Future Ready Healthcare
What if we can?
“The best way to predict your future is to create it”

Abraham Lincoln
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The future is now, because healthcare is changing...

The next generation of healthcare buildings will be very different from the hospitals, clinics and GP surgeries we are familiar with today. A revolution in building design is already upon us, prompted by an acceleration of technological innovation, rapidly-ageing populations, changing expectations of how healthcare should be provided, and a growing realisation that the environment is an important part of the healing process.

According to United Nations estimates, the proportion of the world’s population aged over 60 will triple by the end of this century, to make up more than a third of all people, leading to a huge increase in chronic health conditions relating to old age. And the effects of ageing are likely to be exacerbated by the health problems that accompany increasing obesity, with a fifth of all people predicted to be obese by 2025. In the UK, for example, the number of over-65s with four illnesses is expected to more than double in 20 years to 2.5m people. Countering this, the rise of genomics, stem cell therapy and progress in immunology could limit the mortal threat from infectious diseases and cancer.

It is increasingly understood that the environment in which patients are treated and cared for is a contributing factor to the healing process. As such, patient-centred design is a key ingredient in a successful healthcare facility not only in terms of the physical space but also the virtual one. Patients armed with information about their conditions are already informed consumers of clinical care, rather than passive recipients, and they will increasingly want to access services on smart-phones and mobile devices. But the impact of technology will go far beyond simply providing mobile apps for patients to have basic interactions with doctors, or book appointments. The revolution will be driven by a combination of the widespread use of networked smart sensors, vastly increased computing power, ever better telecoms, improvements in robotics, and strides forward in artificial intelligence (AI), together with algorithmic computer decision-making.

AI-powered systems will be able to analyse data from sensors that provide continual or ‘on demand’ monitoring of a patient’s condition, while video conferencing will enable doctors to reach, diagnose and treat patients wherever they are. This means that an ever-larger proportion of medical care is likely to be provided by teams of experts all housed together in a technological hub. Meanwhile better surgical techniques will vastly limit the time even those undergoing serious procedures have to spend in hospital. Other factors will affect how these changes play out, however, including the continuing drive for efficiency and cost reduction, increasing bacterial resistance, and the need for resilience to climate change and future energy scarcity.

60+yrs
a third of all people will be over the age of 60 by the end of this century
What does the future look like?

Excellence in future healthcare delivery will be enabled by flexible, adaptable buildings that are future-proofed by design.

A hospital commonly takes 10 years from inception to delivery, and has a 60-year life span. So, in order to remain effective through as many as three generations of change, it will have to be technologically smart, resilient and - above all - flexible and adaptable to changing healthcare needs. A new hospital will need to respond to the important trend towards prevention and wellness, and we are likely to see more of the ‘healthcare campus’ approach aimed at keeping people well in the first place.

With a greatly reduced need to house outpatient provision, and in-patients spending less time in hospitals, it is easy to see how future hospitals may become smaller and more resource efficient all round, as the focus of services shifts from reactively curing illness and disease, to proactively promoting health and fitness.

Hospitals will continue to treat the most complex cases, and provide for the most vulnerable patients, so facilities need to be based on a robust, reliable, and resilient infrastructure that can accommodate the most technologically-advanced procedures. But at the same time, hospitals will also evolve into technological hubs, with outpatient services delivered straight to the patient’s home, while a network of community facilities, perhaps built close to shops and other services, provides the hands on nursing care and social support required by an ageing population.

The new breed of smart and connected hospitals will have super-fast communications technology embedded, with thousands of sensors monitoring their rooms, the building systems, and the patients themselves. The sensors will feed patient data into systems with sensitive algorithms and artificial intelligence that will sift them for irregularities and alert doctors when attention is needed. Powerful computer systems will be at the heart of providing the analysis necessary to make much more tailored interventions based on an individual patient’s genetic make-up.

As hospitals evolve to include technological hubs, they will require the capacity to deal with huge amounts of data supporting diagnostic feedback from a range of real-time sources including wearable or digestible sensors. Leveraging this data, along with using delivery mechanisms such as telecare and video conferencing, will provide one stop diagnosis directly to the patient at home.

New hospitals will also need to be environmentally efficient, with highly-effective intelligent buildings systems that link with room booking systems to turn off heating, air conditioning and lighting when it is not needed, and provide patients with control over their room environments via mobile devices and touch screens. These systems will reduce running costs and carbon emissions while offering a better patient experience.

There are ways to build in the flexibility and adaptability required to deal with changing healthcare needs. Modular construction systems can allow walls to be taken out and spaces repurposed at very low cost. This approach means that when the requirement for large outpatient treatment areas declines, rooms can be converted or replaced quickly with other facilities, such as extra care housing for people who may benefit from being close to healthcare services. Other rooms can be converted into technological hubs for telemedicine as technology develops.
Core clinical services that are likely to remain, such as surgical suites, will be centralised, with others located peripherally. New ‘hybrid operating theatres’, where both surgery and diagnostics can be carried out, can be constructed from the outset of a hospital's development, instead of later in the process, with the space to accommodate robotic assistants, augmented reality devices and radiology equipment that monitors the patient during procedures.

The flexibility to adapt to become a community resource, focused on promoting healthy lifestyles, prevention and wellbeing, is one aspect of the resilience which will be essential in new hospitals. But resilience will also relate to the capability of hospitals to provide their own heat and power efficiently, be self-sufficient in the event of outages and, at the same time, counter the effects of climate change and rising energy costs. Resilience aimed at remaining operational during natural disasters such as an earthquake or a flood will also be important in some parts of the world, particularly where there is an indication that such events could be more prevalent in the future.

Resilience to disease and infection are another key consideration, particularly given the trend towards antibiotic resistance. Interiors fitted out with bacteria-resistant materials and ‘self-healing’ surfaces will help infection control, as will rooms designed for cleaning by robots. A resilient hospital will increasingly enhance the working environment, improving staff retention and engagement rates making the facility extremely competitive in attracting the very best clinicians.

“As hospitals evolve to include technological hubs, they will require the capacity to deal with huge amounts of data supporting diagnostic feedback from a range of real-time sources including wearable or digestible sensors.”
10 steps to the future

1. **Plan** your healthcare campuses to meet patient-centric wellness and lifestyle trends
   - **Question:** With patients taking a greater personal interest in their own health and wellbeing, how will you plan your spaces to respond to healthcare as it moves away from being reactive and intermittent and becomes proactive and continuous?

2. **Prepare** your building for the future with the design of flexible and truly adaptable space
   - **Question:** How will you plan your space to meet the future challenges of truly personalised care delivered straight to the patient’s home?

3. **Understand** how today’s Future Ready design enables optimal adjacencies for tomorrow
   - **Question:** As healthcare systems morph and evolve and the patient becomes the point of care, how will you plan your space to ensure its optimum location for its future purpose?

4. **Challenge** your design team to develop environmental controls to combat higher peak temperatures
   - **Question:** With the world’s average temperature predicted to rise by up to 4.8°C by 2100 compared to the turn of the century, how will you prepare?

5. **Create** your technological centre of excellence to enable real-time data and diagnostic monitoring that provides one-stop diagnosis & treatment
   - **Question:** As patients become more and more involved in their own wellness with the use of apps and wearable micro-devices, how are you going to respond in the development of your space and facilities?
6. **Recognise**
the impact of changing treatment regimens on your facility and space requirement as medical science makes exponential progress.

7. **Prioritise**
your investment in spaces that will remain relevant as healthcare becomes more person-centric and community focused.

8. **Make**
use of new and sustainable materials and surfaces that resist infection and self-heal.

9. **Maximise**
your revenue opportunities by understanding the dynamic change in future healthcare trends.

10. **Optimise**
your facilities operational performance and maintenance of assets by use of smart technology so assets are efficient, responsive & connected.

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1. What are the consequences of the advances we are making in combating major disease through progress in immunology, stem cell technology and genomics?

2. With a shift in focus towards a decentralised model of care, how will you invest in your estate?

3. As costs rise and the drive to deliver buildings sustainably and economically increases, what changes should you make in the development and maintenance of your healthcare buildings?

4. The population will continue to grow and people will live longer, so how will you deliver more healthcare for more people with less funding per head?

5. In a technologically developing world, with increasing electricity costs, how will you ensure optimal patient experience and minimise energy consumption?
Hospitals built today are expected to operate successfully for many years into the future, to enable this we are designing for adaptability. This is exemplified by the redevelopment of Kwong Wah Hospital in Kowloon, Hong Kong, where intelligent engineering services will make it possible to manage infections on either a small scale or in the case of a pandemic, 100 patient rooms can individually be switched from “normal” to “isolation” mode.

At some locations, there is a trend for hospital car parks to be designed with higher ceilings so they can be repurposed as offices or homes when no longer needed, adapting to future changes in urban mobility. At the Banner University Medical Center tower in Phoenix, USA, two out of the 13 floors are being built just as shells with maximised structural grids, ready to accommodate whatever challenges the future holds. This provides the ultimate flexibility.

For Sahlgrenska University Hospital, Sweden, flexibility has meant inserting partly removable external walls to enable easy access for new equipment to be installed when technology advances. This feature means that the hospital can take advantage of rapid changes in medical technologies. But Sahlgrenska is not just adaptable, it is also smart and connected. It incorporates the most advanced imaging facilities into its operating theatres, enabling clinicians to perform diagnostics during surgery.
Sahlgrenska University Hospital
Paving the way for breakthrough treatments at a world-class research facility

**Location:** Gothenburg, Sweden

**Client:** Region Västra Götaland

**Services:** Electrical Design and Installation Overview, Geotechnical and Ground Engineering, Construction Design, Medical Equipment: Planning, Management and Installation overview, Logistic planning

**Project status:** Completed in 2017

Sahlgrenska Cancer Centre is a world leading research facility in Sweden dedicated to improving cancer care through scientific discovery and clinical practice. Managed by the University of Gothenburg and Sahlgrenska University Hospital, the building needed complete remodelling to streamline imaging and surgical procedures, promote collaboration between specialists, and accommodate the most up-to-date technologies.

**Advanced medical machines**

Imaging and surgery were previously carried out in separate locations, but the new facility was designed to bring them into the same place to enable several specialists to focus on a patient’s needs simultaneously. Achieving this demanded complicated building design work because an extensive range of technologies are involved including Magnetic Resonance Imaging (MRI), Ultrasound, Computerised Tomography (CT) and Positron Emission Tomography (PET).

Our team developed sophisticated systems to bring many of these technologies, including advanced X-ray machines and a ceiling-mounted mobile MRI into an operating theatre where both imaging and surgery can be performed. During an operation, images are displayed on monitors, both within the room and remotely, to enable specialist clinicians in different locations to monitor and participate in real time. A key challenge was to ensure this facility is adaptable to future advancements in medical technology and to enable Sahlgrenska to stay at the forefront of cancer research and treatment. So we designed robust and flexible solutions: the exterior walls feature removable panels, for example, so that oversized technical equipment can be manoeuvred into the operating theatre, when required. Floor plans are divided into a grid pattern with the same basic structure on each floor for future changes. And the IT infrastructure has spare capacity to manage increasing image data.

**Resilient by design**

Installing a fail-safe power supply was critical to the project’s success. The building has two parts, each with its own power supply. By using the connection capability of busbars on each floor, we designed a back-up system whereby one part of the building can support the other if needed. To mitigate start-up time for the emergency diesel generator, we installed a dynamic uninterruptible power supply (UPS) system. UPS is essential for the below-ground cyclotron that supplies the hospital’s PET scanners with radioactive isotopes.

Working with our client, we have developed leading-edge technical solutions to provide Sahlgrenska Cancer Centre with the most advanced facilities fit for the future. Key to our design was creating an optimum spatial structure to provide an effective workspace for clinicians and assure operational security for patients. We also focused on ensuring this highly complex refurbishment scheme enhances Sahlgrenska Cancer Centre’s reputation as one of most advanced of its type in the world.
Future Ready factors:

- Adaptable for provision of future technologies
- IT infrastructure with spare capacity to manage increasing image data
- Resilient back up system
Kwong Wah Hospital

Redeveloping an ageing hospital to meet the demands of the future

**Location:** Kowloon, Hong Kong, China

**Client:** Hospital Authority

**Architect:** Simon Kwan & Associates

**Services:** Mechanical, Electrical and Plumbing Engineering (MEP), Structural Engineering, Geotechnical Engineering

**Project status:** Ongoing (2013–2025)

In densely-populated Kowloon, Kwong Wah Hospital (KWH) is one of Hong Kong’s oldest and busiest hospitals. Every day, more than 400 people attend its A&E department and up to 2,000 patients are treated in its specialist, family, and general out-patients clinics. Demand for patient services is increasing, too, as the local population ages. Yet some of KWH’s buildings are over 50 years old and require constant repair.

Faced with these challenges, the Hospital Authority decided that a new development was required to replace KWH’s overstretched infrastructure. Their vision was not only to meet the current needs of Kowloon’s residents but create a world-class clinical facility, able to accommodate technological advances and clinical methods that are only just emerging.

We were appointed in 2013 to help bring this vision to fruition by providing a range of engineering and consultancy services across the two phases of KWH’s extensive redevelopment scheme.

The first phase, covers surveys and preparations; the second involves the demolition of most of the existing hospital and the creation of a new main building. This end result will be a complex covering 270,000 m² and providing 1,600 beds.

**A redevelopment providing new opportunities**

The driving principle behind our approach is to exploit every opportunity offered by the almost total rebuild of KWH to weave future-proofing initiatives into the very fabric of the new hospital. This means creating flexible building engineering services that will comfortably accommodate current technologies, such as computer tomography (CT) scanners and allowing for future technologies.

This flexibility is being designed to also meet sudden surges in patient numbers, for example, by supporting spaces for disaster contingency or an epidemic of infectious disease.

Enhanced isolation facilities, easily accessible from A&E and ICU, are designed to reduce the risk of the spread of infection. Isolation facilities with more than 140 beds are designed to be negative pressured. In addition, facilities with approximately 100 beds are convertible from “normal mode” to “isolation mode” in the case of an outbreak of infectious diseases.

Other features of the new building include 20 operating theatres, an ambulatory care centre, specialist out-patient department, new oncology unit, maternity centre and an expanded, state-of-the-art A&E department.

**Iconic community building**

KWH’s long history and a commitment to providing both western healthcare and traditional Chinese medicine mean the hospital has a special place within the local community. Its iconic Tung Wah Museum, KWH’s original building, will remain the cultural focus of the new campus. But the critical zones that provide acute care, along with the rest of the new campus, will be entirely Future Ready.
Future Ready factors:

- Isolation facilities designed to be negative pressured for more than 140 beds
- Facilities convertible from “normal mode” to “isolation mode” for approx. 100 beds
Banner University Medical Center Tower
Integrated design for a flagship medical campus

Location: Phoenix, Arizona, USA
Client: Banner Health
Architect: HKS
Services: Buildings Services, Medical Gases, Electrical Systems Design
Project status: Due for completion, early 2020.

Banner Health, which runs hospitals across the USA, is upgrading its flagship campus in Phoenix, Arizona, to provide the city’s growing population with flexible modern hospital facilities. The campus will accommodate the latest medical technologies and treatment methods, and provide a platform for future expansion.

We are working on several aspects of the project including the design of buildings systems for a new 16-storey tower that will make Banner University Medical Center the tallest hospital in Arizona, and one of the most advanced. The tower will house four ICU (Intensive Care Unit) floors, seven medical-surgical floors, a behavioural health floor, and one shell floor for future build-out. It will be constructed on top of a three-storey emergency department which is linked to two helipads and two power plants, one with emergency capability.

Highly-integrated design opens the way to future flexibility
The integrated project delivery model and co-location approach to designing the project has resulted in a high level of co-ordination. This has enabled Banner Health to make key decisions on the most efficient version of creating ‘universal rooms’ that can flex between ICU and medical-surgical patient accommodation according to the hospital’s needs.

The structural grid and engineering systems provide flexibility for these universal rooms to become exam rooms or house functions such as outpatient care or preventative health and wellness activities. This flexibility is important in Phoenix where the population is both growing and ageing which means that care and treatment needs are likely to change over time. It allows for new technologies and treatments to be accommodated.

Surgery and administrative functions have been positioned in the new tower to enable future expansion, and also positioned in the campus plan to provide a future tower with the best adjacency for future modalities or patient care areas, the same efficient structural grid spacing, access to daylight and views to the outside. Occupancy sensors and modulating air valves in the surgery area provide heating, ventilation and air-conditioning (HVAC) setbacks in the operating rooms during unoccupied times, while maintaining required pressure relationships.

Delivery ahead of schedule
Integrated design has made it possible for Phase 1 of the Emergency Department to open three months ahead of schedule. This is because options were identified to make use of existing MEP services including chilled water, hot water for heating, electrical utility service lines, oxygen lines, and sewer lines. These services are also used to feed existing areas of the campus, so the co-ordination of service relocations and tie-over was a complex undertaking which was aided by integrated project delivery and co-location.

As well as prompt delivery, the advantages of the design include flexibility for future configurations to accommodate further expansion or new energy technologies.

Private bed strategy
Patient accommodation in the new tower will be in single-bedded rooms for privacy, and the rooms will be equipped to offer the most modern treatment methods.

The new tower replaces the outdated West Tower at Banner Good Samaritan Medical Center with a facility that is both flexible and future-ready.
Future Ready factors:

- Provides a platform for future expansion
- Rooms that can flex between ICU and medical-surgical patient accommodation
- Flexibility for future configurations to accommodate new energy technologies
Resilience

Resilience takes many forms. One way that we are enabling resilience is through our ‘SeawoodFM’ service, used in several hospitals already. This facilities management service, which provides building managers and their contractors with always up-to-date plans of their facilities, is accessed via an easy-to-use visual interface. It means less time is spent locating problems when they occur, and more time solving them, thus reducing downtime and enabling clinical staff to get on with delivering patient care.

Similarly, the LEED Platinum-accredited Dell Children’s Medical Centre in Austin, Texas, makes intelligent use of daylight, alongside optimised heat recovery, ventilation, and lighting design to reduce energy usage. This has reduced net energy use by 40% compared with similarly occupied buildings in the same climate and made it one of the most sustainable hospitals in the world.

Resilience also means creating buildings that make patients comfortable and provides a desirable work environment for staff. The Surrey Memorial Hospital in British Columbia, Canada, earned LEED Gold certification for its energy-efficient design. We are proud to have been involved in this project where the use of durable natural materials such as wood and stone has reduced the amount of volatile organic compounds in the building, and helped create an environment that is safe and inviting for staff and patients alike. This form of resilience is important because it is only by retaining the best staff that hospitals can deliver high quality services both now, and into the future.

Environmental sustainability and the ability to reduce carbon emissions or survive power outages are also important aspects of resilience. The 792-bed Kuwait Children’s Hospital, will include its own central energy plant, a 40MW backup generator providing 100% power back up to the facility, and chilled water tanks making it resilient to lengthy utility outages. It will also be a ‘smart hospital’, including spaces to undertake specialised medical research and teaching programmes to develop the next generation of health specialists.

100% redundancy in case of supply failure for Kuwait Children’s Hospital
Kuwait Children’s Hospital

An energy and water efficient design for a centre of excellence

Location: Al Sabah Speciality Medical Area, Al Shuwaikh, Kuwait

Client: Kuwait Ministry of Health and Ministry of Public Works

Architect: HKS and SSH

Services: Mechanical, Electrical and Plumbing Engineering, Fire and Life Safety Systems, Information and Communication Technology (ICT)

Project status: Scheduled for completion in 2020

Kuwait Children’s Hospital (KCH), scheduled for completion in 2020, will be the largest of its kind in the world with 792 beds, 30 operating theatres and more than 11,000 rooms. The 595,000m² facility will provide a full range of clinical services, tertiary care, and wellness programmes within a consolidated paediatric care model. As a national and regional centre of excellence, it will also have state-of-the-art facilities for specialised medical research and teaching.

Situated on the coastline, within the Al Sabah Speciality Medical Area in Al Shuwaikh, the hospital’s distinctive design concept is based on crystalline forms. The main entrance is via a five-storey high, 457m-long, climate-controlled atrium. This area will combine a blend of civic, hospitality and retail services, including play areas with a ‘sea adventure’ theme.

Energy and water efficiency

From the outset, our client, the Kuwait Ministry of Health and Ministry of Public Works, envisaged KCH as a highly resilient and sustainable building. We have worked closely with architects HKS and SSH towards that goal, combining the expertise of our teams around the world.

A major challenge was to find an efficient solution to supply energy and HVAC to such an immense building. Our response was to create a central energy plant with 40-megawatt generator backup capacity, providing 100% redundancy in case of supply failure.

Efficient water use was also a key requirement. Our design features a chilled water plant with a 1.1 million litre domestic water storage tank, a quadraplex pumping system sized at 10,300 l/min (2,750 GPM), 350,000 litre fire water storage tanks with two electric fire pumps sized at 3,800 l/min (1,000 GPM), and a cooling tower make-up storage tank of 1.7 million litres.

Global expertise

The solutions we have developed for KCH have been devised by our experts from around the world working together as a team. We worked on the concept phase of the central utilities and energy plant in Dallas and oversaw the design and development in Canada, including the air handling floor and building tower. Local ICT support was provided in Dubai. Buildings and Information Modelling (BIM), and drafting support, was provided by our team in India.

40MW generator backup capacity
Future Ready factors:

- Efficient water use
- 100% redundancy in case of supply failure
Earthquakes are a known risk in the town of Greymouth on New Zealand's South Island, so when it came to replacing the town's hospital with an up-to-date integrated healthcare centre, seismic-resilience was a prime design consideration.

The existing hospital – called Grey Base - was built in the 1950s on a natural ground escarpment, close to the estuary of the Grey River. Designing seismic-resilient foundations for a new building on this site posed a challenge, yet the location was convenient for serving rural communities on the West Coast, and the site was large enough to accommodate expansion.

With South Island's largest tertiary hospital at Christchurch over 230km away, New Zealand's Ministry for Health wanted a new hospital for the people of Greymouth that could provide 24-hour emergency services, critical care, acute and planned surgical and medical services, a maternity unit, and outpatient care, together with an integrated family health centre to support primary care provision. This multipurpose building must offer full functionality after an earthquake, and be designed for delivery on a tight budget.

We worked with architects CCM and Jacobs, to devise solutions to the unique challenges this project presented.

**Resilient foundations**

The building's essential requirement was that it must be able to withstand extreme weather conditions and earthquakes. Ideally, the whole building would be designed to survive the severity of a '1-in-500 years' earthquake - a risk classified under New Zealand's building codes at Importance Level 4 (IL4). But as it was clear that this level of resilience for all parts of the building would be expensive to achieve on a hillside and riverside site, the project team created 3D models to test the proposed foundation structures under earthquake conditions in an effort to discover more cost-effective options.

The solution they devised involved designing the multi-storey main hospital building to Importance Level 3 (IL3), with seismic loads 130% of a standard building, and designing the attached single-storey family health centre wing to IL4, with seismic loads 180% of a standard building. This would mean that the family centre could be used for triage in the event of a very major earthquake, with patients transferred to Christchurch Hospital for critical care, if necessary. Sufficiently robust to meet the hospital's needs, this solution was selected. It reduced the overall costs of the scheme by over NZ$6M, leaving the Ministry for Health with more funds to channel into frontline clinical services.

**Resource flexibility**

As Grey Base is at least a three-hour road journey from Christchurch, the operating theatres in the new hospital are being equipped with technology that will enable specialist consultants to monitor procedures remotely and offer assistance when required. This capability will be particularly useful when the hospital is difficult to access.

Many of the clinical areas are designed for multiple functions to allow boundary spaces to be used for neighbouring departments as needed. The family centre will share resources and staff with the main hospital, too. The consulting spaces are designed to be flexible so that they can be used for general practitioner services, as well as hospital consultations.

The project will provide Greymouth with a new hospital that will offer 56 inpatient beds, three operating theatres, outpatient services, an accident and emergency department, services that include medical imaging, pathology, pharmacy, maternity, paediatrics, oncology and dialysis, a dental suite, and comprehensive family health services. Its design and buildings services will support the latest technological advances within a safe, modern and secure environment.
Future Ready factors:

- The family centre can be used for triage in the event of a very major earthquake
- Many of the clinical areas are designed for multiple functions
SeawoodFM

Increasing daily operational efficiencies across Canada

Efficiency and resilience are the defining characteristics of a high-performance hospital not just in terms of the facilities design, but of day-to-day operations.

A patient-centred hospital focuses all resources on patient care and provision. To support this, a healthy building should not hinder or restrict the people who inhabit it. With this in mind our Computer Aided Facility Management (CAFM) system SeawoodFM, enables even the most complex healthcare buildings to run at maximum efficiency, saving time, reducing costs and freeing up resources for frontline care.

Each facility has its own dynamic database of as-built drawings and documents. It’s designed to be easy to use to allow daily management of a hospital’s facilities. Using advanced software we take existing data to consolidate drawings and information into an accurate electrical, mechanical, and architectural as-built model and database. This information can then be accessed, queried and leveraged through a web-based interface at any time and from any computer with internet access. This provides operational convenience for clients who have multiple sites, or who may wish to monitor after hours from an off-site location, ideal for a 24-hour hospital.

By engaging with real-time information the database can produce a ‘live’ model of a hospital’s FM capacity and needs. Furthermore, by allowing spaces to be planned in meticulous detail, SeawoodFM can reduce travel distances, giving staff more time to carry out their core work – caring for patients.

In practice, this means efficiently managing essential building services like lighting and ventilation, while minimising downtime for inspections and emergencies. The system’s capacity to perform in-depth risk analysis also supports the planning and coordination of projects.

Making a positive impact

St. Mary’s General Hospital in Ontario, Canada, has worked with the tool since its launch in 2001. Making a positive impact towards daily activities SeawoodFM has increased the efficiency in numerous ways, such as minimising time spent on annual inspections of the facility’s fire alarm system. Prior to the use of SeawoodFM, it would have taken four to six weeks to complete this annual inspection – now the process takes two to three weeks.

When the Royal Victoria Regional Health Centre in Barrie, Ontario went through a major redevelopment, doubling the hospital in size, SeawoodFM was brought in to assist in the expansion. We combined the existing and new building documentation, including verifying actual onsite as-built conditions alongside as-built information submitted by our contractors. This ensured the accuracy of the contractors’ as-built drawings.

SeawoodFM has been implemented into everyday processes in many different facilities including healthcare, education, sports & recreation, mission critical, commercial, hospitality and tourism, and specialised rail facilities.

Looking ahead

Our software developers continue to expand SeawoodFM’s capacities as we seek to further optimise the potential of technology to enable collaborative, effective and highly efficient buildings. SeawoodFM ensures building operators can manage with confidence, whether in developing fiscal budgets, planning for the future, or dealing with emergency scenarios.

SeawoodFM offers multiple benefits for a wide range of hospital stakeholders from the property owner, facility managers, through to contractors, consultants, staff and – ultimately – patients.
Facts:
- 15 years of experience
- 50 customised tools and solutions
- Information is quick and easy to access, allowing for rapid and cost effective solutions
- Improved drawing integrity and accuracy
- Reduced facility downtime during emergencies
- Reduction in drawing and documentation redundancies and inconsistencies

Future Ready factors:
- Streamlines operations to provide optimal patient care
- Leverages data to empower planning and coordination of future developments
- Reduces risk due to personnel turnover
- Performs better risk analysis
Increasingly, **hospitals of the future will rely on smart systems that automate procedures**, and improve the patient experience. We are already helping to develop systems that give patients access to a range of services within the hospital. For example, the patient can check-in and be guided through the building via a smart device that means they can move around freely, and be contacted when necessary rather than sit in a waiting room. This frees patients from the stress of the waiting room making their experience as seamless as possible. On the operational side, insights from smart sensors and analytics can help to dramatically reduce the operating costs of a hospital.

In the new U-City development in Adelaide, a mixed-use development for older people and those living with disabilities, smart technology is helping to meet the challenges associated with having large numbers of people with restricted mobility in high-rise accommodation. This includes smart technology to create an occupant aware building, zoned and horizontal evacuation strategies, and AV-enabled fire alarm interfaces.

Smart technology is also important in medical education. The Sydney Adventist Hospital Clinical Building in Australia supports the education of the University of Sydney’s medical students. As well as an auditorium and teaching space, it offers a state-of-the-art simulation environment for learning, teaching and research for students, clinicians, academics and the broader health community. We provided audio visual and technology services on this project.
Jurong Health Campus

A smart approach to a Future Ready campus

**Location:** Jurong, Singapore

**Client:** Ministry of Health/Jurong Health Services

**Architect:** CPG Consultants Pte Ltd/HOK/Studio505

**Services:** Mechanical and Electrical Engineering, Specialist Hospital Systems Design, Infection Control Provisions Design, Communications Design, Security Systems

**Project status:** Completed in 2015

With healthcare needs continuously evolving, Jurong Health Campus in Singapore was designed and built to offer maximum efficiency in the services it provides.

The campus is based around two hospitals, Ng Teng Fong General Hospital (NTFGH) and Jurong Community Hospital (JCH), designed together to achieve a seamless patient experience. The 700-bed NTFGH provides accident and emergency (A&E) capability, intensive care, high dependency care and general hospital services, while the neighbouring 400-bed JCH readies patients to return home by providing a range of community and therapeutic services.

From the outset, the hospitals were central to a vision to transform healthcare in the region. By collaborating with a range of partners from general practitioners through to community and social care, health and wellness are brought closer to the community with an adaptable, resilient and digitally enhanced design.

**Building in opportunities**

Patients are transferred between the two hospitals according to their needs, so it was important that the design and engineering strategy supported the movement of patients in a safe and secure way. The concept of ‘patient-centric’ services has been applied thoughtfully throughout the campus. An intelligent and innovative approach to the design and engineering of the buildings was essential to allow resources to be deployed with maximum efficiency between the hospitals and across clinical departments.

NTFGH houses Singapore’s first facility to combine the functions of an intensive care unit (ICU) with those of a high dependency unit (HDU); this enables one team, in one location, to deliver critical care. Twinning ICU and HDU means that a patient whose critical condition has stabilised need not be transferred to another ward, making the provision of care seamless.

A&E is designed flexibly so that services can be scaled up to meet an influx of admissions; and the demands of events such as pandemics, mass-casualties or decontamination have been considered as part of the design process. Critical care services are planned vertically and horizontally to facilitate swift care. Built-in flexibility makes it possible to adapt A&E from everyday needs to exceptional circumstances. Planning for an ageing population, A&E is also designed with elderly-friendly features such as natural lighting and ambient temperatures.

**Enabling rehabilitative care**

JCH promotes post-acute and rehabilitative care with the design of a life-sized LIFEHub and Mobility Park. LIFEHub educates the elderly and physically challenged to regain their independence with the guidance of the hospitals’ therapists. It also features a three-room Housing and Development Board (HDB) flat mock-up and acts as an information and education area for patients and caregivers. By showcasing a variety of products and practical solutions, LIFEHub is helping patients to live more safely and independently in their home environment. The Mobility Park simulates a public transport setting where patients can, within a safe environment, re-adjust to everyday scenarios before returning to their daily lives.

Designed to be patient-centric and operationally streamlined, NTFGH’s technological transformation included the implementation of 976 medical devices interfaced directly into the Electronic Medical Record (EMR) system. With 97% utilisation of electronic orders, 98% adoption rate of barcoding and comprehensive analytics across clinical and operational data, the campus is highly energy-efficient. As a result, the development has been awarded a ‘Platinum’ Green Mark Award from the Singapore Government’s Building and Construction Authority.
Future Ready factors:

- Combined functions of an ICU with those of a HDU
- Scaling up of A&E services to meet an influx of admissions
- Elderly-friendly features
- LIFEHub and Mobility Park
In Adelaide, South Australia, we are working with the not-for-profit organisation Uniting Communities on a unique multi-use development that will combine specialist disability living accommodation with retirement apartments, a social services hub, café, offices and retail space.

Called U-City, this exciting project has become known as ‘the vertical city, within a city’ because at 20 storeys high, its upper floors will offer spectacular views of Adelaide and the coastline.

Technologies that will assist U-City’s residents in their day-to-day lives, while at the same time offer optimum energy and environmental performance, were central to the vision of Uniting Communities. So we have worked closely with the scheme’s architect, Woods Bagot, to design features that will address the varying levels of living accommodation to be provided.

**Specialist disability accommodation and assistive technology**

U-City incorporates all the attributes of Specialist Disability Accommodation (SDA) which is specifically designed for people with significant functional impairment and/or very high support needs. In collaboration with various specialised equipment vendors, we combined many types of ‘assistive technology’ into the design of the building.

Assistive technology is not an ‘off the shelf’ solution, so a significant design challenge was to ensure the interoperability of the various technologies, while ensuring the apartments were Future Ready.

**Energy efficient and sustainable**

The embedded technology and assistive technology solutions that have been selected also support U-City’s sustainability goals. Sensor technology is used extensively throughout the building, for example, to manage lighting and heating and ventilation systems depending on occupancy levels. Other high-performance sustainable features include an embedded electricity network, a 55-kilowatt solar PV array on the roof, gas-boosted solar hot water provision, natural-ventilation throughout all living spaces, double glazing, and shading features on the facade.

These initiatives have resulted in the award of a 6-Star Green Star design rating for the development from The Green Building Council of Australia, with the design scoring a total of 84.9 out of a possible 100. U-City has been recognised as South Australia’s ‘greenest’ building design to date, predicted to use 45 per cent less energy and 30 per cent less water than a comparable new building.
Future Ready factors:

- Consumes 45% less energy and 30% less water than a comparable new building
- Embedded electricity network
- 55-kilowatt solar PV array on the roof
- Gas-boosted solar hot water provision
BOE Hefei Digital Hospital
Connected, people-oriented healthcare in a world-class digital hospital

**Location:** Hefei, Anhui Province, China  
**Client:** BOE Global / Dignity Health  
**Architect:** HKS  
**Services:** Buildings Services, Smart Consulting and Building Technology Systems  
**Project status:** Due to be completed December 2018

BOE Hefei Digital Hospital is one of China’s first truly ‘smart’ hospitals. It has been developed by BOE, a leading Chinese LED screen manufacturer, partnered with American medical group, Dignity Health. They wanted to create a world-class hospital incorporating the latest digital technologies and services to deliver the highest quality medical care, patient safety, and user experience.

**Bringing global expertise to a local project**

The 193,000 m², 1,000-bed hospital specialises in cardiovascular, orthopaedics, neurology, and oncology. We were appointed, alongside architects HKS Inc, to provide building services and smart technology systems consultancy. Our healthcare team in the USA and China developed a schematic design with four key goals: to ensure the highest level of productivity for the hospital; to improve efficiency across the board - from energy savings to operational management to patient care; to provide a safe and secure environment for patients; and to provide the best possible patient and user experience.

**Converging networks**

The smart system planned with the owners group and operators utilizes a converged network that acts as a central spine for all the building management system, the hospital's operational procedures and all aspects of patient care via the Internet of Things (IoT). This schematic design allows for considerable operational efficiency to be generated. Previously, each service would have been managed independently, but now all data is consolidated into a single backbone with secure access. The hospital and patient ward buildings are fully equipped with WI-FI system equipment to allow the internet and WLAN communication within the hospital buildings. To compliment this the IT network installation also connects the medical services network, the office administration network and provides a network for the patient and their family. Medical records, patient treatment regimes, medical equipment, gas systems, HVAC, lighting, staff management, voice communications systems, security, and financial services, are all planned for the converged network. This enables better collaboration, the creation of useful applications, and the network can be monitored by a single operations manager. Although the data is in one place, it is separated virtually to provide each team with access to its own system. Security is paramount and provided via a centralised firewall complemented by a strict internet access policy with internal gateways to limit access for patients and public users of the system.

Energy efficiency and cost savings are made possible because the converged network allows services to interact. Building services are linked to the check-in system, for example, so that heating, lighting and air conditioning in individual rooms can be automatically switched on when a patient arrives, and turned off when the room is unoccupied.

Applications are planned to improve patient and hospital user experience including a way-finding system to help navigate the large and complex hospital site, and a check-in procedure linked to the communications system so that staff can contact patients individually. These applications mean patients can move around the hospital while waiting for their appointments, then find their way to the correct treatment centre via an appropriate route, perhaps using elevators instead of stairs if they have difficulty walking, for example. Remote treatment options are also made possible because all data is contained in the Cloud, and communicated via the Internet.

**Connected Healthcare**

As a truly smart hospital, the BOE Hefei Digital Hospital provides a level of connected healthcare that will allow for a model to use in other hospitals and networked together as a provider. By consolidating all functions into one centralised network, capital expenditure and operational costs are reduced, while security is increased.

Our expert team also focused on resiliency planning creating a road map of how our client can enhance their resiliency efforts. We created a large thermal storage concept to enable 24 hour resiliency, confirming this hospital as a leader in future ready design.
**Future Ready factors:**

- All data is consolidated into a single backbone
- Leverages collaboration between networks
- Large thermal storage concept enabling 24 hour resiliency
Community wellness

Today, we are helping to design and build the *healthcare facilities of tomorrow*. We are seeing that a big part of the future will be large mixed-use developments, integrating homes with community health care hubs and other services that are designed to help people live healthier lives. Preventing illness and empowering patients to manage their own long term conditions and stay healthy will be the key focus of these community wellness centres.

At the Hälsostaden Ängelholm health centre in Sweden, we’re helping to design a hospital with a publicly-accessible swimming pool, pedestrian and cycle paths to encourage fitness and bring the community into the shared hospital campus. A similar example is provided by the Dell Seton Medical Center, Austin, Texas, for which our team is providing a range of mechanical and electrical services. Here, a 211-bed teaching hospital will sit alongside the newly built Dell Medical School at the heart of a new healthcare district and, despite Austin’s fast-growing population it will be smaller than the hospital it replaces. This is because it will be supplemented by community services and its design is based on the philosophy of ‘bringing the care to the patient, not the patient to the care’.

On a larger scale the 75ha Westmead Innovation District in New South Wales, Australia will comprise a 400,000m² district of health, research and education-related developments, again with the focus on prevention and healthy living.

In the UK, the Alder Hey Children’s Health Park, completed in 2015, interprets community wellness in a different way. This replacement for an existing children’s hospital places the emphasis on boosting wellbeing by reconnecting patients with nature. Large enough to treat 270,000 patients per year, the hospital has been conceived from the ground up with children in mind. The building is light and airy, with windows built in at child-height to enable young patients to see outdoors. The provision of play spaces and a huge ‘indoor tree’ all contribute to creating a friendly space that doesn’t feel like a hospital, and provides a comfortable healing environment for patients and their families.
Dell Seton Medical Center, University of Texas

A high-performance healing environment that embraces the whole community

**Location:** Austin, Texas, USA

**Client:** Ascension/Seton Healthcare Family

**Architect:** HKS

**Services:** Mechanical, Electrical and Plumbing Engineering, IT Systems, Low Voltage Systems

**Project status:** Completed in 2017

Dell Seton Medical Center, the new primary teaching hospital for Dell Medical School at The University of Texas, anchors a new healthcare innovation zone in the state capital, Austin. The 517,000ft² (45,990m²) facility is dedicated to meeting the medical challenges of the future, with a keen focus on wellness and illness prevention.

Dell Seton also replaces the region’s trauma facilities formerly housed in University Medical Center Brackenridge. Ranking in the top 1% of all trauma centres in the US for best patient outcomes, our client’s aim is to improve its performance further through this entire update of its trauma unit.

**Ensuring a successful future**

The core clinical areas are larger and more numerous than those of its predecessor - Dell Seton has 13 operating rooms and 42 emergency beds - and the building has been designed with longevity in mind. The rooms and treatment facilities are expandable and adaptable, and our building services engineers have designed electrical and IT systems with future technological and medical advances in mind to create an infrastructure fit for the 21st century.

By minimising its impact on the environment, Dell Seton is making an important contribution to the health and wellbeing of the wider community, too. The Level 1 trauma centre achieved LEED Gold certification, thanks in part to features including 100 per cent outside air, heat recovery chillers, LED lighting, verdantly-planted internal courtyards accessible to patients, staff and visitors, and the provision of pedestrian and bike paths outside the building.

Combined with an efficient thermal building envelope, the energy efficient building services create projected annual energy savings of 23% (equating to $240,000 per year saved), compared with traditional systems.

Sustainability and wellness inform every aspect of the Dell Seton concept, creating a high-performance healing environment that extends well beyond the hospital’s walls.

$240,000

energy savings per annum
Future Ready factors:

- 23% energy cost saving over baseline costs
- LEED Gold Certification
Alder Hey Children’s Health Park
Connecting children to nature with a trailblazing ‘health park’

Location: Liverpool, UK
Client: Alder Hey Children’s NHS Foundation Trust
Architect: BDP Architects
Services: Structural Engineering, Geotechnical and Ground Engineering, Transport Planning, Building Acoustics, Noise and Vibration
Project status: Completed in July 2015

Liverpool’s Alder Hey Children’s Hospital is one of Europe’s busiest children’s hospitals treating more than 270,000 patients a year. When the local NHS Foundation Trust decided to modernise the existing building, which was more than 100 years old, its vision extended far beyond a standard revamp. The plan was to create a ‘health park’ connecting children to nature and setting a new benchmark for holistic paediatric care.

Engineering Alder Hey: inspired by children
We worked with architect BDP on the design, but the vision was uniquely inspired by the children themselves – with patients and families being consulted throughout the project from effective access to fresh air to artwork on the walls.

The patient-friendly hospital has been set out to create a calming and happy environment that doesn’t feel like a hospital and enhances the children’s healing.

This excitingly-shaped campus was inspired by a flower drawn by a teenage patient, an image which was fully integrated into the parkland setting. A striking atrium forms the heart of the campus, flooding the 270-bed hospital with light, and it is full of interesting things for children to see and explore, including a giant indoor tree-house. Three sections lead off the atrium, stretching into the parkland like fingers. Grass landscaping continues up from the ground and over the curved hospital roofs, augmenting the building’s seamless connection with the land.

More than 75% of patients are in single rooms, with windows set at a child’s eye level offering park views. Specialist acoustics reduce noise from hospital equipment, alarms and beepers, and protect the privacy of individual rooms. Each floor has an extended balcony, housing a play deck, allowing even the most unwell patients to experience outdoor space. Alder Hey’s 16 operating theatres, A&E and outpatient departments also benefit from parkland views.

Energy efficiency and fast construction
The green roof is indicative of Alder Hey’s design principles; it is one of the most sustainable 24-hour hospitals ever built, with 60% of its energy generated on site. Our client wanted affordability and efficiency and we met this challenge by providing an innovative building-envelope design. More than 1,250 precast concrete sandwich panels on the building’s perimeter distribute loads to the foundations, removing the need for conventional columns, and providing maximum flexibility in creating room layouts. This approach means less cladding requirements, removing the need for external scaffolding, with its associated health and safety implications. Effective installations and the use of high quality, robust and durable materials will help reduce the need for future labour and maintenance requirements. The vast majority of components were manufactured offsite, decreasing build time and boosting energy efficiency.

The former children’s hospital has been demolished and the site reclaimed as green space featuring wildflower meadows and a landscaped children’s sports park for community use. Alder Hey Children’s Health Park has proved to be a regeneration scheme that has benefited the wider community, too.
Future Ready factors:

- 60% of its energy generated on site
- Innovative building-envelope design
Middelburg District Hospital
A modern, sustainable hospital for Middelburg, South Africa

**Location:** Mpumalanga Province, South Africa

**Client:** Mpumalanga Provincial Government

**Architect:** Geyser Hahn Architects

**Services:** Mechanical Engineering, Electronic Engineering Services, ICT, Security, Access control and BMS engineering, Fire Engineering and Wet Services Engineering

**Project status:** Due for completion in 2020 [tbc]

In Middelburg, near Pretoria, our multidisciplinary building services team is working ‘as one’ on the design and delivery of a new hospital that will seamlessly combine the latest developments in modern healthcare with sustainable features. The future-ready design of the hospital means that it is capable of expansion from an initial capacity of 220 beds to 350 beds, as the local population grows.

With budgetary constraints tight, we are maximising cost savings through the use of BIM technology, and software such as the GLUE cloud platform that allows for real time project collaboration to manage the project efficiently. We are also introducing design features that will minimise operational costs to help the hospital channel more funds to frontline clinical services.

**A future-ready design for a growing population**

Mpumalanga Provincial Government has commissioned our team to deliver a new Level 1 district hospital that will offer a wide range of high-quality services. Set for completion in the early 2020s, the new hospital will replace Middelburg Provincial Hospital which is already straining to meet the needs of a rapidly growing population.

The current hospital also lacks a fully functional trauma unit which is much needed in Middelburg because the town is located on the busy N4 road which means there are often casualties from the unfortunately high incidence of road traffic accidents nearby.

The new hospital will be on the outskirts of the town, on a greenfield site that is readily accessible from the N4. It will offer outpatient services, general care, a maternity unit, a 600-seat auditorium, accommodation for staff and students, and a training centre, as well as a trauma unit.

**A sustainable approach that benefits patients and staff**

Operational efficiency will be enhanced by the sustainability of the design. Energy-efficient lighting has been specified, together with low-energy buildings service systems that include highly controllable multi-split (VRV) air conditioning. Water meters will be installed to help the hospital’s facilities managers to monitor water usage, identify leaks early, and improve water management.

As part of a strategy to deliver a full range of sustainable engineering and design solutions within the build budget, and reduce embodied carbon, locally produced building materials, recycled steel, and responsibly sourced timber will be used for construction.

Inside the building, the interior of the hospital has been designed to maximise the benefits of natural light and fresh air. Each ward will look out on to a garden area providing views that will enhance the wellbeing of patients, staff and visitors. Attracting and retaining talented staff is an element of overall sustainability, so this aspect of design is also important.

By putting people first, and delivering a sustainable building, we aim to provide Middelburg with an efficient and effective hospital that will serve the town well for many years to come.
Future Ready factors:

- Capable of expansion from an initial capacity of 220 beds to 350 beds
- Designed to maximise the benefits of natural light and fresh air
- Water meters will help to monitor water usage, identify leaks early, and improve water management
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