



DIGITAL FOUNDATIONS

HOW TECHNOLOGY IS TRANSFORMING AUSTRALIA'S CONSTRUCTION SECTOR





CONTENTS

Scope	3
Executive summary	4
The Australian construction sector	6
Sector dynamics - Change is on the horizon	8
Startup ecosystem fundamentals	18
The Australian ConstructionTech ecosystem	20
ConstructionTech in victoria	22
The benefits of transitioning to digital	24
Australian university/industry partnership	34
Success characteristics of leading ConstructionTech adopters	36
The stages of digitisation	40
Key international developments in ConstructionTech	46
Challenges to digital adoption	48
Next steps - Learning from advanced manufacturing	54
Building the future of ConstructionTech	62
Acknowledgements	66

SCOPE

ABOUT THIS REPORT

This report has been produced by StartupAUS in collaboration with Aconex, Lendlease, EY, UTS and the Victorian Government.



It outlines the current state of play of Australian ConstructionTech and the construction sector more broadly, highlights the potential impact of digital solutions in the construction space, and models effective technology adoption. Finally, it provides recommendations that support productive and focused action to build the future of ConstructionTech in Australia. It is not intended to be a comprehensive view of all ConstructionTech activities and players.

SCOPE: WHAT IS CONSTRUCTIONTECH?

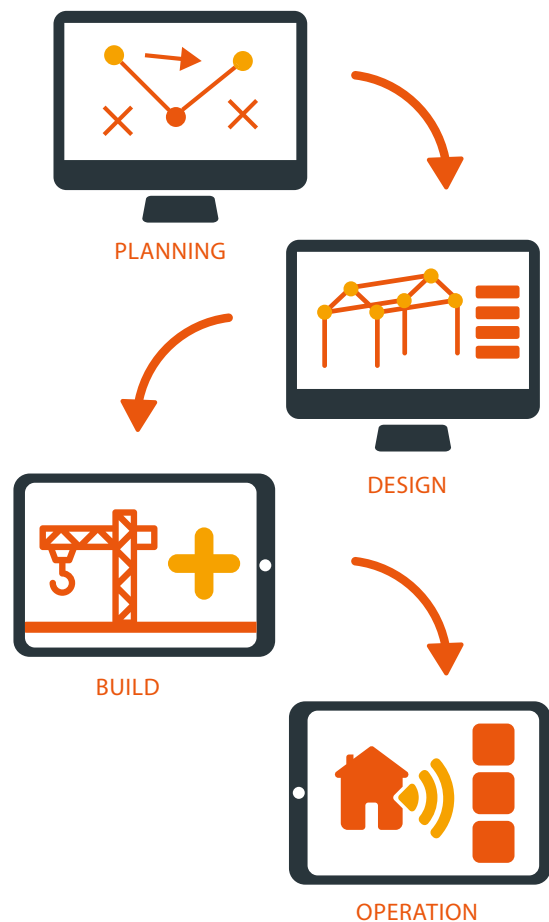
Construction projects are typically broken down into planning, design, build and operational phases. For the purposes of this report, ConstructionTech will consist of digital solutions offered in the planning, design and building phase. These technologies include cloud-based management software, Internet of Things (IoT) sensors, Building Information Modelling (BIM), Artificial Intelligence (AI) and machine learning, Virtual Reality (VR), Unmanned Aerial Vehicles (UAVs) and digital marketplaces.

Many other areas of the construction sector are seeing advanced technological solutions - in particular, pre-fabrication and advanced or smart materials in the build phase. While these technologies may be referred to in our analysis in parts, we have excluded them from the core scope of this report to focus on digital tech.

PRIMARY RESEARCH METHODOLOGY

Primary research in this report consists of interviews with 42 individuals from 31 organisations in the construction sector and construction-focused technology space. The interviews included 16 representatives of the startup community, and 26 construction stakeholders – including tier 1 and 2 construction company representatives, engineers, investment asset managers and sub-contractors.

The report also includes contributions from UTS Associate Professors Julie Jupp and Gerard de Valence based on findings from their research in the area.



EXECUTIVE SUMMARY

Almost two decades after Australia's most successful construction technology company, Aconex, was founded, the local construction industry finds itself at a tipping point. Digitisation is coming fast, and the industry is on the verge of widespread adoption of a range of new technologies. This report examines the collaboration between the construction sector and startups and outlines a path towards digitising one of Australia's largest sectors.

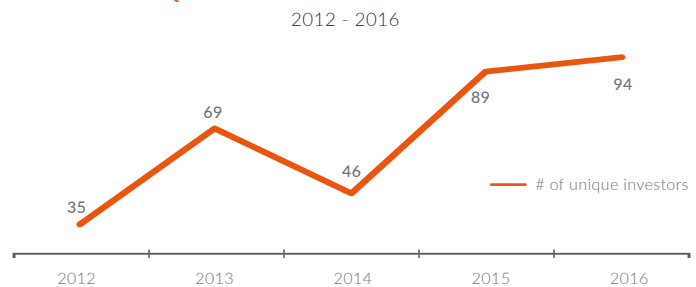
The sense of excitement and activity in ConstructionTech is palpable. Startups are not looking to disrupt tier one construction firms - very high capital costs mean that established industry players remain firmly in position. Instead, startups are looking to provide digital solutions and technological additions that help improve existing businesses and overcome some of the most enduring challenges of this complex sector. The opportunities are vast. Within 10 years, according to figures from BCG, global full-scale digitisation in nonresidential construction could lead to annual cost savings of US \$0.7-1.2 trillion (13% to 21%) in the engineering and construction phases and US \$0.3-0.5 trillion (10% to 17%) in the operations phase. Extrapolating to the Australian construction sector, the potential added value increase could be \$25 billion year on year within the next decade. Startups, therefore, have the potential to add huge value to the local construction sector as well as enjoying healthy global demand for exported technology solutions. Larger firms are themselves proactively exploring how to change. Both the workforce and management are keen to move away from burdensome paper-based administration towards integrated digital solutions. This has opened a significant market opportunity for some of Australia's most promising startups, companies like APE Solutions and SafetyCulture. For these businesses, removing paper translates into a host of business-wide benefits, including providing managers with better, more timely data, improving safety for workers on site, and increasing build speed.

Firms are looking to deliver building assets alongside the 'as-built' building information modelling. This provides the technological features necessary to optimise building performance, maintenance and energy costs long into their lifecycle. Australian startups such as CIM Enviro and 30Mhz (profiled in this report) are able to employ a series of IoT sensors and use advanced data collection coupled with machine learning to optimise building performance. Technology is an edge in a competitive market.

This is not to say it will be easy. Construction already operates with some of the thinnest profit margins of any industry, and firms have large and complex legacy systems. Change management requires significant time and investment, and is hampered by the project-based nature of siloed operations. Construction sectors the world over are grappling with these challenges, and construction remains one of the least 'innovation active' sectors globally. However, when set against a backdrop of a global construction output valued at over US\$8 trillion in 2015 and forecast to grow to US\$15.5 trillion by 2030, it's clear that the stakes are high.

That huge market opportunity has led to a big upswing in global interest in ConstructionTech in recent years. CB Insights estimates more than US \$1 billion has been invested in global ConstructionTech companies across more than 200 deals since 2013, with the trend line moving upwards. Leading venture capital firms including Andreessen Horowitz and Google Ventures have invested heavily in the space, and specialised Australia-based ConstructionTech venture firm Brick & Mortar Ventures has made more than 25 investments since it was founded in 2014. The growth hasn't just been in the amount of money or the number of deals, either - an increasing number of investors have been involved in ConstructionTech deals in recent years. CB Insights estimates the number of unique investors in the space almost tripled from 2012-2016.

YEARLY UNIQUE INVESTORS INTO CONSTRUCTIONTECH¹



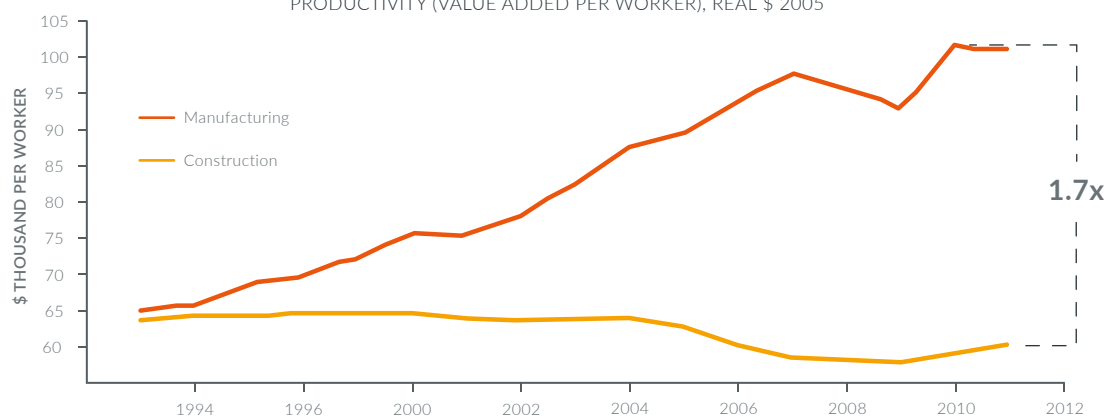
Australia, too, has seen strong growth in the space, with firms like SafetyCulture and Assignar attracting venture capital from leading Australia-based venture funds including Blackbird and Our Innovation Fund, alongside Silicon Valley titans Index Ventures. StartupAUS estimates Australian ConstructionTech startups have attracted at least \$98 million in investment since the start of 2016. With over 75% of these deals at an early stage ('seed' or 'A'), this figure has the potential to rise sharply in coming years.



In fact, as this report highlights, Australia has some significant advantages in the adoption of new technologies in this space. Our construction sector is heavily concentrated, with just 20 firms accounting for 68% of contracts won. That means proactive steps being taken to digitise by sector leaders are already having industry-wide repercussions. Anecdotal evidence also suggests Australia's construction sector has been a leading adopter of technology for some time - most notably in cloud software, use of mobile products for field processes and in adoption of BIM.

OVERVIEW OF PRODUCTIVITY IMPROVEMENT OVER TIME²

PRODUCTIVITY (VALUE ADDED PER WORKER), REAL \$ 2005



Productivity in manufacturing has nearly doubled, whereas in construction it has remained flat

Australian startups in this space are increasingly supported by strong ecosystem fundamentals across the board. 2016 and 2017 were the two biggest years on record for Australian venture capital firms, with more than \$1 billion in funds under management raised in the last 12 months. Policy shifts at both Federal and State level have incentivised a growth in seed-stage angel investment, and encouraged a proliferation of support structures such as startup-dedicated coworking spaces, incubators and accelerators. In order to take full advantage of the potential of ConstructionTech, there is still much to achieve. This report concludes by outlining a series of recommended actions to help unlock this potential. Regulatory frameworks have been introduced overseas encouraging digital collaboration and technological investment in large scale construction projects - Australia should look to expand on these measures locally. Collaboration between research and industry has proven to be effective previously in construction and in aligned industries across the country, it is important to re-establish that link. And ConstructionTech startups need to capture an identity, a density of events and physical space to provide better access to experienced mentors, customers, investors and sector advocates.

With the right action, Australia can capitalise on its burgeoning ConstructionTech ecosystem and drive value throughout the sector and the economy as a whole.

¹ CB Insights

² McKinsey, The construction productivity imperative, June 2015

THE AUSTRALIAN CONSTRUCTION SECTOR



8.1%
OF AUSTRALIA'S GDP

SIZE AND SCALE

The Australian construction sector is the largest non-services sector of the Australian economy, accounting for 8.1% of GDP. Construction employs 1.1 million Australians - more than five times as many as the mining industry. A further 100,000 jobs are projected to be added by the sector over the five years to 2022, with employment growth forecast at 10.9%.

BCG estimate that global full-scale digitisation in nonresidential construction could lead to annual cost savings of US\$0.7-1.2 trillion (13% to 21%) in the engineering and construction phases and US\$0.3-0.5 trillion (10% to 17%) in the operations phase. Extrapolating to the Australian construction sector, the potential added value increase could be \$25 billion year on year within the next decade.

MAKE UP

The construction sector is dominated by large players. While sector overall is made up of 345,480 businesses, the top 20 firms account for 68% of contracts won. As we will see through the course of this analysis, this centralisation of the sector is an important factor in the sector's propensity to adopt technology.

RECENT SHIFTS

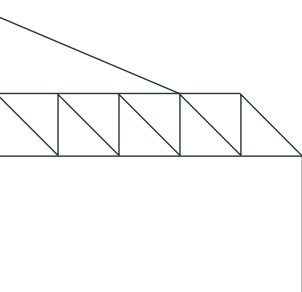
The sector has experienced significant shifts in recent years with a decline in mining-related engineering construction expenditure and increased focus on civil engineering projects.

Significant projects in transport and road infrastructure development are under way, including the Melbourne Metro Tunnel upgrade, the Sydney Light Rail expansion, the Melbourne level crossings removal project, and upgrades to the Princes Highway, which have helped to stabilise the output figure for construction revenue.

Residential construction projects also grew 10.6% from 2015 to 2016³, which played a role in offsetting the gradual decline of mining-related output.

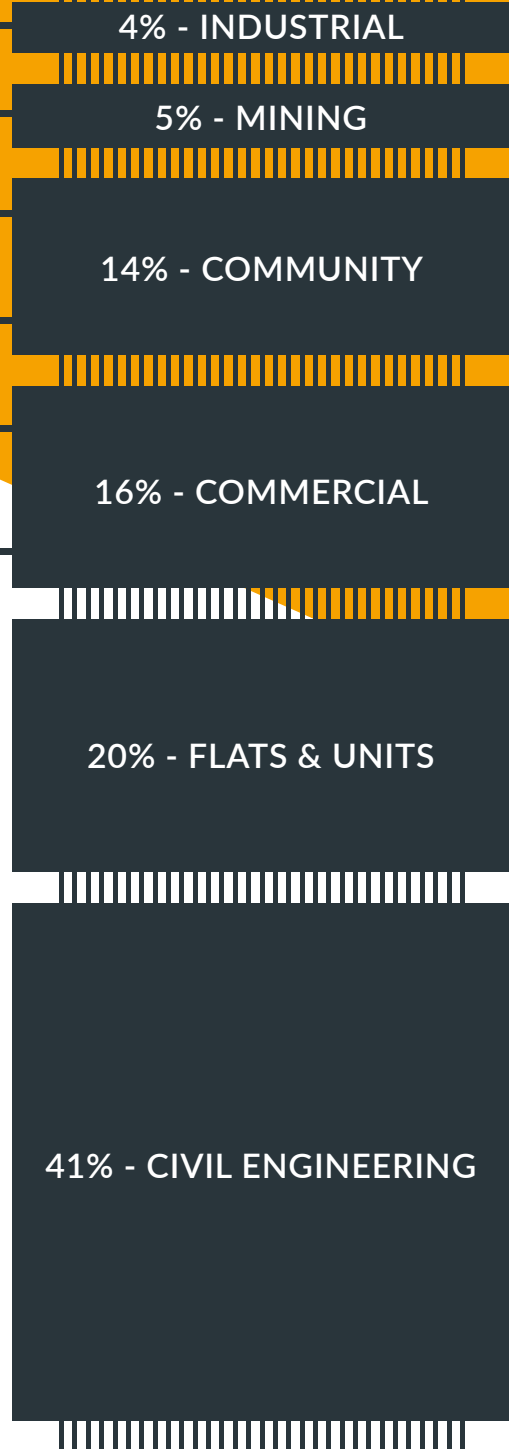
"We've never seen as much money being spent in infrastructure in Australia's history. It's a once in a 75 year occurrence to have two metro systems and everything else in between happening between our two biggest states." Joshua Ridley, Ridley

8.9% OF
WORKFORCE



**\$134B
REVENUE**

MARKET SHARE 2015/16



PRODUCTIVITY & INNOVATION

2016 saw productivity increase in the construction sector, with output growth (2.8%) overtaking employment growth (1.8%)⁴. That increase comes off a high base: according to the Office of the Chief Economist Australia's construction sector is already 19% more productive than its global competitors⁵. However, when it comes to productivity the sector still lags behind other key Australian sectors, including agribusiness, mining, and health.

Despite its size and strong growth, the construction sector has been slow to innovate. In 2014-15 the ABS ranked the rate of innovation in the construction sector third last in the country - ahead of only agriculture and transport. This is reflective of the industry globally - a 2015 report by the McKinsey Global Institute placed the construction industry ahead of only hospitality and agriculture in terms of digital maturity in a US context.

Source:
Australia Industry Report 2016, Office of the Chief Economist, Commonwealth Department of Industry, Innovation and Science
HIA Cordell Construction 100 for 2015/16

³ Australia Industry Report 2016, Office of the Chief Economist, Commonwealth Department of Industry, Innovation and Science
⁴ Australia Industry Report 2016, Office of the Chief Economist, Commonwealth Department of Industry, Innovation and Science
⁵ BenchMark Report, Aus Trade and Invest Commission 2016 Australia Industry Report 2016,

SECTOR DYNAMICS

CHANGE IS ON THE HORIZON

INTERNAL

In recent years, there has been some recognition by the sector that traditional approaches to operations by construction companies are no longer working effectively enough to deliver high quality projects on time and within budget.

With new technological solutions becoming financially and functionally accessible in the market, the industry has begun to recognise that there is now an opportunity to make progress. The motivation for this change in attitude comes from two distinct mindsets:

SURVIVE

Disruptive forces have already transformed a number of traditional industries, and many see the potential for technology to do the same in construction. Increasing client demand for technology is one factor driving this mindset, as is a requirement from other firms in the value chain to pass on and interact with technology driving the project.

Construction companies are starting to investigate new technology models and ways of working via self-funded innovation hubs, and increasingly turning to the startup community for solutions.

THRIVE

These organisations see technology as having the potential to provide a competitive advantage. Whether it is in winning contracts by offering clients additional technological advantages or by improving internal efficiency and increasing margins, these firms increasingly see technology as an investment that is critical to their future growth.

EXTERNAL

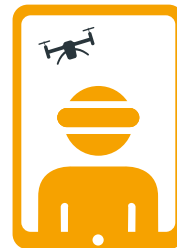
This mindset change did not occur in a vacuum. The change in willingness to actively pursue technology has been brought about by three key external factors:



SOCIAL DYNAMICS OF TECHNOLOGY



BIM (BUILDING INFORMATION MODELING) AND SMART BUILDINGS



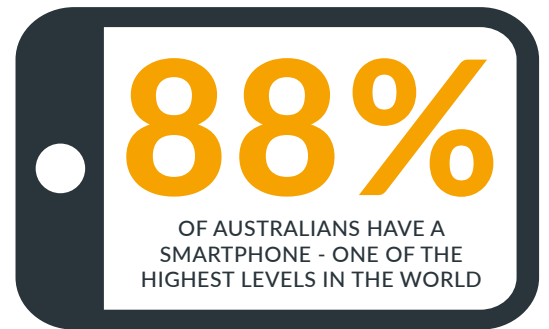
CONSTRUCTION TECHNOLOGY



SOCIAL DYNAMICS OF TECHNOLOGY

PREVALENCE OF MOBILE DEVICES AND SOCIAL MEDIA

The prevalence of smartphones and ubiquity of social media engagement has resulted in a rapid increase in technology literacy at all levels of the construction sector. The mass adoption of internet-connected mobile devices has opened the door to portable solutions, the pervasive use of apps has resulted in user familiarity and comfort with digital interfaces, and the prevalence of digital channels across all forms of everyday activities is building an expectation of a digital solution across all facets of life.



Source: EY Digital Australia: State of the Nation 2017

INFLUX OF YOUNGER WORKERS

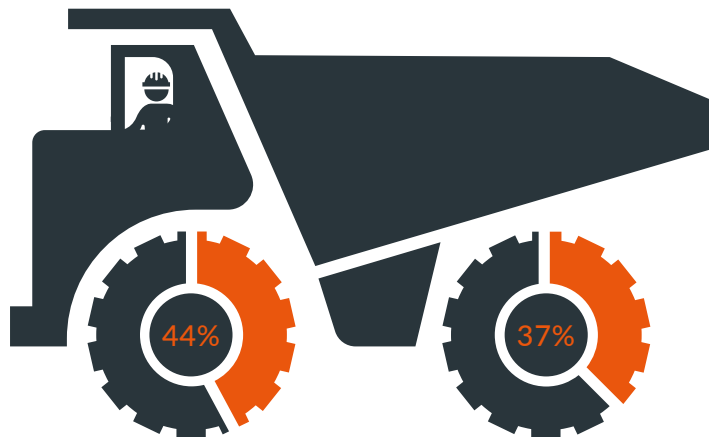
Generational drivers are also having a profound impact on the sector. While older workers may be adapting and adopting technology at a variable pace, younger generations have already integrated digital devices into their lives. The construction sector is the largest employer of young full time workers in Australia. Thus, the emerging sector worker is ready to adopt digital solutions and embrace them as part of the fabric of their working life.

COST OF TECHNOLOGY HAS FALLEN DRAMATICALLY

Cloud services, IT hardware and connectivity have become dramatically cheaper over the past decade. The upgrade in broadband internet connectivity coupled with the growth of cloud-based computing and SaaS providers have enabled construction firms to roll out powerful and complex IT systems in the field at a fraction of the cost of large scale bespoke IT projects.

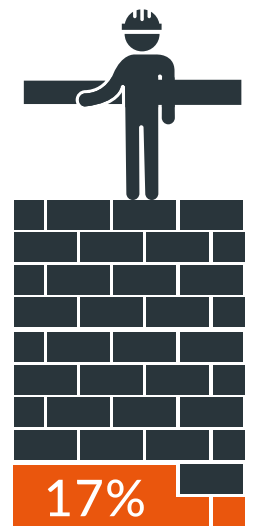
“There’s been a massive change. Five years ago I was fighting with people to get paper out of their hands – “You don’t need to print this, you don’t need paper”. Then the shift occurred. About two years ago I got an email from a construction industry subbie who said to me, “What kind of tier one company are you when you don’t have an app for this?” Now that is a massive turnaround in the construction industry.” Ryan Macnamee, Laing O’Rourke

LARGEST EMPLOYER OF YOUNG FULL TIME WORKERS



CONSTRUCTION INDUSTRY AGED 15 TO 34

ALL INDUSTRIES AGED 15 TO 34



FULL TIME WORKERS AGED 15 TO 24

Source: Australian Bureau of Statistics – Labour Force, Quarterly, Detailed – May 2017



BIM AND SMART BUILDINGS

BUILDING INFORMATION MODELLING (BIM)

BIM technology is the digital modelling of a building project. It encompasses the whole lifecycle of a project, from design, to build, to operations.

BIM affords numerous benefits, such as more effective design, a reduction in change orders, fewer on-site mistakes and a more efficient construction process overall.

BIM is the centrepiece of the digital revolution in construction. As a digital model it is able to be extracted, exchanged or networked, interfacing with countless digital technologies operating within large-scale construction projects. Within the industry, BIM has become synonymous with construction technology.

In the Australian construction market there has been varied adoption of BIM. Although it is part of the picture for many construction firms, it can often be vulnerable to cost cutting early in the project cycle.

The use of BIM depends on the complexity requirements of each individual project. In a 2014 study, 45% of Australian construction industry professionals said they had an advanced or expert understanding of BIM use. Although the sector accepts BIM as part of the new landscape, the full impact of widespread adoption of BIM as an interactive model, complete with historical records, is not expected to be a reality for some time.

Australian startups boast many leaders in BIM, including GeometryGym, Urban Circus and iConstruct.

“The use of BIM in construction has the potential to save firms between 3-5% in costs. BIM could have a huge effect not just in design and construction, but on the economy... could boost gross domestic product by 0.2 basis points above the “business as usual” scenario, rising to 5 points by 2025.” Michael Bleby

MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

The increase in available data from BIM and other digital solutions provides the necessary operating environment for machine-based optimisation. Machine learning and AI are able to process and analyse vast quantities of data extremely quickly, finding small but significant improvements across complex projects. These improvements can potentially flag dangerous activities or practices, inefficient energy usage, labour shortages or design flaws.

Built.

6D BIM

At Investa’s new 22,000 sqm PCA A-Grade commercial office development at 151 Clarence Street in Sydney, known as Barrack Place, Built is employing one of the most comprehensive levels of BIM integration in the market today. BIM is a set of processes and methods used to organise structured geometry and data that allows a building to be designed, constructed and operated in virtual space.

For Barrack Place, the project team developed a highly detailed virtual model that goes beyond 3D modelling, with the 6D model linking programme, cost control and facilities management modules. This provides the ability to steer the most efficient construction process with a single source of truth, eliminating cost, co-ordination and duplication inefficiencies. Practical examples of 6D BIM on the project have included improving the construction sequence to obtain greater efficiency in the build through to modification of prefabricated risers to create a safer construction methodology.

There will also be a verification of the BIM model against the as-built building at the end of construction. This verification will create a robust dataset that feeds into the final Building Management System (BMS) to optimise the operation of the tower for Investa into the future.



SMART BUILDINGS

The industry predicts that in 15 years' time, the internet of things (IoT) and smart buildings will be the norm – with all new buildings incorporating a 'smart' element, and existing buildings being retrofitted to include smart elements. Uptake will be driven by client demand, based on the efficiencies that coincide with access to real-time data from an integrated system.

'Smart' is a function of smart technology and materials that will ultimately allow for the convergence of real-time data across functions and sites. The delivery of sensor-based environmental controls, fully integrated systems for people tracking, and improved resource management are just some examples of current and emerging smart building capabilities. These levels of control and data allow building owners to optimise energy usage, monitor tenant usage and redesign space accordingly, take advantage of just-in-time maintenance and repair, and provide added safety features.

Eventually, smart buildings are likely to begin to redefine how the built environment enhances the customer experience (and the value proposition to investors) through the provision of more flexible and connected spaces. Smart buildings are likely to facilitate the provision of a broad array of services through integration with adjacent businesses.

"Let's say, for instance, you're walking through a part of the city with your mobile phone. It might tell you that there's a coffee shop, or a hair dresser and therefore, because you're using my community and my airspace to access it, what I can do is every time you visit that coffee shop, I can take a clip of it. So you start to open up to what I call adjacencies, where there's all these applications that you can start putting in and around the property that start to create revenue that is not associated with the property and construction industry, it's more of a retail place." Richard Ferris, Lendlease

The demand for smart buildings is expected to force collaboration early in the value chain as the digital layer within a building becomes a defining feature of the building's value proposition.

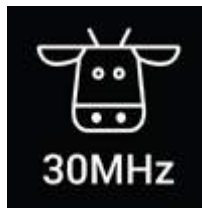


CIM ENVIRO MACHINE LEARNING

CIM Environmental Group has developed a machine learning hardware and software solution called the ACE Platform to optimise how buildings perform. The platform uses machine learning to run simulations on data collected across a property site and optimises building behaviour to avoid wasted energy costs.

Hotel Realm wanted to save energy and optimise business performance by leveraging insights from their data. When trialling the ACE Platform, the hotel saved \$155,430 via 122 individual measures. Energy consumption dropped by 32%.

Melbourne Museum were able to use CIM Enviro to achieve a 20% kWh reduction, 13% kVA reduction and 28% reduction in gas, for an overall saving of \$203,000.



“30MHz believes that with technology and data, organisations of any size can innovate to become more efficient, sustainable and cost-effective. Using easy to deploy wireless sensors, we’re empowering businesses to turn metrics captured from the physical world into actionable insights at industry-scale.”

NAME:

Jurg van Vliet, Flavia Paganelli and Jasper Geurtsen

BACKGROUND:

30MHz was founded from the successful cloud consultancy 9apps. Its founders are leading experts on cloud computing and the business is built on decades of experience in engineering, systems architecture, distributed and embedded software, user experience, hardware and industrial design. Together, the co-founders have written several introductory and advanced books on Amazon AWS for O’Reilly.

ABOUT THE TECHNOLOGY:

A user-friendly and easy to deploy smart sensor solution. Modular, scalable and cost-effective, the 30MHz Smart Sensing Toolkit is scalable in number of sensors as well as sensor type, and is interoperable with third-party technologies.

WHAT’S NEXT:

Extending the proposition into commercial insurance, moving that industry into digitally enabled interactive risk management services.

ADVICE TO CON TECH STARTUPS:

“Position yourself to co-develop solutions. Start small, learn about the customer, find the right business case, learn and begin to see the value - then build out from there.”

The 30MHz Smart Sensing Toolkit lowers the barrier to entry to industrial sensor and data capture technology. It is designed for quick roll-out of sensors in the hundreds of thousands, and is paired with an intuitive analytics dashboard that allows for data monitoring on any device. The sensors are also flexible and durable enough for heavily industrial environments.

The modular sensor technology allows for full customisation of metrics, enabling builders to constantly engage with their operations. Data gained from the sensor array is available for analysis, monitor and control operations, optimisation and automation.

While advances in safety continue for workers, monitoring the site itself has been slow to develop. IoT sensors are able to assist in the prevention of fire, water leaks, mould, impact damage and theft. Without a previous digital record of build history, these risks cost builders millions of dollars per year, and are the biggest causes of loss, claims, overrun and downtime.

By combining data points from potentially hundreds of sensors, management, foreman and contractors can understand the changing environmental conditions across an entire construction lifecycle, checking in on people, spaces, materials, assets and equipment to keep the site safe, productive, efficient and secure.

“With the right combination of sensors, the 30MHz Smart Sensing Toolkit enables both the construction site supervisor and project manager in the office to be alerted to issues, incidents and safety concerns easily and immediately, potentially preventing and significantly reducing the chance of accidents and costly insurance claims - all from a mobile device.”



“Being on the cloud is a lot more than just being online. The software prioritises user experience, offers flexible payment options, promotes collaboration, integrates with other software; all on a platform that can give structural engineering software to anyone who needs it.”

For the last 30 years, structural engineering has been dominated by traditional install-maintain software. Over time, these software packages become expensive, difficult to use and require perpetual licensing. SkyCiv aims to change this by offering clean, powerful, intuitive software that requires no downloading, installing or updating.

SkyCiv intends to take advantage of the growth of cloud-based software. Cloud software is a growing industry with a CAGR of 19%, and has consistently grown at a similar rate for the last 4 years. The construction industry in particular sees cloud-based software as a key component of its operations now and in the future.

SkyCiv was released two years ago and since then has bootstrapped its way to now having a team of 8 and more than 50,000 registered free users. SkyCiv’s software has been used by at least one person in every country of the world. SkyCiv say its vision is to bring all the benefits of the cloud to the structural engineering industry.

The main focus is now on the US. “We have a strong US user base, so it makes sense for us to focus our attention and resources towards this market.”



NAME:

Sam Carigliano and Paul Comino

BACKGROUND:

Sam and Paul grew up together as next door neighbors. While studying Engineering at the University of New South Wales, they discovered a gap in the market for cloud-based structural engineering software.

ABOUT THE TECHNOLOGY:

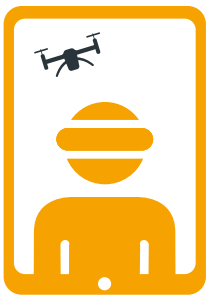
Structural Engineering Software that is online, easy to use and available to everyone under flexible pricing.

WHAT’S NEXT:

SkyCiv is now focusing on enterprise accounts. With the aid of sales representatives in the US, SkyCiv is now refining its enterprise sales business model with the aim of scaling in the coming months.

ADVICE TO CON TECH STARTUPS:

The industry, particularly the engineering space, is fairly slow to move. But in this difficulty is a lot of opportunity - there are many processes that are outdated and open to be disrupted. Find the pain, and build your solution around this.



CONSTRUCTION TECHNOLOGY

THE ADVENT OF NEW CONSTRUCTION-FOCUSSED EQUIPMENT

The development of new construction equipment is opening the door to a completely different industry paradigm. Advances in physical equipment work hand-in-hand with digital technologies to create powerful new methods of operation.

GEOGRAPHIC INFORMATION SYSTEM (GIS)

VR allows construction companies, investors and customers to visualise elements of the design, build and post-construction phases. Virtual reality can help decrease costs (by creating mock-ups/designs virtually rather than building physical models) and increase customer/investor satisfaction, by allowing a greater degree of input and customisation in the initial planning and design phase. Scann3d, Bimar and Snobal are pioneering this technology in Australia.

ROBOTICS

An increase in the use of robots in construction will allow complex physical tasks to be performed without human intervention. Robotic systems are being used in construction projects for a variety of applications, including bricklaying, welding and concrete dispensing. This presents a huge opportunity to drive down cost while increasing consistency, predictability, and safety.

3D PRINTING

Internationally, 3D printing in the construction sector has evolved to printing complete houses and offices. In 2014, Winsun, a Chinese company founded by inventor Ma Yihe, built 10 houses of 200sqm in a day using an industrial-scale 3D printing machine.

3D printing in Australia has yet to reach China's scale, but is developing rapidly. One of the more advanced examples is Laing O'Rourke's use of 3D printing in wax to create intricate building facades.

PREFABRICATION

Prefabrication is fast becoming established as a core part of the construction sector with strong investment in this area occurring in Japan, Singapore, Germany, India, Sweden, New Zealand, the US and the UK. It has the potential to increase efficiency, precision, productivity and affordability, while simultaneously reducing construction waste. All 128 rooms of the four-storey Bendigo Hospital Hotel were assembled in just six days on site with one crane and a small team, after being prefabricated and shipped to the site.

There is an ongoing debate in Australia about the extent to which modular and prefabrication technologies can be adopted more widely. Many industry participants argue Australia presents a unique set of geographic barriers, limiting economies of scale and driving down return on investment. The countervailing view is that the dynamics of the Australian sector make it well-positioned to adopt prefabrication, particularly because big players in the Australian construction sector control large segments of the value chain. Prefabrication can help amplify that advantage.

Prefabrication requires extensive digital modelling to be successful. Since construction is completed off-site, the ability to accurately design, measure and test prefabricated and modular construction is critical to the success of the final assembled product. Increasing the digital capability of construction projects directly encourages the adoption of prefabrication techniques.



DRONES

Drones are beginning to be used widely on construction sites for site inspection and progress monitoring. Having the ability to capture broad-scale aerial photography and send real-time images and data to computers or mobile devices is ultimately expected to be used for simulating a construction environment to test scenarios and facilitate evidence-based decision making.

In Australia, Propeller Aerobotics and Swarm UAV are leading the way on this technology. In labour-deficient Japan, Komatsu has started using drones that create 3D maps, extract blueprints and simulate construction plans. This has led to more efficient pre-construction work as well as a boost in worker safety. Japan has, in an attempt to increase efficiency, also mandated the use of drones on construction sites.

Australian construction companies are using drones to varying degrees. While the most common use is for aerial photography, drones are capable of boosting productivity on construction sites in many ways. Increasingly, Australian construction companies are using drones for BIM and geographic information system (GIS) mapping to remotely track project progress. The relative immaturity of core technology systems and their limited ability to integrate with drone data present a barrier to more widespread take-up in Australia.



NAMES:

Murray James, Co-founder & CEO
Ann Nolan, Co-founder & CMO

BACKGROUND:

Murray James has over 25 years of professional experience spanning design, building information modelling (BIM) and 3D visualisation.

Ann Nolan has a background in psychology and screenwriting and has worked across diverse sectors including health, tech startups and private enterprise. Her expertise cover brand development, user experience and digital transformation.

ABOUT THE TECHNOLOGY:

Snobal is an award winning Melbourne based technology company that creates VR Tools for business specifically for design, engineering and construction markets.

Snobal's smart VR technology combines machine learning with virtual reality to enable collaborative real time design of complex built environments and the capture of critical data on how users feel and interact with the proposed design thereby enabling measured design. This technology has been proven to be faster and more cost effective than existing methodologies.

Founded in 2014 Snobal was awarded the 2015 iAward Victorian Merit Recipient. In 2017 the company was invited to join the HTC Vive X Global Accelerator program. Snobal is also an invited participant on the IBM Global Entrepreneurs Program.

WHATS NEXT:

Snobal is further developing machine learning for predictive design, light field technology and virtual dashboarding of instrumented environments (IOT). The company is also focussing on the rollout of its technology across the Australia and Greater China markets.



“Our focus at Snobal is on creating smart virtual reality tools so that designers, engineers and city planners can quickly and easily collaborate on design in VR and then test design with stakeholders and engaged citizens before it is physically built. We like to say it’s about building things better.”

Use of emerging technologies such as virtual reality (VR) and artificial intelligence (AI) in public infrastructure development is an innovative undertaking. Snobal, with its client, engineering design company SMEC with VicRoads has applied its technology to the design of the Swan Street and Punt Road intersection, as part of the Streamlining of Hoddle Street project.

The intersection is the focus of an Australian first continuous flow design to reduce congestion along one of Melbourne’s busiest and most complex arterial roads.

Snobal created an interactive virtual Swan Street and Punt Road intersection. The SMEC team can now import files, collaborate, take measurements and experience the integration of traffic modelling software all in VR. Regarding stakeholder engagement, the integration of computing AI enables SMEC to quantitatively and qualitatively measure how end-users and stakeholders interact and feel about proposed design all before the design is physically built.

Daniel Gregor, Manager, Transport Engineering Consulting Services at SMEC believes Snobal’s technology has been “influential in the road and urban design outcomes” with potentially huge impacts in terms of helping avoid rework and errors through the ability to make data driven decisions faster and more often. The technology also provides the ability to deepen relationships with stakeholders and enrich their understanding of complex designs before they are physically built.



LOOKING FORWARD

Further innovations are on the horizon, focussing on the entire lifecycle of construction projects, from planning to operation. Widespread take-up of autonomous trucks and wearables is likely in the construction sector over the next five to ten years. The incorporation of artificial intelligence systems, drones and robotics will also become more commonplace. Materials used in the build phase of construction projects, such as concrete, will also be transformed through innovation. Research facilities in the United States are exploring adding carbon fibres to concrete mixture, so that the slab of concrete is able to conduct electricity. Smart concrete has many potential applications, including helping structural engineers to identify problematic areas in a concrete structure long before stress or cracking is visible.

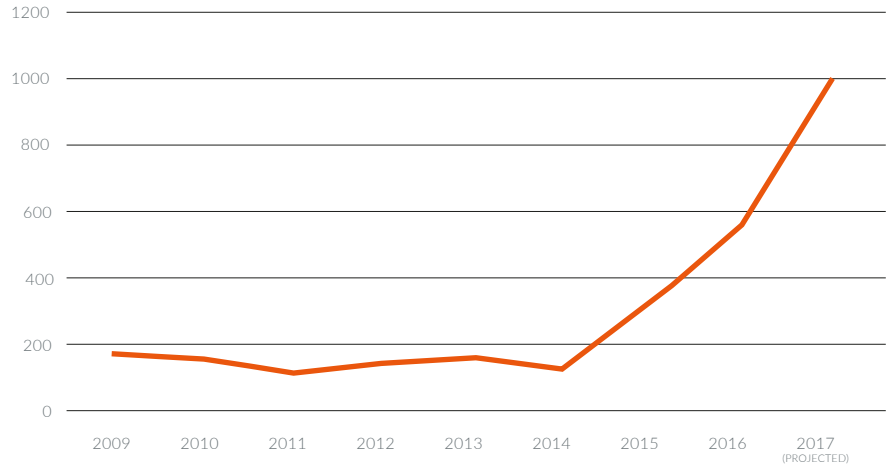
STARTUP ECOSYSTEM FUNDAMENTALS

AUSTRALIA HAS GOOD (AND IMPROVING) STARTUP FUNDAMENTALS

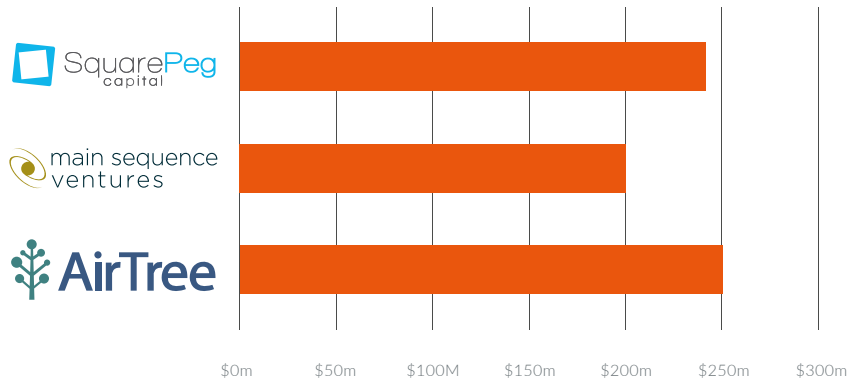
Australia's healthy (and improving) startup ecosystem fundamentals provide a solid platform from which ConstructionTech startups are able to launch. Investment capital, in particular, has been growing rapidly in recent years. FY 2015-16 was a record year for Australian VC fundraising, with \$568m in new funds raised. That has been followed by a substantial increase in the 2016-17 financial year, with new funds raised in excess of \$1bn.

Two consecutive record fundraising years have provided a firm base for both early and growth-stage businesses. Correspondingly, VC activity has increased substantially over the course of this decade. This is likely to continue to increase strongly as the large amount of 'dry powder' under management by VC firms is deployed over the next 3-5 years.

AUSTRALIAN VENTURE CAPITAL FUNDRAISING⁶

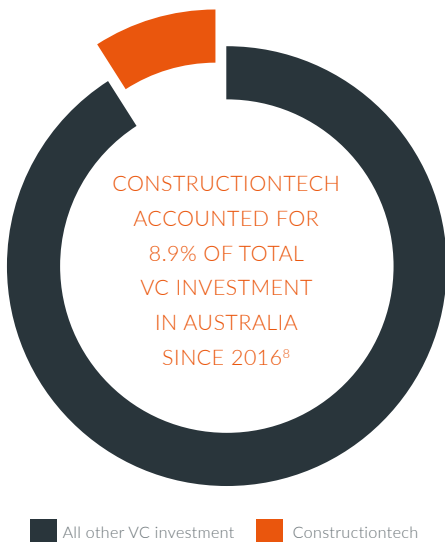


RECENT VC FUNDS RAISED OVER \$200M⁷

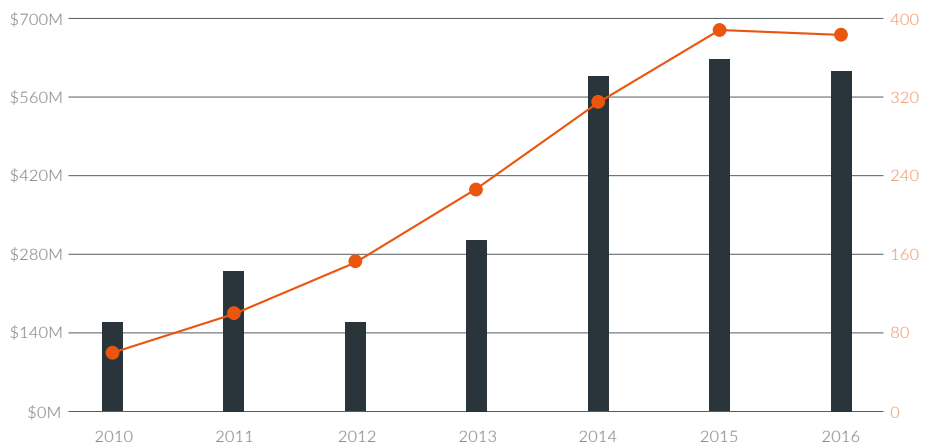


CONSTRUCTIONTECH IS A SUBSTANTIAL PART OF THIS STRONG ECOSYSTEM GROWTH

ConstructionTech startups have benefited from this growth, with 8.9% of total VC investment in Australia going to ConstructionTech companies since the start of 2016. Notable deals have included Safety Culture (\$30m), Propeller Aero (\$4m), and Assignar (\$3m).



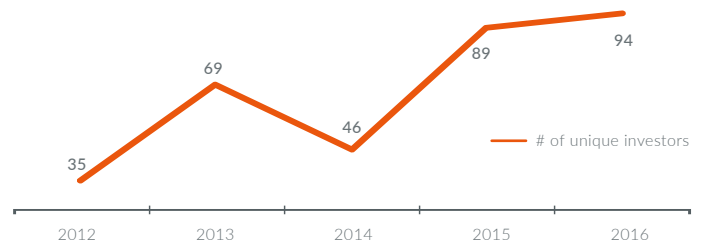
CAPITAL INVESTED AND DEAL COUNT⁸



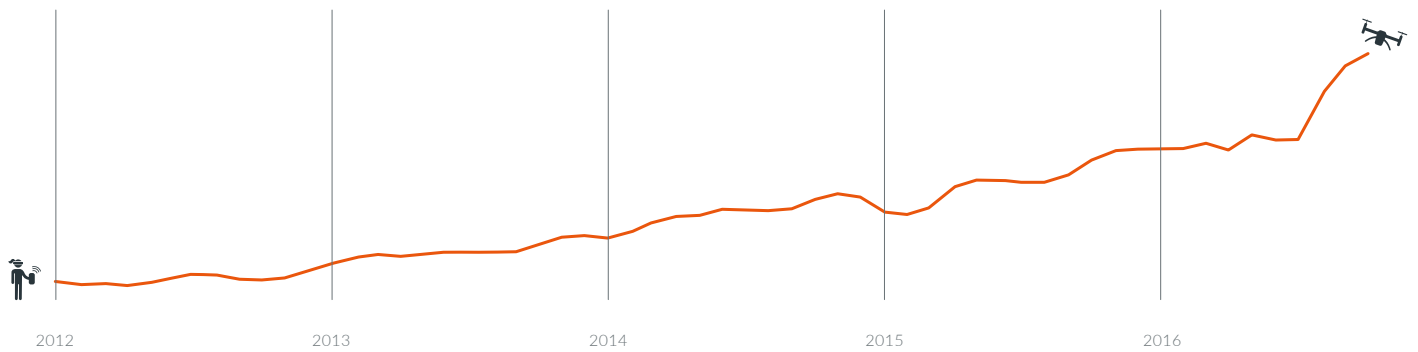
GLOBAL INTEREST IN CONSTRUCTIONTECH IS GROWING RAPIDLY

This investor interest in Australian ConstructionTech companies mirrors a rapid increase in the global interest in the sector. CB Insights estimates that the number of unique investors in ConstructionTech companies globally has increased 250% since 2012, with media interest in topics related to ConstructionTech increasing exponentially over the same period.

YEARLY UNIQUE INVESTORS INTO CONSTRUCTIONTECH⁹ 2012 - 2016



MEDIA INTEREST CONSTRUCTIONTECH¹⁰



CONSTRUCTIONTECH AS A DISCRETE ECOSYSTEM

Despite these encouraging growth numbers, few construction sector-specific resources exist to support the growth of startups in this space. Other sectors, most notably fintech, have benefited strongly in recent years from industry-focused clusters being developed to help build capability and capitalise on emerging market opportunities.

Stone & Chalk, a Sydney-based fintech hub which recently announced an expansion to Melbourne, was launched in 2015. Backed by almost 50 corporate partners in the finance sector, including three of the big 4 banks, Stone & Chalk houses almost 100 high-growth fintech companies. It is part of a growing trend in Australia, with new industry-focused accelerators, incubators and coworking spaces opening in creative tech (Collider), cyber security (CyRise), and agtech (SproutX), among others.

The benefits of 'verticalised' startup support structures are clear: concentrated spaces where sector-specific startups are clustered facilitate improved access to those startups by corporates, investors, and customers. Construction companies find it difficult to locate and engage with emerging technologies, so this element is particularly appealing in the construction space.

Research suggests there are strong network effects associated with density. When that clustering is industry-focused, outward visibility of the sector is increased, resulting in increased media attention and profile. Inside the spaces themselves, startups have increased access to each other and can substantially improve growth and success rates by learning from their peers. With increased density come common mutual interests, and sector-focused representative organisations often result. Fintech Australia, born around the same time as Stone & Chalk, is housed in the fintech hub's Sydney headquarters, has been a vocal and highly effective advocate for the national fintech sector since its inception. Its work is a substantial part of the reason fintech has become a priority for Federal Treasurer Scott Morrison and has received specific regulatory reform.

The success of sector-focused initiatives is often strongly linked to their support from the sector itself, particularly financially. A well-funded ConstructionTech hub, strongly backed by a range of major players in the construction sector, could go a long way to boosting the visibility, growth, and sustainability of the sector. It could also help established corporates get closer to technology designed to improve their businesses, providing strong positive outcomes in both directions.

⁶ AVCAL
⁷ StartupAus analysis
⁸ StartupAUS analysis and Pitchbook data
⁹ CB Insights
¹⁰ CB Insights

THE AUSTRALIAN CONSTRUCTIONTECH ECOSYSTEM

PROJECT MANAGEMENT



Envision.



COLLABORATION



ESTIMATING AND TAKE OFF

Estim8

~~exactal~~

pronamics

MINING



PDF MARKUP



DRAWBOARD

PAYMENTS



DESIGN COMPARISON



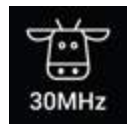
PROGRESS CLAIMS



SUBCONTRACTORS



SITE TOOLS



Docketbook

FIND WORK

 **EstimateOne™**

 **BUILDING INDUSTRY ONLINE**

 **WORKYARD**

 **plantminer.com.au**
ONLINE CONSTRUCTION MARKETPLACE

 **ConX**

TENDERLINK

UAV



propeller

ASSET MANAGEMENT

 **assetic**

 **iSeekPlant.com.au™**

Track'em

INSPECTIONS

DefectsMobile

 **SafetyCulture**

safesite

 **SignOnSite**



COMPLIANCE

 **CodeSafe Solutions**

 **CoverCard**

 **done safe**

 **iCompli**

 **iCURO**

systems on a shoestring

JOB MANAGEMENT

 **BuildTools**

 **CONSTRUCTIONCLOUD**

 **fewzion**
coordinate productivity

simPRO

AR

 **bimar**

 **SCANN3D**

CONSTRUCTIONTECH IN VICTORIA



In recent years, Victorian public works projects have served as leading examples of the incorporation of BIM and ConstructionTech solutions:

VICTORIAN COMPREHENSIVE CANCER CENTRE

The VCCC is a \$1 billion facility purpose-built for cancer research, treatment, care and education. It was delivered as a Public-Private Partnership (PPP). Construction incorporated BIM that is currently employed by Honeywell for operations of the building.

MELBOURNE PARK REDEVELOPMENT

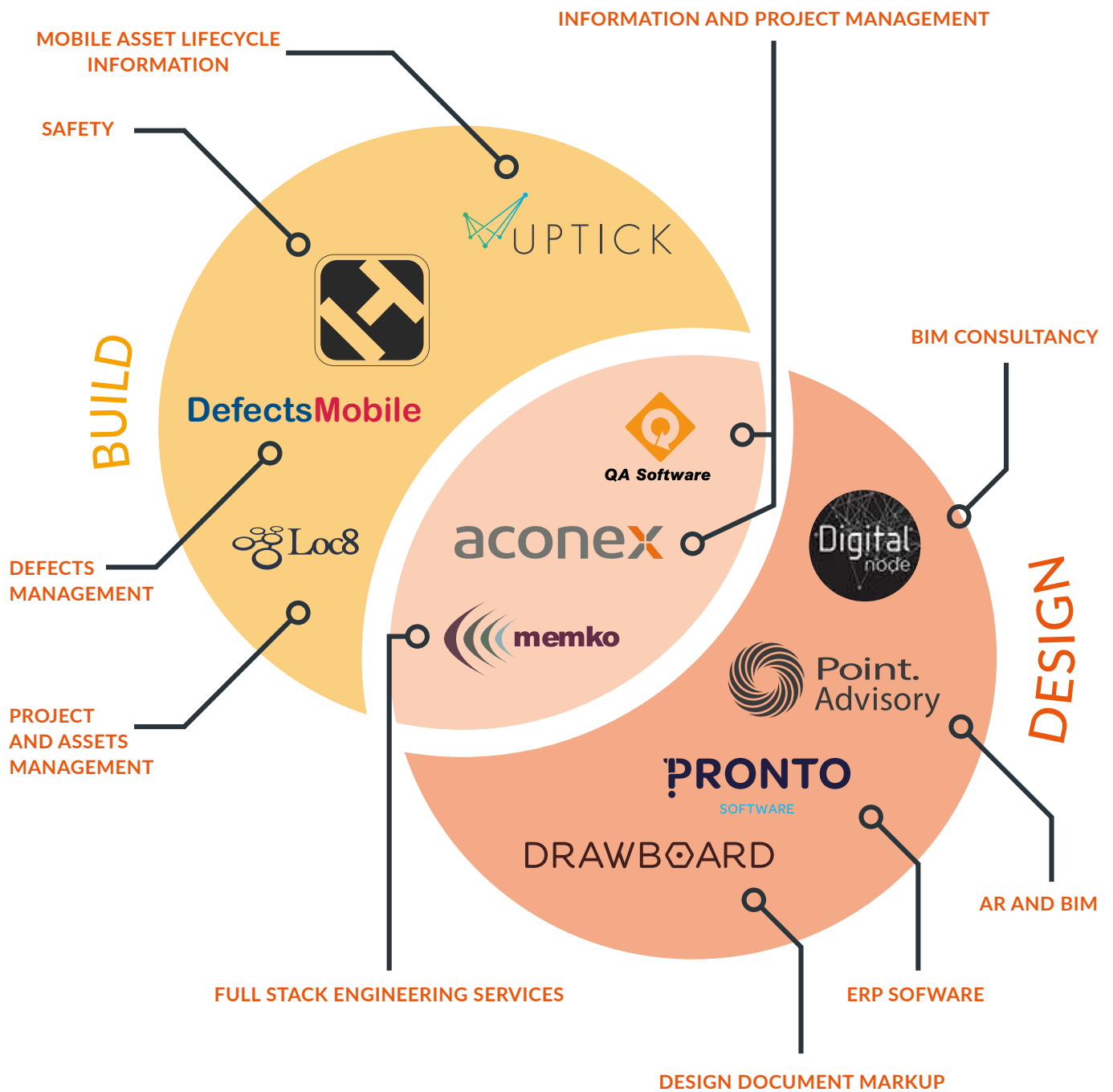
A project to overhaul Melbourne Park, including adding a closing roof to Margaret Court Arena in addition to increasing seated crowd capacity by 25%. A.G. Coombs provided 3D drafting and modelling to address design challenges and ensure a trouble-free installation.

LEVEL CROSSING REMOVALS

The Level Crossing Removals project is a combination of a \$2.4 billion plan to remove at least 20 level crossings by 2018, with a view to removing all 50 by 2022. BIM has been instrumental in ensuring the complexity of the projects was managed and aligned with just-in-time manufacturing.

Other successful Australian projects that have used elements of BIM include¹¹:

- Royal Adelaide Hospital Project;
- Moorebank Intermodal Terminal Project;
- Barangaroo development, including Wynyard Walk;
- North West Rail Link;
- Southern Freight Link;
- Regional Rail Link Victoria;
- South West Rail Link;
- Auburn Stabling Yard;
- New Generation Rolling Stock Stabling, Ipswich;
- Sydney CBD light rail early works;
- Perth Children's Hospital;
- Perth Stadium; and
- Perth Museum.



¹¹ Institute of Public Works Engineering Australasia
www.ipwea.org/blogs/intouch/2016/08/01/what-you-need-to-know-about-bim-in-australia

THE BENEFITS OF TRANSITIONING TO DIGITAL



IMPROVING
SAFETY



SHORTENING COMPLETION TIME
AND ACHIEVING COST REDUCTIONS



SECTOR
COMPETITIVENESS



EFFICIENT SUBCONTRACTOR
RESOURCE MANAGEMENT



AUTOMATED AND TIMELY
IT ENHANCEMENT



IMPROVED QUALITY





IMPROVING SAFETY

MONITORING QUALIFICATIONS OF WORKERS ON-SITE

Apps have allowed for the collation of the relevant qualifications held by all workers on site, ensuring all workers have adequate certificates and licenses. Technology also allows for those without particular qualifications to be geofenced, whereby everyone on site is tracked via GPS and a system alert is created if a worker enters an unauthorised area. This can substantially boost compliance and increase safety.

REDUCING THE NEED FOR WORKERS TO PERFORM HIGH-RISK ACTIVITIES

Employing drones to survey hazardous or toxic areas, sites with limited access, or where significant elevation is required greatly reduces the risk of significant injury or death. Easier and cheaper methods for surveying can also lead to more regular monitoring of potential safety hazards and more effective maintenance.

SAFETY ISSUE IDENTIFICATION AND RESOLUTION

Safety can be improved substantially through the provision of effective, easy to use, real time feedback systems to identify safety issues, including on-site scenarios and equipment issues that can be quickly addressed. Improved collection and analysis of data on site will also help better understand and avoid risk factors.

BEHAVIOUR CHANGE

Shifting behaviour changes through targeted digital reminders, providing a practical and timely message to challenge complacency and build better workplace behaviours. Data analytics of safety reports can note high-risk jobs or areas and provide real time messages to workers prompting use of safety gear and protocols at precisely the time they are most in need.

"...a systems manager from one of our clients took her first aid register - where people report if they need to get something out of the first aid box they'll write down what is it - she noticed a trend in cuts and lacerations during a certain stage of the project. So the next day with SignOnSite she put in the daily briefing, "Hey guys, remember to wear gloves". It's a simple improvement of communicating something in the right moment." Mitch Harmer, SignOnSite



donesafe

NAME:

Matthew Browne (Donesafe), Francene & Michael Mountford (Mountford Plumbing).

BACKGROUND:

Francene and Michael Mountford of Mountford Plumbing Services have been in business for over 30 years. As a commercial, industrial maintenance business they do a lot of work with local government and industrial businesses so WHS is a key concern.

Mountford Plumbing adopted the Donesafe WHS management platform seven months ago to help them deal with the mounting complexity of safety management.

ABOUT THE TECHNOLOGY:

Donesafe is an end-to-end OHS safety software system that is cloud based, jargon-free and works on any device with a browser.

ADVICE TO CON TECH STARTUPS:

Finding partners who have great client relationships, understand their clients' problems and are open to expanding their offering is a great way to validate your idea.

Before adopting the Donesafe WHS platform, Mountford Plumbing had been looking for WHS app solutions for years to help manage the administration of the business.

"We used to be completely paper driven with a bit of management through Excel. We were literally running out of paper. We filled out our 12-page Safe Work Method Statements every time we had a high risk job - every time we even looked at a roof we had to fill one out."

"I'm a one person office, and it was not easy to get information to the customer. You'd be scanning and printing - it was just so cumbersome. It was too much when you had to consider all the other paperwork that we needed just for the day-to-day."

Since adopting the Donesafe WHS compliance software, Mountford Plumbing has been able to systemise and automate large amounts of their WHS management process.

"We've phased all paper out, bar one A4 piece of paper. It's so much easier. We don't have to carry physical manuals, our code of practice or safe work method statements with us anymore. We used to have big plastic crates with all of our materials in them in every van."

A software WHS management system has helped keep their team safe, while adding a great deal to their brand.

"We had a university job and the boys were able to fill out the SWMS right in front of the customer on their iPad. They got the client's email address and it was instantly sent to his phone. The client was really impressed with us; it made us efficient. I'm actually upgrading our advertising at the moment and I will be focussing on having Donesafe as one of our attributes."

Mountford Plumbing is now developing the QA and environment aspects of their business in Donesafe in order to get accredited and gain some government work.

Since implementing Donesafe, Mountford Plumbing was awarded the NSW Master Plumbers Award for Safety and has successfully received NSW government accreditation.



ASSIGNAR

“At Assignar we focus on the contractors that do the work on site. Their workforce is often working with paper forms and timesheets, causing poor project tracking and reporting. Processes are prone to costly errors and projects experience unnecessary expensive delays due to shortcomings in scheduling and communications.”

Assignar is a cloud-based operations platform built to improve those processes. The platform takes the hassle out of resource scheduling and dispatching and ensures safety, quality and compliance is managed. Contractors can benefit from operational workflows of timesheeting, payroll and invoicing.

“Our system is designed to streamline operations for contractors with 15 to 1,500 field operators. As an end-to-end software provider we are able to reduce the technology suite for larger contractors. Contractors generally require an estimating software, Assignar, and an accounting program in order to run their entire business. That shows how extensive the platform is. We’re able to help them save money by eliminating various point solutions.”

Assignar counts companies like UGL, Lendlease, Sydney Trains, Built and Liebherr among their significant and fast growing client list in both Australia and the United States. The company has received Series A funding of \$3 million led by Our Innovation Fund, LP (OIF) to promote further growth.



NAMES:

Sean McCreanor, Founder and CEO
Marko Tomic, CTO

BACKGROUND:

Serial entrepreneur Sean McCreanor started his career in tech in the mid 90s and had an exit of his tech business in 2005. He went on to found a construction sub-contracting business in 2007 and when he couldn't find a platform to systemise and scale his 250+ employee business, Assignar was created. Assignar was commercialised in 2014 and has a team of 20 employees and offices in Crows Nest NSW and Oakland CA.

ABOUT THE TECHNOLOGY:

Assignar is a cloud-based operational platform designed for general contractors and subcontractors. It helps contractors manage their workforce, assets and equipment, safety, quality and compliance and supplier chain. The basic principle of Assignar is to improve communication and paperwork to eliminate safety risks and cost blowouts.

WHAT NEXT:

Assignar is working on the rollout of its subcontractor supply chain management solution with a focus on improving overall industry safety, efficiency and profitability.



ENHANCE TIME AND COST EFFICIENCIES

IMPROVED ON-SITE PRODUCTIVITY

Technology can provide more efficient systems and processes that ease the administrative burden of workers, allowing them to focus on their core task. These include simplified or automatic sign-in protocols, toolbox talks and qualification management.

"We've got lots of smart people in our business, and all of the a sudden, they're starting now to be freed up to think about improving time, cost, quality and the outcomes on projects rather than being stuck managing paperwork trails." Brett Mason, Built

TIME SAVED ON SITE

Site managers are able to upload data on site without necessitating a return to the office, increasing the timeliness of the data collected and the likelihood that it will be reported at all.

"We don't want to see site managers and engineers in the office prior to 7:00am in the morning because they need to submit a particular request for information or submit a timesheet. They can do it on the run, they can do it out on site, they've got a portable device in their hand and they can actually put in a safety observation as they're walking through the site. They don't need to come back to the site office to log an observation." Emma Shipley and Damian Vella, Roberts Pizzarotti

EFFECTIVE WORKER ENGAGEMENT

Immediate and wide-scale communication to workers and reallocation of worker resources across sites creates a more effective relationship between the labour force and head office.

"We had a flood in Sydney about 18 months ago and a lot of our clients couldn't get to the office because the power went out, but they were able to access their system from home using Wi-Fi. And we had customers calling in telling us how amazing it was that they didn't need to be in the office and could still access all their timesheets and allocate the workers and have data coming in from home." Sean McCreanor, Assignar

ENHANCED HEAD OFFICE EFFICIENCY

Immediate and automatic updating of data combined with extensive reporting gets important information in the hands of decision-makers quickly. Without technology, construction suffers from geographically dispersed projects and long lag times for any data collection. Live data creates greater visibility across disparate activities, assisting with the management of timeframes and task completion, implementation of just-in-time delivery and reduction in material wastage.

IMPROVED EMPLOYEE SATISFACTION

Allowing staff to focus on tasks considered core to their role rather than being buried by paperwork addresses a key frustration with on-site workers.

"You actually get staff retention based on using technology and not having to do stupid administrative stuff— it makes people's lives better."



OPERATING WITHOUT A CENTRAL ASSET DEPOT

Since traffic management contractor Allroad Group started using Assignar, their 300 fieldworkers no longer need to go into the office. All traffic plans are shared through the app, forms and timesheets are submitted through the fieldworker app. This has given Allroad Group the flexibility to operate without a central asset depot.

Allroad's workforce now operates remotely and jobs are aligned to the location of trucks and staff. Allroad has saved on fuel, tolls, driving time and rent for a central depot.



SECTOR COMPETITIVENESS

As a wealthy country with stable political, social and economic foundations, Australia is seen as an attractive environment for construction companies. That has resulted in an increase in international operators entering the Australian market. Competition in the sector is likely to continue to increase, making the adoption of digital solutions an important part of maintaining a competitive advantage.

TECHNOLOGY AS AN EDGE

Australian construction firms see adoption of new technology as a path to boosting domestic competitiveness as well as generating international opportunities. Technology that reduces costs and minimises risks can be a powerful guarantee for clients in an industry plagued by cost and deadline blowouts.

"We're very good at adopting technology because we have to be competitive. Australia could be one of the leaders here if we get our act together and look to be an export economy to the world." Joshua Ridley, Ridley

LONG-TERM BENEFITS FOR CLIENTS

By providing smart sensors, ongoing data collection and advanced modelling of building assets, Australian construction firms can provide a compelling solution that focuses on the future efficiency and performance of the project, not just cost saving on the design and build phase.

"I think in Australia, we're really well-placed to do this [innovate], because we have a really high labour cost and a finite labour pool, so we're actually incentivised to come up with more efficient ways to do things. In other parts of the world, the labour's not as expensive, and therefore there's less incentive to have that labour be more productive." Brett Mason, Built



SUBCONTRACTOR MANAGEMENT

Digital solutions play a leading role in sourcing and managing outsourced work across the economy. The construction sector relies on a complex web of interconnecting subcontractor relationships, making this a key area where technology can have a proven impact.

IMPROVED PAYMENT CYCLES

More immediate recognition of work completion can be aligned with payment schedules and shorten payment cycles for smaller operators. This alleviates some of the risk for smaller operators and decreases delays due to administrative processing.

LABOUR SOURCING

Digital marketplaces such as Fiverr, Freelancer.com, and Airtasker have been successful in broad sourcing of basic labour. Startups such as Expert360 have shown the potential of specialised professional labour marketplaces. ConX are aiming to adapt that business model for the construction sector. Construction is particularly well-suited to networks that increase visibility of projects for both employers and labourers because it has a large and mobile labour force.



ConX

ConX is a platform built to connect contractors in the construction industry, simplifying how they win work, hire and establish a reputation online. ConX was born out of Keith's pains as a carpentry subcontractor trying to line up a consistent pipeline of work for his business and hire skilled tradies in line with an increased workload.

ConX gives head contractors access to a wider pool of subcontractors, opening up networks far beyond the contacts in their phone book to provide more competitive quotes and keep costs in check. For subcontractors, it is an easy way to line up a consistent pipeline of work.

The platform automatically pre-qualifies members by collecting targeted, construction-specific data on profiles such as skills, experience, licensing, insurances, qualifications and tickets.

An API was launched with OneGov to validate trade licenses, keeping real time data on member profiles. Built into ConX is a two-way rating system, so the quality of the platform is upheld by the members themselves.

In the past 24 months, ConX has custom designed, built and stress tested the platform to the point where it is now capable of scaling throughout Australia and into international markets.

They are currently raising a round of seed funding to invest in personnel, develop the business model and scale.



NAMES:

Annie Slattery, Keith Moore, Jonathan Clarke

BACKGROUND:

Keith has worked in construction, Annie has a background in accounting and finance, working in startups for 5 years and Jonathan has been building software for 20 years. The team pitched at Google Demo Day in Silicon Valley in 2016.

WHAT NEXT:

Building out the product and business model and start scaling throughout Australia.

ABOUT THE TECHNOLOGY:

A two-sided digital marketplace powering connections in the construction industry. ConX allows contractors to find, verify and hire qualified tradespeople.

ADVICE TO CON TECH STARTUPS:

"Get on site and talk to your users every day."



NAME:

Matt Edwards

BACKGROUND:

Matt started as a “kid on the tools” in construction, going on to spend his career traveling the globe fixing ‘toxic projects’.

With over 20 years in construction, Matt found himself in Australia, waking up at 4am with an idea to fix site paperwork.

ABOUT THE TECHNOLOGY:

APE Mobile transforms established site paperwork to a paperless site app for contractors, enabling a cloud connected world for construction.

WHAT'S NEXT:

Continue connecting to leading industry systems, adding to the 800 cloud solutions already connected.

ADVICE TO CON TECH STARTUPS:

“It’s key to be sympathetic to the unique constraints of an industry where the impact of change can be economically catastrophic. Providing efficiency gains isn’t enough, you have to minimise risk by design.”

APE Mobile transforms established site paperwork to a paperless site app for contractors, enabling a cloud connected world for construction. It has grown rapidly since release in 2014, and now boasts contractors in USA, Europe, Australia and New Zealand.

“We’ve Integrated to the USA’s top 3 construction ERP platforms, and connected to over 800 cloud solutions because we believe successful construction companies of the future will have to be data driven to win.

There are two parts to being data driven, collecting data and using data. It has been surprisingly difficult in the construction industry to do that first part well. Every CIO will know of failed mobility projects, but we’ve solved that problem”

The construction site provides unique challenges, even within the context of a construction company, so it has to be treated differently to the rest of the business. Data from site is already enabling the insights that drive optimisation. APE Mobile sees a future with exponential growth in the movement of data, with best in breed systems inter-operating, from paperless solutions to 5D BIM, Augmented Reality and the IoT

for buildings and infrastructure, all connected to industry focused ERPs and project management systems.

APE Mobile is providing comprehensive access to data, partnering with major SaaS vendors and participating in the Construction Open Standards Alliance, a group in the USA building on the efforts of the Association of General Contractors.

“We’d love to see a similar level of cooperation between Australian vendors. Customers now demand portability of their data, and don’t take well to having their data locked to any particular vendor.”

APE Mobile is looking to continue to expand its team supporting its rapid growth, both here in Australia and overseas.



AUTOMATED AND TIMELY IT ENHANCEMENT

Unlike traditional and bespoke IT solutions, digital solutions allow for seamless and more timely updates of systems – updates are not dependent upon capital and time investment and therefore allow seamless and continuous enhancement.

FLEXIBLE TECHNOLOGICAL INTEGRATION

Digital systems allow additional modules to be integrated into the platform through application programming interfaces (APIs). This allows firms to expand their technical systems with lower expenditure and risk. Advances in digital solutions across the entire project, from accounting to document management, data analysis and reporting can be rolled out across the entire platform quickly and easily compared to traditional bespoke IT solutions.

RISK MANAGEMENT

Unlike traditional bespoke IT systems where construction firms took on all risk, SaaS suppliers are tasked with system upgrades, security and reliability. Upgrades are also typically faster to roll out and more common with digital solutions.



IMPROVED QUALITY MANAGEMENT

The ability to capture data in real time reduces the reliance on human memory and limits the potential for data entry error at the initial point of capture on site, and again at the point of transfer in head office. This is critical in a sector where projects at vast scale rely on effective quality management at all levels. Even small quality management errors can be extremely costly and have substantial flow-on effects across the project.

ISSUE MINIMISATION

Real time data allows for increased responsiveness to issues and more accurate assessment of needs, leading to issue minimisation, shortening resolution and build times.

QUALITY CONTROL

Improved data quality also supports risk management should future issues arise by allowing for accurate records throughout the project. One senior construction industry executive told us data quality was critical both in making sure the final product was up to standard, and in saving time during the process. *“We might send through a quality hold point and that data point doesn’t upload properly and, for whatever reason, there’s an error and it references the wrong room or building.”* When the team is sent to inspect the issue, the error leads to the wrong area being inspected and the defect goes unremedied. *“That’s when you get phone calls, when you get confusion. That’s when you get a lot of frustration on site.”*

AUSTRALIAN UNIVERSITY INDUSTRY PARTNERSHIP



For the past eight years Hansen Yuncken has invested in a number of R&D initiatives and grown an in-house innovation team that has developed an innovative integration platform, known as HYway. The HYway platform has the capability to inform decision making at the project coalface and in the boardroom – having positive impacts on not only the triple bottom line but also on organisational change, fostering an environment that encourages innovation and increases the efficiency of work processes. The HYway platform takes a lifecycle perspective of information management and leverages the value of data, information and knowledge at all levels of the organisation. HYway's innovative approach encompasses an enterprise-level information management platform and its use is being studied by UTS researchers as an exemplar of the rapid innovation that is changing the way the contractor does business.

The research shows how HYway has transformed Hansen Yuncken's approach to construction services and corporate decision making. Research study findings have demonstrated the extent to which a web-enabled information integration platform is able to support contractor activities, including: (i) real-time data-driven decision making, (ii) transparent reporting across project, program- and corporate-level management activities; (iii) use of predictive analytics for performance evaluation and business planning; and (iv) consistent deployment of BIM across all projects and organisational divisions.

The researchers have been studying how Hansen Yuncken's project managers are able to utilise HYway's smart dashboards to support daily activities by accessing performance graphs and risk indicators from across all project disciplines and sub-contractors. The benefits of the integration platform's automated reporting capabilities from information captured at the source process is quantifying the time savings for project and program managers in relation to the number of hours saved in the preparation of monthly reports. The UTS research team is also helping Hansen Yuncken to document the effectiveness of the

early risk identification capabilities of HYway, with the utilisation of the "internet of construction things" to collect data and visualise lead indicators that are supporting the predictive and proactive measurement of work patterns, which are then being used to influence strategy and changes in worker behaviour. This form of project and business intelligence relies on data generated from tens of thousands of safety and quality checklists, and the observations that are resulting from the university-industry partnership are able to facilitate further refinement of Hansen Yuncken's processes as part of their continuous improvement loop.



UNIVERSITY-INDUSTRY R&D PARTNERSHIP

The desire of industry, policy makers, analysts, government, and researchers to advance the construction sector through research-based innovation continues to stimulate new initiatives. A vigorous university-industry network across Australia provides benefits from the active involvement in construction technology research.

The formation of the Cooperative Research Centre (CRC) for Construction Innovation in 2001 was an important milestone in university-industry partnerships supporting Australian construction research. Underpinning the CRC for Construction Innovation was the most significant commitment ever made to construction research in Australia, an eight-year \$14M Commonwealth grant and \$53M in industry, research and other government funding. More than 350 individuals participated and an impressive alliance of 27 leading partner organisations were involved in and supported the activities of Construction Innovation. Innovations arising from the research program included specifications for a BIM Collaboration Platform, Automated Code Checking Software, Sydney Opera House FM Exemplar, and the BIM National Standards and Case Studies.

Since the closure of the CRC for Construction Innovation in December 2009, a variety of CRC and Australian Research Council (ARC) centres have since been established and have incorporated projects focused on ConstructionTech R&D, including the CRC for Low Carbon Living, Centre for Advanced Manufacturing of Prefabricated Housing, and the Advanced Manufacturing of High Performance Building Façade Systems. In addition a number of advanced research groups specialising in the development and use of construction technologies have emerged, including the Sustainable Built Environment National Research Centre based at Curtin University.

SUCCESS CHARACTERISTICS OF LEADING CONSTRUCTIONTECH ADOPTERS

ACTIVELY ENGAGE WITH DIGITAL STARTUPS

Construction companies differ substantially in terms of the degree to which they are engaging directly with startups. More digitally mature firms appreciate that working with startups requires a different approach, and proactively develop a stance designed to leverage and integrate new digital solutions. Techniques for effective engagement include:

- Continual engagement - taking the time to proactively identify, track and meet startups and actively support their work.
- Ability to assess concept readiness for the business, identify when solutions are underdeveloped or when they are ready to be integrated.

Recognising and tolerating the operational differences that are typical of startups, including:

- Bringing a completely different point of view to a long-standing problem.
- Not being able to meet standard business measures of stability, notwithstanding the value of their product.
- Recognising that solutions presented by startups are often subject to continual evolution, and approaching these questions with the agility and flexibility to adapt ideas.
- Requiring a level of support - startups regularly struggle with long payment and sales cycles when dealing with large enterprises.

An investment point of view:

- A strategic stance on whether the business will invest directly in startups and at what point
- Consider partnership as an anchor client and help the startup develop their idea
- Clarity on the types of investment that would be considered (monetary, in kind, proof of concept trial) and under what circumstances
- Actively consider employing startups as employees
- Establish key metrics to assess continued investment and value of solutions
- Consider the prospect of acquisition of tech startups as a medium term strategy

THOSE WHO DO VS THOSE WHO DON'T

Differences between organisations were stark:



DIGITAL STRATEGY AT THE CORE

Organisations achieving the best results are re-thinking their business strategy and operating model for digitisation:

- Recognising that digital strategy is integral to the overall business plan
- Acknowledging the importance of 'C suite' digital engagement
 - CEO actively pursuing a digital strategy in the business
 - CIO is engaged directly in the strategy development
 - Board buy-in for making digital a priority
- Backing the strategy with funding
- Embracing mobility through cloud-based solutions and SaaS
- Recognising the transition will take time

"It's impossible to do it unless you have a leadership team who gets it. The chairperson of the board needs to get it. CEO and CFO certainly do. Commercial, IT, HR – they all need to get it. If you're sitting there trying to persuade them what to do, you've got Buckley's chance."

Brian O'Connor, CIO Construction & Engineering Industry

INNOVATION MINDSET

Digital solutions are readily embraced as a means to achieve efficiencies, but digitally mature companies also see digital solutions as part of a broader innovation platform. Establishing end-to-end innovation capability also includes investing in incubating new ideas and business models. Digitally mature construction firms tend to be:

- Looking to the broader and longer term impacts of technology, beyond digital
- Creating a culture of constant evolution
- Recognising the importance of engaging the full business
- Open to new ways of operating and moving past traditional practices

DRIVING A USER-CENTRIC APPROACH

A key shift in engaging with digital solutions is that leaders in the sector now recognise the value in creating more intuitive and user-friendly systems for on-site staff, head-office, and suppliers. A user-friendly interface eases change management and enables intuitive adoption.

A holistic approach to user engagement minimises multiple system interactions. The fundamental intent is to move away from clunky systems and create a new environment that empowers users to engage effectively and efficiently, alleviating the significant administrative burden that has become standard within the sector.

CEOs who involve their CIO in setting business strategy outperform their peers by a margin of almost 2 to 1.



CULTURAL CHANGE

Companies embracing digital also recognise that it is ultimately a culture change challenge. Commitment to change from leaders is required to establish a culture that aligns with the continual evolution of digital and leveraging this to develop a competitive advantage. Any strategy needs to be translated into business as usual - a training and cultural adoption program is essential.

"I think there was a general want in the business at the base level for some change. So we saw that base level—or grass roots, if you will—we had a lot of support there and a lot of hunger there. I was lucky enough to have some interactions with a company, they attacked it from an organisational change point of view and just looking at those change acceptors and those change drivers, supporting the people who wanted to be supported. Eventually they start to tow everybody with them. So in the last three years I've seen incredible changes in support, like I'm just pushing against open doors now. From management it's quite encouraging. I think I've been helping out for three years, there were a few tough times, but overall I think I just kept ploughing along and I'm really encouraged now, I'm quite actually surprised."



Creating the best places takes imagination, insight... and innovation.

For us, innovation is change that unlocks value. Practically applied to design and construction, innovation elevates project outcomes. And increasingly, it is powerfully enabled by new and emerging technologies.

We're proud to partner in the publication of this report – and to support the many start-ups that will continue to drive innovation in our industry.

INNOVATION APPLIED

The Darling Exchange, Sydney.

3D modelling and prototyping have brought to life this project's structurally complex and architecturally striking façade – read more at lendlease.com/betterplaces

lendlease

Ranked in the top 50 Most Innovative Companies 2017,
The Australian Financial Review

Can digital help you construct value beyond bricks and mortar?

EY is passionate about the growth and development of the construction sector through industry insights, innovation and research.

EY is the proud lead researcher of this report and is committed to working with construction companies to shape their growth journey.

For further information contact the EY Real Estate, Hospitality and Construction team on realestate@au.ey.com.

THE STAGES OF DIGITISATION



STAGE 1: INITIAL SHIFT FROM STATIC DATA



STAGE 2: INTERNAL INTEGRATION



STAGE 3: EXTERNAL PARTY INTEGRATION



STAGE 4: PREDICTIVE ANALYTICS

BECOMING DIGITAL

The spectrum of digital and IT maturity in the construction industry and value chain varies from those who continue to rely largely on people and paper-based processes to those who have sophisticated IT environments and have actively engaged in capitalising on digital solutions.

FOUR KEY STAGES

As part of their research and analysis for this report, EY has identified four key stages in the digitisation of mature construction companies.



STAGE 1 INITIAL SHIFT FROM STATIC DATA

This is the formative step in the process and entails the initial move from paper-based primary data capture and storage to real time data. While difficult to initialise, the sense of urgency to move through this stage increases once an organisation recognises the efficiency and intelligence benefits from:

CREATING ACTIVE DATA

Capturing and storing information on paper means data remains static, is not available for live status monitoring, requires time to be introduced to the system and cannot be analysed, without effort, in order to find efficiencies. Digital data storage is far more dynamic, and many metrics can be pulled from the data, analysed and iterated on.

MINIMISING ERROR

Manual data manipulation and double entry introduces the risk of inaccuracy and version control which, in turn, can lead to costly errors.

ELIMINATING DUPLICATE ACTIVITIES

Entering information into the system at a later time following initial capture on paper requires double data entry, adding unnecessary time and resource costs.

ONE SOURCE OF TRUTH

The switch to digital is also driven by the need for version control. Having the right versions in the hands of the right people at the right time is critical, particularly in the context of projects where the participants are cross-organisational.

Many in the industry are well-progressed with live data capture. While it may take some time (estimates from sector participants vary from 3 to 10+ years) for the industry to move off paper entirely, there is a strong commitment within the sector to move towards this goal.

“We have tremendous opportunity to enable our process digitally. At the moment, in some places we’re paper heavy, in some places we’re paper light and in some places we’re digitally enabled.” Adrian Hondros, Porter Davis

“A monthly report would usually take two weeks to prepare. By the time we go through and present that information, it’s all null and void. A monthly review should be a click of a button and we have all the information there on our desktops to see.” Emma Shipley and Damian Vella, Roberts Pizzarotti



aconex

Aconex is one of Australia's most successful ConstructionTech companies to date. It is the most widely-used cloud collaboration platform in the world for construction, infrastructure and energy and resource projects. Its software allows owners, contractors, construction managers, EPCs, project managers and consultants to collaborate securely, efficiently and easily. It is an ASX-listed business headquartered in Melbourne and, since listing in 2014, has had a market cap as high as A\$1.5bn.

Aconex's key insight was to focus on improving project design and construction co-ordination via a cloud-based (software as a service) delivery model. Traditional construction IT infrastructure was a costly and difficult investment and capital expenditure of the magnitude required was very difficult to secure. Via the cloud, it was now possible to deliver collaborative, project-wide software that could be easily used by all project participants and could be updated and tweaked with relative ease.

Additionally, Aconex also was quick to support mobile devices for its platform. While this transition is happening in many large tech platforms, it is particularly important in construction where the platform is used extensively on the construction site itself.

Since 2000, Aconex has managed projects in over 70 countries worldwide, with over 70,000 user organisations. It currently employs more than 850 people.



NAME:

Leigh Jasper and Robert Phillpot

BACKGROUND:

Leigh Jasper and Rob Phillpot met at boarding school before studying together at the University of Melbourne. Phillpot worked in construction at Multiplex, Jasper worked at McKinsey, and the two combined to provide a cloud-based collaboration solution for construction and engineering projects.

ABOUT THE TECHNOLOGY:

Aconex was founded as an online collaboration platform for construction and engineering projects. The Aconex platform now also covers construction project workflows and process management, jobsite mobility apps, handover manuals and collaborative BIM.

WHAT'S NEXT:

In the coming year, we will continue to extend our leadership position through further investment in our international markets and ongoing product development.



STAGE 2 INTERNAL INTEGRATION

Once captured and stored in digital format, Stage 2 focuses on the alignment and integration of data systems to enable end-to-end oversight, automation and analytics.

Key to this stage is mobility – given the nature of the construction environment and the at times patchy nature of coverage (particularly underground, but also often above ground), there is a need for workers to have continued access to systems even when there is no internet coverage. Offline availability is key.

Digitally mature construction firms highlighted the following key elements of data and systems integration:

SELECT A DIGITAL CORE

The organisation first selects a digital core which is able to be connected to a variety of other applications through an API framework. This allows the core software of the business to integrate digital solutions directly into current processes.

VISUALISATION TOOL

The visual display of data is critical to integrating all digital solutions into standard business processes. A dashboard provides a convenient and intuitive access point for the user, showing the power of the flexible reporting and live data that digital solutions offer. A good dashboard delivers a single point of entry and engagement, addressing the frustration experienced by on-site users having to engage with multiple systems.

REVIEW PROCESSES AND AVAILABLE SOLUTIONS

Some solutions may be available as standard features from the ERP but in many cases, given the specific needs of the construction industry, there is a need to integrate outside technology, particularly in the form of mobile add-on solutions. Best results come from identifying bottlenecks, opportunities for efficiency and critical path processes, then assessing available solutions in the market to automate these processes. Central to this step is prioritising the user in any software solution (including by focusing on intuitive user interfaces) to facilitate easy adoption.

ESTABLISH A DASHBOARD/

The feasibility of digitising internal systems effectively and rapidly has been supported by the advent of Robotic Process Automation (RPA) which has enabled the integration of legacy systems as well as spreadsheet-based data. This has reduced the need to embark on costly, high risk, time-consuming systems integration projects.



CONSERVATISM 1.0
Strict cost management

THE SURVIVAL PARADIGM SHIFT

The new paradigm is to engage with the digital revolution for survival. Organisations which remain in Stage 1 will not survive the future.



CONSERVATISM 2.0
Engage with digital



“Out on site, there is frustration from not only our direct team but from the subcontractors as well. There is a lot of time being wasted and primarily that is in duplication of documents and in having different management systems. So my last project, as an example, we would have had close to a dozen different management systems and each of those needed a unique login, a unique password. By the time you actually go in to complete your monthly safety inspection, it will take you 10-20 minutes to work out your login details and your password for that particular system.”



STAGE 3 EXTERNAL PARTY INTEGRATION

This stage involves the integration of live external party data to contribute to a digitally integrated, end-to-end supply chain.

Data to be integrated comes from each stage of the project lifecycle, from the architect forward, including subcontractors and materials suppliers. While Stage 1 could be summarised as 'getting off paper', external data integration could be characterised as 'getting off the phone'. Integration should be bidirectional, with the general contractor, sub-contractor and materials suppliers each having visibility of the project progress. This enables just-in-time scheduling and delivery, potentially condensing project timelines further and cutting costs.

Human interaction will continue to play an important role here, as each project is individually designed and draws on different techniques and materials. But integrating external party data into a quick-access dashboard saves significant time following up with suppliers and contractors.

Big data and analytics stands out as an essential digital technology moving forward, as it affords the potential for improvements in productivity, cost efficiency, project estimations and performance monitoring.

Source: Digital in Engineering and Construction - The Transformative Power of Building Information Modelling - The Boston Consulting Group, 2016



STAGE 4 PREDICTIVE ANALYTICS

Predictive analytics involves using automated, real time data augmented by data modelling to provide predictive outcomes.

Once implemented, organisations can use continuous analysis and modelling to look for patterns across all data sources and multiple projects, creating predictive or lead indicators. This can help deliver predictive insights about a project's ability to be delivered on time, on budget, and to specification. The results of predictive analytics can deliver powerful benefits, including:

- The ability to calculate the impact of efficiencies/delays
- Significantly improved scheduling
- Scenario testing of project management variables
- Reduction in waste through materials analytics

Holistic data analysis leads to analytics along each of the separate processes of the construction project. As one startup executive put it, this is like moving from fighting fires to predicting where the fires are likely to start and avoiding them entirely.

Currently the industry relies on the expertise of experienced and talented project managers to use their judgement and make decisions on the data they have at hand. This feeds into long work hours and increased pressure which could be addressed through supportive systems. Digital datasets also open the possibility of big data analytics conducted via machine learning. AI analysis of vast datasets to find predictive indicators is one of the most powerful potential benefits of digitisation for construction firms.

Use of predictive analytics and developing lead indicators is an area where only the most mature construction companies are venturing. Industry leaders now investing heavily in these systems are likely to reap significant benefits.



NAMES:

Mitch Harmer

BACKGROUND:

Mitchell Harmer previously worked advising government, corporates and SMEs in mobile device strategy. Krishan Caldwell has worked consulting on some of Australia's largest construction projects and has previously worked on cutting-edge biomechanical sensor research.

ABOUT THE TECHNOLOGY:

Through a world-leading location engine, SignOnSite allows workers to automatically sign on and off construction sites using their smartphones, and rapidly evacuate in the event of an emergency.

Site managers can manage their site from an online platform, simplifying record keeping and safety compliance.

WHAT NEXT:

To develop functionality that enables the delivery of further valuable insights to construction teams and streamline compliance with other construction safety procedures.

ADVICE TO CON TECH STARTUPS:

Get your solution into the hands of people in the industry then watch, listen and learn. Keep pulling on the thread as you never know what you may discover.



SignOnSite is an award-winning construction site management system that leverages smartphone technology to manage safety of personnel on site. Traditional safety processes are notoriously unreliable on construction sites - some evacuations count 50% more people than they have on their attendance register. This is because of the difficulty of enforcing paper sign-ons in large sites where site offices can be kilometres away from where workers start, especially when time is critical.

SignOnSite began as a solution for this unique attendance register problem. SignOnSite uses location to provide an accurate register of who's on site, simultaneously giving site managers a powerful communication tool for daily briefings and emergencies.

SignOnSite launched out of beta in 2016, powered by a location engine running completely in the background of a smartphone, using just 1-3% battery. On the back of this, SignOnSite has since recorded 300,000 sign ons for over 15,000 users in 3 countries.

SignOnSite's key insight is to embrace the mobile nature of the workforce. Workers operate across multiple sites at a time, often in the same day. Principal contractors need to coordinate hundreds of workers from their own company and many others just to keep projects moving forward.

For workers, SignOnSite has become a "construction passport", valid across multiple companies and hundreds of sites. With the app on user's phones across each site, SignOnSite is now in a position to streamline a variety of daily safety procedures like worker inductions and licenses.

SignOnSite's bottom-up approach and wide presence across sites allows them to use quantitative tools to bolster traditional qualitative practices for construction firms. The technology creates data, allowing for a move towards a data-driven predictive approach.

KEY INTERNATIONAL DEVELOPMENTS IN CONSTRUCTIONTECH

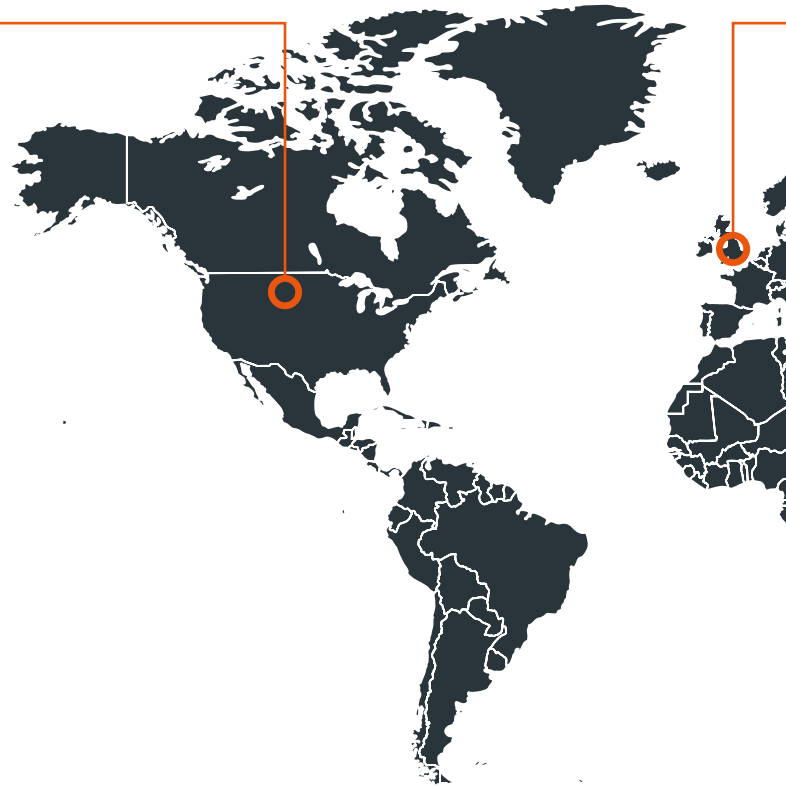
UNITED STATES

In the US, increasingly complex buildings and the jobsites that construct them produce a growing amount of data that can be used to manage systems, increase efficiency, improve safety, and support a higher quality result for end-users. This data is often generated via sensors that are integrated into different systems and distributed throughout the building. A number of main contractors in the US are working with universities and are setting new standards for innovation, creating programs to deploy new workflows, leveraging sensors and data to improve safety during the construction process and integrating sensors and smart networks within completed buildings.

In a joint R&D project, the University of Illinois in collaboration with the Turner Construction Company developed “Flying Superintendent”, a predictive visual data analytics tool. The tool automates and streamlines the time-consuming practices of onsite construction progress monitoring. Utilising both images and videos taken with camera drones and 4D BIM, the technology is able to identify and visually communicate the actual and potential performance problems during the execution of construction projects via smartphones and tablets to project participants. The web-based solution provides real-time visual reporting to stakeholders onsite or back in the office, using unordered images that can be collected by any device, including from drones or iPhones.

Mortenson, a Minneapolis-based construction and real estate development giant, has over the past two decades actively partnered with academia to develop a variety of construction technologies, including with the University of Minnesota, the University of Washington, the University of Wisconsin, and Stanford University.

In a recent project, Mortenson is investigating the ‘Internet of Construction Things,’ including intelligent tools and use of sensor technologies in the construction phase to assess worker behaviours and to help identify opportunities for improving safety. The company is also experimenting with methods to automate data capture of workers performing their tasks which can support predictive analytics.



FINLAND

Aalto University and 11 companies from the construction industry have established a consortium that aims to develop Vision 2030 for the Finnish construction sector. The vision will be based on international comparisons with other industries and the changes in operating practices enabled by technology and utilisation.

At the same time, concrete research projects search for solutions for tackling the most important problems in the industry immediately. Aalto University’s involvement in constructiontech R&D also extends to their partnership with a range of Finnish companies and the VTT Technical Research Centre of Finland on the Tekes-funded VARPU project, which focuses on virtual and augmented reality content production and use. The project has developed 3D measuring technology, virtual reality and augmented reality for industrial applications and construction.



HONG KONG

The Construction Industry Council (CIC) is a coordinating partnership between Hong Kong's main universities and the construction industry. The CIC and the Hong Kong Innovation and Technology Commission (ITC) have funded research projects that are developing RFID-enabled service-oriented BIM platforms for enhancing prefabrication production. Location-based technologies for asset tracking and risk management systems have been developed and tested in construction projects, including the application of Chirp Spread Spectrum (CSS) and RFID technology.

The University of Hong Kong has also established its Advanced Robotics Laboratory, which is currently working on the development of robotics systems for operation in dangerous, degraded, human-engineered environments with the use of available human tools, ranging from hand tools to vehicles.

UK

In 2011 the UK government mandated the use of BIM on all public sector projects over £50 million by 2016. The BIM mandate has supported the formation of new university-industry partnerships across the construction sector. These partnerships have resulted in the development of a "technology roadmap" to provide a mutual understanding of the key challenges that need to be overcome and the supporting technologies that will enable this to happen.

The UK's Infrastructure Industry Innovation Platform (i3P) aims to utilise smart design and manufacturing, new materials, smart infrastructure underpinned by artificial intelligence, virtual and augmented reality, autonomous vehicles and drones, as well as protecting people through wearable technology. While many organisations have experimented with some of these technologies, a commitment to collaborative innovation is aiming to achieve widespread adaptation.

A number of UK firms such as Skanska, Laing O'Rourke and Belfour Beatty are investing more heavily in collaborations with universities to develop construction technologies. Skanska has recognised the need for continuous improvement and staying at the forefront of technology, investing around £12m a year in research and development while also searching actively for grant funding opportunities across the UK.

In their most recent collaboration with Cambridge University, Cementation Skanska have developed distributed fibre optic sensing techniques for pile and wall integrity testing during excavation work for the new tube stations and tunnels on the extended Northern Line. The traditional method has been to use sonic tubes, which have to be installed in a reinforcement cage before concrete is poured. Fibre optics replace these sonic tubes. They are cheaper, considerably safer, and provide better and longer-term data. Low-cost standard telecommunication fibre optic cables are attached to several sides of the reinforcement cage of the element and temperature measurements obtained at close spatial intervals along the cage. The measurements are taken at short time intervals to record the evolution of the temperature profile of the element during concrete curing.

This application of fibre optic sensing emerged from research undertaken at the University of Cambridge and was standardised by the Cambridge Centre for Smart Infrastructure and Construction. The commercial application of distributed fibre optic sensing by Cementation Skanska has allowed it to add a new specialist service to its portfolio, called CemOptics.

CHALLENGES TO DIGITAL ADOPTION

Although there is the promise of greater monetary and time efficiency to eventuate from implementing the practices, construction companies globally have been resistant to shell out the initial investment in these new technologies due to data security concerns, investment in people, adaptation of process, fear of failure and of course expected negative impact to bottom line.¹²

Based on the research conducted for this report, Australian construction companies appear to have broadly accepted that digital evolution is inevitable. Many are moving to embrace that change. In fact, the view among most executives was that construction companies not investing in digital solutions now risk being left behind by the industry in the next 5-10 years.

"[Construction companies are] starting to recognise that in the old days the way you would solve your growth challenges or your business problems is you would throw more resources into your backend or delivery team. "I'll go and hire some more admins, I'll go and hire some more operations people". You can't afford to do that now because margins are diminishing and regulation is increasing." Sean McCreanor, Assignar

"I think the risk, as always in any business, is if you just put your head in the sand you become a Kodak. I just think it's so clear to me that you have to think of this as a completely new way to run your business, not 'how do I defend my business as it is today.'" Joshua Ridley, Ridley

Despite growing acceptance that a move towards digital is inevitable, the sector still faces some significant challenges in adopting new technology. These challenges can be seen across six broad pressure areas:



1. SECTOR DYNAMICS



4. FINANCIAL CONSTRAINTS



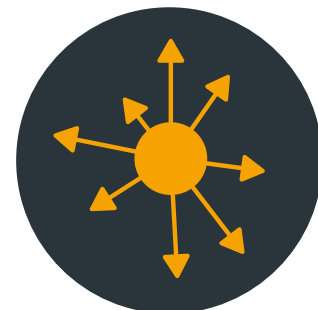
2. CORPORATE CULTURAL BARRIERS



3. SOLUTION LIMITATIONS



5. CHANGE FATIGUE BARRIERS



6. LACK OF REGULATION AND STANDARDS



1. SECTOR DYNAMICS

COMPETITIVE ENVIRONMENT

The construction sector is characterised by slim margins, complexity of the build process, the pressure to de-risk activities and a propensity to push risk down the value chain. Project scale presents a huge challenge. Construction projects can be so large that a single project has the capacity to bring down a business.

A comparison of 37 global cities in the 2016 Turner and Townsend Construction Survey indicates a spread of project margins between 3.5%-15%. The top three economies are largely outliers, with the average sitting around 5%-7%. Globally, margins in the construction sector are some of the slimmest of any industry.

For Australian construction firms, margins are even tighter. Sydney's average margin in the construction sector is less than 5%, below the global average of 6.3%, reflecting high labour costs and input costs compared to the global construction industry. Melbourne, Perth, Sydney and Brisbane were all located in the 'very high' labour cost category, with an average of more than US\$51 per hour.

Alongside slim margins, the inherently risky nature of the build process – with a high possibility for time and cost blowouts – is a significant factor that continues present a barrier to change. Startup solutions are viewed as relatively new to the sector and, except for a few well-established providers, are still perceived as lacking the evidenced success and stability that a risk averse sector requires.

“There’s so many performance guarantees on major projects, and stakeholders are acutely aware of financial and reputational consequences. The industry is quite reluctant to try new things because there’s just too many negatives if they don’t deliver. Whereas I’d see it the other way, change your thinking and mindset - this is going to help me have better quality, better surety of time, and better end product outcomes.” Mark Tait, Investa

SILO OPERATIONS AND PROJECT FOCUS

Traditional organisational structures can also hinder adoption of new solutions. Individual projects tend to operate in a silo and that information isn't easily transferred across the rest of the business/other concurrent or future projects, particularly in large established construction firms. This leads to a duplication of errors or slow adoption of new, more efficient practices. This is exacerbated by a 'project over process' mindset where behaviours adopted only last the lifetime of a project. Once the team is disbanded and a new team is formed for the next project, processes reset and need to evolve from scratch. Staggered start times of project teams also prevent cross-team knowledge transfer.

“In construction, every project is essentially a large 'startup' company – average size of \$300-500 million. We design, launch, run that company for 2 or 3 years and then shut it down and hand it over. At Laing O'Rourke, we've been encouraging people to step out of their roles, think broadly about what the business and its projects need, and help work with IT to come up with a solution that's not only better for them, but for the next round of projects.” Ryan Macnamee, Laing O'Rourke

This siloing also effects startups in the sector. Sales processes are made much more difficult and lengthy: having successfully pitched to one project manager, startups have to start the process again for a second project manager. This also has the effect of reducing the reliability of revenue streams and significantly increasing risk for startups in the space.



2. CORPORATE CULTURAL BARRIERS

The adoption of new technology is both a process change and a broader cultural challenge. This is true in any organisation, and is particularly true in large established firms. In the Australian construction sector the top 20 firms account for 68% of contracts won, meaning large organisations dominate the space. Cultural resistance to change is therefore a significant barrier for this sector in particular.

CHALLENGING ESTABLISHED WAYS OF WORKING

The internal culture of an organisation and its appetite for change is a significant influencing factor in its uptake of new technology. Construction sector participants think about their industry as having 'always worked this way'. As such, tried and true practices and conventions provide a level of certainty, reduced risk and comfort for operators. There is a sense that working to the same established practices delivers its own efficiency born from familiarity and common understanding. New practices and behaviours that result from technology solutions may generate new issues that will, in turn, require new decisions to be made without the benefit of precedent or benchmarks.



3. SOLUTION LIMITATIONS

INTEGRATION ISSUES

New software products often require integration with established systems, including SAP and other ERP platforms. Integration difficulties (whether perceived or real) can present very significant barriers to adopting new technology. The challenge of integrating digital solutions into complex infrastructure is a substantial challenge for startups to overcome and adds to perceived cost and risk for their customers. Equally, the prospect of having to deal with a myriad of single point digital solutions creates concerns about incremental complexity creep.

LIMITED PERCEIVED NEED

Reliance on, and familiarity with, legacy technology systems (many of which are bespoke) also diminishes the perceived value of emerging digital solutions. Often, users of established IT systems will be very familiar with the capability offered by existing systems, and under-informed about the value able to be added by new solutions. That can lead to a false perception that new systems are only an incremental improvement (if at all).

LACK OF CONNECTIVITY

Construction sites may lack access to high bandwidth internet connections, particularly in regional environments. Many solutions require a reliable and robust internet connection to access cloud-based data or analytics directly.

"A lot of organisations haven't invested in the backend systems to manage and drive technology. Instead they take bespoke, one-off solutions to fix a problem and they don't integrate them – either because they can't afford it or they don't want to. So that creates a mountain of burden and so then you get multiple systems and it just becomes harder and harder to do anything with it. It all needs to hang together." Brian O'Connor, CIO Construction & Engineering Industry



4. FINANCIAL CONSTRAINTS

LEGACY INVESTMENT

There exists a lack of organisational appetite to re-invest on top of current IT infrastructure. This reluctance is most pronounced when the investment in existing systems was relatively recent or was expected to have a significantly longer life span. In these instances, there is a tangible financial barrier to further technology spend that is difficult to counter if the benefits of new solutions are not fully recognised. One senior construction executive told us, “our organisation hasn’t made an important technology decision since SAP and I think has been stuck or overwhelmed by choice. We haven’t known what to do. We have to cut through that, make some decisions and move on.”

“We can all see the things that have held those organisations back, simply because of legacy systems, legacy processes, capital constraints we haven’t been able to change, but when you do change, you don’t always have people wanting to change, because change is hard and that’s what we want to do.” Emma Shipley and Damian Vella, Roberts Pizzarotti

LIMITED R&D FUNDING

The tight margins in the construction industry also limit its capacity to invest in technological advances as a standard business practice. Moreover, IT development has traditionally been associated with large capital expenditure outlays that can also lead to costly implementation delays and failures. The IT industry is moving to a SaaS (software as a service) model and cloud environment, therefore eliminating much of the large upfront investment, however the attitude toward investment continues to be influenced by past experiences. One senior manager reported that the appetite for technology investment at his firm had dropped substantially after it had “spent \$400m on a failed system a few years ago”. Similar experiences appear to be relatively common in the sector.

UNCERTAINTY OF SUCCESS

Startup solutions are constantly changing and evolving. This adds an additional level of uncertainty to the decision-making, as companies are unsure which startup to back and how quickly their chosen solution will be superseded. This presents a particularly big challenge in an industry where project lifecycles can be lengthy. A mid-project failure or pivot from a technology provider could be very costly.

“The technologies that are out there [are] confusing... there’s a new startup coming up every six months. You get a phone call from a new technology company saying, ‘Hey, I’ve got this new technology, can we come and present to you?’ and you think, ‘Wow, that’s the best thing I’ve seen’ and then six months later you see another piece of technology and go ‘Wow, that’s even better than what I saw before...” Emma Shipley and Damian Vella, Roberts Pizzarotti

“How do we pick the one that’s gonna survive? Because 20 of them won’t survive. The best one will. The other thing that’s changing is that the one that’s best today may not be the one that’s best in 5 years.” Brett Mason, Built



5. CHANGE FATIGUE BARRIERS

RESOURCES REQUIRED FOR CHANGE

Change places substantial demands on a business. Implementing any new system is often resource intensive in terms of time and effort required to communicate, implement and bed down the new process, especially with a diverse mix of system users.

The appetite for change is further compromised if the business has recently invested significant resource in training on new systems. Equally, if a system implemented does not deliver as expected, or proves to be onerous for users to interact with, the business will face further hurdles in engaging staff.

Change fatigue can be particularly problematic in an industry where change is often seen as top-down. The geographic divide and cultural distance between administrative staff (including corporate leadership) and on-site workers can generate specific cultural difficulties here. If 'Head Office' is perceived to be imposing changes on the company more broadly, this can have significant cultural consequences if the need for change is not communicated clearly.

"...So often corporate come in with their requests asking sites to do more and more reporting, making their lives harder. Then when you introduce new technology that hopefully makes their life easier, it just becomes difficult because they fear that any time we add a new technology it's adding more work to their already busy, busy day. So we've got to be careful with making sure that what we're putting in actually does help, not hinder. Too often we don't think through what our changes might mean to the guy on the site, that's the key." Richard Ferris, Lendlease



6. LACK OF REGULATION AND STANDARDS

CONTRADICTING STANDARDS

A lack of technological standards leads to contradicting standards across projects and firms. Delivery of digital requirements for a project is thus made difficult and furthers the 'silo' effect. Collaborations between contractors, subcontractors, BIM managers, project teams, startups and all other members of the value chain are also limited unless all of the organisations are working to the same set of standards.

As construction companies begin to define their own standards and set up their investment, technology, governance and business structure around them, so too do they expose themselves to greater risk that when universal standards are agreed or imposed upon the industry, the standards will not match what has been established internally.

CLIENT EDUCATION

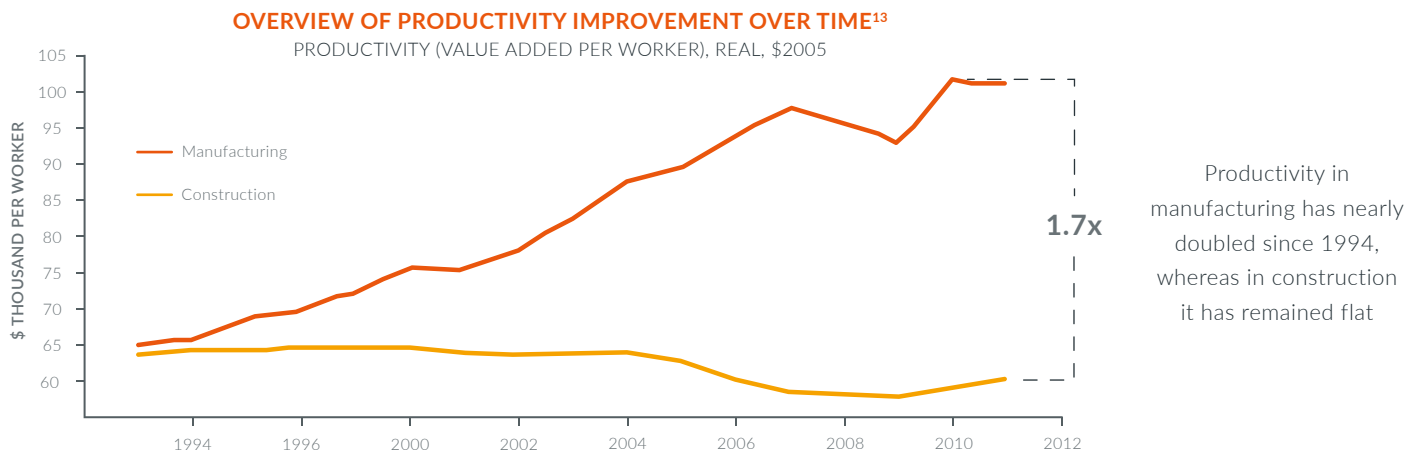
Client-provided scopes and briefs typically do not include detailed digital requirements. This makes the addition of digital features an uphill battle that can be seen as an upsell, or a competitive disadvantage. Expectations for these digital features is also at risk due to the lack of standards - different implementations of digital features can have widely variable depth, value and cost.

The asset management team, often one of the biggest beneficiaries of particularly BIM, is typically not even consulted at this point in the development process.

NEXT STEPS

LEARNING FROM ADVANCED MANUFACTURING

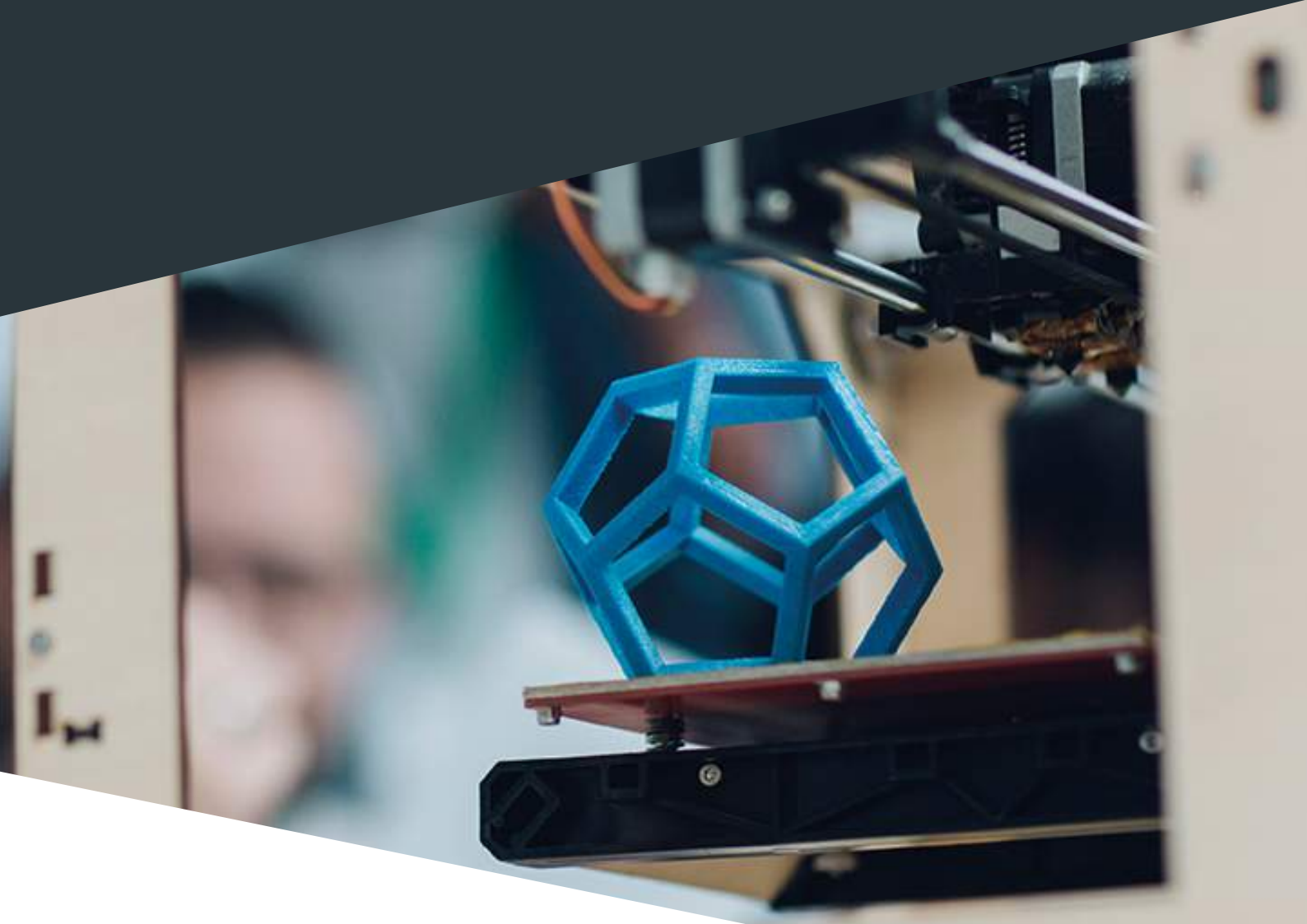
There are clearly huge benefits to digitisation in construction, alongside a unique set of challenges. Nevertheless, construction is not an industry that has to blindly forge ahead with digitisation. Other sectors have helped forge the way, here, and we can benefit by looking at the lessons learned in manufacturing over the past two decades.



Clearly, manufacturing comes in many forms. However, strong parallels can be drawn with the technological overhaul of discrete, complex sectors such as aerospace, automotive and shipbuilding manufacturing. While these sectors differ significantly with regards to their products, services, and industry structures, they share a common problem in their shift from file sharing to data sharing. If a rapidly digitising construction sector can digest some of these lessons it can increase the effectiveness of technology adoption and potentially even leapfrog the advances made in other industries.

Manufacturers have also required new digital skills. They have sought to understand the massive increase in new data and how to manage it so that it becomes useful and not overwhelming. They have had to adapt existing technologies to run their operations more seamlessly. As a result, they have found talent adept at software programming and analytics, built strategic partnerships with academic researchers and external companies, and have found new ways to monetise digitisation.

The impact of the construction sector's technology-based innovation depends on firms addressing similar requirements. ConstructionTech increasingly requires long term knowledge sharing commitments, including technology transfer, intellectual property licensing, co-production arrangements, and local sourcing and training of workers in skills that allow them to handle new information-centric responsibilities. The construction sector needs to examine alternate industrial strategies, business models, and technology programs to continue its trajectory of innovation. The sector has much to benefit from in considering seven critical lessons:



1. OVERHAULING
ANTIQUATED IT SYSTEMS



2. LIFECYCLE THINKING



3. GENERATE NEW
BUSINESS MODELS



4. DATA AND ANALYTICS
AS A SERVICE



5. STRATEGIC
ALLIANCES WITH
EXTERNAL PARTNERS



6. STRATEGIES AND
SYSTEMS FOR
TALENT IDENTIFICATION



7. KNOWLEDGE
SHARING ACROSS
THE SUPPLY CHAIN

¹³ McKinsey, The construction productivity imperative, June 2015



1. OVERHAULING ANTIQUATED IT SYSTEMS

One of the largest challenges identified in this report is the inertia created by large, complex, legacy technology infrastructure. Managers within construction sector firms must recognise the imperative to transform and proactively begin the difficult process of overhauling their IT systems, creating an entirely new systems architecture and providing the backbone for both external and internal technology initiatives. Legacy IT footprints in construction-based firms may seem stable on a day-to-day basis, but in an era of rapid-fire innovation with cloud, mobile, and analytics, architectural maturity is an ongoing challenge.

Startups and other tech firms which operate on the edges of the construction sector will continue to fuel disruption and expose new opportunities in the sector. Engagement with new cost-saving technologies will increasingly be slowed or blocked by limitations in existing IT architecture. Cumbersome IT systems customisation, complexity, security vulnerabilities, technological incompatibility, and poor scalability in the IT environments of construction firms have, directly or indirectly, begun to impact the bottom line.

The lesson to be learnt here from discrete manufacturing is that technology architectures need to support systems that are capable of:

- communicating throughout the organisation with standardised protocols;
- enabling access to data that is instantaneous and location agnostic; and
- managing data collected from a huge array of different pieces of equipment both in office and on site;
- integrating with third-party software solutions to enhance adaptability as the technology environment develops.

Some construction firms are already adopting and developing such architectures and gaining greater visibility into their business processes, with customised analytics and reporting to serve business needs.

This sort of 'systems thinking' approach will enable construction firms to engage with new technologies (both from startups and existing providers) and thrive in information-centric project environments.



2. LIFECYCLE THINKING

One key challenge that startups are actively seeking to help construction firms overcome is how to provide disparate stakeholders access to the right data across vast, complex projects. Designing, delivering, operating and using built assets require that the right information is accessible by the right people, as and when required. The range of stakeholders is broad, and includes project clients, architects, engineers, contractors, subcontractors, suppliers, management, and operators. Solutions range from full-stack project management collaboration (such as Aconex) to services targeted at particular stakeholders (Assignar's product is specifically aimed at sub-contractors) or project phases (companies like SkyCiv are providing discrete solutions for cloud-based planning and design processes).

Through this report we have explored the application of BIM in construction projects. It has become a key part of more broadly managing product lifecycle in construction. The product lifecycle management concept (PLM) has also manifest in the industrial strategies of complex discrete manufacturing sectors, over the last three decades.

PLM can be best understood as a strategic business approach to the efficient management of corporate intellectual capital. PLM serves both project and business level objectives via the consistent integration of data and linking of associated IT systems. It may include, for example, computer-aided design (CAD), Computer-aided manufacturing (CAM), Computer-aided engineering (CAE), and product data management (PDM), as well as enterprise portals for collaboration and smart dashboards for business intelligence and reporting. The various IT systems contain data, information, and knowledge about the manufacturer's products. As an integration platform, PLM practices typically link to enterprise resource planning (ERP), supply chain management (SCM), and customer relationship management (CRM) systems.

As an integration platform, PLM capabilities have rapidly developed over the last decade from a set of engineering design-oriented tools into enterprise-level solutions that serve as central hubs for product data to support collaborative design, production and service processes. The use, traceability, and management of information across the extended enterprise support closed-loop engineering in new product development processes. Linked data facilitates better connections and collaborations between the actors involved in the realisation, maintenance and use of the product.

PLM has become a holistic business concept that encompasses both a business approach and a software solution. The latest generation of PLM systems are being developed to meet the challenges surrounding product customisation and traceability, competition and globalisation, shorter product development and delivery timescales, and the ever tighter regulations and legislation that are common in construction today.



3. GENERATE NEW BUSINESS MODELS

We have seen already in our analysis that the business model of construction firms often make technology adoption difficult. Here, too, the experience of the global advanced manufacturing sector can provide some points of reference.

Complex discrete manufacturing sectors are increasingly bundling a range of services which have largely been enabled via the integration of IT systems and connection of data. The 'product-service system' concept has been refined to provide a business model where systematic evaluation of service requirements occurs during new product development through the use of operational and maintenance knowledge coupled with infield service and performance data.

A well-known example of the product-service systems business model is the CorporateCare service developed by Rolls Royce. The idea behind the core 'Power-by-the-Hour' service is a complete engine and accessory replacement service which offers a fixed-cost-per-flying-hour basis. Rolls Royce refined this concept in 2002 to include additional features which provide sensor-based performance tracking, lease engine access during off-wing maintenance, and a global network of maintenance centres. The business model aligns well with customer interests and allows operators to reduce risk related to unscheduled maintenance, making maintenance planned and predictable.

In the construction sector, systems for the predictive performance management of large assets and equipment are beginning to emerge too. Nevertheless, better real-time decision support for building managers and occupants that facilitate a user's experience represent untapped potential. The breadth and value of the new services that can be provided by construction firms provide opportunities for deeper and more lucrative contractual engagements with clients and open up new value streams via smart devices and applications that can enhance building user experiences.



4. DATA AND ANALYTICS AS A SERVICE

For construction companies, data and analytics are increasingly seen as strategic components of modern business. Their effective management is quickly becoming a critical business challenge and opportunity. The flow of digital information in construction has not only been growing in volume at unprecedented rates, but also its value to all business in the construction supply chain has never been greater. BIM, IoT, GIS and web-based project management tools have all added to the pressure for better information management. The management of information throughout the life of a project (if not the product) has become a business-centric strategy.

Digital technology can play a leading role in this space. Young Australian firms like Assetic and Uptick are looking to capitalise on strong growth in digital asset management. In fact, the majority of startups profiled in this report are, from various angles, seeking to help large firms tackle this growing challenge.

Many of these shifts have already occurred in advanced manufacturing. The impact of service-oriented architecture (SOA), cloud computing and IoT on data and analytics has been profound in the aerospace industry, as well as in automotive sectors. New technologies have converged and transformed the IT ecosystem for the better while at the same time imposing new complexities. With this convergence, a large amount of structured and unstructured data is being created and shared over disparate networks and virtual communities. To take advantage of these changes, new and more efficient ways of collecting, storing, transforming, sharing, utilising and disposing of data have been developed. These efficiencies have bolstered service-oriented thinking with most complex manufacturing organisations implementing decision support systems that utilise agile data and analytics capabilities as services.

In construction, initiatives are proliferating to enhance not only a firm's information management capabilities but also the client's capabilities via data-as-a-service (DaaS) and agile analytics. Perth-based startup Pointerra's founders used their experience in the mining sector to become leading exponents of 3D data DaaS capability in construction. simPRO and Built have expanded globally by moving data into the cloud. Additional capabilities range from centralised cloud-based information management and data integration to information quality control, data classification and automation as well as business intelligence reporting.



5. STRATEGIC ALLIANCES WITH EXTERNAL PARTNERS

Construction data is proliferating not just internally, but also from external sources. The construction sector therefore needs to figure out how to manage the flow of digital information that is collected on projects from an avalanche of sources – from 3D, 4D and 5D software, project and document management systems, detectors, and sensors. There is a critical need for construction firms to form strategic partnerships with those who can mine these ‘bits and bytes’ of information and work more closely with clients and building operators to use the maintenance and asset data that can improve performance.

Manufacturers of complex products such as aero engines and vehicles have become more active players in their surrounding technology ecosystem, and have long sought out expertise outside their core industry to develop software, data connectivity and analysis capabilities, and customer experience applications that are beyond their current abilities. Europe and the US’s civil aerospace and automotive industries have long recognised that they cannot grow their technological ecosystem alone. It has resulted in a journey that has seen them align and partner with a range of technology firms to create dedicated cloud-based platforms that can support the new industrial strategies and business models.

Startups will play a key role on the periphery of the sector, looking to provide new approaches and business opportunities to those firms that dominate markets where barriers to entry are high.



6. STRATEGIES AND SYSTEMS FOR TALENT IDENTIFICATION

As tech-capable employees become increasingly in-demand in the construction sector, a shortage of talent is likely to emerge. Large tech-smart engineering firms, contractors, and BIM consultancies need to take steps to prepare for this scarcity.

The high stakes surrounding digital innovation mean that companies must overcome competitive challenges when attempting to attract and retain tech-savvy talent. Typically, the best and brightest technology and engineering graduates prefer to work in companies where innovation is a mantra and a meaningful part of organisational culture

This bias of any sector’s graduates is today a reality of recruitment and one that companies must plan for if they are to attract and retain the right kind of talent and mindset. Many advanced manufacturing firms are therefore purposefully mapping out their technology strategy with specific benchmarks and achievements anticipated in both the short and mid-term. In doing so, this strategy and its execution plan can then be communicated to new graduates and confirmed internally as young tech-literate employees climb the organisation’s business ladder.

In developing a recruitment program, construction-based firms should heed the lessons learned in discrete manufacturing and not just advertise for someone who can read and analyse the data, only to find out that they do not understand how the turbine aero engine works. Balancing digital and professional discipline-based capabilities is as important in the construction sector. Allowing the construction project manager to use smart project data and sensor analysis in real-time to gain insight into how actual progress onsite compares to planned progress – and encourage innovation to improve these activities – is critical to leveraging the benefits of constructiontech and those that drive it.



7. KNOWLEDGE SHARING ACROSS THE SUPPLY CHAIN

As the construction sector continues to digitise, investment and partnerships in local, regional economies are increasingly becoming a cost of doing business. The days when a company could simply bid on a lucrative contract, show up and then sub-contract to local firms have gone as the industry increases its digital skills base and assists small to medium enterprises to invest in software. Examples of construction contractors adopting a similar 'investment' strategy to support technology transfer and digital skills development in local markets are an illustration that this has been a successful strategy.

For access to local markets, companies in complex discrete manufacturing have had to demonstrate their commitment to the industrial base and a willingness to transfer technology and skills. Given that the return on this kind of investment is not immediate, some companies have struggled to justify the expense. Aerospace and automotive manufacturers have however had to demonstrate their commitment by establishing training centres and R&D partnerships in developing economies such as India and Brazil.

Tech leaders in the construction space will need to look closely at how they can build an ecosystem that capitalises on the promise of digital information, analytics and connectivity to maximise efficiency for themselves, their partners and their clients. This can be done by mapping out their strategies and prioritising measures that bring the most value to their business, by investing in technology and skills development, continuing with pilot projects, and building greater strengths in data analytics with interdisciplinary project teams. It's also important that they start getting closer to their client's requirements, creating suites of product-service packages that go beyond the initial design or construction contract, and expanding opportunities as they create new partnerships that utilise data and analytics to provide new offerings that supplement their core specialty areas.



NAME:

Hartley Pike

BACKGROUND:

Hartley grew up laboring for his dad's construction business in the school holidays before studying civil and structural engineering at the University of Technology Sydney (UTS), where he met his co founders Jan Schroeder and Samuel McDonnell. Hartley started working as a construction engineer in 2010 with Abigroup, and went into Lendlease's Engineering division.

ABOUT THE TECHNOLOGY:

Construction Cloud aims to help project teams deliver on time and on budget by finding their issues and overcoming them. Construction Cloud has created a workspace where owner/operators, general contractors, designers, subcontractors and suppliers can build and manage their own digital construction documents, workflows and actions.

WHATS NEXT?

Construction Cloud is continuing rapid rollout across Australian states, launching first projects overseas.

ADVICE TO CON TECH STARTUPS:

Keep your finger on the pulse; get your boots on and speak to people in the field. It's not about the technology, it's about the people. Construction Cloud is allowing people to become collectively productive when building infrastructure.

Construction teams can create documents and run workflows for project safety, quality, commercial and environmental processes.

Construction Cloud is addressing the problem of siloing by allowing clients to select and modify best practice templates from the industry's open marketplace. A single unique instance is created for each project, for example 'Melbourne Metro', where multiple parties can set up private teams and customise the platform to suit their needs. People can work across teams with other parties, just like what happens between design, project management and site offices during the project lifecycle.

The \$2.6bn NorthConnex tunnel project in Sydney found that live digital documents in a shared workspace reduced non-value adding time spent on managing and sharing physical paperwork, pdfs and word doc templates by over 80%, or approximately 100,000 productivity hours.

"We believe that the reason 98% of major infrastructure projects face cost overruns or delays is because the right information isn't being shared with the right person at the right time."

Construction Cloud allows users to regain control of document template compliance and workflows - significantly de-risking project operations. For an individual, Construction Cloud saves all professional records and evidence of completed work as part of a team's workspace.

Construction Cloud won the 2015 3P Business Plan competition at UTS, and then represented Australia taking 1st place at the Virginia Tech Knowledge Works global competition in the US. Construction Cloud launched their initial MVP in 2016 with support from UTS Business School and NSW Department of Industry.

Construction Cloud has secured contracts with 80% of Australia's top 10 general contractors, as well as owner/operators, subcontractors and suppliers and has now launched the platform in beta.

BUILDING THE FUTURE OF CONSTRUCTIONTECH



LOOKING FORWARD

ConstructionTech in Australia boasts considerable potential. The size of the construction sector both in Australia and globally coupled with our world-class research and early development of technology in the sector present us with an opportunity to be global leaders in the implementation and export of digital construction solutions.

To realise its potential, startups in the sector will need to continue to mature and professionalise, and connections between stakeholders will need to strengthen and multiply. To support new innovations coming through, and standardise approaches to technology, the sector will need to work together.

Based on the research and analysis in this report we have identified six key areas for stakeholders to work towards.



RECOMMENDATION:

Industry to develop a set of standards around technology adoption and use, with support from government.

PRIORITY:

Very high importance. Action required immediately.

RATIONALE:

A consistent set of standard for the structure of deliverable information would provide significant efficiency benefits for the industry. Fragmented standards require each project to be started from scratch with no framework and improvised internal processes.

An established set of standards to codify the technological deliverable requirements of construction projects would set a base of expectations from which construction firms could work.

Such standards would also allow for application programming interfaces (APIs) that would allow startups to develop solutions that cater to a broad range of clients.



RECOMMENDATION:

Conduct an independent review into the implementation of the universal adoption of BIM, using an assessment of the UK's experience as a guide to adopting a similar or expanded mandate in Australia.

PRIORITY:

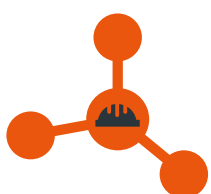
High importance, action required with a year.

RATIONALE:

The UK's decision to mandate BIM technology was a bold, tech-positive action to move the construction industry forward. Early analysis from the NBS National BIM Report 2017 suggests that while there were some hurdles, the mandate as a whole has been broadly successful. *"The future of the design process is BIM. 78% see it as the future of project information... 65% see that using BIM results in operational and maintenance savings."*

Australia has a clear second mover advantage in this space. An independent review should be established to analyse and assess the impact of the mandate in the UK.

Additionally, Australian implementation could include measures that go even further than the UK in driving the utilisation of existing innovators' products. Consideration should be given to the mandate including external assets, roads and underground services, or transparent publication of BIM data with a view to designing a similar mandate to be rolled out in Australia.



RECOMMENDATION:

Construction sector to establish a dedicated coworking space for ConstructionTech startups alongside a ConstructionTech accelerator program.

PRIORITY:

High importance. Target implementation within 12 months.

RATIONALE:

ConstructionTech has the critical mass to sustain a dedicated industry-specific support structure. A physical space and accelerator program increases intra-startup co-operation and co-development and serves as a focal point for larger firms looking to engage with current startup technology.

The programs can be modelled off of successful programs in other industries, such as Stone & Chalk in the fintech space.



RECOMMENDATION:

Governments to lead by proactively incorporating adoption of new technology for large infrastructure projects.

PRIORITY:

High importance. Minimum requirements for government projects to be set within 6 months.

RATIONALE:

The Federal and State Governments are uniquely positioned to provide client-side leadership in the adoption of new technology. Requiring tenders to incorporate technology that digitises projects and provides in-depth data that aligns with the broader economic and social goals of public works.

These flagship projects can then be used as a prominent example of the success of ConstructionTech, providing success cases for both startups and construction firms.



RECOMMENDATION:

Government and industry to support and expand events focused on identifying technology opportunities in the construction sector and connecting emerging companies with customers and investors.

PRIORITY:

Medium importance, networks to continue to be developed.

RATIONALE:

Centralised events and marketplaces make for efficient networking and more rapid development of tech solutions.

Recently, industry-led measures to promote sector connectivity have been established. The Construction Technology Summit, established in 2016, has been critical to establishing links between firms and startups. Localised events, such as the Sydney chapter of the Society for Construction Solutions, continue to maintain networks in the industry. And Lendlease is among the inaugural members of Slingshot's online CoVentured platform which seeks to connect startups with corporate projects.

Continued support for events and projects such as these are critical to helping develop relationships that will spur growth in the sector.



RECOMMENDATION:

Provide additional support for collaborative research initiatives focused on ConstructionTech.

PRIORITY:

Medium importance, development over the next year expected.

RATIONALE:

While Australian research is consistently ranked among the best in the world, particularly in construction, there are comparatively few paths through which that research may be commercialised. Industry-research cooperation allows tech solutions to be developed and employed in practical projects, creating a commercially-friendly development cycle.

A 2012 Allens study of the CRC program estimated its net contribution to the Australian economy was \$7.5 billion.

The 2016 \$50m funding of the Food Agility CRC, coupled with over \$160m of private funding, was the most recent contribution to innovation in the AgTech space, adding to over a dozen agriculture CRCs.

The CRC for Construction Innovation came to a close at the end of 2009, and only a relatively small number of RDCs remain in the space.

Additional support by both State and federal governments in fostering collaboration between research and commercial interests in the construction space will greatly support the burgeoning ConstructionTech ecosystem.

ACKNOWLEDGEMENTS



CONTRIBUTORS

Alan Noble	Kate Nelson
Alex Gruszka	Kathryn Muzzi
Alex McCauley	Luke Fielding
Anna Straton	Milena Savanovic
Athena Andriotis	Nick Peace
Bert Bardeel	Ofer Assor
Chris Brown	Pia Herbezt
Conrad Hamill	Sarah Bond
Eugene Dolgikh	Selina Short
Femke Mason	Steve Thomas
Fleur Brown	Teresa Engelhard
Jennifer Hodges	Topaz Conway
Jillian Harriott	Tsu-Mei Liew
Kate Dezarnaulds	

StartupAUS is Australia's national startup advocacy group. It is a not-for-profit organisation formed in 2013 by fifty leaders in the national startup community. Our mission is to transform Australia through technology entrepreneurship - by making Australia one of the best places in the world to build and grow a tech company.

StartupAUS produced this report to highlight one segment of Australia's traditional economy where technology startups can make a very real, positive impact. Startups are solving real problems across a wide range of traditional industry sectors, adding to the productive capacity of Australia's economy as a whole.

We're grateful to our partners on this report, as well as our organisational sponsors - UTS and Google - for their forward-thinking approach and commitment to Australia's economic future.

With the converging of industries and the integration of digital into business as usual, the construction sector faces a period of major opportunity. Now is the time for the sector to create their own future direction.

We are proud to be the lead researcher of this report that lives and breathes our purpose to build a better working world.

EY has the largest integrated real estate and construction practice with 12,000 professionals around the globe providing assurance, tax, transaction and advisory services to real estate owners, investors, lenders and users. We serve more than 4,000 real estate and construction clients throughout the world. From startups to major corporates to provide the insights, assurance and innovation that support a resilient, sustainable and agile industry.

This industry report on the status of Australian Construction Tech is an important and timely showcase of R&D in digital technologies. The sector's ability to respond to changes in our environment and global market depends on Australia's capacity to grow innovation.

The participation of UTS in this report brings together contributions from individuals and organizations who are striving to make a difference to the sector and deliver the benefits of technology led innovation across the built environment. The report will assist organisations by providing a snapshot of Australian Construction Tech success, and demonstrating how new opportunities are being captured via investment in digital innovation.

Digital construction technologies are increasingly re-shaping the way we teach at UTS; traditional areas of expertise such as time management and cost estimation, for instance, can now be integrated with design management to ensure decisions are optimized at every stage of project development. UTS's contributions to the report demonstrate how our research in Built Environment Informatics and Innovation informs our teaching and harnesses our cutting edge research.

UTS LEAD AUTHORS

Julie Jupp
Digital Design and Construction,
School of Built Environment,
Faculty of Design Architecture
and Built Environment

Gerard de Valence
Senior Lecturer,
School of the Built Environment

INDUSTRY STAKEHOLDERS:

Thank you to everyone who agreed to be interviewed. Your time and expertise were critical to the development of this report.



The smarter use of technology in the design and construction space has the potential to be a major game changer, particularly in terms of project delivery efficiency and innovation.

As a leading international property and infrastructure group, Lendlease has a vested interest in supporting the emergence of new technologies that will help us create the best places and continue to push the boundaries of our building and development projects globally.

But we also have a responsibility – to challenge and change the industry for the better. That can only be achieved through disruptive thinking and increasingly, the availability and adoption of digital solutions. We're confident this report will help unlock the potential of the industry, and are proud to be a consortium partner in its production.

The construction technologies sector is important to the economic prosperity of Victoria and a source of future employment for Victorians. It is vital to Victoria's rapidly changing construction industry and supports the delivery of the state's future infrastructure and housing needs.

The evolution in construction technologies is being driven in part by demands for better environmental performance in construction as well as new and emerging production methods. Digital technologies used in construction processes have significant potential to transform the construction sector, improve productivity and boost the state's economy. To this end, the Victorian Government is actively encouraging the use of digital technologies in its large infrastructure projects.

The Victorian Government is proud to support this report, and will continue working with the industry to secure the state's position as Australia's leader in construction technologies.

Aconex is the world's leading cloud collaboration platform for construction and engineering projects. Aconex provides the most secure, only easily adaptable platform, connecting teams, processes and data across the entire project lifecycle. With greater control, visibility and insights across projects and processes, companies are able to decrease costs, increase productivity and reduce risk.

The company was founded in 2000 and pioneered digital transformation for project management in the construction, infrastructure, energy and resource sectors. Today, Aconex continues to invest in digital cloud technologies to further drive performance through design and construction coordination, modernized project controls and jobsite mobility.

Aconex serves more than 70,000 clients globally and delivers over \$1 trillion of project value in more than 70 countries. Customers include nine of the world's top ten engineering procurement and construction (EPC) firms, 23 of the 25 leading global design firms, and nearly all Fortune 500 construction and engineering firms.



ALEX GRUSZKA
LEAD AUTHOR

Alex is the Chief Operating Officer of StartupAUS, taking responsibility for managing its research, data and communications.

After an eight-year career in media, Alex transitioned into the startup space, initially as a founder, then educator until he found a home at StartupAUS, working to further Australia's burgeoning startup ecosystem.

Alex has previously co-authored the Powering Growth AgTech report, edited Crossroads 2016 and the upcoming Crossroads 2017.



Report designed by
Chris Brown - Freelance Design
WWW.IMCHRISBROWN.CO.UK



Transforming Australia through tech entrepreneurship

www.startupaus.org

StartupAUS is proudly supported by:

Google

