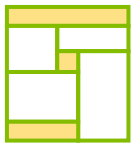
How smart construction improves the flexibility and sustainability of healthcare infrastructure

aurecon

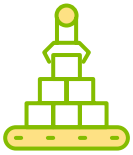
Bringing ideas to life

When it comes to healthcare projects, funders and providers are looking for certainty in programme and cost, while still achieving facilities that are flexible and sustainable in the long-term.

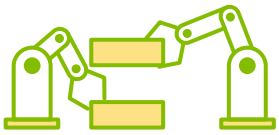
Now, in the wake of COVID-19, smart construction plays an important role in designing and delivering efficient and effective infrastructure. Using smart construction approaches can have a significant impact on schedule, cost, safety and sustainability of healthcare projects, and could lead to better long-term outcomes for patients and staff. Other industries are using smart construction techniques successfully. Some of the areas that could benefit healthcare infrastructure include:



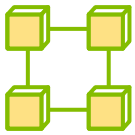
Modular design and construction



Design for Manufacture and Assembly



Automated construction



Emerging blockchain functionalities

Modular design and construction

Prefabricated, modular construction is a design and construction approach that involves manufacturing components off-site and assembling them on-site. It's not a new concept, and sectors such as residential, hotels, education and mining have been using prefabricated, modular building panels or elements for many years.

The technologies have existed for a long time but haven't been used widely in health infrastructure. With the health sector now challenged by the speed and flexibility required to respond to the pandemic and the need to update and replace ageing assets to meet increasing demand, modular construction could help to ease these pressures.

There are many benefits to modular construction. It is a faster and more efficient way to construct, that also improves safety and reduces noise, waste and dust on-site. This is a clear benefit, particularly for the expansion of healthcare facilities.

Modular construction also improves scale and optimisation.

For example, rather than investing capital to build an extra 10 per cent of floor space in a hospital today, sections can be added when required in the future using modular additions.

This scalability allows the asset owner to extend the facility in accordance with changes in demand, regulation, or to respond to specific public health events.

Healthcare infrastructure requires flexibility in accommodating the ever-changing environment of healthcare, while safely resisting forces that may be imposed on it for its design lifetime. In accommodating modifications to existing facilities, minimising disruption to operations while maintaining patient and staff well-being is critical. COVID-19 has also highlighted the need for flexibility to reconfigure and rapidly expand existing facilities to meet new demands, including entire sections of a facility.

Modular construction provides this ability to be flexible both now and into the future. It makes it easier to maintain operations during construction, but also allows health infrastructure to adapt to future requirements and technology.

The **2019 McKinsey report** *Modular construction: From projects to products*, states that modular construction:

- Reduced construction time by 20–50 per cent
- Had the potential to reduce costs by 20 per cent
- Increased safety on site
- Increased speed and ease of construction, particularly in urban and/or congested areas
- Reduced wastage and improved opportunity to use alternative materials
- Increased certainty and reduction of rework
- Provided opportunities to take advantage of repeatability with standardised design

The rise of 3D printing also means that the creation of prefabricated components off-site can be further streamlined. In healthcare, 3D printing is already revolutionising the manufacture of prostheses, organs, medical devices and, as we witnessed during the COVID-19 pandemic, surgical masks and face shields. So, why wouldn't 3D printing be explored in the context of the construction of healthcare facilities? This could mean huge benefits for the healthcare sector, by delivering services to the community faster with reduced costs, while improving equity and access to quality facilities, especially in remote areas.

The construction industry has already seen great benefits from the use of 3D printed building components including large reductions in labour and materials costs and quicker construction times.

*For example, by **2025 Dubai plans to have 25 per cent** of new buildings made by 3D printers, aiming to reduce labour by 70 per cent and cut costs by 90 per cent.*

Case study

Temporary expansion of the emergency department at Melbourne's Monash Medical Centre

In response to the **COVID-19 pandemic**, Melbourne's **Monash Medical Centre Emergency Department** required additional accommodation to treat and isolate patients presenting with symptoms. As the existing Emergency Department at Clayton is undergoing a major reconfiguration and expansion, it wasn't possible for the hospital to respond to the evolving COVID-19 pandemic.

Complete rooms to isolate and treat patients presenting with symptoms of coronavirus were manufactured entirely off-site in a factory-controlled environment and built to the specifications of Monash Health, which included ventilation, medical supply systems, nurse call, fire protection, power and data.

Prefabricated modules were craned into position during a 15-hour work period to minimise the operational impact on Monash Health. The ready-made units meant that the **construction** team didn't have to design a building envelope, instead focusing on services and infection-resistant finishes, to satisfy the strict requirements around infection control.

Design for Manufacture and Assembly

Design for Manufacture and Assembly (DfMA) focuses on prioritising both the manufacture and assembly of components in the construction phase within the design phase. It effectively combines design, manufacturing and construction as a seamless process, enabled through sophisticated modelling and workflow strategies.

With DfMA, components are designed and built at the same time, instead of using traditional on-site construction methods where they are done in sequence. This can have the effect of significantly reducing time and costs, and processes become streamlined. It also improves on-site safety and reduces the risk of errors, as building occurs in the controlled environment of a manufacturing facility.

As a form of design and construction, DfMA is seldom used in the health sector, but is starting to be recognised as providing a more standardised, systematic and streamlined approach for capital projects across other industries. Adopting DfMA as a viable design and construction approach for healthcare infrastructure could see some of these benefits realised.

Crucial to the success of DfMA is effective collaboration between the designers and all parties in the supply chain to ensure any design changes are reflected throughout the entire process.

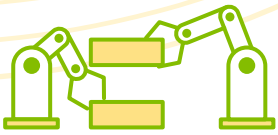
Case study

A DfMA approach that reduced design and construction time and cost

Aurecon was part of the project team, along with lead contractor Lendlease and architects Populous, that delivered the AUD 360 million **Bankwest Stadium** in Sydney for the NSW Government, providing structural, civil, sustainability, MEP, security, fire and wind services.

To meet the challenging client brief of designing and building a stadium in two and a half years to be ready for the 2019 football season, Aurecon adopted a ground-breaking 'shop draw first' and BIM workflow strategy where the team developed a ready-for-fabrication design with architectural, constructability and engineering design requirements converging to a single outcome – a ready-to-build stadium that was quick to manufacture, easy to assemble, cost-effective and architecturally impressive.

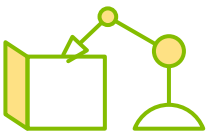
This DfMA approach reduced manual labour and maximised constructability, dramatically reducing the overall design and construction programme by three months, significantly reducing fabrication and installation time, improving safety, reducing the risk of error and reducing costs by over AUD 2 million.



Automated construction

Automated construction techniques can deliver significant benefits such as reducing construction time by creating efficiencies, improving accuracy and increasing on-site safety.

Some examples include:



Robotics to assemble components on-site or undertake tasks such as painting further downstream

Autonomous vehicles to transport materials on or between sites

Remote-controlled drones and sensors to monitor construction progress, or access remote or difficult sites to capture data

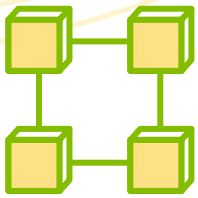
To take advantage of the benefits of automation, construction needs to move from a 'craft' approach, to the use of standardisation and prescriptive solutions and systemisation where this work can be undertaken by technology.

Widely used in the manufacturing sector for decades, increasing the use of automation and robotics in construction would lead to more efficient, cost effective, faster, safer, better quality (due to eliminating the risk of human error) and practical construction. Robotics has been used in surgery for some time. For example, we have seen robots used in **hospitals around the world** to protect medical staff from contracting COVID-19. Despite this, we are yet to see automation widely used in the construction and maintenance of healthcare facilities.

In a healthcare setting, this could mean being able to deliver much needed access to health services quickly, which is vital in pandemic events and natural disasters, as well as opening more access to healthcare in regional areas. It also means making our hospitals cheaper and faster to build.

Using automation not only makes construction easier and safer, but can also assist with building operations and maintenance, driving down short- and long-term costs.

For instance, measuring and adjusting internal temperatures or air quality in completed buildings can be effectively achieved with the help of lasers, sensors, thermal imaging and machine learning, which can be factored into the construction process.



Emerging blockchain functionality

Emerging technologies are driving change in the construction industry and the sector is realising plenty of benefits in improved return on investment and increased efficiency.

One trend that is helping enable smarter construction is **blockchain**. Blockchain is a decentralised database that securely records transactions and, given the data is resistant to modification, is being explored increasingly to improve supply chains. Blockchain allows the creation of smart contracts along the supply chain to increase trust between project partners, making the process of construction easier, cheaper, safer and faster.

The increased use of modular construction has highlighted the need for improved accuracy, accountability and robustness of design documentation.

Blockchain can be used to connect the supply chain from planning to documentation through smart contracts. When connected to other digital design and construction software, blockchain can also enable greater collaboration, transparency and real-time sharing of data and design changes. Payments can also be facilitated via blockchain to automatically facilitate invoicing and receivals on completion of pre-determined milestones. It could even be applied beyond construction to understand healthcare asset efficiency, as well as help to streamline building maintenance.

The impacts of smart construction on sustainability

With sustainability and net-zero targets becoming a focus for both the community and governments, we should also consider the entire supply chain and how we can incorporate more sustainable practices in construction.

Smart construction approaches, such as prefabrication and modularisation, improve sustainability by creating less waste, less noise, fewer truck movements and less dust on site, as well as increased safety. But sustainable materials also have a part to play.

Considering the use of construction materials such as recycled steel, 'green' concrete and timber can improve the sustainability of projects. Over the past decade, there has been an **increasing trend towards engineered timber** as a viable mass-scale complement to traditional materials such as concrete and steel.

Advances in timber construction technology and improved availability have enhanced the supply chain options. Some of the **benefits of using timber** as a construction material include faster, quieter, and safer construction with less waste and reduced labour requirements.

Timber construction is also the only true renewable mainstream building material, so delivers sustainability and environmental benefits while sequestering carbon.

The use of timber and other biophilic design and construction approaches that reflect nature, have also proven to **improve overall health and well-being** of building occupants and recovery outcomes for patients. In his research report: **'Wood, Well-being and Performance: The Human and Organizational Benefits of Wood Buildings'**, author Graham Lowe, Ph.D., summarises the findings from multiple studies demonstrating that wood improves patient health outcomes and reduces stress and length of stay for hospital patients.

Although the use of engineered timber as part of healthcare construction has not yet taken hold in Australia and New Zealand, it is being used overseas. **The Dyson Centre for Neonatal Care** in Bath, England, is constructed of cross-laminated timber, exposed in the interior, creating a calm environment in an acute clinical setting. It was built in three weeks, utilising a quick, clean construction method, essential within an existing healthcare environment. Researchers studying the impacts of the building discovered that it was quieter, more energy efficient, and interestingly, improved parents' interactions with their babies. Most importantly of all, babies slept 20 per cent longer.

Maggie's Cancer Centre in Oldham, UK, constructed from cross-laminated, sustainable tulipwood, is part of a grander plan to revolutionise the design and construction of health facilities, based on the philosophy that "in wood there is hope, humanity, scale and warmth."

Case study

Putting people at the heart of the design of Australia's tallest and largest engineered timber office building

25 King is currently the tallest and largest engineered-timber office building in Australia. A co-creation between Lendlease and Aurecon, together with Bates Smart, 25 King is a world-class **building of the future**.

Inspired by the environmental benefits and versatility of timber, 25 King utilises a combination of cross-laminated timber (CLT) and glulam (glue laminated timber) across 9-storeys. It demonstrates to industry that performance solutions for this scale of timber building could be achieved, delivering a highly sustainable development that is low carbon, low waste, aesthetically attractive, highly energy efficient, cost effective, and promotes the well-being of occupants.

The building saves 74 per cent embodied carbon when compared to equivalent concrete buildings, has achieved a 46 per cent reduction in energy and 29 per cent reduction in potable water consumption. Occupants have also reported a greater sense of well-being and increased productivity.

What needs to change for smart construction to occur in the health sector?

While there have been many advances in construction in health infrastructure, there are many more benefits of smart construction that the sector is yet to realise. Faced with increased pressure to deliver improved outcomes from limited investment dollars, smarter construction can reduce the cost and timing of delivery and enable more flexibility and adaptability to future demands. It can also improve sustainability outcomes. This means that we can deliver better, more affordable infrastructure to our entire healthcare system, including to regional communities.

Despite the clear benefits of smart construction for the delivery of healthcare infrastructure, some of today's construction methods are still lagging. What needs to happen for this to change?

For smart construction methods to take hold, there must be a change in the design and construction of healthcare facilities across all areas of the supply chain:

Infrastructure owners and investors should think long-term and be prepared to explore new and emerging approaches and technologies to understand the benefits they can bring.

Designers and contractors need to invest in efficient and scalable techniques to enable fast design and construction of repeatable components.

Material suppliers may need to invest in sustainable, standardised components applicable to healthcare infrastructure.

Building regulators may need to adapt codes to different methods of construction and new materials.

These shifts, while in some cases significant, are not insurmountable and are already occurring in other sectors. With new technologies and materials emerging, as well as a need for more affordable and efficient construction to meet the pressures of rising healthcare demand, there has never been a better time to make the change to smarter construction.

About the author

Gillian Forde is Aurecon's Buildings Leader, Western Australia, with more than 14 years' experience delivering engineering solutions for a diverse range of projects across international markets. As a structural engineer, Gillian has a record of implementing innovative ideas and applying technical skills and creativity to challenge the status-quo and deliver better outcomes for clients on projects across health, education, commercial, residential, transport, Defence and public infrastructure.

This article is part of the Reimagining healthcare infrastructure series. **Find out more.**

About Aurecon

Aurecon brings ideas to life to design a better future.
Imagining what is possible, we turn problems into solutions.

For more information please visit
www.aurecongroup.com

Bringing ideas to life