of civic pride. Their procurement process should:

- State clearly in their aims that beauty and popularity with the local population are key elements of the design brief;
- Involve the design teams following protocols described in the Building Better Building Beautiful Commission report, *Living with Beauty*;
- Involve polling on local popular design preferences; and
- Seek to make use of the emerging 'science of place' on the likely impact of different design approaches on metrics such as patients' health, resident happiness and air quality.

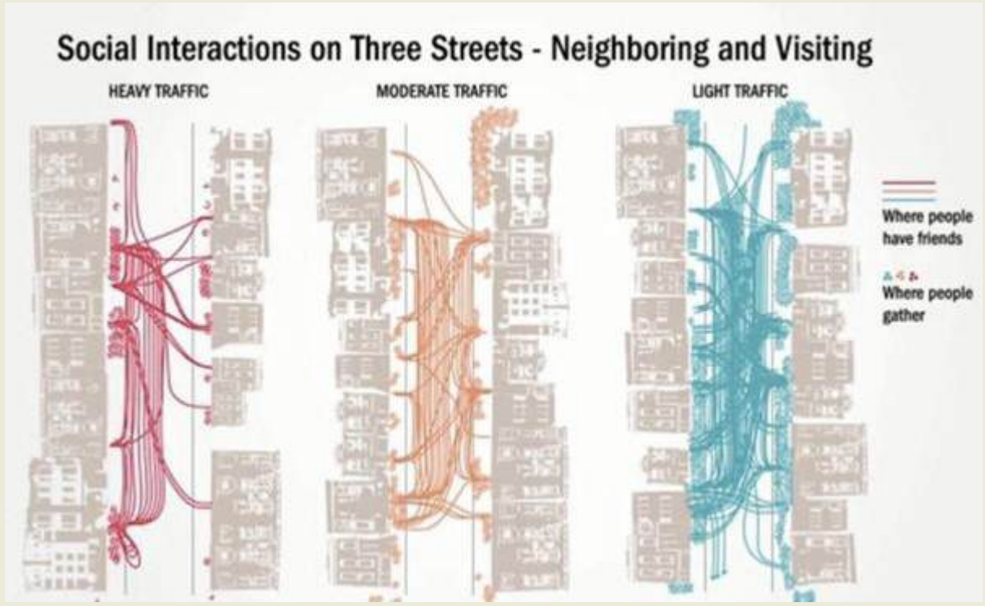
Throughout, public engagement, citizen involvement in scheme selection and data on local preferences should axiomatically underpin the process to avoid some of the major errors of the last 50 years in public sector procurement.

Encourage less traffic and cleaner air. There is a robust corpus of evidence linking over-exposure to traffic with bad health outcomes. This is true for people living and working in a neighbourhood as well as for drivers. One summary concluded:

'While considerably strengthened in recent years, the link between air pollution and respiratory health was established years ago. Breathing higher concentrations of CO, VOC, fine particulate matter (< 2.5 microns) and other emissions released from tail pipes has consistently been shown to induce detrimental health outcomes. More specifically, concentrations of ozone in excess of 80 parts per billion sustained over an 8-hour period has been found to reduce lung capacity, increase instances of severe asthma, and in certain cases, impact life expectancy. Recent evidence also shows how increased exposure to fine particulate matter can trigger heart attacks amongst the elderly and other at-risk populations.'[83]

Interior of common room at the DMRC [AP]

Heavy vehicular traffic also has a malign impact on social connectivity and neighbourliness – both of which we know to be associated with wellbeing. The best-known study of the impact of traffic on neighbourliness found that on busy vehicular streets people know far fewer of their neighbours particularly from the other side of the carriageway. These were mapped as shown.



Levels of traffic and social interactivity, San Francisco (1972) [AQ]

The researchers wrote of the lightly trafficked street: 'Front steps were used for sitting and chatting, sidewalks by children for playing.' However, the heavy street 'was used solely as a corridor between the sanctuary of individual homes and the outside world. Residents kept very much to themselves so there was no feeling of community at all.'[84] This study was replicated in Bristol in 2008.[85]

As far as possible therefore, hospitals and their immediate neighbourhood should be traffic free. Patients and staff will breathe cleaner air. And this will support higher levels of interaction within the hospital community.

Create positive spill over effects into the surrounding community. Hospitals are 'anchor institutions' within a neighbourhood. They should be in situ for hundreds of years. They are profoundly invested in the health and wellbeing of their communities. Wherever possible, therefore, the creation of a hospital should be used as the catalyst to improve the surrounding built environment for everyone's health and wellbeing.

One obvious way would be creating green corridors so that staff and visitors can readily and safely reach the hospital by active travel along a pleasant, attractive, green and safe route. Another is by planting street trees in neighbouring streets. For an incredibly modest budget increase, this will create measurable benefits for the hospital itself but also for neighbours.

Street trees are associated with slower traffic and fewer accidents.[86] They improve air quality.[87] They moderate heating and cooling energy use.[88] And people aesthetically prefer streets with trees in them.[89] Above all, and perhaps astonishingly in the complexity of human life, street trees have a measurable effect on human health even taking into account income, age and education. One recent London study found an association between the density of street-trees and the rates of antidepressant prescribing:

'After adjustment for potential confounders … we find an inverse association, with a decrease of 1.18 prescriptions per thousand population per unit increase in trees per km of street (95% credible interval 0.00, 2.45). This study suggests that street trees may be a positive urban asset to decrease the risk of negative mental health outcomes.'[90]

A Canadian study agreed:

'Having 10 more trees in a city block, on average, improves health perception in ways comparable to an increase in annual personal income of $10,000 and moving to a neighbourhood with $10,000 higher median income or being 7 years younger.[91]'

Where possible the budget for a programme of hospital building should also be used to plant and maintain trees in neighbouring streets. And the community of doctors, nurses and other staff who work at a hospital may wish to support charities or civic groups that plant and maintain local street trees. It would be a win/win for the neighbourhood and for the health staff themselves. Planting and looking after greenery is provably good for us.[92]

* * *

This chapter has reviewed the important relationships between hospital design and health and wellbeing The next chapter will review the relationships between design and lifetime sustainability.

CHAPTER 3

DEEP GREEN NOT THIN GREEN - PLANNING FOR LIFETIME SUSTAINABILITY

"The greenest building is the one that is already built."

Carl Elefante

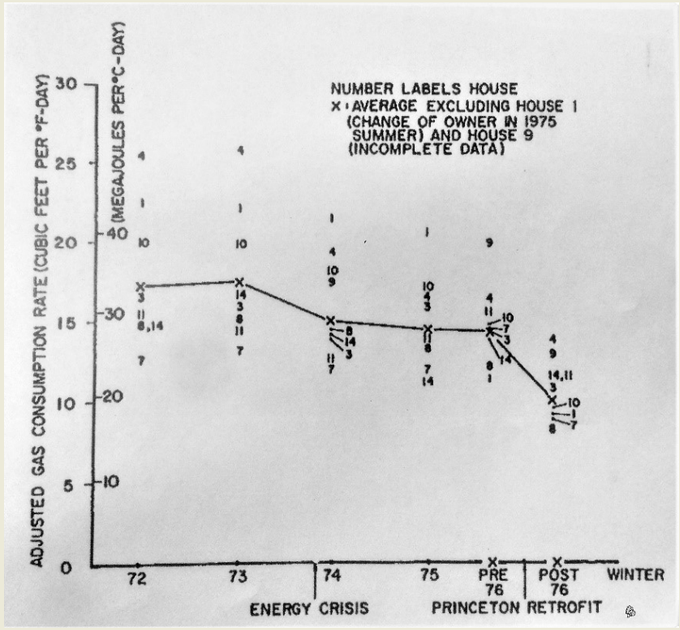
Terraces overlooking parkland at the new DMRC near Loughborough [AR]

Deep green not thin green. The Climate Change Act 2008 committed the UK to an 80% reduction in carbon emissions relative to 1990 levels by 2050. In 2019, parliament passed secondary legislation extending that target to 'at least 100%.'Both the House of Lords and the House of Commons passed this unopposed. The political consensus for tackling climate change is clear. And the built environment contributes about 40% of Britain's emissions. What does this mean for hospital design?

Above all, it means taking a holistic 'deep green' approach. Designing for sustainable growth is too often siloed within professional fields. What you focus on depends on to whom you are talking. If you have a hammer every problem looks like a nail. Too much discussion of sustainability is focused on ongoing energy usage. Self-evidently future hospitals will need to be energy efficient. However, a truly sustainable approach, a 'deep green' approach as we term it, must be more broadly based. As well as considering the readily measurable thermal efficiency of new buildings, five additional factors will crucially influence hospitals' lifelong carbon footprint. These are:

- *People*: how people will behave in and around a new hospital;
- *Form*: the shape and height of buildings;
- *Longevity*: the adaptability of hospitals' design;
- *Materials*; some materials require far more energy to create; and
- *Location*: where a hospital is and how people get to it.

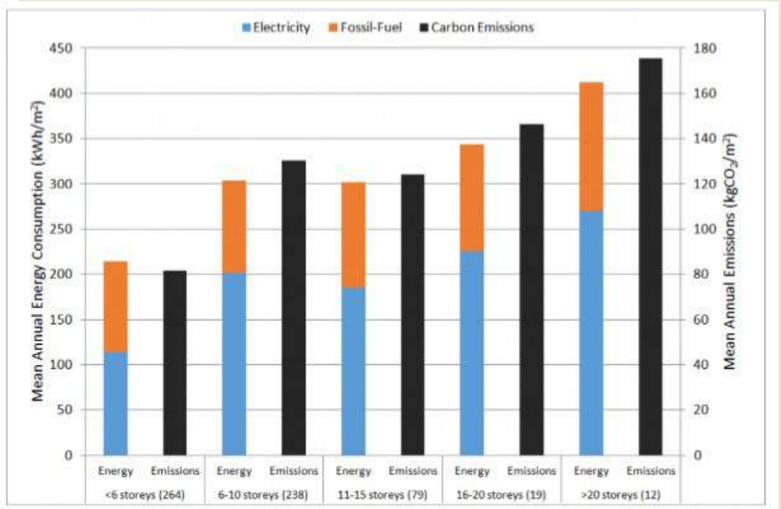
Sustainable buildings help people behave sustainably. Research has shown for many years that human behaviour is often more important than building efficiency in determining energy usage. Human behaviour is in turn influenced not just by personality (do you put on a jumper or turn up the heating?) but by building form and patterns of use. (You open the window more onto a quiet street than a traffic-thronged one). The chart below shows an early study into different levels of energy usage in similar homes in the same street. Different residents had different energy uses.



People matter as well as buildings in achieving sustainability (each letter for each year shows different levels of energy usage in identical houses with different inhabitants. Different residents have very different energy uses)[93]

What types of place will encourage staff or visitors to use less energy? It will vary by person but places which are naturally lit, naturally ventilated and naturally insulated will tend to encourage less use of artificial light and less use of artificial heating and cooling. Where possible, this is how hospitals should be designed.

Form and height – lower buildings use less energy. Increasingly clear evidence suggests that the height and depth of buildings matters to their energy consumption. For example, a recent study of the energy use of over 700 London buildings' found that when comparing buildings of 6 storeys and fewer ('low-rise') with buildings of 20 storeys and more ('high-rise'), electricity use in the high-rise was nearly two and a half times greater per square meter than in the low-rise (a 135% increase). The increase in fossil fuel use (by 40%) was less marked but still stark. Carbon emissions more than doubled going from 'low-rise' to 'high-rise'.[94] (A similar pattern has emerged in a Hong Kong study where each additional storey added on average 3 kilowatt hours per square metre.[95])



Energy usage, carbon emissions and height in office buildings[96]

Research has also shown that buildings can tend to become less energy efficient when they are wider than about 14-15 metres in depth ('deep plan space'). This is the point at which buildings normally have to be mechanically ventilated or air conditioned and artificially lit, which increases their use of electricity, unless they are cleverly broken up with internal open space such as courtyards creating air conduits.

In short if new hospitals are to be sustainable in energy use over time, they should rely on a range of medium sized, medium rise buildings. Larger buildings can be made more sustainable with the insertion of courtyards.

Arcade at the new DMRC near Loughborough [AS]

The most sustainable buildings are adaptable and long-lived. The most important ways that new hospitals will support sustainability may well be their longevity. Hospitals should be built adaptably for the long term as the needless destruction of buildings is grotesquely wasteful not just of financial resources but of embodied carbon. (Embodied carbon is the carbon dioxide emissions associated with materials and construction processes throughout the whole lifecycle of a building.) Longevity is a matter of sustainability, as has been reported in a parliamentary select committee.

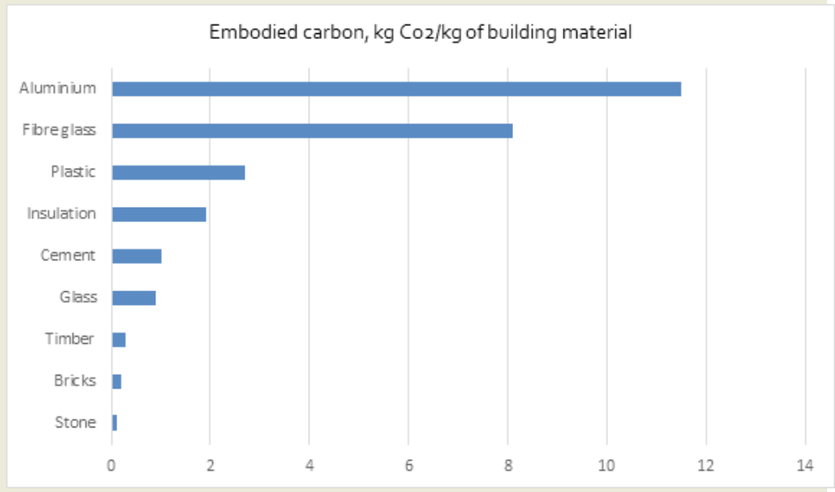
- The largest producer of waste in the UK is demolition and construction which produces 24 per cent of the annual 434 million tonnes.
- For every inhabitant in the UK, six tonnes of building materials are used every year.
- It takes the energy equivalent of a gallon of petrol to manufacture six bricks. The embodied energy in the bricks of a typical Victorian terraced house would drive a car more than ten times around the world. The equivalent for an older hospital will be many multiples of this.[97]

Walled garden at the new DMRC near Loughborough [AT]

When we create buildings, particularly large ones, we must therefore build for the long term if we wish to do so sustainably. This means creating buildings which are specified to last 500 years (or more) not 50 or 25. It means creating buildings with a clear hierarchy of construction: robust, load-bearing walls, not reliant for their integrity on metal than can rust or plastic joints, rubber gaskets and mastic that will fail. (Mastic is particularly problematic. It is used to keep water out on facades. However, it degrades with sunlight so has a built-in life of only 25 years before needing to be replaced.) It means creating large internal spaces into which non-load bearing walls can freely be inserted and moved: think a Lego set within a fixed box. The one thing of which we can be certain is that we cannot guess the specific technological requirements of hospitals one hundred years hence. The future is unknown. We cannot design precisely to meet it. But we can anticipate it. To be sustainable, hospitals need to be flexible and readily adaptable.

This will also save money. The combined cost of replacing a mechanical plant, which in a hospital would normally be over 30% of the build cost, together with refurbishing the exterior and reorganising the interior, usually makes it no more expensive to demolish and start again than to struggle with the exiting fabric. This is why current buildings become obsolete so quickly.

Materials also matter. The embodied carbon of a hospital will include any carbon dioxide created during the manufacturing of building materials (material extraction, transport to manufacturer, manufacturing), the transport of those materials to the site and the construction practices used. Some materials inherently have far lower embodied carbon than others, as shown in the table.



In short buildings using stone, brick and wood but not cement will tend to have lower embodied carbon. It is also better to achieve high thermal efficiency through design and the use of materials such as stone than through over-reliance on artificial insulation materials. This also chimes with the evidence on longevity. Sustainable hospitals will have brick or stone load-bearing walls designed to last hundreds of years with wooden non-load bearing walls which can be changed every twenty to fifty years as clinical best practice and need evolves in ways which we cannot today confidently predict.

The evidence on embodied carbon represents another problem for the lifetime efficiency of buildings that are too high. A 2001 Australian study found that the embodied energy per square metre of floor area in Australian office buildings was 60% greater in buildings of 42 and 52 storeys than in three and seven storey buildings.[98] The differences were largely - as one might expect - due to structural components.

Patients and staff cafe at the DMRC [AU]

Hospital location, active and public transport. We have already considered the profound cultural and civic virtues of a firm link between hospitals with the communities that they serve. Particularly for Primary and Secondary Care hospitals, the physical ways in which staff, patients and visitors travel to and from hospitals will form a major part of their carbon footprint. Transport accounts for about 27% of the UK's carbon emissions.[99] Public transport or active transport is provably more energy-efficient than cars and can significantly reduce air pollution.

Energy usage and transport-related energy consumption[100]

Ospedale Santi Giovanni e Paolo, Venice incorporates the cloister of a Dominican convent. The overall plan shows how the old and the new interact reusing buildings over 300 years old [AV]

Bird's eye view of St Bart's Hospital, London, showing the hospital integrated into the surrounding urban fabric [AW]

How people reach new hospitals will therefore form a material component of their lifetime sustainability. Where it is possible to 'build in' attractive incentives to active transport and public transport, hospitals' carbon footprints will be materially reduced. This should be done where it can. This will also have material health benefits for staff, patients and visitors. About 40% of our personal health outcomes is a function of where we live not who we are. One of the best ways to influence individual health outcomes is to make it easier and more pleasant to use active travel on a daily basis. If the number of health workers cycling to work was doubled, a hospital would be materially more sustainable and also have healthier workers. For example, the Physical Activity for Health Research Centre (PAHRC) at the University of Edinburgh has estimated that walking and cycling at moderate to vigorous intensity can achieve reductions in premature mortality of 11% and 10% respectively.[101]

Location matters as well. Wherever possible (it will not always be possible) hospitals that are located in existing centres, on existing high streets or in readily accessible extensions to existing settlements will have much lower carbon footprints as well as supporting the physical and mental health of their staff and visitors. Again, the evidence on active travel and health is clear. Long commutes tend to be bad for our physical and mental health. Shorter commutes, above all if they encourage active travel, are good for us. For the good of the hospital staff, as well as for a hospital's environmental footprint, hospitals should be situated close to existing settlements so as to discourage long commutes.

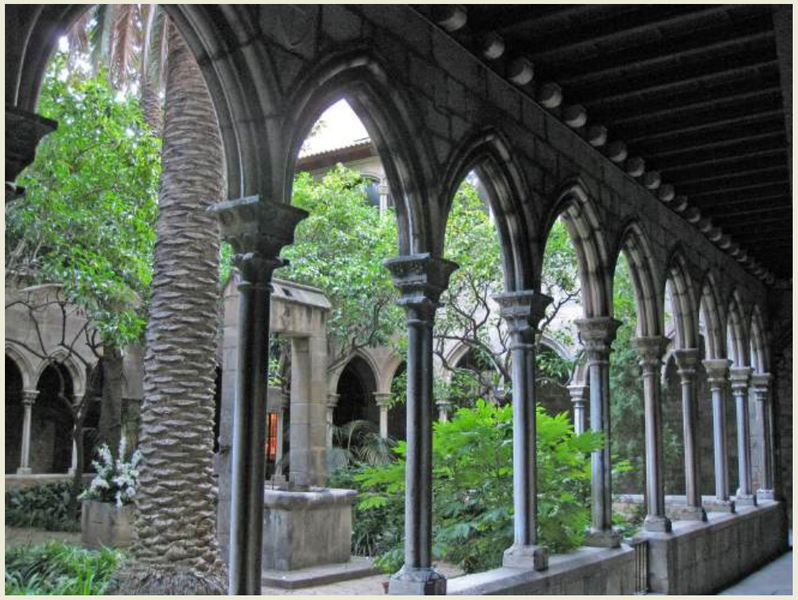
This will support staff health outcomes. A study of suburban sprawl and health found a reliably predictive link to chronic medical conditions: 'an increase in sprawl from one standard deviation less to one standard deviation more than the average implies 96 more chronic medical problems per 1,000 residents, which is approximately similar to an aging of the population of 4 years.'[102] Even more important is the psychological and social impact of space and the long commutes that the suburban form often necessitates. For example, a German study found an inverse correlation between the length of the average commute and someone's reported overall life satisfaction.[103] Driving is seemingly the worst culprit with longer drives reliably associated in a US study with higher blood pressure, more headaches and higher levels of frustration.[104]

Bridge at Hertford College, Oxford, links College buildings, without interrupting the street pattern [AX]

Where appropriate, integrating with surrounding streets will have other benefits. Like an Oxbridge College, a network of beautiful buildings, cloisters and courtyards can have safe, private and sequestrated areas, and bridges across streets for those who need level and clean access to other parts of the hospital. But it can also have more public areas where visitors and patients can meet or where recovering patients can start to 'step back' into the wider world.

* * *

Part one of this submission has reviewed the 'problems' with how we currently design hospitals and the evidence for how to do so better for both humans' wellbeing and for the weight with which we tread upon the planet. Part two of this submission will set out a practical and enumerated process for putting this programme into action.



Cloister at Santa Anna de Barcelona [AY]

PART II

FROM FACTORIES FOR FIXING TO PLACES FOR HEALING

Sunlight animates the arcade to the main courtyard at the DMRC [AZ]

CHAPTER 4

GOVERNANCE: THE COMPLETE HOSPITALS FRAMEWORK AND KPIs

'It can be quite easy in acute care to treat hospitals like a factory. I think we are moving beyond this now. We need to build the argument that says that going to a business park outside the town and building a factory is not always the right thing.'

NHS Acute Hospital Manager

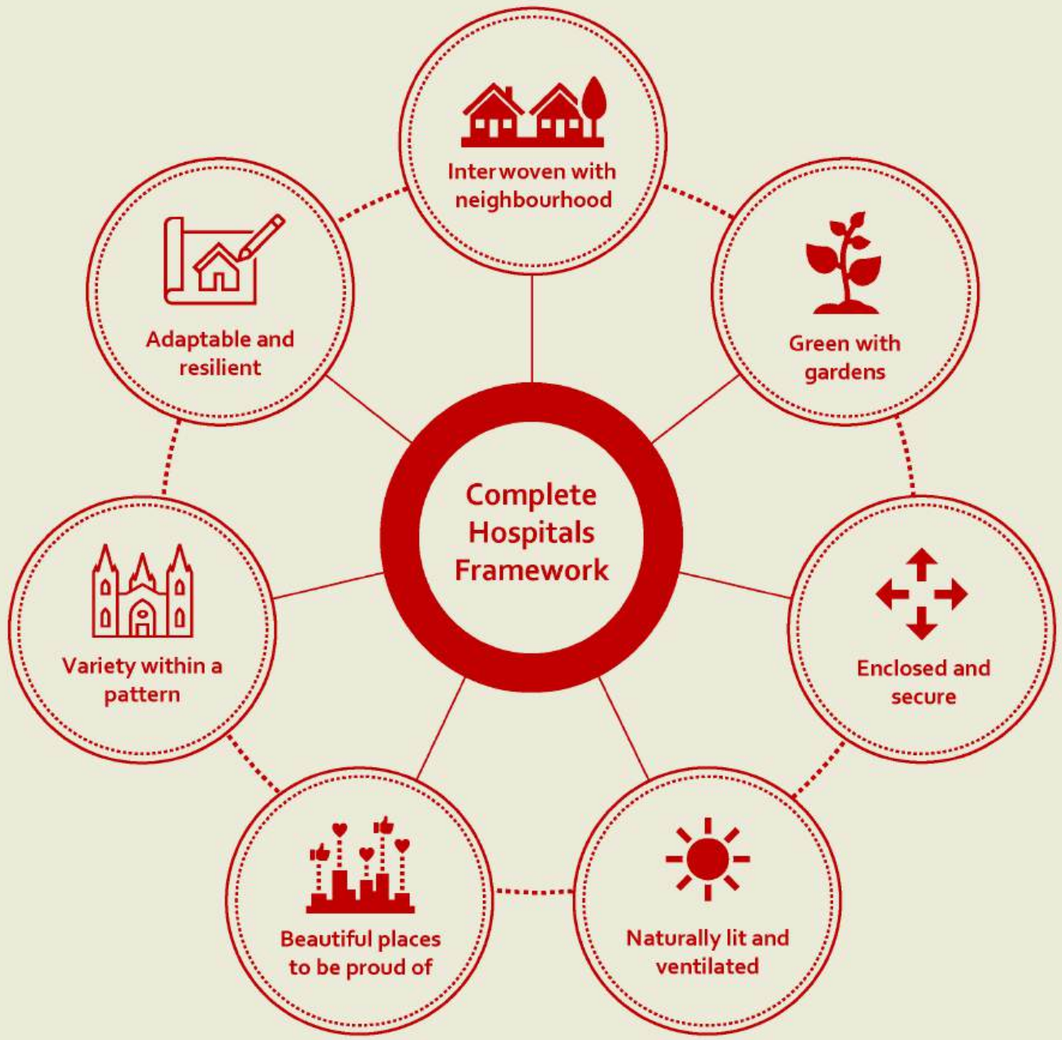
View at Weihai Hospital of Traditional Chinese Medicine, Shandong, China [BA]

Complete Hospitals Framework

Part one of this submission has reviewed the problems. Part two suggests a way forward. Our intent is to propose a framework for setting and managing a design and development brief for new hospitals which, given the wider evidence, is highly likely to improve patient experiences, clinical outcomes and staff wellbeing whilst also integrating with wider civic society and health and social care. This should also help deliver new hospitals more sustainably.

This chapter sets out the high-level framework and metrics, provides a governance structure for creating complete hospitals and suggests high level KPIs. Chapter 5 focuses on delivery. It develops this framework into a practical series of questions, a process map and a 'pattern book' for those charged with developing new hospitals. This will allow them to 'set a brief' which goes beyond minimising cost and creating a 'factory for fixing': it is intended to help them convert the conceptual framework into a practical design blueprint.

We have called this framework our Complete Hospitals Framework as it is based on the more holistic approach to human wellbeing set out in part one. The framework is designed not to replace but to be layered over the precise clinical requirements of an individual brief. The framework has seven key components.



1. Interwoven with neighbourhood.
2. Beautiful places to be proud of.
3. Variety within a pattern.
4. Naturally lit and ventilated spaces.
5. Enclosed and secure.
6. Green with garden.
7. Adaptable and resilient.

Components	Metric
Interwoven with neighbourhood	• Where appropriate, site hospitals so that they relate to the communities they serve and are within easy reach. • Connect them directly into the surrounding pedestrian street network so that they are not one single large block surrounded by a car park.. • Conceived of them as part of the surrounding urban or suburban framework with elements of the hospital, if appropriate, integrated within the existing street pattern so as to create a range of defined private and public areas – rather like an Oxford or Cambridge College. • Use them so that together with adjacent buildings they form public spaces such as a green square that will benefit both the hospital and the local community. • Create easy, safe and pleasant 'active travel' routes (walking and cycling) to hospitals for staff and visitors (consider greenways, cycle paths and well-treed boulevards). Plant and maintain street trees in surrounding streets and encourage and support hyper-local tree maintenance by surrounding communities • Championing health promotion and healthy prevention through the physical nature of its interaction with neighbourhood • Create public transport routes to hospitals for staff and visitors (Consider 'trams in greenways'). • Where appropriate consider creating homes and other land uses actually on the hospital site, particularly accommodation for health staff. (This may be particularly appropriate for older very low density hospitals sites being re-planned).
Beautiful places to be proud of	• Create interiors which most patients, staff and neighbours consider beautiful. • Create exteriors which most patients, staff and neighbours consider beautiful. • Create hospitals which can serve as noble fulcrums of local civic pride and achievement particularly in the medical field. • Create buildings with an architecture that has a connection with the community it serves. • Create pleasing elements of internal and external symmetry.
Variety within a pattern	• Use symmetry with harmonies of colour, natural materials and biophilic references and patterns to create a balanced architecture that evokes pleasure and reduces stress for patients, visitors and staff. • Create interiors that provide variety within an established easy to understand overall pattern to provide interest and help with orientation around the hospital. • Dementia friendly interiors with variety within a pattern • Use buildings, corridors or rooms as mini-destinations with an identity of their own. • Have clear routes through the hospital with an option to use external spaces (cloisters and streets) where possible. • Use architectural devices such as prominent stairs and landmarks to help patients and visitors find their way about and encourage use of stairs for those who can.

Components	Metric
Naturally lit and ventilated	• Create rooms with ample natural light and views onto green external spaces. • Draw visitors and patients through the buildings with long views, pools of light and sunlit arcades to waiting areas overlooking outdoor green open spaces. • Create rooms in which patients, staff and visitors know the time of day and the season. • Use windows to frame views and create a places from which to enjoy the natural world outside. • Create rooms with windows that open and do not rely just on piped air.
Enclosed and secure	• Create a range of outdoor spaces, cloisters and courtyards with various degrees of privacy. • Break up the scale of large buildings. • Communal dining halls for those who wish • Linked smaller buildings can be used to form enclosed external spaces. • Create private rooms internally where the adverse effects of unwanted noise and light pollution can be controlled. • Create options for using stairs not lifts to avoid cross infections and promote physical health.
Green with gardens	• Create gardens and greenery of different types that patients can see from their rooms. • Create gardens and greenery which patients, staff and visitors can actively use and sit in and that, at certain times of the year, can become part of the circulation routes through the hospital. • Create opportunities for patients and staff gardening (including growing vegetables and fruit). • Use gardens and possibly ponds to provide a natural habitat for flora and fauna.
Adaptable and resilient	• A priority should be to create long lasting buildings constructed of materials that have a low carbon footprint and are easy to maintain. • A building quality that will last between 100 and 500 years should be considered. Building forms that are reliant on short life mechanical equipment that need to be replaced every 25 to 30 years should be avoided. • Buildings should be created using a 'hierarchy of construction' so that the interior is adaptable and built of materials 'easy and cheap' to change within an external overall shell that is long lasting and sustainable. • Large adaptable spaces which can readily be reconfigured and repartitioned. • Consider creating separately capitalised charity to maintain external physical infrastructure for the long term.

Delivering Complete Hospitals will mean treating patients and health professionals as humans not as robots. Medicine and cleanliness are vital to recovery. But so are restful, reassuring, green and beautiful places.

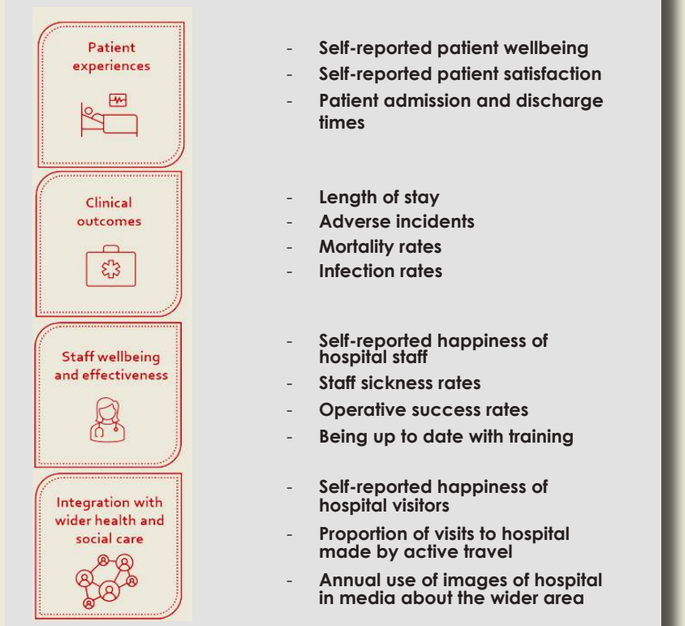
Complete Hospitals Governance and management KPIs

Not all Complete Hospitals components will always be achievable. Some will be more appropriate for some types of hospitals. For example, access to greenery and gardens to walk in will be especially important for a hospital focusing on long term recuperation (as we will explore in chapter six). By contrast, proximity to an existing urban core and ready 'active travel' access will be more important to a small local Secondary Hospital.

Governance and process will also matter. In order to help manage and trade off any tensions between immediate clinical needs with longer term issues of resilience, recuperation and sustainability, a wider range of KPIs will be necessary than has historically been the case. World class project-management, clear KPIs and a clear brief can ensure that these requirements (though they can sometimes conflict) are held in creative rather than destructive tension.

Working *with* communities not at them can also lead to wiser and wider outcomes than just meeting immediate clinical needs would dictate: engaging not only with leaders but also with the users of a hospital and the communities that will rely upon them. Programme governance will need to take account of this. A possible overarching Complete Hospitals Governance structure might include:

The right KPIs to run a Complete Hospital will need to include the 'standard' (and critically important) metrics of clinical care. But they should also involve the wider metrics of wellbeing.



One issue that has emerged in our research is what might be termed 'Health first, hospital second.' Hospital managers often struggle to prioritise spending resources on maintaining the physical infrastructure of their hospitals. This should not be surprising. Hospitals exist to cure the sick. That is the focus of their efforts and management time. It will always be difficult to divert funds from improving clinical care to, for example, repairing a door.[105] As happens at the Defence Medical Rehabilitation Centre (see chapter 6) one model for dealing with this is to create a separately-capitalised charity (or public body) which is tasked with maintaining the physical infrastructure for the long term. This is not without demarcation challenges but will permit a higher standard of sustainable maintenance for the long term and help prevent fabric maintenance perpetually being the "poor cousin" to the hospital's immediate primary purpose.

We believe that this Complete Hospitals approach will help new hospitals to do even more than fix the sick: they should become true cornerstones to their communities and beacons of civic pride; the parish churches and Victorian town halls of the future. This is a high aspiration but we believe it is necessary, achievable and affordable. Chapter 5 explores the questions and process to set the brief for designing and delivering a Complete Hospital. Chapter 6 then shows how this process can be used in two different circumstances before chapter 7 explores the cost and benefit analysis.

Entrance to main courtyard with view of statue of General Sir Robert Jones at the DMRC [88]

CHAPTER 5

DELIVERY:

THE RIGHT QUESTIONS, PROCESS AND 'PATTERN BOOK' TO 'SET THE BRIEF' FOR A COMPLETE HOSPITAL

This chapter outlines a five-step process for asking key questions with which a CEO or COO tasked with delivering a new hospital can set the design brief and link the wider *academic* evidence on healing and wellbeing with the *practical* designs for a Complete Hospital. It permits those tasked with delivering hospitals to decide which elements of the Complete Hospitals Framework are either highly relevant, relevant or irrelevant to their specific circumstances and in what specific way. During the course of preparing our brief we have trialled it with several former and current hospital managers and believe that it 'works'.

A FIVE-STEP PROCESS FOR ASKING KEY QUESTIONS.

We have set out a five-step process of questions that a leader charged with delivering a hospital can pose in order to 'set the brief.' These questions are intended to be supremely practical and to lead to specific answers which can be recorded.

Key questions are:

1. WHAT KIND OF HOSPITAL IS IT?
2. HOW SHOULD IT BE INTEGRATED INTO THE COMMUNITY?
3. HOW SHOULD THE HOSPITAL BE PLANNED?
4. HOW SHOULD THE HOSPITAL BE BUILT?
5. HOW SHOULD THE HOSPITAL BE MANAGED?

The detailed questions are set out below.

There is an approximate but imperfect relationship between different steps of the process and different components of the Complete Hospitals Framework. The earlier stages focus on the relationship with the neighbourhood and the need for beautiful places. Later questions address issues of enclosure and security. The final questions about construction and management inevitably focus on adaptability and resilience. However, hospitals are complex physical entities whose components are interdependent. We have not therefore tried to over-simplify.

THE PATTERNS OF A COMPLETE HOSPITAL.

Working from the components and metrics of the Complete Hospitals Framework set in the previous chapter, we have a created a list of 36 specific 'patterns' which collectively define the possible design parameters of a Complete Hospital. Formally using the five-step process and asking its questions should identify which of these patterns should be emphasised, included or excluded and how to approach them. These patterns 'fit' within both the Complete Hospitals Framework and the five-step process.

Process and key questions for setting the brief for a Complete

- How wide is hospital's catchment area?
- How will staff and visitors travel to the hospital?
- What opportunities are there for re-greened active and public transport? Can we create greenways, trams with trees? Can we plant trees?
- How can the required carparking be economically and sympathetically incorporated?
- How much interaction will/ should there be with the local neighborhood and community?
- Does it have any overriding unique requirements such as access to countryside or proximity to specialist facilities?

- How can we maintain permeability through the site for users and visitors and at different grades?
- How can we relate the building to existing site and its immediate surroundings?
- How can the hospital brief be subdivided to relate to surrounding building scale and urban grain?
- How will it use and create public space?
- How will the hospital both stand out and fit in?
- How will the hospital express community identity and pride?
- How will hospital feel familiar and healing?

- Which spaces do & don't require natural light and/or ventilation?
- How many private rooms will we need?
- What different privacy levels are needed and how do we ensure they are achieved?
- Where can we create alternative external circulations routes?
- How much external space would benefit the hospital and where would it be best located in relation to other facilities?
- How do we create a variety of outdoor green spaces with differing privacy levels?
- How we connect upper floors with gardens?
- Where should prominent continuous stairs be placed?
- How do we avoid noise and light pollution?

- What is the right hierarchy of construction for different elements of the facility?
- How do we avoid short term technological obsolescence?
- How can we use public funds efficiently?
- How do we create buildings that people want to keep?
- What materials with low embodied carbon would be suitable for your hospital?
- What materials will have longevity appropriate to the different levels of hierarchy?
- How can we use materials and architecture to ensure minimized requirements for long term maintenance?

- How do we ensure ongoing focus on building maintenance for long term sustainability?
- How do we ensure ongoing opportunities for patients to garden?
- How do we support the surrounding community?

CREATING A COMPLETE HOSPITAL

CREATING A COMPLETE HOSPITAL

1 Interwoven with neighbourhood

- 1a Catchment
- 1b Public transport
- 1c Car parking
- 1d Urban grain
- 1e Block sizes
- 1f Scale & frontage
- 1g Connectivity
- 1h Public realm

2 Beautiful places to be proud of

- 2a Landmarks
- 2b Reflecting comunity
- 2c Celebrating pride

3 Variety within a pattern

- 3a Symmetry
- 3b Biophilia
- 3c Variety

4 Naturally lit and ventilated

- 4a Building Depth
- 4b Windows
- 4c Views
- 4d Connectivity

5 Enclosed and secure

- 5a Secure
- 5b Public space
- 5c Privacy levels
- 5d Circulation
- 5e Stairs
- 5f Light & Noise

6 Green with gardens

- 6a Greenways
- 6b Trees
- 6c Greenery
- 6d Biodiversity
- 6e Gardening
- 6f Upper Floors

7 Adaptable and resilient

- 7a Hierarchy
- 7b Technology
- 7c Economic
- 7d Attractive
- 7e Sustainable
- 7f Well detailed
- 7g Maintained
- 7h Community

STEP ONE:

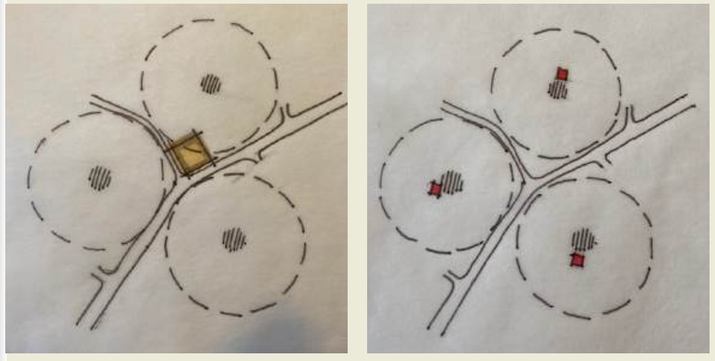
WHAT KIND OF HOSPITAL IS IT?

A Hospital is a civic building that should be at the community's centre. It often needs to be part of the neighbourhood in which it is set. Taking each of the components of the Complete Hospitals Framework the criteria that should be considered are:

How wide is the hospital's catchment area?

Hospital buildings should be considered in relation to the community and the neighbourhoods that they serve. The bigger their catchment area the more significant their location becomes in relation to local bus, tram and rail transport infrastructure. This is an issue of sustainability but is also significant in relation to the land and resources that need to be allocated to car parking. Large areas of car parking can have a significant impact on the way buildings can relate to their surroundings.

PATTERN 1A: LOCATION RELATED TO THE CATCHMENT AREA



CATCHMENT

An acute hospital serving several neighbourhoods would be located at an intersection common to them all so that it feels relatively equidistant from each.

Primary care or community facilities should be located at the centre of the neighbourhood they serve (perhaps in a high street) and relate to the pedestrian network of streets and squares of the locality. Preferably adjacent to shops and cafes.

How will staff and visitors travel to the hospital? What opportunities are there for re-greened active and public transport?

In order to provide sustainable access for everyone a hospital needs to be planned so that it connects well with local green active transport corridors. Part of their siting would be to support predictable and beautiful public transport and car share options to encourage healthier and more sustainable transport. These should be pleasant routes along which people would choose to walk or cycle and which can be combined with public transport services such as trams and electric buses. This is more sustainable and reduces the need for car parking.

PATTERN 1B: ENCOURAGING HIGH QUALITY PUBLIC TRANSPORT (EXPRESS BUSES AND TREE-LINED TRAM ROUTES)

PUBLIC TRANSPORT

Although this will normally go beyond NHS budgets, wherever possible new hospitals should co-ordinate with surrounding Highways Authorities, Active Travel England (when it has been created), the Office for Place and charities such as Sustrans, Living Streets, Trees for Cities and the Create Streets Foundation to support public transport, to make active travel simpler and safer and to re-green surrounding streets. This programme of wider NHS engagement with civic society can build on the learnings of the NHS Healthy New Towns initiative.

Can we plant street trees to improve surrounding neighbourhoods and support active travel?

Both public and active transport should be conceived not as the 'choice of last resort' but as a safe, pleasant and agreeable way to get to the hospital.

PATTERN 6A: CREATING WALKING AND CYCLING GREENWAYS TO HOSPITAL.

GREENWAYS

This is about re-greening the neighbourhood as well as integrating the actual hospital and thus involves other components of the Complete Hospitals Framework.

PATTERN 6B: WORKING IN PARTNERSHIP: PLANTING STREET TREES IN NEIGHBOURING STREET

TREES

How can the required car parking be economically and sympathetically incorporated?

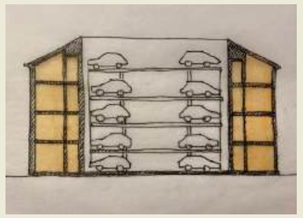
Large areas of parking can be unsightly. Placing them between a building and the pavement in a street should be avoided as it discourages pedestrian traffic into the buildings. Simple solutions such as dedicated on-street parking should be adopted with cars parked on the road side parallel with the pavement in the traditional urban manner. This does not interfere with pedestrian traffic and maintains a close relationship between buildings and the pavement. If parking requirements cannot be fulfilled in this way car parking needs

to be accommodated at the rear of the building away from the entrances within mews areas or within a court. Large parking areas unless disguised by trees and shrubs should generally be broken up into smaller groups of no more than about 20 cars. Alternatively parking below the building at basement level can be considered. However, this can be expensive. If significant carparking is unavoidable and a multi storey structure is necessary it should be embedded behind single aspect buildings so that the street frontage, especially at the ground level is not compromised.

PATTERN 1C: CREATING CAR PARKING WHICH IS NOT DISORIENTATING

CAR PARKING

Multi-storey parking which isn't disorientating and harmful to the neighbourhood.



Using trees to break up parking. Cars should always remain remain on the roadside of the pavement.

Further questions which will lead to case specific answers include:

How much interaction will/should there be with the local neighborhood and community?

Does it have any overriding unique requirements such as access to countryside or proximity to specialist facilities?

STEP TWO:

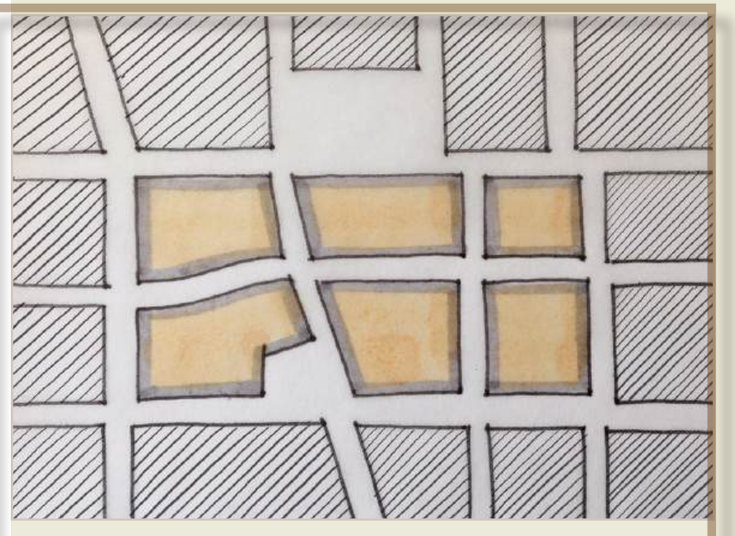
HOW SHOULD THE HOSPITAL BE INTEGRATED INTO THE COMMUNITY?

A hospital needs to sit seamlessly within its locality so that it is incorporated into the surrounding urban grain whether that is a town, city or suburb. It needs to function as an integral part of the community. A hospital should normally be broken into smaller component buildings of a size that relates to the blocks and buildings within the surrounding neighbourhood.

How can we maintain permeability through the site for users and visitors and at different grades?

Hospitals by their nature can be large buildings and often overwhelm their surroundings. If hospitals are to operate as an integral part of their community they need to feel as the natural extension of their immediate surroundings. By breaking down the programme into discrete components, each provided in a separate building, rather than one enormous building, they can be made to relate to their location more easily.

PATTERN 1D: RELATING THE BUILDING TO THE SURROUNDING URBAN GRAIN



URBAN GRAIN

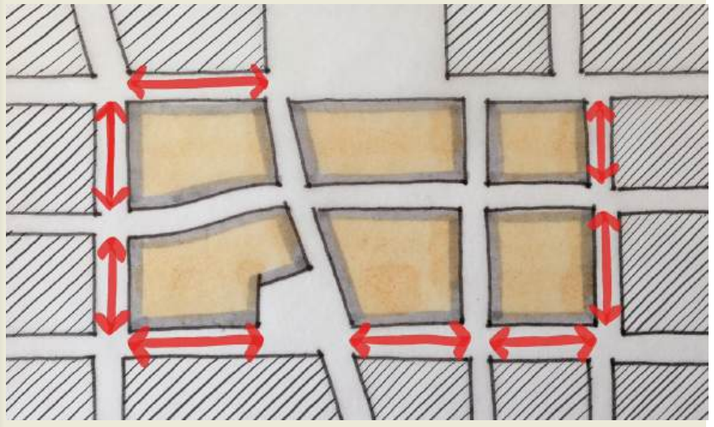
It is important to avoid packing the whole programme into a single, excessively large building.

How can we relate the building to the existing site and its immediate surroundings?

Functions that operate together should be grouped together so that each building would have its own identity. By becoming a destination in their own right this would bring them closer to the patients they serve. An outpatients' department for instance could have its own entrance which would be recognisable from the street or square.

Relate the size of components to their context by picking up on the size and scale of building in adjacent urban blocks.

PATTERN 1E: RELATING BLOCK SIZES

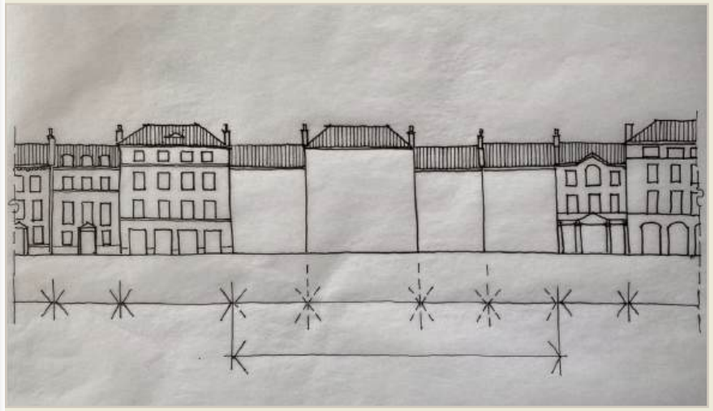


BLOCK SIZES

How can the hospital brief be subdivided to relate to surrounding building scale and urban grain? The architecture of most of the component buildings that form the bulk of the hospital should be treated in a similar manner to the surrounding buildings so that they become part of the neighbourhood's fabric. These would normally be relatively modest functional buildings with modest frontages. At street level these frontages should be used for publicly orientated facilities and where appropriate should include non-clinical uses such as retail or cafés. This will make for a livelier street life that will complement the hospitals' services and improve the manner in which they can be delivered.

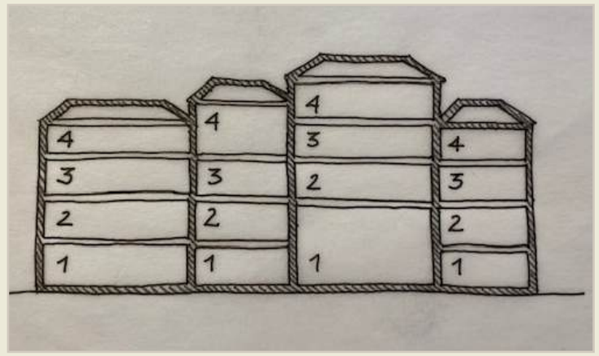
The height of the buildings should also be related to the surrounding architecture with buildings of a similar height to adjacent blocks. As individual floor heights within a hospital are unlikely to match those of other adjacent uses, as a general rule, this height should be set as a number of storeys rather than as a specific dimension from street level. This will allow for a more functional flexibility within the hospital and a variation of building height along the street giving the clinical buildings their identity and allowing them to accommodate greater functional variation within.

PATTERN 1F: BUILDING SCALE, FRONTAGE WIDTHS AND BUILDING HEIGHTS



SCALE & FRONTAGE

Relate the new hospital buildings to the scale and width of frontages of those in the surrounding blocks with a continuity at street level which may include non-clinical retail uses.

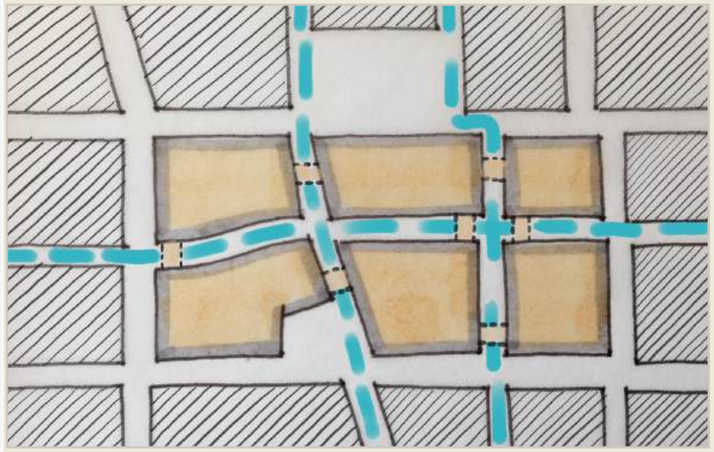


Building heights should be defined by the number of storeys and not a definitive height from pavement level. This will provide continuity with neighbouring buildings and allow for the required functional variation within.

For a hospital to operate effectively it will be important sometimes to connect adjacent related blocks so that patients and staff can get from one facility to another within the hospital. In order not to compromise the public street network by the addition of a building that might be too large and out of scale it will be important to connect them without destroying the permeability of the street network outside.

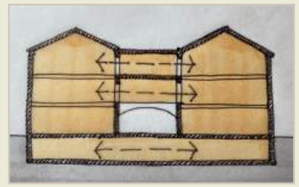
Individual buildings can be connected via a bridge over the street or a passageway under the road so that adjacent buildings can function together efficiently and effectively.

PATTERN 1G: RETAINING THE CONTINUITY OF THE SURROUNDING PUBLIC STREET NETWORK



CONNECTIVITY

Buildings can be connected using brides and below street links.

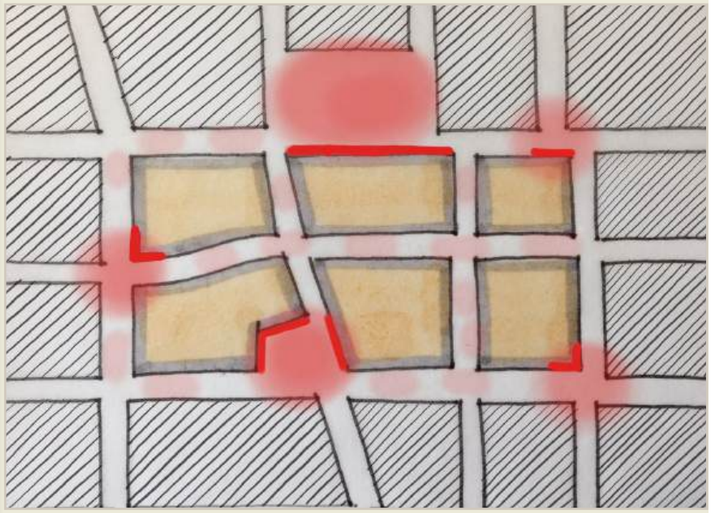


These connections ensure the efficient operation of the hospital whilst providing the permeability necessary at street level to bind the hospital in with its surroundings.

How will the hospital use and create public space?

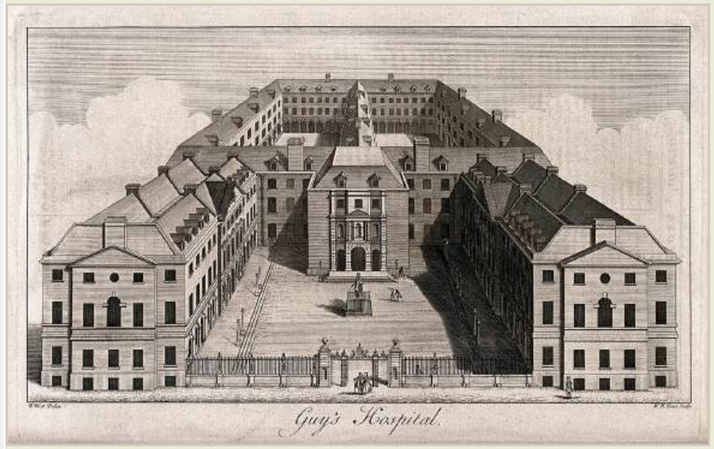
Together with neighbouring blocks hospital buildings can be used to extend the network of surrounding public spaces and create an attractive and varied streetscape by adding squares, boulevards and avenues to the neighbourhood. These would provide an amenity benefiting the hospital as well as the wider community. A square, for instance, by the entrance to the Hospital could give it greater dignity as a civic building whilst providing space for trees and community related activities.

PATTERN 1H: USING THE BUILDING FORM TO CREATE PUBLIC SPACES THAT BENEFIT THE HOSPITAL AND THE SURROUNDING COMMUNITY



PUBLIC REALM

New squares can be created at the entrances to the hospital to form public spaces that relate to the hospital.



The buildings around the main entrance to the old Guy's hospital create a forecourt to welcome visitors and patients.

How will hospital both stand out and fit in?

It is common in a town or a city to have landmarks with which people can navigate. These are usually large and significant buildings in which the community can take pride which become locally popular and significant over time. Where a hospital is made up of several buildings it is appropriate for the public elements such as the entrances to be treated in a more elaborate architectural manner that will help patients and visitors orientate themselves. Similar patterns should be created internally as well.

PATTERN 2A: CREATING LOCALLY POPULAR ARCHITECTURE WHICH CAN MAKE ENTRANCES AND SIGNIFICANT BUILDINGS 'STAND OUT'

LANDMARKS

Entrance to Bart's Hospital, London. Architecture has been used to indicate the entrance.

How will hospitals express community identity and pride?

Architecture needs to be familiar to users and express local and community identity of the locality. Too many public sector buildings fail to achieve this.

PATTERN 2B: REFLECTING COMMUNITY IDENTITY BY CO-CREATING ELEMENTS OF THE DESIGN WITH THE WIDER POPULATION

REFLECTING COMUNITY

The building that serves as the entrance to Louth County Hospital, was designed originally for Louth Workhouse, built in 1837 to the design of George Gilbert Scott. The old building was retained and reused because it was considered an important part of the local heritage.

PATTERN 2C: EXPRESSING COMMUNITY PRIDE

CELEBRATING PRIDE

Buildings need to celebrate and express the pride of the community in their own hospital, its high civic purpose and its medical and palliative achievements. Caring for the sick is a noble activity. The building should reflect this. Statues or buildings named after locally prominent or admired figures should be commonplace: particularly, those associated with caring for the sick.

Mary Seacole, St Thomas' Hospital (Left) and Sir Robert Jones, DMRC, Loughborough (Below)

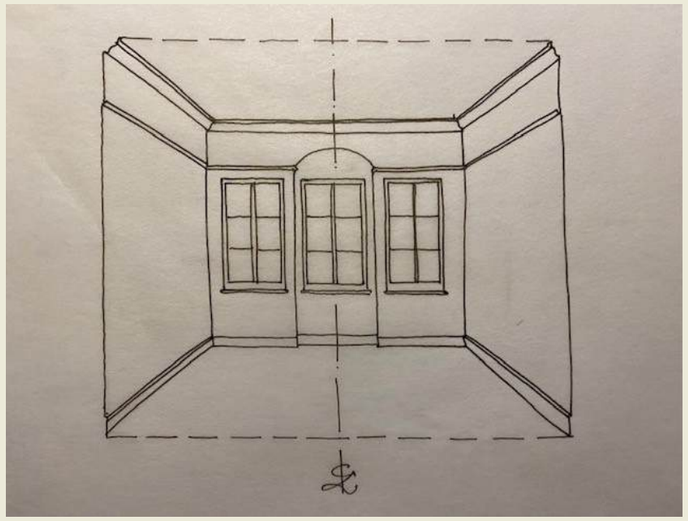
How will hospitals feel familiar and healing?

The human preference for bilateral 3-part symmetric compositions implies the use of various patterns at different scales within a structure. These include (i) long view symmetry (longer than an arm's length such as at the end of corridor, upon entering a room, lift or lobby, across a courtyard or upon entering a building), (ii) medium view symmetry (at arm's length such as wall, floor or tile patterns, placement of artwork, bath fixtures, furniture layout, windows and door deign and cabinet design) and (iii) short views (at less than an arm's length such as wall and floor tiles, furniture design, accessory arrangement and door details).

PATTERN 3A: CREATING SYMMETRY AND FAMILIARITY AT DIFFERENT SCALES

A Long view: using symmetrical composition at a hospital's entrance

SYMMETRY



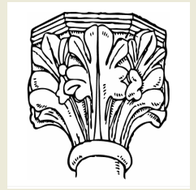
A Medium view: use of symmetry in a patient's room

As we have seen, design and details inspired by the natural world can humanise an environment making us feel safer and more secure. Bringing the reinterpretation of the natural environment into the one we create for ourselves is one of the ways in which we can stay connected with nature. This inclination to recreate safe and familiar environments was followed by our ancestors instinctively and can be observed, for example, in the column entasis which mimics the trunk of a tree.

PATTERN 3B: USING BIOPHILIC ARCHITECTURE TO REMIND US OF OUR CONNECTION WITH NATURE

Egypt

Rome



Middle Ages

Art Nouveau

American order

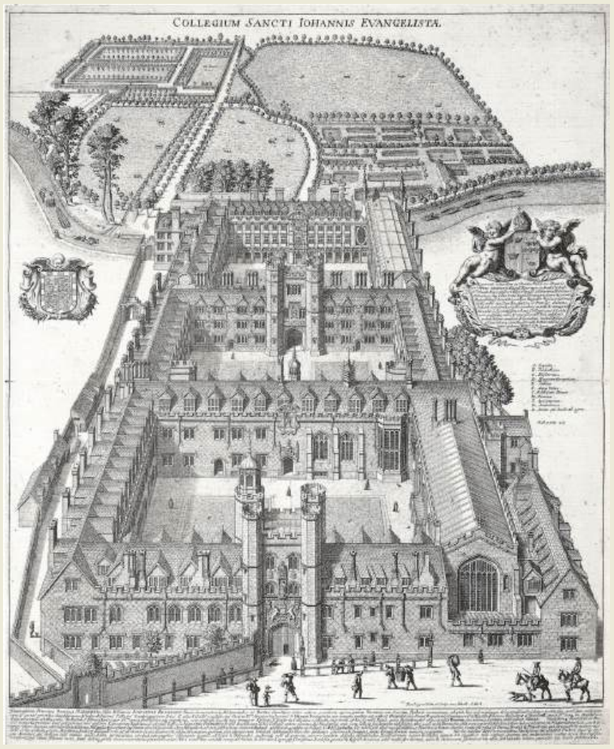
Lutyens

BIOPHILIA

Hospitals are usually disorientating places with long rambling corridors that rely entirely on signage to help people get around. In order to overcome this particularly in larger facilities it can be useful to use a development pattern that is familiar and easily recognisable. This familiarity reassures and provides a calm environment within which variety and interest can be introduced with an appropriate level of stimulus.

Use well established development patterns (such as collegiate buildings, organic village development patterns, or buildings organised as urban blocks) as a framework within which variety can be introduced.

PATTERN 3C: FAMILIAR DEVELOPMENT PATTERNS OF VARIETY WITHIN A COHERENT PATTERN



VARIETY

Cloisters and courtyards permit a well textured mesh of private and semi-private spaces. St John's College, Cambridge.

STEP THREE:

HOW SHOULD THE HOSPITAL BE PLANNED?

A hospital's architecture should work alongside the science of medicine to help in the recuperation and healing of patients. It should be a calming and welcoming environment, easy to navigate intuitively, so as to minimise stress and anxiety in patients.

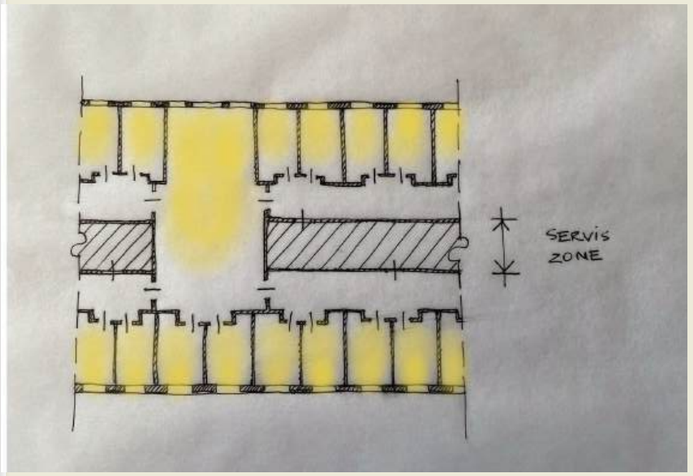
Which spaces do and do not require natural light and/or ventilation?

Spaces required should be divided into two categories. The first category are spaces where patients and staff are going to spend most of their time. The second are internal and do not need natural light and ventilation such as stores and support spaces such as utility rooms, bathrooms and toilets. There are also clinical spaces such as operating theatres and radiology departments which by their very nature require deeper space and where natural light, although desirable, is less essential. These are spaces too that require a degree of isolation and rely on mechanical support systems for safety such as in radiology or where a sterile environment is required such as in operating theatres.

It is the first category that will inevitably form the bulk of the hospital space. This type of space must be appealing to patients and staff and conducive to patients' rehabilitation and recuperation.

In order to do this, buildings need to be designed so that they have a good aspect and do not rely entirely on artificial lighting and ventilation. This comes down to proximity to windows and the perimeter of the building. This generally means buildings about 15 to 16 meters deep from external wall to external wall. They can be made deeper if there is a requirement for a service zone that does not require natural light which can be incorporated at the centre, resulting in a deeper plan that does not have a detrimental effect on the quality of the environment that the patients will use regularly. Spaces should not normally be deeper that 22 metres.

PATTERN 4A: CREATING THE RIGHT BUILDING DEPTH



BUILDING DEPTH

Provide buildings with the depth allowing for naturally lit and ventilated spaces within, designed for human comfort and enjoyment and not just function. It should be easy for patients, staff and visitors to know the time of day. Individual rooms within the buildings should all have windows so that they have an aspect onto the outside world and provide natural ventilation.

Windows are our main connection with the outside world. A design needs to make the most of this simple yet important device. Big, thermally efficient, triple glazed, easily closed windows can flood a room with natural light when desired and be closed to light when needed.

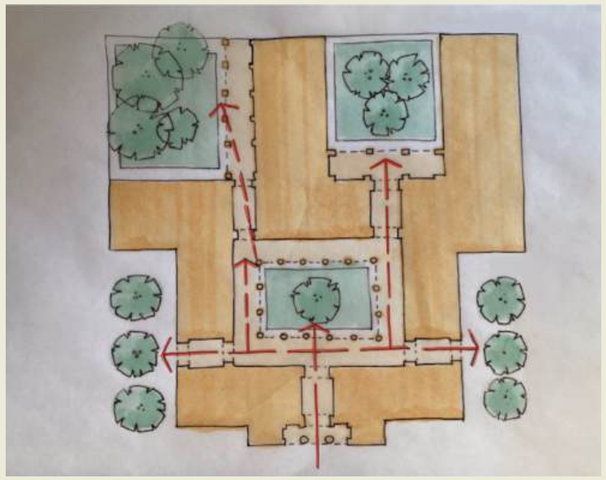
PATTERN 4B: LARGE AND BEAUTIFUL WINDOWS

WINDOWS

A common assumption is that large plate glass windows are the answer but these can be expensive, uncomfortable suffering from solar gain in summer and heat loss in winter, often cumbersome to operate, and wasteful in terms of energy. It is not size that matters most. Sometimes much more can be made of a view by using the window to frame it like a picture, perhaps combined with a seat to make it an especially attractive and appealing place to be, whether it be an individual seat in a ward to privately contemplate the scene outside or as part of a dedicated waiting area in a clinic. Issues of orientation and sunlight can also play their part and importantly a window needs to be convenient to open with blind and or a curtain to control glare.

Views through the building along circulation routes should, wherever possible, terminate with a window looking out onto greenery.

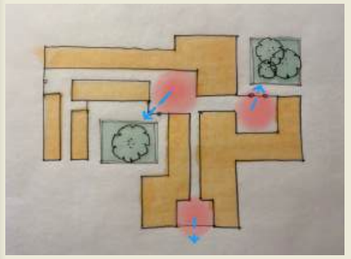
PATTERN 4C: CONNECTING CIRCULATION ROUTES WITH GARDENS



Vistas through the buildings should capitalise on views of gardens, nature and the outside world.

VIEWS

PATTERN 4D: RELATIONSHIP WITH OUTSIDE SPACE



Pools of light and vistas should be used to draw people along circulation routes and give those in waiting areas a suitable and comfortable environment.

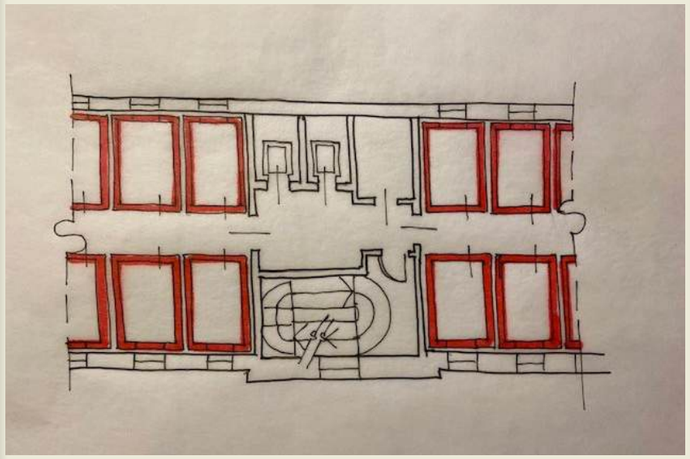
CONNECTIVITY

How many private rooms will be needed?

Most of the provision for new hospitals should be in single rooms except when there is a need for non-private rooms such as for the ICU or the elderly who often prefer company. This reduces infection rates and provides patients with the security, enclosure and privacy when they feel most vulnerable. Quiet spaces should also be available for staff to work from – particularly given the growing importance of digitally remote interaction with outpatients. Both these came up frequently in our staff survey.

Single rooms can be simple wooden modules which can be inserted within the long-lasting building shell. The scale of interior and exterior spaces should be considered in relation to the patient.

PATTERN 5A: CREATING PRIVATE ROOMS THAT CAN CHANGE WITH TIME



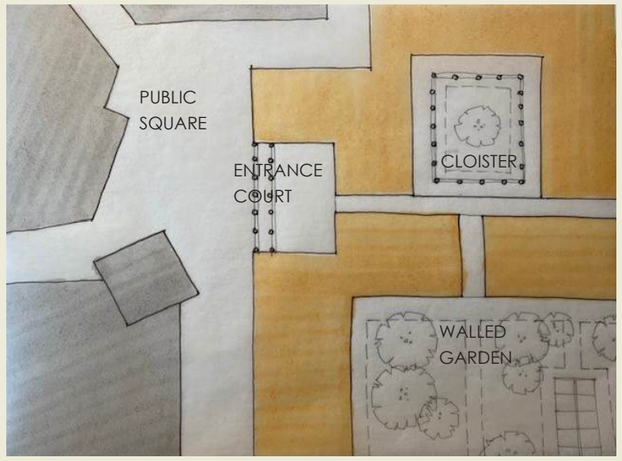
SECURE

What different privacy levels are needed and how do we ensure they are achieved?

Buildings should be arranged to form sheltered and enclosed external spaces such as courtyards, cloisters and green courts planted with shrubbery and trees, each with a distinctive identity and purpose. They should be varied both in character and in the level of privacy they provide. When possible, patients can then choose the place in which they feel most comfortable.

Use buildings to define external spaces for the use by patients and staff. Create the variety of types, configurations and sizes of external space providing different levels of privacy and enclosure such as squares, cloisters, 3-sided courtyards and walled gardens.

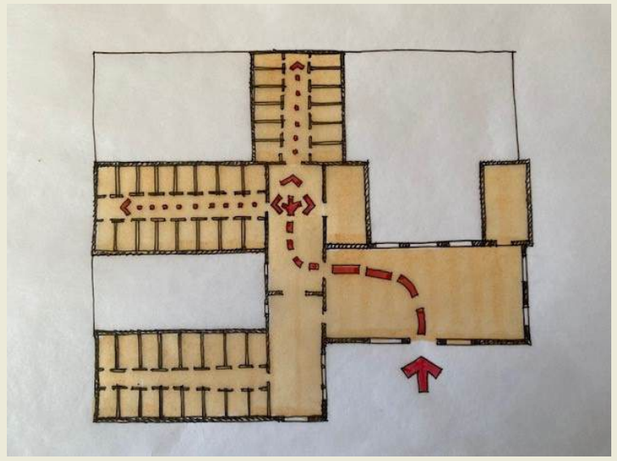
PATTERN 5B: ENCLOSED AND SECURE OUTDOOR SPACES PROVIDING DIFFERENT LEVELS OF PRIVACY



PUBLIC SPACES

Internal spaces need to be created so that there are a variety of configurations and sizes that provide different levels of patient privacy and security. This way patients can gradually acclimatise themselves to the return to normal life.

PATTERN 5C: INDOOR AREAS WITH DIFFERENT LEVELS OF PRIVACY



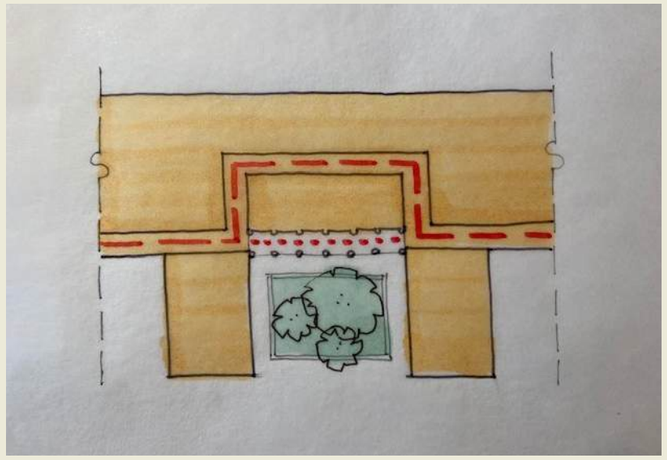
GREENERY

A range of spaces which can provide different levels of privacy are important.

Where should we create alternative external circulations routes?

Internal circulation routes should be designed through the buildings where there are alternative route, one entirely internal and enclosed and another that offers patients and staff access to the outside with the opportunity to walk through some of these external green planted courtyards.

PATTERN 5D: CREATING ALTERNATIVE CIRCULATION ROUTES



CIRCULATION

Routes through buildings should integrate the outdoor and courtyard spaces and the interior ensuring that the links with nature are not simply visual. Plants can be placed within buildings as well as outside.

How much external space would benefit the hospital and where would it be best located in relation to other facilities? How do we create a variety of outdoor green spaces with differing privacy levels?

Hospitals should have informal walled gardens with facilities such as a greenhouse providing gardening opportunities and covered access exclusively for patients and staff. But there should also be more open gardens and courtyards so that patients can spend time there with visitors. Different gardens serve different purposes.

PATTERN 6C: AN ENCLOSED AND SECURE VARIETY OF GREEN OUTDOOR SPACES PROVIDING DIFFERENT LEVELS OF PRIVACY

Walled garden relatively private calm space for staff and patients, to enjoy nature.

Cloister with fountain, a relatively private garden for staff and patients, with covered access.

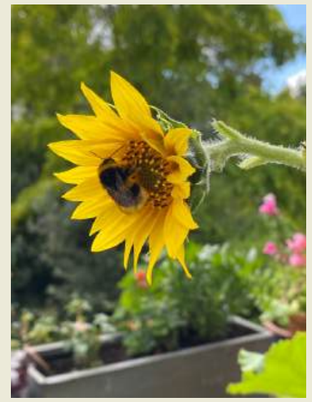
Court with trees; a relatively public outdoor space open to visitors, patients and staff

GREENWAYS

When designing hospital gardens and courtyards we should ensure that the hospital gardens provide a variety of managed natural habitats to encourage and foster biodiversity which will in turn provide added interest for patients and staff.

PATTERN 6D: PROVIDING LIFE AND BIODIVERSITY IN GARDENS

Even in urban settings, insect and bee-friendly plants can be introduced. Water should be incorporated to help local wildlife and birds.



BIODIVERSITY

Actual and intimate contact with living forms nourishes us and should be encouraged. The model of the Horatio's Garden charity is particularly inspiring. This will require a capital fund or ongoing revenue funding to support. It will also require a garden with ready and level access.

PATTERN 6E: PROVIDING GARDENING OPPORTUNITIES IN THE GARDENS





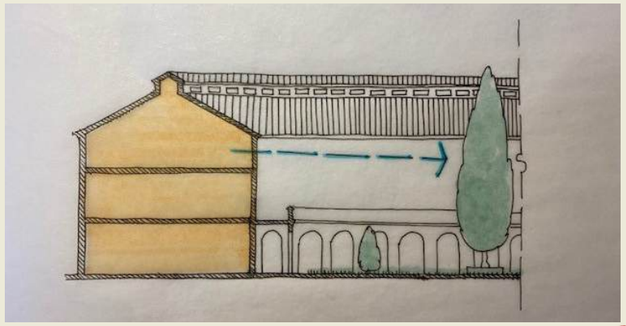

Where appropriate opportunities for patients and staff to garden on site should be provided.

GARDENING

How do we connect upper floors with gardens?

It is desirable for all the hospital levels where possible to have a connection with the gardens. Some on upper levels will be purely visual from windows but where possible a physical connection should be devised through the use of terraces and balconies associated with the gardens accessed by internal stairs.

PATTERN 6F: CONNECTING UPPER FLOORS WITH GARDENS



UPPER FLOORS

Where should prominent continuous stairs be placed?

Although hospitals need lifts these should be conceived only be for those who need them. Staff, visitors and patients who are able should be encouraged to use the stairs by provision of beautiful, prominent stairs which normally link to all storeys. Stairs are good for us and their use should be encouraged for those who can.

PATTERN 5E: PROMINENT CONTINUOUS STAIRS

Wherever possible, stairs should be in prominent and consistent locations to encourage their use. Examples include the axis of a building or a corner of a courtyard. This will help the users instinctively to navigate the facility.

STAIRS

How do we avoid noise and light pollution?

Careful attention should be given to ensure that the needs of one patient do not intrude on the next. This should include light and noise.

PATTERN 5F: AVOID NOISE AND LIGHT POLLUTION

Prevent noise and unwanted light pollution, particularly in patient areas

Use appropriate technology to facilitate difficult issues such as access, lighting and so on.

LIGHT & NOISE

STEP FOUR:

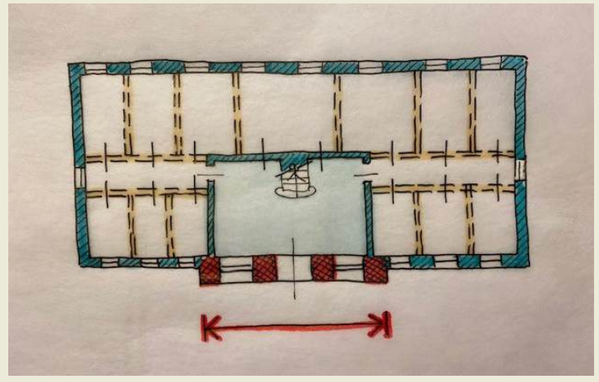
HOW SHOULD THE HOSPITAL BE BUILT?

The construction of a hospital should take into account whole life cost and issues of sustainability and longevity.

What is the right hierarchy of construction for different elements of the facility? Apply a clear hierarchy to the buildings' construction. Certain parts of the building should be regarded as permanent with a life of up to 500 years. Other parts of the building should be regarded as demountable and adaptable so as to allow for change and reuse. This gives the building a longer life. Normally the exterior is the longer life element with the interior adaptable.

Use the hierarchy and function of buildings to decide appropriate level of longevity and cost. For example, buildings reliant on technology with a relatively short life (25 to 30 years) such as an energy centre can be utilitarian and if appropriate designed to accommodate new technology in the future. Façade construction can be substantial. The interior should be flexible and adaptable.

PATTERN 7A: HIERARCHY IN CONSTRUCTION



HIERARCHY

How do we avoid short term technological obsolescence?

Technology should be applied to provide longevity and lower maintenance cost, whilst ensuring adaptability within the building. When selecting make sure that it is not unnecessarily complicated and as such vulnerable to failure or redundancy.

PATTERN 7B: APPROPRIATE TECHNOLOGY

TECHNOLOGY

If the same aims can be achieved in a straightforward manner, choose the simple and tested solution. At the same time capitalise on benefits brought by new ways of doing things such as digital communications or data and patients' records storage, which give opportunities for decentralising healthcare facilities and bringing them closer to the communities they serve.

How we can we use public funds efficiently?

Some of the elements of the Complete Hospitals Framework will undoubtedly cost more in the short term (though they pay back over time due to better outcomes and lower long term maintenance costs – see chapter seven). In order to appropriately minimize this additional up-front cost, a range of building types should be employed. There will often be a place for architecture which is a little more expensive (by the main entrance for example) but much of the hospital, though elegant and built to last, can nevertheless be quite simple and economical to build.

PATTERN 7C: ECONOMY OF CONSTRUCTION

ECONOMIC

Do not be afraid of simple and utilitarian design where appropriate. Reserve more expensive detailing and materials for the locations where they are necessary.

Elegant but simple. Use economy of construction wherever possible as here at the DMRC.

How do we create buildings that people want to keep?

Design with characteristics that appeal to human senses not just function so that the users form a positive emotional attachment to the buildings. This will support a desire to nurture the hospital in the long term. This will be achieved by applying patterns which use symmetry, human scale, memories and biophilic design to calm and heal.

The buildings of the old Covent Garden fruit and vegetable market were repurposed in the 1980s due to popular demand

PATTERN 7D: CREATING BUILDINGS THAT PEOPLE WANT TO KEEP

ATTRACTIVE

What low embodied carbon materials are suitable? What materials will have longevity appropriate to the different levels of hierarchy?

Select appropriate and long-lasting materials which should be both attractive and have a low carbon footprint. Wherever possible, natural and renewable materials should be used as they will have the added benefit of making the building more attractive to users. Natural material such as wood is particularly conducive to patients.

Use the characteristics of long-lasting materials to the full by avoiding making them reliant on materials which have a shorter life such as mastic, plastics or metal cramps.

PATTERN 7E: SUSTAINABLE AND NATURAL MATERIALS

New bricks and timber columns on a new building will last for many centuries.

SUSTAINABLE

The texture of natural materials such as wood or stone is pleasing to humans and their carbon efficiency is far greater than concrete or plastic. Stone or bricks for the external façade will ensure longevity and pay for themselves over time (See chapter 7).

How can we use materials and architecture to minimise long term maintenance requirements?

Reduce necessity for maintenance by, for example, using self-finished materials such as brick in preference to render, capitalizing on self-healing properties of lime or avoiding the use of elements which require re-painting especially at high level.

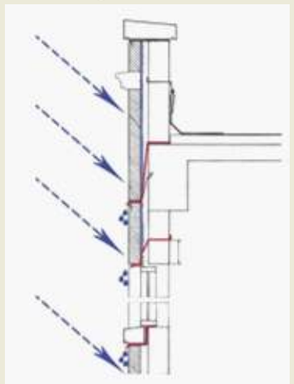
PATTERN 7F: MINIMISED REQUIREMENT FOR MAINTENANCE

Both of these buildings are built of stone. The one on the top uses this technology. The result is that the stone is very badly stained. The building on the bottom in Lincolns Inn is over 200 years old and does not have this problem.

WELL DETAILED

While detailing elevations, consider the location of movement joints and weepholes to ensure that the buildings weather well and do not stain. Facades will need to be articulated in a way which allows for these elements to be placed deliberately where they will not negatively impact on the buildings' long- term appearance.

Architectural elements such as cornices, string courses and cills should be employed to throw the water off the building and to control its impact on the façade over time. Rather than staining, they should allow a patina to build up in places where it emphasizes the architecture rather than undermining it.



Most buildings in recent years are designed so that the exterior finishes are only ornamental. Rainwater is collected by plastic trays and chanelled through weepholes in the façade.

STEP FIVE:

HOW SHOULD THE HOSPITAL BE MANAGED?

The approach to hospital management should consider how to optimise its whole life costs and improve sustainability. This may suggest dedicated charities focused on building maintenance and patient gardening as well as a wider approach to civic engagement as is being pioneered by the Healthy New Towns initiative.

How do we ensure ongoing focus on building maintenance for long term sustainability? Consider creating a separately capitalised charity (or separately targeted public body) tasked with maintaining the physical infrastructure for the long term. This may not always be possible and will need very careful definition of demarcation of responsibility.

Where possible, a dedicated maintenance charity will permit better sustainable maintenance and help prevent fabric maintenance perpetually being the "poor cousin" to the hospital's immediate primary purpose. This is the approach being taken at the DMRC (see chapter 6).

The most effective charity supporting patient gardening in the UK is Horatio's Garden. Their approach to patient gardening should become business as usual wherever humanly possible.

PATTERN 7G: DEDICATED MAINTENANCE AND GARDENING CHARITIES

MAINTAINED

How do we ensure ongoing opportunities for patients to garden?

Consider creating or working with a separately capitalised charity focused on supporting patients' gardening activities. The best example in the UK is Horatio's Garden. Their approach to patient gardening should become 'business as usual' wherever possible.

How do we support surrounding community?

There is an opportunity for a programme of wider NHS engagement with civic society building on the learnings of the NHS Healthy New Towns initiative. This should be embedded within the Hospital Building programme.

PATTERN 7H: WORKING IN PARTNERSHIP: ENCOURAGING STREET BY STREET COMMUNAL TREE MAINTENANCE

Gardening and communal activity is good for both individuals and for communities. Hospitals should work with wider civic society to encourage hyper-local communal tree maintenance. This will support residents' physical and mental health in the hospital's neighbourhood.

COMMUNITY

People always find ways to repurpose the buildings they love

CHAPTER 6

DELIVERY: CREATING COMPLETE HOSPITALS - TWO WORKED EXAMPLES

'A checklist that help us make decisions and make a difference would be very welcome.'

NHS Manager

The DMRC main court showing the pool and gym- a centre of everyday activity

This chapter shows how following the five-step process to create a Complete Hospital can help set very different design briefs to the status quo which, though radically different in their details, respond to the specific requirements brief and sensibly take account of the evidence on patient and staff wellbeing to create better hospitals for humans and for communities reviewed in part one. We do so, using two case studies.

- The first case study, the Defence Medical Rehabilitation Centre, is a specialist tertiary care hospital in the countryside whose design and quantity surveying was led by two members of our team and whose inception, challenges and creation have helped us evolve our Complete Hospitals Framework.
- The second case study is a notional Acute Hospital which we have called Barchester Hospital. We have assumed it is near the centre of a medium sized historic town: precisely the sort of place from which hospitals have foolishly been fleeing for 70 years. We have used our survey and a range of conversations with health professionals and hospital managers to shape this case study and to refine our Complete Hospitals Framework.

THE DEFENCE MEDICAL REHABILITATION CENTRE (DMRC)

The Defence Medical Rehabilitation Centre (DMRC) is at Stanford Hall near Loughborough. The process of designing it has helped create our suite of Complete Hospitals Framework tools. Available evidence was gathered and used to create a new type of hospital which could not only deliver the technology and clinical knowhow of modern medicine but do so within an environment that would be good for staff and patients. This was to improve clinical outcomes but also to make the process of rehabilitation more pleasant for both patients and staff. As we have seen, some of the elements of the Complete Hospitals Framework can be in tension with one another. This varies hospital by hospital. Given the DMRC's role as a nation-wide specialist Tertiary Care Hospital, the focus on local connectivity and neighbourhood was less important, for example, than that of greenery and its critical recuperative role.

Complete Hospitals five-step process and 'pattern book.' Although the five-step process was not formally followed, the same questions were asked in pretty much the same order. Below we set these out and patterns chosen to design the hospital.

The entrance to the clinical core

STEP ONE:

WHAT KIND OF HOSPITAL IS IT?

Question	DMRC design approach and 'pattern book' approach chosen
How wide is the hospital's catchment area?	• Nation-wide, explaining its central location accessible to those in all three armed forces, and close to Birmingham's Queen Elizabeth Hospital which is the specialist defence trauma hospital. • Pattern 1a: immediate relationship to catchment area not critical
How will staff and visitors travel to the hospital? What opportunities are there for re-greened active and public transport?	• Patients- by ambulance or car, or train and taxi, bus. Visitors by car or train and taxi, bus; Staff living on site, walking or cycling, bus or car. • Pattern 1b: high quality public transport likely to be most relevant to staff and some visitors • New bus stops were provided as part of the project
Can we plant street trees to improve surrounding neighbourhoods and support active travel?	• Not important due to rural location • Pattern 6a: Need for cycling way which was provided but less required focus on planting • Pattern 6b: Street tree planting not relevant given rural location
How can the required car parking be economically and sympathetically incorporated?	• Pattern 1c: There was enough space to incorporate car parking out of the way, located behind the new buildings, so it is both convenient and unobtrusive, except for disabled parking which was located adjacent to building entrances
How much interaction will/ should there be with the local neighborhood and community?	• The ongoing interactions involved cooperation with Loughborough University and occasional events for local community.
Does it have any overriding unique requirements such as access to countryside or proximity to specialist facilities?	• DMRC needs to be collocated with the National Rehabilitation Centre to facilitate exchange of expertise and specialist equipment and knowledge. Physical and visual access to parkland was required. • Extensive and varied sport facilities were located throughout the estate and were to be used by patients and staff.

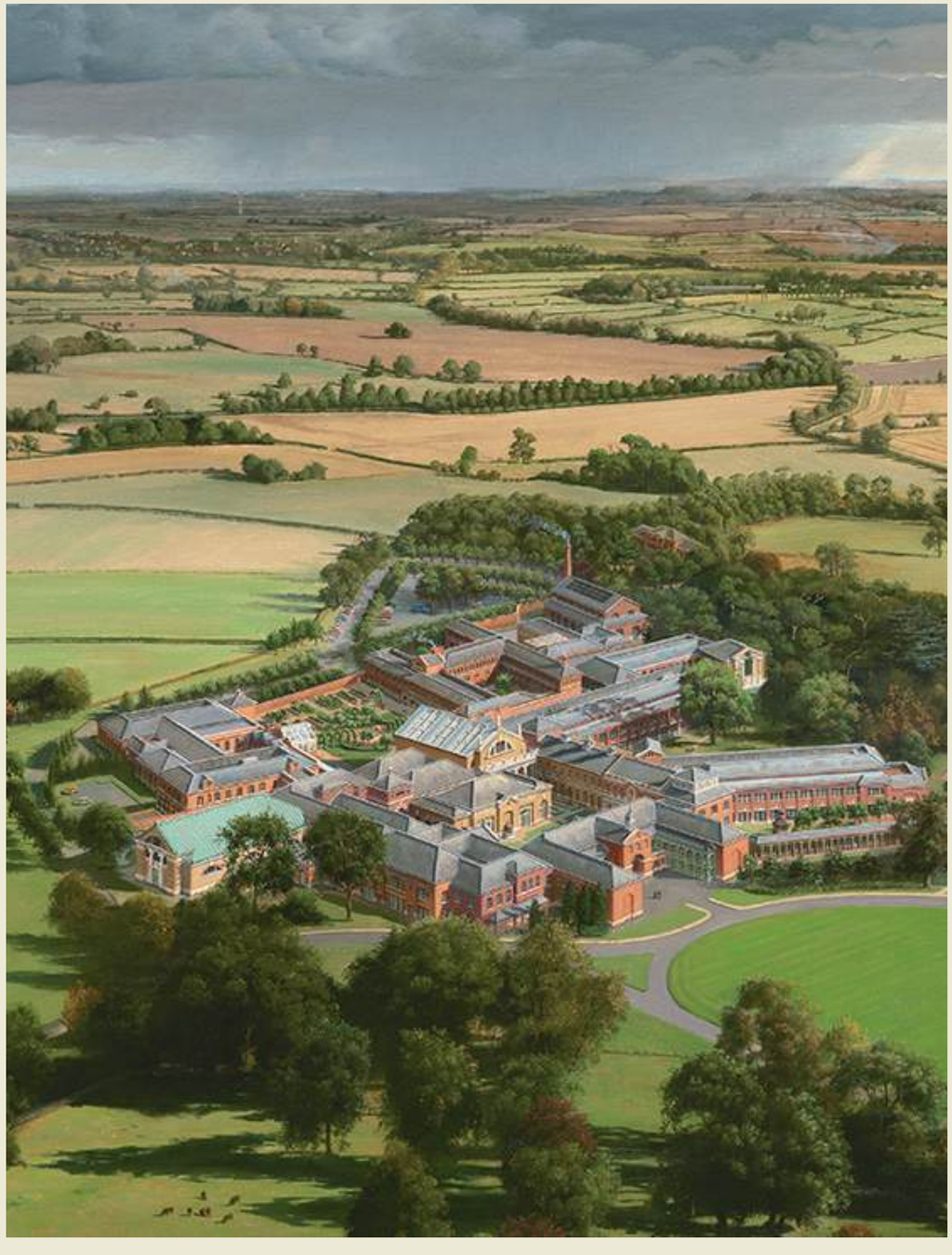
Main court with statue celebrating the medical achievement of the DMRC

Patient rooms with central terrace overlooking the parkland at Stanford Hall

Key

1. Main Court
2. Walled Garden
3. Prosthetics Courtyard
4. Pool Courtyard
5. Mental Health Garden
6. Neuro Garden
7. Patient Terrace
8. Neuro Ward Garden
9. Treatment Area
10. Force Generation Courtyards
11. Lower Limbs Garden
12. Orchard
13. Sea Lion and Penguin Pools
14. Stable Courtyard
15. Entrance Court
16. Cloister Courtyard

Plan showing gardens and courts



STEP TWO:

HOW SHOULD THE HOSPITAL BE INTEGRATED INTO THE COMMUNITY?

Question	DMRC design approach and 'pattern book' approach chosen
How can we maintain permeability through the site for users and visitors and at different grades?	• Pattern 1d: By providing both covered walkways linking courtyards and buildings and bridge links. Wider urban grain not applicable
How can we relate the building to existing site and its immediate surroundings?	• Pattern 1e: Not applicable
How can the hospital brief be subdivided to relate to surrounding building scale and urban grain?	• Patterns 1f By designing new facility to build on the historic development pattern of the estate • Pattern 1g: Not applicable
How will the hospital use and create public space?	• Pattern 1h: Different uses were identified and grouped in appropriately sized clusters and then located in relation to each other, the historic buildings and landscape to create an efficient facility and complement the estate.
How will the hospital both stand out and fit in?	• Pattern 2a: The scale, materials and architectural detailing were chosen to fit in with the historic estate. Significant buildings were designed to be individual and memorable.
How will the hospital express community identity and pride?	• Pattern 2b: The community served is the military community. The architecture deliberately draws on the military architecture so that personnel would feel at home in it. There is no freely accessible public space created at DMRC due to the facility's military nature. • Pattern 2c: Statues included Sir Robert Jones and a frieze celebrating the DMRC's work at its previous home at Headley Court. Sir Robert Jones is regarded as the father of Rehabilitation Medicine and a pioneer in orthopaedics who also served during World War I as Director General of Military Orthopaedics.
How will hospitals feel familiar and healing?	• Pattern 3a and 3b: Symmetrical elements at various scales were embedded in designs. There is a long tradition of buildings common to many military establishments. Much of this is classical and is a particular form of classical: relatively plain and robust without much detailed embellishment. • Pattern 3c: Courtyards, patterns and architecture drew not only on the local precedent but referred to the historic military buildings such as Woolwich Arsenal and Sandhurst.

Adjacency plan

STEP THREE:

HOW SHOULD HOSPITALS BE PLANNED?

Question	DMRC design approach and 'pattern book' approach chosen
Which spaces do & don't require natural light and/or ventilation?	• All the support areas within the wards were identified as not requiring natural lighting. They were located in the centre of long ward blocks allowing for the improvements in floor to external wall ratios. • Pattern 4a: Building depths were typically 11m to 26m • Pattern 4b: Large windows were used to give visual access to gardens and the courtyard • Pattern 4c: connecting circulation routes linked gardens and buildings • Pattern 4d: pools of light populate the facility
How many private rooms will we need?	• Pattern 5a: All the patient ward rooms were designed to uniform standards and were private, allowing for flexible allocation dependent on specific and changing pressures.
What different privacy levels are needed and how do we ensure they are achieved?	• A variety of privacy and security needed to be provided both internally and externally with, for example, neurological wards having totally private and secure wards, treatment areas and dedicated gardens. • Pattern 5b: Most of the courtyards around which the treatment areas were organised had full access for all the patients and staff. The accommodation blocks for short term patients and staff accommodation had private courtyards or terraces accessible from their dining facilities. Neuro patients were given separate areas for additional quiet and privacy. • Pattern 5c: Internally the patients had a range of spaces from the privacy of their individual rooms to communal facilities associated with the wards to the general patients messes.
Where can we create alternative external circulations routes?	• Pattern 5d: All the courtyards as well as covered and open walkways provided opportunities for using the external spaces for daily travel across the facility.
How much external space would benefit the hospital and where would it be best located in relation to other facilities? How do we create a variety of outdoor green spaces with differing privacy levels?	• Pattern 6c: As many of the facilities as possible were arranged around external courtyards, or overlooking the parkland, with particular attention paid to the patients' rooms orientation and views. • Pattern 6d and 6e: A walled garden with raised beds suitable for use by patients with impaired mobility was provided within the walls of a historic garden together with two glasshouses giving patients opportunities to reap the benefits of winter gardening.

Staff welfare facility in the new West Wing to Stanford Hall

Question	DMRC design approach and 'pattern book' approach chosen
How we connect upper floors with gardens?	• The main clinical areas of DMRC were only two stories with communal areas on the upper level to a large terrace overlooking parkland. • Pattern 6f: Only partly relevant. Achieved with windows and vistas not balconies.
Where should prominent continuous stairs be placed?	• Pattern 5e: The main stairs within the clinical facility are in the corner of the main court, on the principal route connecting all the facilities from the carpark via the walled garden and a cafe to the main court, the house and the staff areas. • Their location has been carefully chosen to make it easy for anyone to reach the stairs and access anywhere within the facility be it on the ground or first-floor.
How do we avoid noise and light pollution?	• Pattern 5f: All wards are single rooms ensuring greater privacy for patients. Neuro patients are provided with additional privacy. The facility's rural location also meant that the design of new lighting had to be carefully considered to prevent light pollution to the surrounding countryside and minimise impact on wildlife.

The walled garden at Stanford Hall

STEP FOUR:

HOW SHOULD THE HOSPITAL BE BUILT?

Question	DMRC design approach and 'pattern book' approach chosen
What is the right hierarchy of construction for different elements of the facility?	• Pattern 7a: The exterior of the new clinical buildings was built to last, using durable and well-tested materials such as brick, stone, slate and terracotta tiles. Interiors, where the need for a more frequent change and adaptations should be expected, were fitted out with more suitable light weight construction, making future changes easier and more economical.
How do we avoid short term technological obsolescence?	• Pattern 7b: A loose fit design for the areas where new technology was incorporated was adopted to allow for future changes.
How can we use public funds efficiently?	• Pattern 7c: Simple and utilitarian design was used over many of the courtyards and gardens. Elements of ward design were standardised whilst ensuring colour and individuality.
How do we create buildings that people want to keep?	• Pattern 7d: By creating a beautiful and relaxing series of gardens and specialist facilities, a statement was being made of investment in injured soldiers. The hospital was meant to tell them "you matter."
What materials with low embodied carbon would be suitable for your hospital? What materials will have longevity appropriate to the different levels of hierarchy?	• Pattern 7e: Sustainably sourced timber was used throughout to form covered walkways, links and shelters including two large bat houses located in the parkland ,as well as most of the windows which were made of timber.
How can we use materials and architecture to ensure minimised requirements for long term maintenance?	• Pattern 7f: Self-finished materials such as brick and reconstituted stone were used, avoiding the need for repainting especially at high level. Cornices, string courses and cills were used to throw the water off the building, creating a patina in places where it emphases the architecture.

STEP FIVE:

HOW SHOULD THE HOSPITAL BE MANAGED?

Question	DMRC design approach and 'pattern book' approach chosen
How do we ensure ongoing focus on building maintenance for long term sustainability?	• Pattern 7g: A dedicated maintenance charity, the Black Stork Charity, is tasked with managing the estate
How do we ensure ongoing opportunities for patients to garden?	• Pattern 7g: At present no dedicated gardening charity has been created
How do we support the surrounding community?	• Pattern 7h: Even though the DMRC, due to its military nature, cannot be fully opened to the public it has brought benefits to the local community. These include providing good local employment, adding to the bus network by providing a new bus stop, improving the local cycle network, and improving access to a historic house, estate and registered parkland, giving it a new lease of life for years to come. By providing space for an NHS facility on the same site adjacent to the DMRC, data can be pooled making Stanford Hall an important research centre for rehabilition medicine.

The lower limbs gym facing the entrance to the clinical core

In consequence of this process and these decisions, the DMRC's key features include:

• Green with gardens. Greenery in surrounding parks and gardens so that patients and staff don't just see them but also enjoy, use and even garden in them. The Parkland includes trim trails, running and hand cycle tracks for use by the patients.

• Enclosed and secure. External cloisters connected by arcades and colonnades and the old walled garden all create enclosed and secure places for patients and staff.

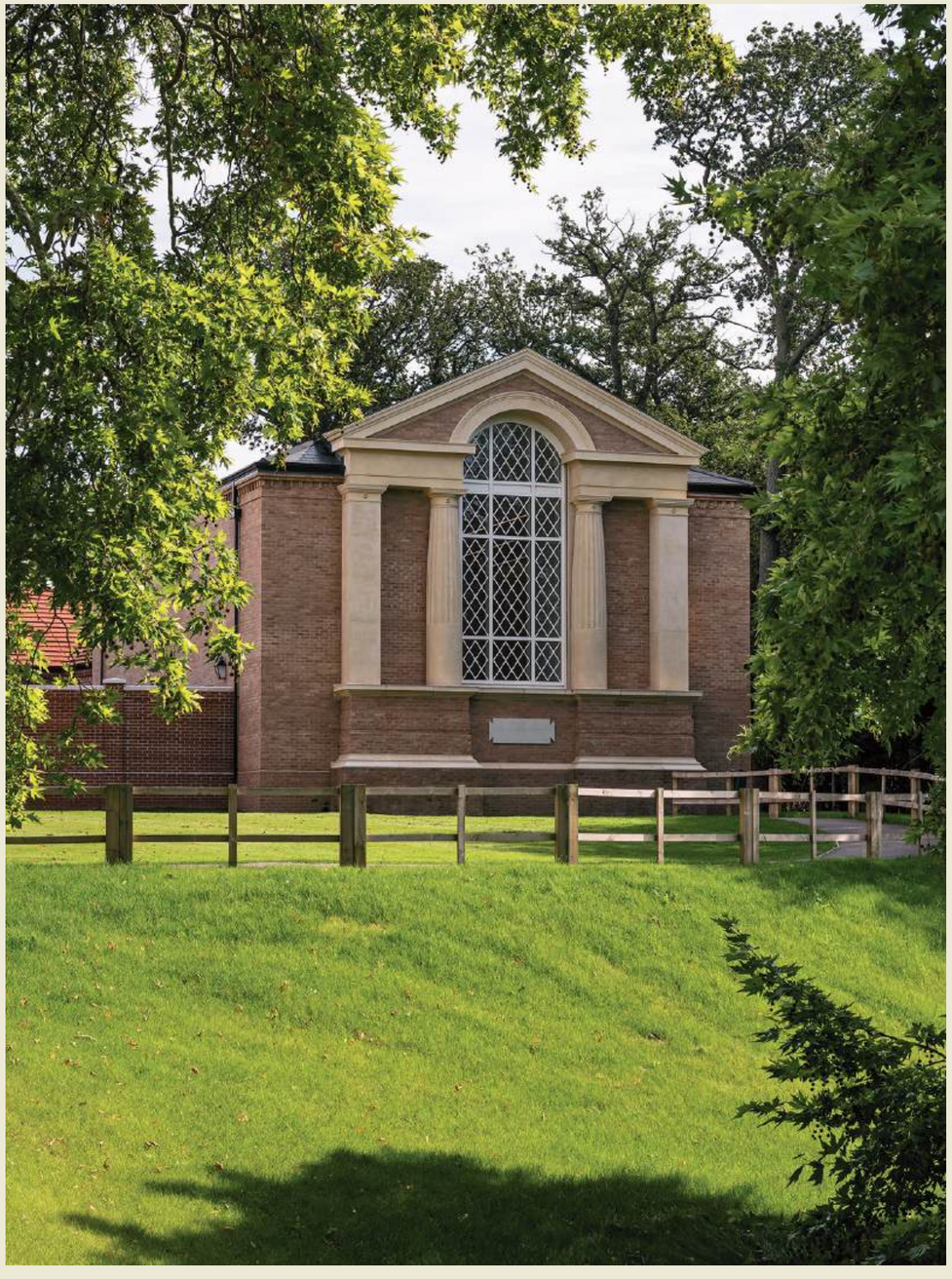
• Naturally lit and ventilated. There is ample natural light and ventilation throughout with large windows.

• Beautiful places to be proud of. One of the stipulations made by the funder was that the DMRC should convey to the injured service men or women a clear message that the nation cares about them. It was designed as an institution of which the nation can be proud.

• Variety in a pattern. The overall hospital is broken down into component parts. Each is put into adjacent connected buildings, building on the pattern of courtyard buildings associated with a large country house. This kept the hospital at a scale which avoids being overbearing, anonymous and institutional.

• Adaptable and resilient. There is a 'hierarchy of construction' with external walls in masonry which is 'hard to change' whilst internal arrangements are cheap and easy to change.

The DMRC was designed before the Complete Hospitals framework was created but illustrates many of its features – as appropriately interpreted for a specialist Tertiary Care Hospital with strong military connections. However, the same principles of a hospital as a beautiful 'place for healing' not a 'factory for fixing' can and should apply to all hospitals.



The gym to the neuro treatment unit nestled in the arcadian landscape of the Park

CHAPTER 6

BARCHESTER HOSPITAL

To illustrate how the Complete Hospitals Framework can be applied to a large general hospital in an urban area with an extensive catchment area, we have put together a sketch scheme following our five-step process and discussions with NHS managers and health professionals. We have not attempted to design individual rooms or wards but have attempted to show how the application of the same process in different circumstances leads to very different results in how the hospital is integrated into the community and planned.

What kind of hospital is it?

We assume that this is a new acute hospital in a medium sized historic town or cathedral city with a population of about 100,000. The hospital would have a catchment area of around 500,000 people. Let us call it Barchester. It needs to have about 700 beds and significant space for tests and treatment of patients as day cases without the need for overnight stays. We see an increase of day care in the future as treatments such as interventional radiology and immunotherapy for cancer begin to replace surgery as the mainstay of cancer treatment. The population is older than average in the UK, with expected higher need for cancer specialists and treatment. Above all, the design needs to take into account the functions of the building for staff and patients, with departments co-located where appropriate.

How should it be integrated into the community?

For this hospital, we believe, good neighbourhood integration is essential. There are two alternatives, both standard practice at present but neither desirable.

- The first is to design it as a single mega building within the town surrounded by a large 'sea' of parking. This creates an impermeable and unpleasant 'island', isolates the hospital and destroys urban cohesion.

- The second, increasingly common, alternative is to create a mega building on a major road junction outside the town. This has some advantages for ease of access for the wider hospital catchment. It has the disadvantage of harder access for town residents, of draining life, prosperity and activity out of the town centre, of requiring far more land and of encouraging less sustainable or healthy living patterns for staff and visitors alike.

CREATING A COMPLETE HOSPITAL

Instead, a hospital should be a font of civic pride at the heart of a community not sequestrated away from it. The creation of a central green space, which is accessible to both the general public and hospital users is a key to this urban setting as it provides a focal point to the facility and a much-needed green oasis. It also means that in peoples' minds, the hospital can be associated with the welcoming, green environment this space provides.

How should the hospital be planned?

All buildings are arranged around this space. There is a major axis running through it which encompasses both the main hospital entrance building and the building most frequently visited by the public – typically the outpatient's department and the associated cafe and dining areas.

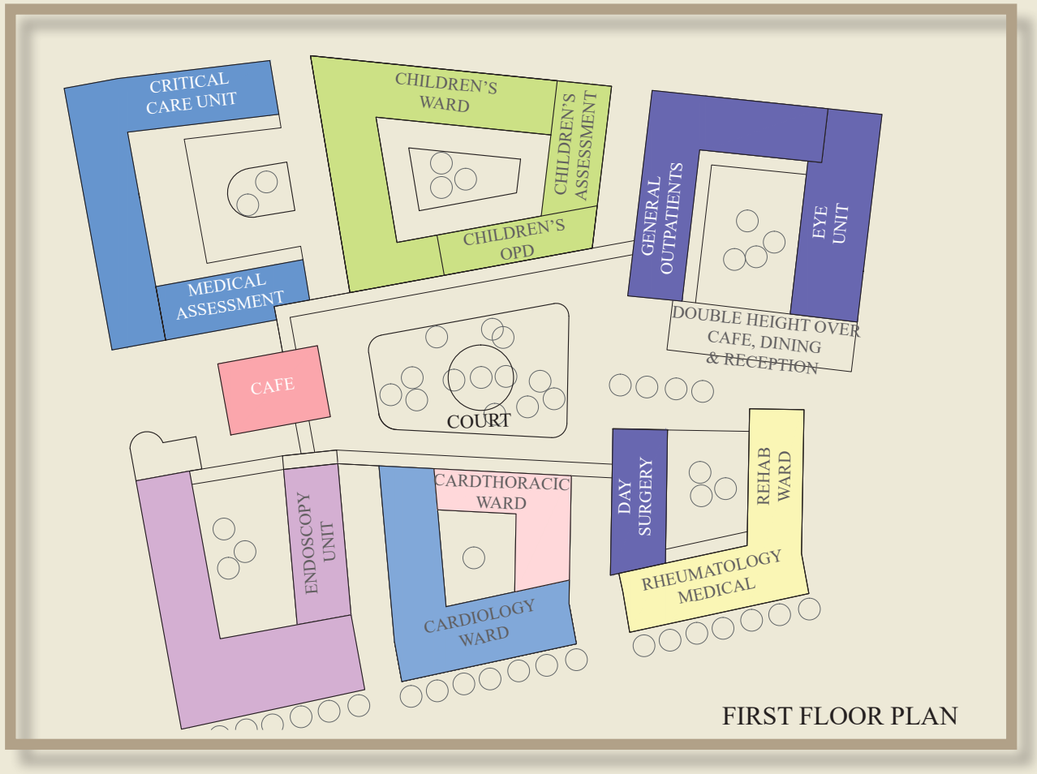
Placing these two key buildings on either side of the central green square creates an animated space which visitors can easily find and from which they can orientate themselves in relation to all the other hospital facilities they may require.

This major axis is an extension of the existing street network allowing the hospital to integrate with the town and its facilities including public transport, cycle ways and pedestrian links.

The same principle of extending existing streets is applied to two roads running across the site to ensure further integration with the neighbourhood and to increase permeability through the hospital site.

Main Hospital Square

Continuous streets



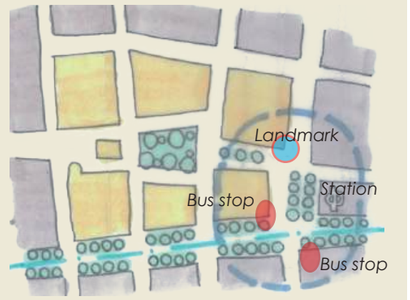
FIRST FLOOR PLAN

The inclusion of the shops at some of the ground floors of the hospital provides an active frontage for the street and helps the hospital buildings fit in comfortably and naturally within the neighbourhood.

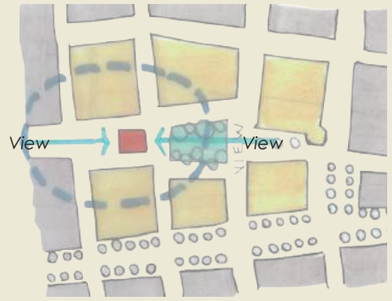
Additional planting is introduced on the streets running along the hospital's western edge creating a tree-lined boulevard which is a continuation of an existing boulevard to the site's north and south. At the southeast corner a small square is created to relate to two new bus stops. (There are also plans for a tram that will pass through). On two sides the square is defined by the hospital buildings, one of which is in a prominent position suitable for a significant architectural element such as a small tower. It is used to mark the hospital complex's entrance and an outpatient department in particular. Its design is distinctive and easily recognisable helping orientation and making a positive urban contribution.

Large trees are planted in this square to improve the neighbourhood and provide a green outlook for the hospital's patients, staff and visitors.

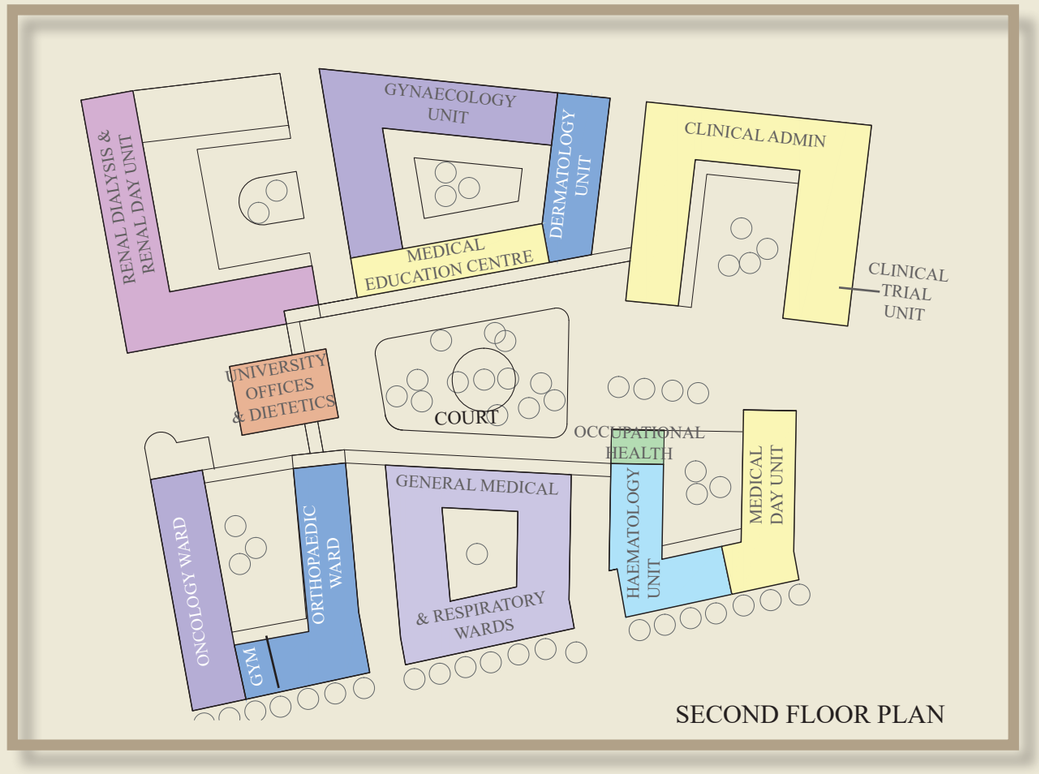
The main hospital entrance building is designed as a singular and distinctive structure located at the main hospital axis's northern end . To the north, in front of the building, a public square is created which acts as a forecourt offering space to visitors, allowing taxi drop offs and signalling to all that they have arrived at an important place. The façade is designed with the reference to facial pattern and local symmetry and to a scale which acknowledges that it will be seen from



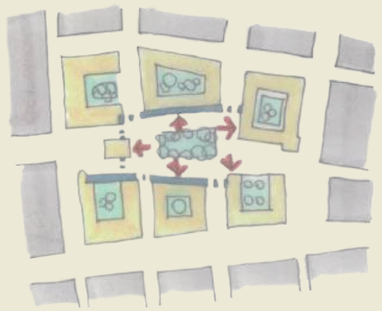
Public Square by Outpatients Entrance



Main Entrance



SECOND FLOOR PLAN



Principal Circulation

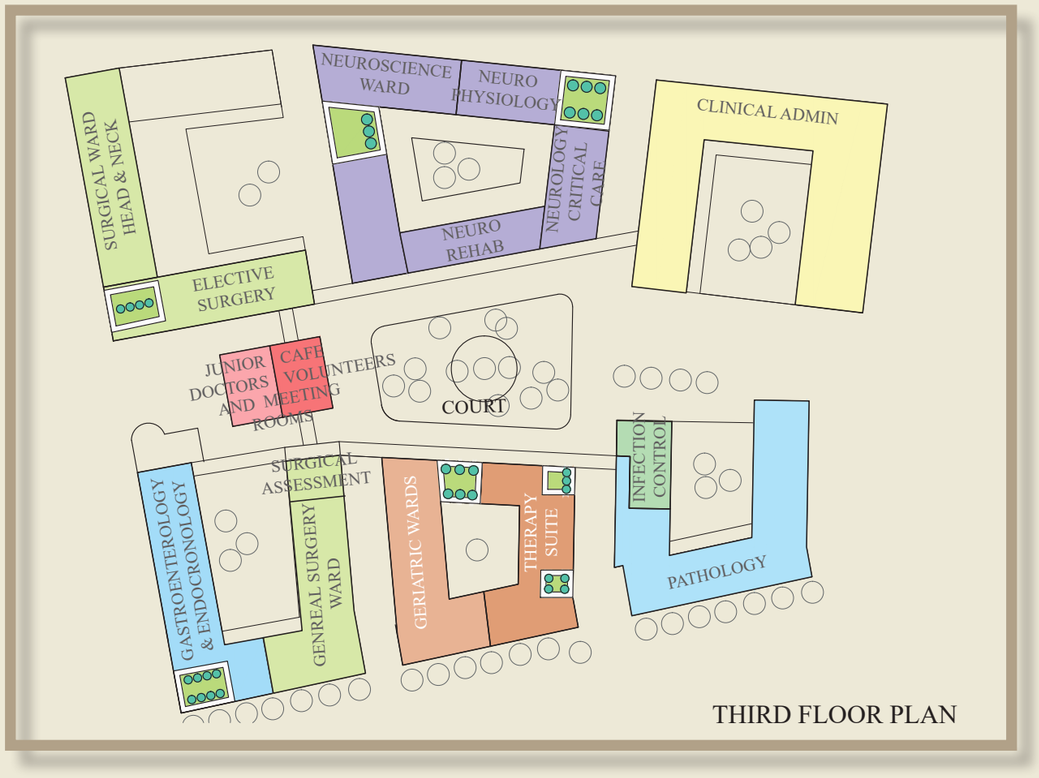
a distance. Its location at the end of the approach to the hospital to the north makes it a significant landmark. In future its façade will probably become identified with the hospital.

A small faith centre or house of prayer is located in this space, adjacent to one of the hospital blocks and designed so that it is distinct from other buildings and its function is recognizable. The square itself is a good location for a monument associated with the town. Perhaps a significant doctor or medical researcher who came from the town? The square also has two new bus stops.

The same main entrance building is a focal point of the Main Green Square in the centre of the development. Its south façade is designed to respond to this location and to be 'read' as a welcoming entry point.

Required carparking is provided along all the hospital streets as dedicated on-street spaces with trees used to break it up into smaller groups. Additional required parking is in the basement and is accessed via a dedicated ramp in the southeast hospital block where some additional shops are provided on the ground level. However, as far as possible the focus is on making it easy for staff and healthier in-patients to come by public or active transport.

A separate ramp located in the northwest block is dedicated to hospital service deliveries. The remaining basement is used to provide surgical theatres and associated functions as well as the radiology department and a fracture clinic. A number



THIRD FLOOR PLAN

of large sunken courtyards bring natural light to this level so that where there is a need for either the patients or the staff to take a break, they can do so in a pleasant and green environment.

The A&E department is located on the ground floor level in the northeast corner of the site. It is organised round a large court serving as a drop off area and with dedicated lifts linking it to the radiology department located directly below. In addition, a dedicated A&E x-ray is provided to ensure smooth running of the department. Upper storeys contain private rooms for inpatients. There are some further private gardens on the roofs for patients and staff to relax in and for gardening.

All the urban blocks which form the hospital complex are not only organised around the central green space but also have their individual entrances facing that square. All also relate to a principal circulation route with vertical circulation in the form of prominent staircases and associated lifts organised at each of the corners. At the ground floor this is an open arcade On the upper levels it is connected by a series of bridges between the buildings. This ensures that it is easy to find one's way around the hospital. A variety of courtyard forms is provided. Each has a unique character determined by the configuration, architecture and planting making them distinguishable from one another and once again helping wayfinding.

How should the hospital be built?

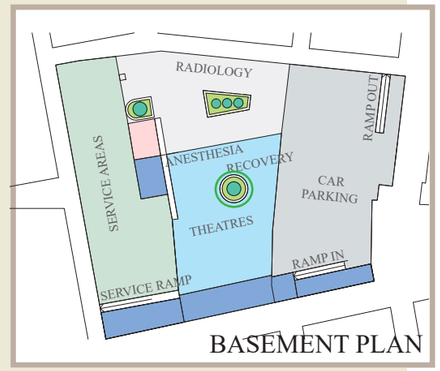
The hospital would be mainly built from materials such as local stone and bricks which are long-lasting, require low maintenance and have much lower embodied carbon than steel and concrete. These are natural materials that can be configured to provide symmetrical balance architectural compositions reflecting the history and identity of the locality which will appeal to the local community. The interior of the hospital building is designed so as to be easily adaptable using materials that are easy to change and rework.

The local civic society, the preservation society and parish councillors and neighbourhood forums will all be actively involved in selecting elements of the design which integrate with the surrounding town. Some aspects of the design were also shared online through online mapping and preference survey tools. This helped set the brief and informed the design.

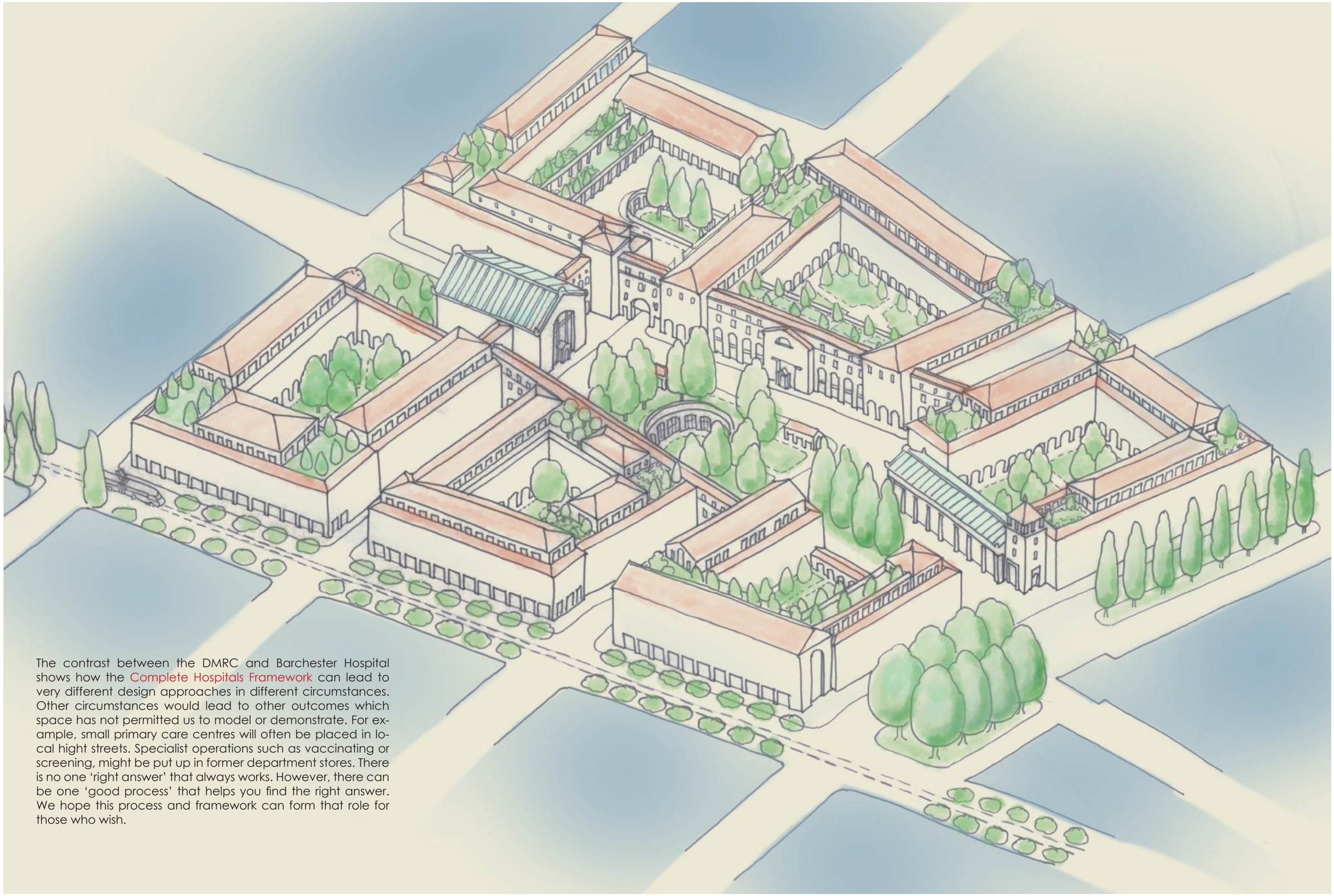
How should the hospital be managed?

A charity runs some of the private gardens for patients' use. An independent advisory fabric committee, rather similar to that of a cathedral, is being established to care for the long-term stewardship of the building. Members of the hospital community volunteer in the local tree-planting charity and are actively involved in supporting Barchester's street tree planting. Some streets are being declared green routes, others as 'woonerfs' in which it is much easier to walk or cycle. Everyone who lives in the town can travel to the hospital by public or active transport thanks to the growing network of safe routes crossing Barchester. The main one joins the train station and the hospital with the historic town centre.

Carparking along streets



BASEMENT PLAN



The contrast between the DMRC and Barchester Hospital shows how the Complete Hospitals Framework can lead to very different design approaches in different circumstances. Other circumstances would lead to other outcomes which space has not permitted us to model or demonstrate. For example, small primary care centres will often be placed in local hight streets. Specialist operations such as vaccinating or screening, might be put up in former department stores. There is no one 'right answer' that always works. However, there can be one 'good process' that helps you find the right answer. We hope this process and framework can form that role for those who wish.

CHAPTER 7

EVALUATION: DO THE SUMS ADD UP?

'There is a big drive for standardisation of hospitals. But what will that mean? The bit you offer the most on is: how do you make the standard design beautiful and healthy to help patients and staff.'

NHS Manager talking to the competition team

Methodology for evaluating benefits.

The Complete Hospital framework is designed to be a practical tool for setting and prioritising a financially sustainable design brief and monitoring against that design brief. It is not a wish list. In order to evaluate its financial sustainability we have used a partial Green book methodology as set out in The Green Book (2020) and HM Treasury's Guide to Developing the Programme Business Case and Guide to Developing the Project Business Case (both 2018).* We have also taken account of some widely respected third sector evaluations of the socio-economic value of policy and practice interventions, for example the 2019 evaluation of The Value of a social tenancy by the Hyde Group, and peer-reviewed analysis of monetised health, wellbeing and environmental impacts. We have categorised potential benefits from our Complete Hospitals approach into six main sections.

1. Staff productivity;
2. Staff health and wellbeing;
3. Patient health and wellbeing;
4. Reduced carbon emissions from staff, patients and visitors' sustainable transport;
5. Reduced carbon emissions from adaptive, long-lasting and resilient design; and
6. Reduced financial costs from adaptive, long-lasting and resilient design.

* Partial, because we have only modelled it vs. presumed 'business as usual 'as opposed to other distinct options as recommended by chapter four of The Green Book. We have also only modelled differences between options not the full financial performance over 60 years.

Potential benefits emerging from the literature review in chapter 2 are set out in the table. All are based on peer-reviewed studies though most of our scenario modelling assumptions are more conservative than the numbers listed. Appendix 3 has more details.

Category	Benefit	Potential variance	Source
Staff productivity	Increased quantity and/or quality of work**	Up to 15%	Alhor et al (2016) Leaman & Bordass (2010) Clements-Croome & Li (2000) Fisk (2000)
	Reduced errors	Up to 26%	Buchanan et al (1991)
Staff wellbeing	Reduced sick leave	Up to 25%	Caspari (2006)
	Improved health from increased active travel	Up to 10% reduced chance of premature mortality	PAHRC
Patient wellbeing	Reduced in-patient durations due to green, naturally lit rooms	8% - 30% reduction of in patient stay durations	Ulrich (1984), Ulrich (2004), Beauchemin & Hays (1998)
	Reduced patient mortality in acute wards for green naturally lit rooms	Up to 60%	Beauchemin & Hays (1998)
	Reduced reinfection for naturally ventilated rooms	Up to 350%	Escombe et al (2007)
Reduced carbon emissions	Reduced staff and visitor greenhouse emissions due to active transport	Up to 18% reduction	OECD/ITF (2020) Census (2011)
	Reduced staff and visitor greenhouse emissions due to public transport	Up to 5% reduction	OECD/ITF (2020) Census (2011)

We have used the Green Book Social Cost Benefit Analysis (CBA) framework. This means that costs and benefits are assessed from the perspective of UK society, not just the public sector or organising institution. It also sets out the types of costs and benefits which may be considered in a decision-making cost benefit analysis. These are listed in appendix 3 and used below.

** It can in practice hard to disentangle improvements in quantity and quality.

Methodology for evaluating capital costs.

The Complete Hospital Framework (CHF) sets out seven components and design criteria that should be considered. It is not an "off the shelf" design but a design tool to establish a brief to achieve the CHF components in an economically feasible manner.

We recognise that the CHF will have a moderate impact on capital cost. To assess that impact to feed into the green book evaluation, we have analysed at high level, likely adjustments on the building elemental costs using data from completed/ construction stage P22 schemes.*** We have also reviewed the Defence Medical Rehabilitation Centre (DMRC) which incorporates many of the principles of the CHF which was described in chapter 6.

The cost impact has been assessed as a percentage of £/m2 of Gross internal floor area (GIFA) based on typical elemental costs from these data sources. The results of our analysis are set out below. Space has not permitted setting out all logic and assumptions but more detail is available in appendix 3.

1. Interwoven with neighbourhood. The patterns considered include location in relation to the neighbourhood served, surrounding urban grain, block sizes, building scale, circulation network and flexibility of building types and heights. Potential impacts on capital cost are:

Impact	% Impact of £/m2 of GIFA
• Increased wall to floor ratios (building scale and individual blocks rather than one whole). - Light within hospital buildings - Number of storeys.	0.81 0.0 (4 considered standard - no impact)
• Higher proportion of circulation space (to connect individual blocks/"bridge" local roads/maintain existing networks).	0.35
• Increased entrance spaces (each department with a front door').	0.21
• Building height changes (assessment of required clinical adjacencies and minimum heights required while integrating within the local landscape)	0.14
• Supporting public transport (to encourage healthier/more sustainable transport) - This move is healthcare wide so no additional impact is assessed for the CHF.	0

*** NHS P22 Projects Elemental Cost analysis downloaded 6 Oct 21.

2. Beautiful places to be proud of. The patterns consider the hierarchy of the architecture, orientation, use of public space, community identity and pride. Potential impacts on capital cost are:

Impact	% Impact of £/m2 of GIFA
• Increased costs of the envelope (a hierarchy of architecture/gateways/public aspects stand out).	2.72
• Creating statement entrances within the buildings (possible introduction of community history, larger welcoming spaces)	0.06
Total assessed impact	2.78

3. Variety within a pattern. The patterns consider familiar development patterns, orientation by mini destinations and economy. Potential cost impacts are:

Impact	% Impact of £/m2 of GIFA
• Increased space introduced by building patterns (to create familiar spaces) - Potential increased circulation space – considered with 1	Included
• Increased costs by introduction of patterns, e.g., arches, use of colour and introduction of location details (to promote easy orientation).	0.74
• Hierarchy of buildings (to introduce economy)	Included
Total assessed impact	0.74

4. Naturally lit and ventilated spaces. The patterns consider avoiding deep spaces with wno external aspect, relationship with outside space and beautiful windows. Potential cost impacts which are not considered elsewhere are:

Impact	% Impact of £/m2 of GIFA
• Reduced cost of ventilation (avoidance of deep spaces)	0.0
• Higher cost for window element (to introduce light and create beautiful rather than utilitarian windows)	2.44
Total assessed impact	2.44

5. Enclosed and secure. The patterns consider outdoor/indoor spaces with differing privacy levels, private rooms, use of technology, use of natural materials, avoiding noise and light pollution, continuous stairs and scale. Potential cost impacts are:

Impact	% Impact of £/m2 of GIFA
• Increased use of natural materials (to form enclosures/ private space within the open space).	0.14
• Increase in private spaces internally (to create stepping-stones back to normal life)	0.35
• Private rooms	0.00
• Increased use of technology (to facilitate public access)	0.19
• Use of natural materials (pleasing to humans and carbon efficient). - Net zero carbon is a current key target within healthcare establishments and is adding costs in the region of 5% to other healthcare schemes For that reason, it is not considered an additional cost as this is becoming the "norm".	0
• Increase noise reduction/acoustic treatments and controllable lighting (to prevent noise and light pollution)	0.97
• Prominent continuous stairs (encouraging their use)	0.80
• Reduce space (create corridors/spaces on a human scale)	-0.11
Total assessed impact	2.34

6. Green with garden. The patterns consider a variety of outdoor space, circulation and the connection of upper floors with gardens, vistas through the building, biophilic architecture, biodiversity and gardening. Potential cost impacts are:

Impact	% Impact of £/m2 of GIFA
• Increase in costs spent on landscape elements (to create variety)	1.42
• Increase in the envelope cost (creating connection of indoor and outdoor spaces)	1.22
• Increase in gardens cost (to provide gardening spaces)	0.11
Total assessed impact	2.75

While this list is not exhaustive it covers some of the major factors affecting capital cost. The total impact assessed above is: **12.57%**.

Based upon the analysis of recent new build P22 healthcare schemes, the average works cost per m2 (excluding fees/ charges, client supplied furniture/equipment, VAT), uplifted to current day prices (based on the BCIS Pubsec indices 13/9/21 for 4Q21) equates to £4,226/m2. Using the above assessed impact, the CHF would increase this cost to circa £4,757/m2.

Methodology for evaluating life cycle cost

The seventh component of the CHF relates to the design and construction taking account of whole life costs and the wider issues of sustainability and longevity. The capital aspects of these costs are considered above and those higher initial capital costs will in turn lead to reduced life cycle costs through the more substantial forms of construction inherent in the CHF.

The cost impacts are based on data from the DMRC for which life cycle costs were calculated based on the more substantial forms of construction referred to in CHF and a hierarchy of building forms.

7. Adaptable and resilient. The patterns here involve applying hierarchy to ensure longevity and lower maintenance cost, appropriate technology, buildings that people want to keep, sustainable materials, minimising maintenance requirements and dedicated maintenance charity/public body.

Impact	% Impact of £/m2 of GIFA
• Reduced costs of life cycle replacement cost applying hierarchy and substantial façade/envelope construction	-3.00

Based upon published BCIS life cycle cost data for hospital schemes, with adjustments for an extended life cycle period of 120 years, the likely cost for replacement and maintenance is circa £69 per m2 of floor area, per annum.

Green book cost benefit analysis

Scenarios – timeframe. We have run eight scenarios. In scenarios (1) to (4) we have run the analysis, as advised by the Green Book, over sixty years for a new building. We do not believe that fully captures the embodied carbon, resilience and sustainability advantages of our approach. We are designing a hospital to last for 500 years not 60. This has material benefits in terms of embodied carbon and financial costs. Therefore, in scenarios, (5) to (8) we have run the cost benefit analysis over a doubled timeframe of 120 years.

Scenarios – benefits. We have run four scenario pairs:

- In the pessimistic case, we assume that our largest benefit, reduced length of stay, delivers only one fifth of the benefits we expect from the peer reviewed literature, as well as discounting all of our other benefits by 40%. We also assume that costs run 20% higher than expected.
- In our conservative case, we have made very conservative assumptions of monetised annual social benefits of £7.5m: we discount all our benefits by 40%, as in the pessimistic case, but without the extra 80% discount we apply to our largest benefit, length of stay (see benefits analysis in the appendices for full breakdown). We also assume that costs run 20% higher than expected.

• In our base case, the annual social benefits are modelled to increase to £9.9m. In this case, we discount each of our benefits by 20%. We assume that costs run as expected.

• In our stretch case assumption, benefits are modelled to increase to £12.4m based on the full opportunity from peer-reviewed research. We assume that the full estimated benefits in the model, as extrapolated from examples around the world, and that costs run 20% below expected.

More detail is in appendix 3.

NPV vs business as usual (£m)	Over 60 years	Over 120 years
Pessimistic case (£1.8m of annual social benefits)	Scenario 1: *– £9m*	Scenario 5: +£3m
Conservative case (£7.5m of annual social benefits)	Scenario 2: +£135 m	Scenario 6: +£163 m
Base case (£9.9m of annual social benefits)	Scenario 3: +£206m	Scenario 7: +£241m
Stretch case (£12.4m of annual social benefits)	Scenario 4: +£278m	Scenario 8: + £319 m

Conclusion

Our cost benefit analysis finds that in the majority of scenarios, the Complete Hospitals Framework adds monetisable net present value as measured by the Green Book. Even with a highly pessimistic set of assumptions, the Complete Hospitals Framework has a modestly net positive value over 120 years and only has a very modestly negative value (-£9m) over 60 years. In all other scenarios, this approach is highly value positive. We conclude that the Complete Hospitals Approach can be justified as delivering good value for the public purse as well as for society, patients, visitors and medical staff.

Next steps. As part of the process of working up this submission we have begun conversations with several hospital managers currently making or likely to make bids to the hospital building programme. Several have indicated a concern about the likely 'standardisation' of future hospital design and an enthusiasm to create better places. We think this modelling points the way. Certainly, were we to win the competition, and hopefully even if we do not, we hope to work with hospital managers to refine this evaluation model to permit the Complete Hospitals Framework to be taken forward in real situations. This would mean more fully applying the Green Book programme and project business case methodology; in particular (1) modelling of all factors over lifespan not just differentiating factors and (2) working up other development options for full comparative analysis. The model would also ultimately need to be owned by and the cost benefit analysis conducted by officials not by us!

As well as being better for patients, staff and visitors and representing more sustainable approach, the Complete Hospitals Framework adds monetisable public value under all but the most pessimistic of scenarios.

NOTE: *In all scenarios we have made the following assumptions:*

• We have not assumed or modelled for any distributional or equality effects; and

•We have applied the Green Book Social Time Discount Rate of 3.5% which adjusts for

CHAPTER 8:

WHAT NEXT: A LETTER TO THE COO OF BARCHESTER HOSPITAL

NEW HOSPITAL PROGRAMME
Department of Health & Social Care
39 Victoria Street, London, SW1H 0EU

29 October 2021

Dear Chief Operating Officer,

Many congratulations on your recent appointment to lead the hospital development project at Barchester Hospital. As one of our next phase of 'large and complex' schemes we have requested you to pilot the Complete Hospitals Framework. Thank you for agreeing to do so.

What is the Complete Hospitals Framework?
The Complete Hospitals Framework is not one single design but a series of six management frameworks, KPIs and tools. For ease of reference, five of these are collated in Appendix 1 of this document and the sixth (the Green Book cost benefit tool) is explained in Appendix 2 and is available on request. These tools and their primary purpose are set out below:
Next steps

	Tool	Purpose
1	The Complete Hospitals Framework	Setting the overall requirements and metrics for hospitals that improve wellbeing
2	The Complete Hospitals Governance board	Suggested board members nationally and locally for hospital delivery
3	The Complete Hospitals KPIs	KPIs to manage a hospital by
4	The Complete Hospitals five-step process	A process of five key question types to 'set the brief' for a new hospital
5	The Complete Hospitals 'pattern book'	A detailed series of [x] patterns which should be emphasised, included or not used in your design brief
6	The Complete Hospitals Green Book Cost Benefit Analysis tool	A model which, with further function-ality, can serves a basis for making design decisions trading off present costs for long term gains

Your next steps should be to;

- establish a confident project board along the lines suggested in tool 2 (Complete Hospitals Governance) ensuring strong wellbeing and sustainability design expertise as well as a confident patient and community voice;
- familiarise yourself, key staff and project board with the underpinning research and rationale for the Complete Hospitals Framework (tool 1);
- agree timeline and deadlines with project board and NHS New Hospital Programme;
- define key clinical needs and expected volumes over the next 20 years;
- review and tabulate staff engagement and wider neighbourhood health and wellbeing metrics;
- Set project aims and KPIs for delivering systemic change in neighbourhood, patient and staff wellbeing (use tool 3);

- Appoint a designer and project manager (ideally a mixed internal and external team) to run the options feasibility project and workshop;
- Run a two to three day design workshop to work up different options using the five-step process and 'pattern book' (use tools 4 and 5);
- Refine these options and conduct both NHS Project management and Green Book analysis (tool 6) on options using a range of scenarios;
- Agree preferred option and appoint design and delivery team;
- Establish a clear process for agreeing deviations from design brief by categorising elements of design into four clear 'buckets';
  - Must not: the design element is axiomatically important and cannot be abandoned;
  - Should not: the design element is important and should not be abandoned. Doing so will require project board sign off;
  - Can: the design element is not critical and can be changed with Project Director sign off; and
  - Can readily: the design element is not critical and can be changed with line manager sign off.

Thinking longer term: growing the framework with a Complete Hospitals accreditation programme

There are constraints on public and private sector capacity to deliver the national hospital programme. As was commented recently 'the market is not there.' This is the key risk to the delivery both of the quantity and the quality of the New Hospital Programme.

If your feasibility study, RIBA design to stage 3 and ongoing cost modelling progress satisfactorily, we will ask you to work with wider NHS colleagues to agree a Complete Hospitals accreditation programme. This will be based on a combination of learning and practical experience and will probably be based on:

- Knowledge of the Complete Hospitals Framework and tools;
- Conceptual awareness of underpinning relationships between design and patient wellbeing and staff retention and engagement;
- Practical experience of translating these relationships into design and development decisions within the hospital and wider neighbourhood;
- Practical experience of hospital design and development delivery, budgeting and governance.

With very best wishes,

Director, New Hospital Programme

CONCLUSION:

PUTTING THE 'HOSPITALITY' BACK INTO 'HOSPITAL'

The origin of the word 'hospital' is instructive: it is derived from the medieval Latin, hospitale, or hospice from the classical Latin, hospes, meaning guest or host. And this was its original meaning. Originally, a 'hospital' was a home for the old, the poor and the young. Only during the nineteenth century did its meaning evolve to the modern one of a medical facility for the sick. The Royal Hospital in Chelsea still preserves the older nomenclature and there are other institutions throughout the country that do the same. The Fishermen's Hospital in Great Yarmouth, for example, nestles beside the ancient market square. It was founded by the town's corporation in 1702 as an almshouse for 'decayed fishermen' and to this day it provides affordable homes, small by modern standards, but dignified and a source of pride to those who need them.

We all need hospitality in our lives. And pride. This submission is written in the spirit of rediscovering this older meaning of hospital alongside the modern, of unleashing the 'power of place' to nourish rather than to repel and of creating modern and adaptable medical facilities which are hospitable not alienating

The Fishermen's Hospital,
Great Yarmouth.
Charity with dignity

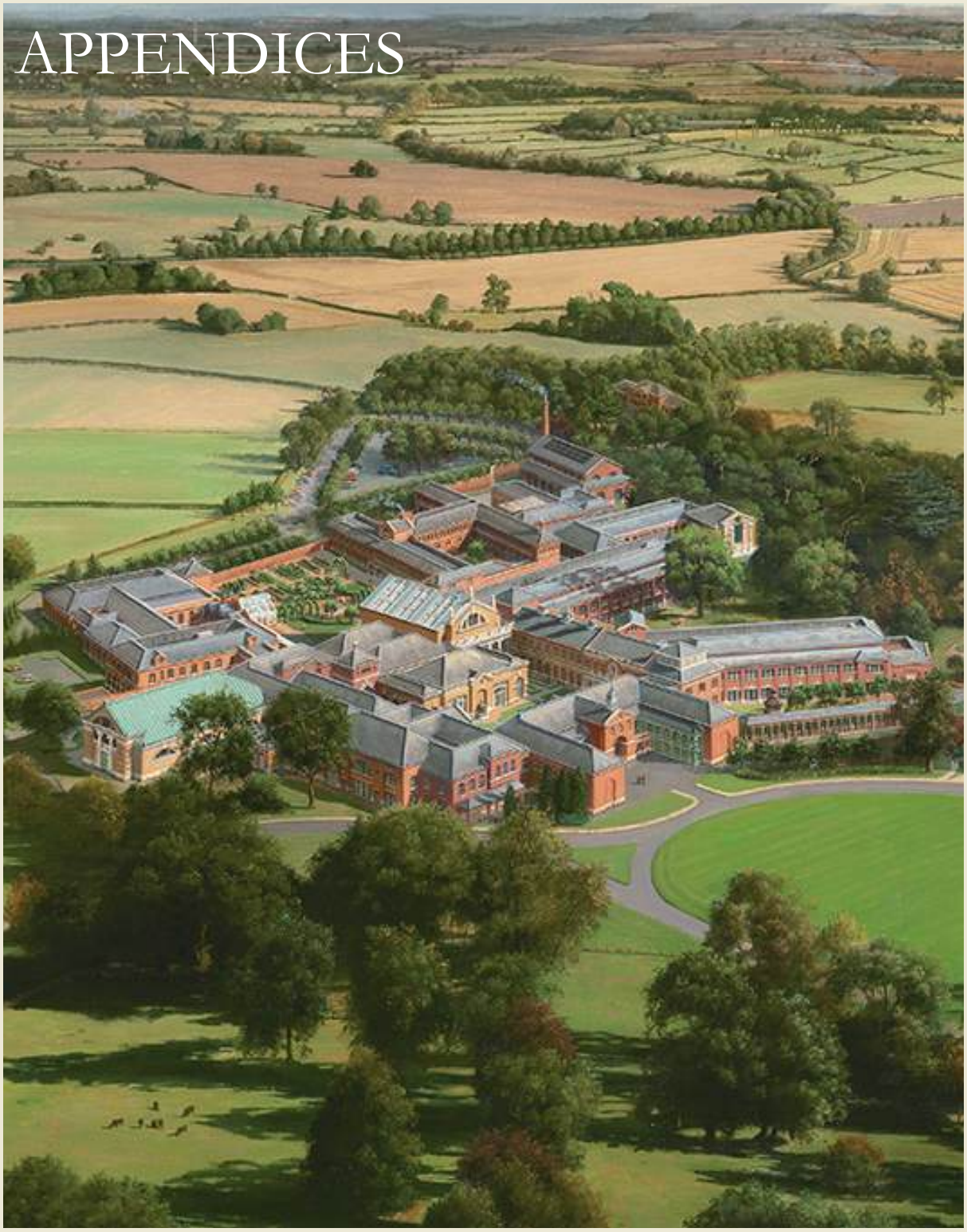
to those within them. The poor physicality of too many hospitals lets down the dedicated and passionate professionals who staff them. That must now change. We wish to move hospital design from the twentieth century to the twenty first, from 'factories for fixing' to 'places for healing'. And we believe that the increasingly clear evidence from neuroscience and environmental psychology makes this not only possible but inescapably necessary.

In our first submission we wrote that, were we to be selected for the final round, we would work up more detail for those charged with creating new hospitals with costings, a suggested management approach and more on sustainability. We promised to apply the framework to different hospital types to show how it would generate healthy and resilient hospitals in both town and in country which could support good outcomes for patients, staff and society. We hope that we have achieved that. In our further work and research we have detected a real desire among many health professionals to create better environments both for themselves and their patients. We want the Complete Hospitals Framework to meet that desire. It is not one single solution but is intended to be a practical process that those charged with creating hospitals can take forward to 'set the design brief' and then later to measure their own success or to find opportunities to improve.

In working up this submission we have begun conversations with several managers currently making or likely to make bids to the hospital building programme. Come what may, we hope that this work will help them to meet their expressed need to do better. As one manager put it to us, 'a checklist that help us make decisions and make a difference would be very welcome.' We hope that the frameworks and process in chapters 4 and 5 and summarised in chapter 8 and appendix 1 will be useful. Clinical outcomes depend on environment as well as medicines. Our work and research leaves us with no doubt that 'places for healing' are more effective than 'factories for fixing.' The evidence for the potential of place to assist, or undermine, medical science is now ineluctable. The question is not whether we need to create better places in which to work and recuperate but why we have not done so already.

CREATING COMPLETE HOSPITALS

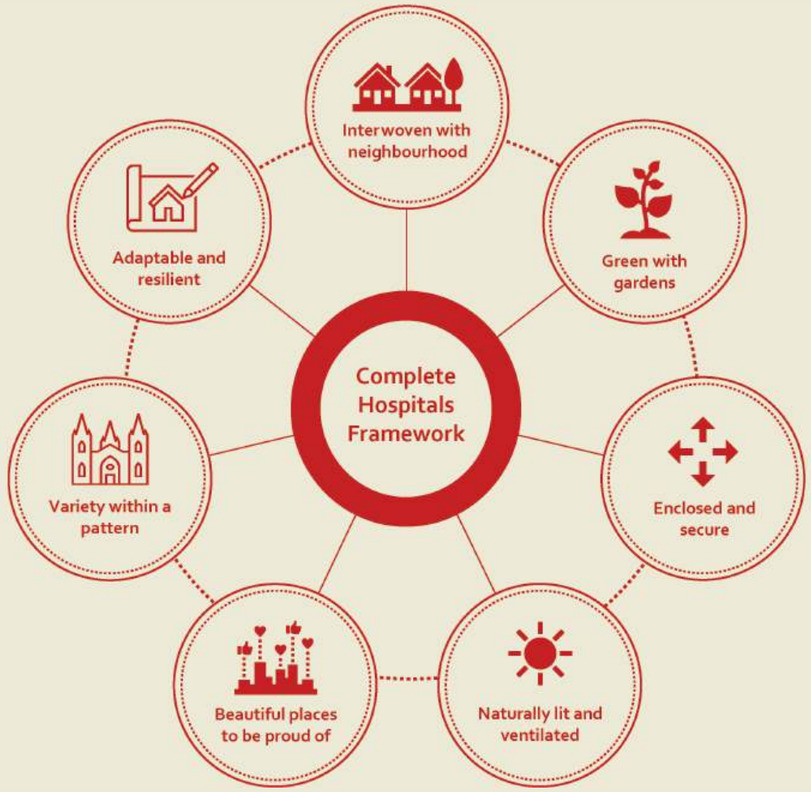
APPENDICES



APPENDIX 1:

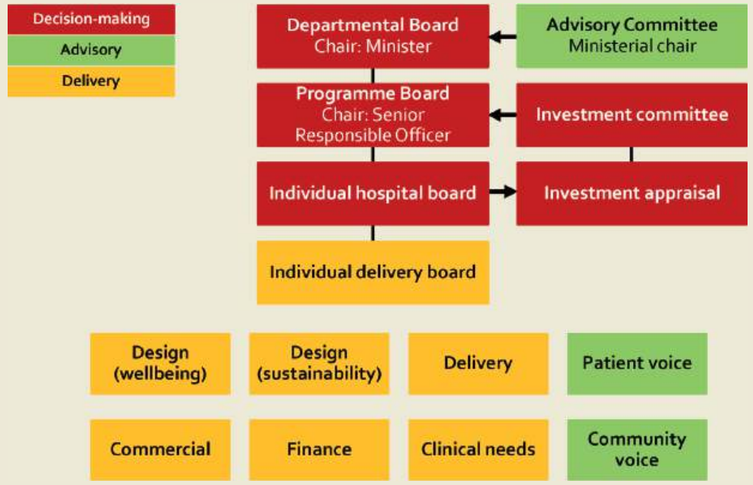
COMPLETE HOSPITALS FRAMEWORK MANAGEMENT TOOLKIT

Complete Hospitals Framework



1. Interwoven with neighbourhood.
2. Beautiful places to be proud of.
3. Variety within a pattern.
4. Naturally lit and ventilated spaces.
5. Enclosed and secure.
6. Green with garden.
7. Adaptable and resilient.

Complete Hospitals Governance Board



Complete Hospitals KPIs

- Self-reported patient wellbeing
- Self-reported patient satisfaction
- Patient admission and discharge times
- Length of stay
- Adverse incidents
- Mortality rates
- Infection rates
- Self-reported happiness of hospital staff
- Staff sickness rates
- Operative success rates
- Being up to date with training
- Self-reported happiness of hospital visitors
- Proportion of visits to hospital made by active travel
- Annual use of images of hospital in media about the wider area

CREATING COMPLETE HOSPITALS

Complete Hospitals Five-step Process

Process and key question for setting the brief for a Complete Hospital

- How wide is hospital's catchment area?
- How will staff and visitors travel to the hospital?
- What opportunities are there for re-greened active and public transport? Can we create greenways, trams with trees? Can we plant trees?
- How can the required carparking be economically and sympathetically incorporated?
- How much interaction will/ should there be with the local neighborhood and community?
- Does it have any overriding unique requirements such as access to countryside or proximity to specialist facilities?

- How can we maintain permeability through the site for users and visitors and at different grades?
- How can we relate the building to existing site and its imitate surroundings?
- How can the hospital brief be subdivided to relate to surrounding building scale and urban grain?
- How will it use and create public space?
- How will hospital both stand out and fit in?
- How will hospital express community identity and pride?
- How will hospitals feel familiar and healing?

- Which spaces do & don't require natural light and/or ventilation?
- How many private rooms will we need?
- What different privacy levels are needed and how do we ensure they are achieved?
- Where can we create alternative external circulations routes?
- How much external space would benefit the hospital and where would it be best located in relation to other facilities?
- How do we create a variety of outdoor green spaces with differing privacy levels?
- How we connect upper floors with gardens?
- Where should prominent continuous stairs be placed?
- How do we avoid noise and light pollution?

- What is the right hierarchy of construction for different elements of the facility?
- How do we avoid short term technological obsolescence?
- How can we use public funds efficiently?
- How do we create buildings that people want to keep?
- What materials with low embodied carbon would be suitable for your hospital?
- What materials will have longevity appropriate to the different levels of hierarchy?
- How can we use materials and architecture to ensure minimized requirements for long term maintenance?

- How do we ensure ongoing focus on building maintenance for long term sustainability?
- How do we ensure ongoing opportunities for patients to garden?
- How do we support surrounding community?

CREATING COMPLETE HOSPITALS

1 Interwoven with neighbourhood

- 1a Catchment
- 1b Public transport
- 1c Car parking
- 1d Urban grain
- 1e Block sizes
- 1f Scale & frontage
- 1g Connectivity
- 1h Public realm

2 Beautiful places to be proud of

- 2a Landmarks
- 2b Reflecting comunity
- 2c Celebrating pride

3 Variety within a pattern

- 3a Symmetry
- 3b Biophilia
- 3c Variety

4 Naturally lit and ventilated

- 4a Building Depth
- 4b Windows
- 4c Views
- 4d Connectivity

5 Enclosed and secure

- 5a Secure
- 5b Public space
- 5c Privacy levels
- 5d Circulation
- 5e Stairs
- 5f Light & Noise

6 Green with gardens

- 6a Greenways
- 6b Trees
- 6c Greenery
- 6d Biodiversity
- 6e Gardening
- 6f Upper Floors

7 Adaptable and resilient

- 7a Hierarchy
- 7b Technology
- 7c Economic
- 7d Attractive
- 7e Sustainable
- 7f Well detailed
- 7g Maintained
- 7h Community

APPENDIX 2:

HOSPITAL STAFF SURVEY RESULTS

In September and October 2021, we conducted an anonymised online indicative staff survey of those working within the NHS hospitals. The survey was accessible on google forms and typeform platforms. Responses were not weighted by demographic or job role, hence its merely indicative nature. We had 60 respondents. Split of respondents by demographic, age and role is set out below.

Question	Demographic	%
Gender	Male	57
	Female	43
Age	Under 30	28%
	30-39	20%
	40-49	17%
	50-59	18%
	60+	17%
Role	Doctors	62%
	Nurses	12%
	Administrative or management	13%
	Other Roles	13%

In addition to specific suggestions as to how hospitals might be improved, key findings were that large majorities of our respondents were not happy with the current physical environment of their hospitals and believed that their working environments had negative effects on patients and staff.

Do you think the current physical environment of your hospital has a positive or negative effect on the service you and your colleagues are able to give your patients?	
Very positive	3%
Positive	5%
Neutral	38%
Negative	43%
Very negative	10%

Do you think the current physical environment of your hospital has a positive or negative effect on your personal productivity or your personal mental or physical health?	
Very positive	2%
Positive	10%
Neutral	32%
Negative	47%
Very negative	10%

c a

APPENDIX 3

COST BENEFIT ANALYSIS

Methodology for evaluating benefits

Category	Benefit	Max change	Units	Max annual benefit	Explanation of main calc
Staff productivity	Increased quantity of work	15%	Higher productivity		
Staff productivity	Reduced errors	25%	Fewer errors	£208,333	[1]
Staff wellbeing	Reduced sick leave	25%	Fewer days off	£229,166	[2]
Staff wellbeing	Health benefits from greater active travel	10%	Lower premature mortality	£80,000	[3]
Patient wellbeing	Reduced in-patient durations due to green, naturally lit rooms	30%	Length of stay	£11,400,000	[4]
Patient wellbeing	Reduced patient mortality in acute wards for green naturally lit rooms	60%	Lower mortality	£360,000	[5]
Patient wellbeing	Reduced reinfection for naturally ventilated rooms	66%	Fewer healthcare acquired infections	£148,500	[6]
Reduced carbon emissions	Reduced staff and visitor greenhouse emissions due to active transport	30%	Of commuters who shift from driving to active travel	£928	[7] [8]
Reduced carbon emissions	Reduced staff and visitor greenhouse emissions due to public transport	20%	Of commuters who shift from driving to transit	£265	[9] [10]

1. Errors cost the NHS around £1bn per year, or around £830,000 per hospital per year (https://www.bmj.com/content/349/bmj.g6287). Cutting these by a quarter could deliver benefits of around £200,000.

2. An NHS Digital report estimated that staff sick leave cost the NHS £1.1bn or around £900,000 per hospital per year. Reducing that by 25% would be a saving of £229,000.

3. The effect of walking and cycling are, according to the largest and highest quality meta-analysis of all available studies (https://ijbnpa.biomedcentral.com/articles/10.1186/s12966-014-0132-x) quite similar. Therefore, the result that cycling 5x per week for one's working career adds about 0.4 QALYs (https://academic.oup.com/eurpub/article/22/6/869/542542?login=true) is likely to obtain for walking too. A QALY is typically valued at £20,000 in the UK. We judge that each hospital has around 1,000 employees, and 30% of those would switch from driving to active travel. 20,000*(1/30)*1,000*0.4*0.3 = 80,000.

4. An extra bed day costs the NHS around £400 (https://www.ageuk.org.uk/latest-press/articles/2017/october/four-million-hospital-bed-days-lost-since-2011-due-to-problems-securing-social-care/). The average length of a stay in an NHS hospital

5. There are 180,000 or so critical care / acute admissions in the UK per year (https://ccforum.biomedcentral.com/articles/10.1186/s13054-016-1390-6/tables/1). Of these, around 20% die (https://ccforum.biomedcentral.com/articles/10.1186/s13054-014-0551-8). Reducing this rate by 60%, would reduce the mortality rate to 8%. Per hospital, this means 18 fewer death per year. The average age of ICU admissions is in the mid-60s; in this estimate 66 (https://ccforum.biomedcentral.com/articles/10.1186/cc13246). Older ICU admissions tend to die earlier. Assuming an extreme lower bound of 1 QALY saved per patient, this would be 18 QALYs saved per year. Since a QALY is worth £20,000, this is £360,000 of value.

6. Healthcare acquired infections are believed to cost the NHS some £2.7bn each year, excluding the benefits from years of life saved, and the days of absenteeism from staff. This is around £2.25m for each of the UK's roughly 1,200 hospitals. Reducing this 66% saves them £1.49m annually.

7. 30pp greater active travel (cycling or walking) estimated by comparing the LSOA containing Northumbria Specialist Emergency Care Hospital in Cramlington (in the exurbs of Newcastle) and Royal Victoria Infirmary in central Newcastle. Comparisons between similar hospitals in other UK cities provide similar results. Cycling on a personally-owned bicycle has lifetime emissions costs of around 20g/km, compared to around 160g/km for a car; walking emits close to zero. The average commute is around 4km each way. Assuming the same distance is commuted (this will almost certainly shorten, as commuters are willing to cycle and walk shorter distances than they are willing to drive, although e-bikes do change this), then those shifting driving create 160g/km, or 1.29kg each day, or, assuming 250 work days in a year, 320kg annually, and reduce that by 1.12kg daily if they cycle, or 87.5%. But since only 30% shift, that's a 26.25% reduction for the average staff member, or an 84kg reduction for the average staff member.

8. $50 is a standard value for the social cost of a tonne of carbon (https://static1.squarespace.com/static/54ff9c5ce4b0a53decccfb4c/t/59b7f2409f8dce5316811916/1505227332748/CarbonPricing_FullReport.pdf), which is £36.82, and 3.682p per kg. There are about 1.2m NHS staff working in hospitals (out of a total workforce of 1.5m), and there are about 1,200 hospitals in the UK, so the average hospital has around 1,000 employees. There are also around 1.5m outpatient attendances in the UK per month, so perhaps 1,250 per hospital per month, or 15,000 per year. The median distance to a hospital in the UK is 10km, but I halve this for conservatism. That would imply the total employee km per year are 250 work days x 1,000 employees x 8km (both ways), or 2m; patients by contrast comes out as 15,000 visits x 20km (both ways), or 0.3m, so would come out as increasing the number 15% if included.

9. 20pp greater use of transit (bus, metro, tram, or train), estimated by comparing Northumbria Specialist Emergency Care Hospital in Cramlington (in the exurbs of Newcastle) and Royal Victoria Infirmary in central Newcastle. Comparisons between similar hospitals in other UK cities provide similar results. Taking a metro, bus, or train produces about 70g/km of emissions, compared to around 160g/km for a car. The average commute is around 4km each way. Those shifting from driving create 90g/km less, or 0.72kg less each day, or, assuming 250 work days in a year, 180kg less annually, or 56.25% less. But since only 20% shift, that's an 11.25% reduction for the average staff member, or a 36kg reduction for the average staff member.

10. $50 is a standard value for the social cost of a tonne of carbon (https://static1.squarespace.com/static/54ff9c5ce4b0a53decccfb4c/t/59b7f2409f8dce5316811916/1505227332748/CarbonPricing_FullReport.pdf), which is £36.82, and 3.682p per kg. There are about 1.2m NHS staff working in hospitals (out of a total workforce of 1.5m), and there are about 1,200 hospitals in the UK, so the average hospital has around 1,000 employees.

Costs in the appraisal of social value

For the purpose of appraising green book cost benefits analysis, the following guidance is given for what many be modelled. We have tried to follow this guidance.

- Total direct public costs (to originating organisation):
  - Capital
  - Revenue

- Total indirect public costs (to other public sector organisations):
  - Capital
  - Revenue

• Wider costs to UK society:

- Monetisable including cash costs
- Quantifiable but unmonetisable costs
- Qualitative unquantifiable costs

• Total risk costs (the costs of mitigating or managing risks):

- Optimism bias (decreased as estimated risk costs are included)
- Estimated or measured risk cost

Benefits in the appraisal of social value

• Direct public sector benefits (to originating organisation):

- Cash releasing benefits
- Monetisable non-cash releasing benefits
- Quantifiable but not monetisable benefits
- Qualitative unquantifiable benefits

• Indirect public sector benefits (to other public sector organisations):

- Cash releasing benefits
- Monetisable but non cash releasing benefits
- Quantifiable but unmonetisable benefits
- Qualitative unquantifiable benefits

• Wider benefits to UK society (e.g. households, individuals, businesses):

- Monetisable including cash benefits
- Quantifiable but not monetisable benefits.

• Qualitative unquantifiable costs and benefits."****

Methodology for evaluating capital costs.

The cost impact has been assessed as a percentage range of £/m2 of Gross internal floor area (GIFA) based on typical elemental costs from these data sources. The full results of our analysis more briefly explained in chapter 7 are set out below.

1. Interwoven with neighbourhood. The patterns considered include location in relation to the neighbourhood served, surrounding urban grain, block sizes, building scale, circulation network and flexibility of building types and heights. Potential

**** Green Book (2020), Box 12.

Impact	% Impact of £/m2 of GIFA
• Increased wall to floor ratios (building scale and individual blocks rather than one whole). - Light within hospital buildings is often created by the use of courtyards and a typical 'depth' is 16m. The Healthcare Premises Cost Guide (HPCG) includes a wall to floor ratio of 0.62 (external wall/ window/door element) but generally, a ratio of circa 0.4 - 0.5 is accepted as being economic. Typically the CHF network of blocks based on the example design has a wall to floor ratio of 0.48 based on a typical storey height of 4.2m. Compared to a mid-range of 0.45, this slightly uplifts the £/m2 rate.	0.81
- Number of storeys. The typical design shows a maximum number of above ground storeys of four. Modern hospital complexes can range from two to many storeys which has some economy of scale but increases vertical travel distances. Four storeys is considered average with no cost impact.	0.0
• Higher proportion of circulation space (to connect individual blocks/"bridge" local roads/maintain existing networks). - Communications space between departments is typically 10% - 15%. The CHF introduces blocks with longer connecting.	0.35
• Increased entrance spaces (each department with a front door').	0.21
• Building height changes (assessment of required clinical adjacencies and minimum heights required while integrating within the local landscape).	0.14
• Supporting public transport (to encourage healthier/more sustainable transport) - This move is healthcare wide so no additional impact is assessed for the CHF.	0
• Increased cycleways and tree planting (to benefit/ improve sustainability/health).	Included 0.01
Total assessed impact	1.52

NHS Healthcare Premises Cost Guide 2nd edition cites 10% .

8. Beautiful places to be proud of. The patterns consider the hierarchy of the architecture, orientation, use of public space, community identity and pride. Potential impacts on capital cost are:

Impact	% Impact of £/m2 of GIFA
• Increased costs of the envelope (a hierarchy of architecture/gateways/public aspects stand out).	
- At the DMRC, key facades and roofs were selected to create statements whist other elevations repeated patterns but on a more standard/repetitive manner. This, including larger window sizes added circa 37% to the average costs of the external envelope. However, a selection of facades and roofs could be more modest (assessed as 25% of external wall/roof cost).	2.72
• Creating statement entrances within the buildings (possible introduction of community history, larger welcoming spaces).	0.06
- Increases to finishes, art-work/displays and heights within these spaces to create and define public spaces.	
Total assessed impact	2.78

9. Variety within a pattern. The patterns consider familiar development patterns, orientation by mini destinations and economy. Potential cost impacts are:

Impact	% Impact of £/m2 of GIFA
• Increased space introduced by building patterns (to create familiar spaces).	Included
- Potential increased circulation space – considered with 1.	
• Increased costs by introduction of patterns, e.g., arches, use of colour and introduction of location details (to promote easy orientation).	0.74
- A modest increase in the budget costs for interiors can introduce themes which significantly aid wayfinding. A 10% uplift will add:	
• Hierarchy of buildings (to introduce economy).	Included
- Potential increased costs of envelopes and interior space considered with 1.	
Total assessed impact	0.74

10. Naturally lit and ventilated spaces. The patterns consider avoiding deep spaces with no external aspect, relationship with outside space and beautiful windows. Potential cost impacts which are not considered elsewhere are:

Impact	% Impact of £/m2 of GIFA
• Reduced cost of ventilation (avoidance of deep spaces).	
- The avoidance of deep spaces where clinically possible can increase wall to floor ratios but should result in savings from reduced ventilation; this is not currently assessed but may be when further detail is available.	0.0
• Higher cost for window element (to introduce light and create beautiful rather than utilitarian windows).	
- Larger, triple glazed windows to replace the standard double glazed functional units often installed. Based on DMRC windows, with a further adjustment for triple glazing, this would increase overall cost by:	2.44
Total assessed impact	2.44

11. Enclosed and secure. The patterns consider outdoor/ indoor spaces with differing privacy levels, private rooms, use of technology, use of natural materials, avoiding noise and light pollution, continuous stairs and scale. Potential cost impacts are:

Impact	% Impact of £/m2 of GIFA
• Increased use of natural materials (to form enclosures/ private space within the open space).	
- Increased use of green walls, cloisters (considered above), walled spaces will have a further impact on costs. A 5% area allowance for green walls will typically add:	0.14
• Increase in private spaces internally (to create stepping-stones back to normal life).	
- Increased floor areas to provide additional rooms for privacy, reflection). Adding 10 rooms per floor @ 15m2, equates to a total impact of:	0.35
• Private rooms.	0.0
- The general targets in healthcare are now 100% so this is not considered to increase cost.	
• Increased use of technology (to facilitate public access).	0.19
- Higher cost of modern but user-friendly systems for information in addition to information desks where people can speak to humans (particularly important for older adults); the impact of an extra £1M for systems is	

Impact	% Impact of £/m2 of GIFA
• Use of natural materials (pleasing to humans and carbon efficient). - Net zero carbon is a current key target within healthcare establishments and is adding costs in the region of 5% to other healthcare schemes For that reason, it is not considered an additional cost as this is becoming the "norm".	0
• Increase noise reduction/acoustic treatments and controllable lighting (to prevent noise and light pollution) - More acoustic partitions, materials and increased controls on lighting systems	0.97
• Prominent continuous stairs (encouraging their use) - Increase the cost allowances for stairs. Often the main staircase is a grand design encouraging and enticing its use, but departmental stairs are often soulless, cost economic spaces. A relatively small increase in the overall budget can have a significant impact on the look and feel of these spaces. Doubling the stair costs adds:	0.80
• Reduce space (create corridors/spaces on a human scale) - A minor saving can be achieved by reducing ceiling heights in certain spaces, narrowing corridors where patient access is not required.	-0.11
Total assessed impact	2.34

12. Green with garden. . The patterns consider familiar development patterns, orientation by mini destinations and economy. Potential cost impacts are:

Impact	% Impact of £/m2 of GIFA
• Increase in costs spent on landscape elements (to create variety) - Greater diversity of outdoor spaces with increased elements within courtyards and use of fountains, features etc. A modest increase of £100/m2 of all landscape area can have a significant impact.	1.42
• Increase in the envelope cost (creating connection of indoor and outdoor spaces) - Creating features such as cloisters to provide protection whilst being outside and potentially larger windows to give greater visibility into the outside space and views/vistas through buildings. The DMRC introduced both of these elements, most of which is included at 2 above.	1.22
• Increase in gardens cost (to provide gardening spaces) - Larger gardens for horticulture including storage for tools and implements, potting sheds, greenhouses and watering systems. In conjunction with the landscape element above a modest additional £500K adds:	0.11
Total assessed impact	2.75

While this list is by no means exhaustive it covers some of the major factors affecting capital cost from the CHF. The total impact assessed above is: 12.57%.

Based upon the analysis of recent new build P22 healthcare schemes, the average works cost per m2 (excluding fees/charges, client supplied furniture/equipment, VAT), uplifted to current day prices (based on the BCIS Pubsec indices 13/9/21 for 4Q21) equates to £4,226/m2. Using the above assessed impact, the CHF would increase this cost to circa £4,757/m2.

A further note on scenario timeframe

We assume in scenarios (1) to (4) that the Complete Hospitals approach reduces the frequency and cost of refurbishments over the model's lifespan. In the first four scenarios, we assume a total replacement of the business-as-usual hospital in year 61. For scenarios (5) to (8), we assume the Complete Hospitals Approach hospital lasts for all 120 years (as many similar hospitals from the past have indeed lasted).

Green book cost and benefit analysis

	Anual benefits	NPV of benefits (60y)	NPV of benefits (120y)	Extra costs	NPV of net benefits (60y)	NPV of net benefits (120y)	BCR (60y)	BCR (120y)
Stretch [1]	£12m	£313m	£350m	£35m	£278m	£319m	8.8:1	9.9:1
Base [2]	£10m	£251m	£280m	£44m	£206m	£241m	5.7:1	6.3:1
Conservative [3]	£7m	£188m	£210m	£53m	£135m	£163m	3.5:1	4.0:1
Pessimistic [4]	£2m	£44m	£49m	£53m	-£9m	£3m	0.8:1	0.9:1

In all scenarios, we have discounted future costs and benefits by 3.5% per year, in line with the Treasury's Green Book standards for business cases.

1. In the stretch scenario, we assumed we could get the max benefits in the benefits model, but assumed costs would come in 20% lower than our costs model

2. In the base case, we assume benefits will be 20% lower than in our max benefits model, and assume costs are right on the line of our costs model

3. In the conservative scenario, we assume benefits will be only 60% of the benefits model, and that costs are 20% higher than in our costs model

4. In the Pessimistic scenario, we assume benefits will be 60% of the benefits model, and that our largest projected benefit (reduced length of stay) will be just 10% of the size we project. Costs are again 20% above expectation.

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AX. Hertford Bridge, Oxford from https://commons.wikimedia.org/wiki/File:University_Of_Oxford_The_Bridge_Of_Sighs.jpg

AY. Santa Anna de Barcelona, by By Enfo - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=16480925

AZ. Grant Smith / John Simpson Architects Ltd. 2018, Defence Medical Rehabilitation Centre, Loughborough

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BE.

BF. NN.Create Streets

BG. OO.Ospedale Santi Giovanni e Paola, Venice from https://marilynyung.com/2019/06/

BH. PP.Ospedale Santi Giovanni e Paola, Venice from http://www.studioglass.it/?p=260

BI. QQ.Bart's Hospital, London, edited from https://www.semanticscholar.org/paper/Visions-of-charity%3A-English-art-and-the-creation-of-Culwell/37bda9e362f4062b08af435b7975d6a9b4da73eb/figure/10

BJ. RR. Hertford Bridge, Oxford from https://commons.wikimedia.org/wiki/File:University_Of_Oxford_The_Bridge_Of_Sighs.jpg

BK. SS. Li Yao, Weihai Hospital of Traditional Chinese Medicine, China https://www.archdaily.com/898817/weihai-hospital-of-traditional-chinese-medicine-gla

- Chapter 4 all exterior photographs of the Defence and National Rehabilitation Centre are by Andreas Von Einsiedel / John Simpson Architects Ltd. 2017, Defence and National Rehabilitation Centre, Loughborough
- Chapter 4, all interior photographs of the Defence and National Rehabilitation Centre are by Grant Smith / John Simpson Architects Ltd. 2018

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