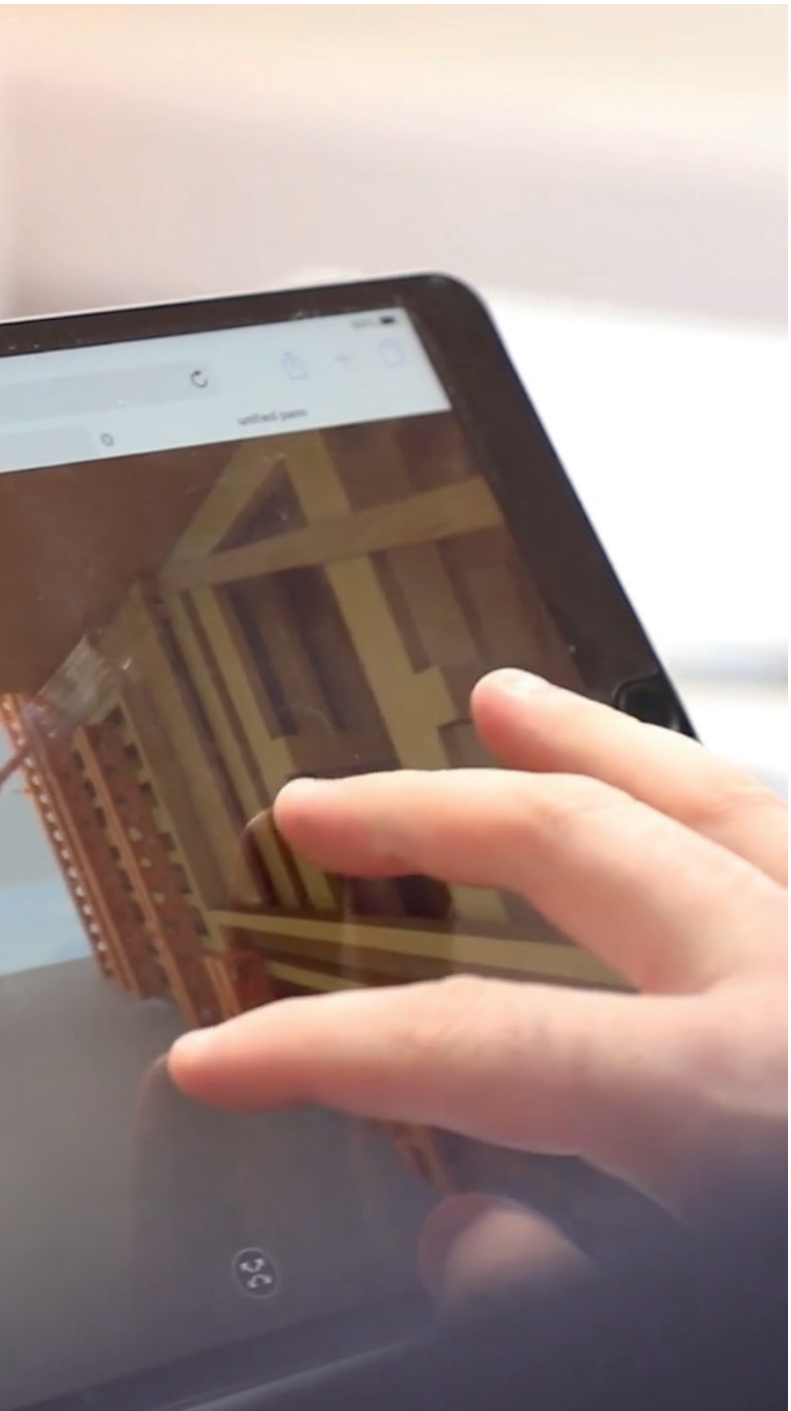
CITB RESEARCH

UNLOCKING CONSTRUCTION'S DIGITAL FUTURE:
A skills plan for industry



This research is part of CITB's
Changing Construction – Changing Skills programme

October 2018



REVEALING REALITY

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INTRODUCTION

INTRODUCTION

The benefits of digital construction are well rehearsed. The adoption of digital technologies is a huge opportunity for the UK construction industry, providing it with the chance to improve its productivity, increase efficiency and attract a younger and more diverse workforce[1,2].

These advantages will be realised at all levels – by individual workers, by employers, training providers and the industry as a whole – and they will allow UK construction to continue to export its expertise and compete globally.

The risks of not embracing technological opportunities are also well known. Without widespread adoption of digital technologies, the industry will become marginalised and at risk of significant disruption. Competitors with technological expertise are likely to enter the market, potentially squeezing out traditional contractors and suppliers[3,4].

And yet the industry has yet to undergo the digital transformation it needs. Why is this? What is needed to make it happen?

At the heart of the required change is a need for the industry to digitally upskill its workforce. Construction businesses not only need to be able to use technology, but to make the most of it.

This means:

- knowing when to use it – and when not to;
- actively considering the problems it could solve rather than adopting technology for its own sake;
- understanding how to embed its adoption and how to communicate its benefits;
- being clear on the information management needed to support it.

Digital transformation requires a fresh approach to developing skills. The industry must be clear what skills people have – and what they need.

This must go beyond 'how to use tech' to a focus on behaviours and attitudes and the development of the 'softer' skills, mindsets and knowledge that must underpin them.

It must include an understanding of what 'data' is in the context of digital construction – and what it isn't. Data must be harnessed to help the industry improve its processes and challenge traditional ways of working, making it integral to digital transformation.

1 Modernise or die – Farmer review. Mark Farmer. 2016. http://www.constructionleadershipcouncil.co.uk/wp-content/uploads/2016/10/Farmer-Review.pdf

2 Creating a digital built Britain: what you need to know. HM Government. 2017. https://www.gov.uk/guidance/creating-a-digital-built-britain-what-you-need-to-know

3 Our revolution – what technology will do to global construction. Construction News. 2016. https://www.constructionnews.co.uk/analysis/news-analysis/our-revolution-what-technology-will-do-to-global-construction/10014428.article

4 Imagining construction's digital future. McKinsey & Company. 2016. https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/imagining-constructions-digital-future



CITB, as the training board for the UK construction industry, should be at the forefront of this digital transformation, working with the industry to support and develop the skills and competencies it requires. This research explores what those skills and competencies are, and how the industry – as a whole and at an individual company level – can ensure they are developed.

In addition to trying to address less surprising – but no less important – cultural[5] and structural barriers to the wider adoption of technology, there are a number of practical changes to skills that can be made by CITB, business leaders and employers to begin to break down the barriers that prevent the digital transformation that UK construction so badly needs.

5 How ready are UK companies to adopt new digital technologies? Institution of Civil Engineers. 2017. https://www.ice.org.uk/news-and-insight/the-civil-engineer/july-2017/how-ready-uk-companies-to-adopt-new-digital-tech'



METHOD

BACKGROUND TO THE REPORT

CITB is in a unique position to proactively support construction employers to develop and action a clearer understanding of the skills and training required for digital transformation.

As part of its reform programme, CITB has committed to working with the Construction Leadership Council, the government, training providers and employers to create a more outcomes-oriented business based on a sound evidence base to determine the industry's skills and training needs.

This research was commissioned to better understand how digital technologies are being used on construction sites across the country and the associated skills needed within the industry to strengthen and expand their use. More specifically, the objectives were to:

- Explore what technologies are being used/will soon be used across the construction industry;
- Understand how technology is implemented by organisations and the strategies they use to facilitate digital skills among the workforce;
- Explore what skills, knowledge, behaviours, and competencies are needed and what training exists to embed them;
- Uncover how employers and training providers are planning to develop the workforce for the future.

This research focused predominately on digital technologies being used onsite to improve process and output, deliberately looking beyond building information modellling (BIM) (defined as an information management process) and offsite construction, which have been covered in other work.

OVERVIEW OF THE APPROACH

This report is the result of qualitative research with industry-leading experts and practitioners working in construction. Interviews were conducted with people across the UK from different sub-sectors in roles spanning industry oversight, senior leadership, and site and project managers. In many cases they were digital and innovation specialists or worked in HR, talent and learning and development teams.

These interviews were supplemented with in-depth interviews and site visits in England and Scotland organised to observe and understand in more detail how some digital technologies are being used onsite. More details on the methodology and people involved are in Appendix 1.



HOW DIGITAL TECHNOLOGIES ARE BEING USED



"THERE IS A LOT OF OPPORTUNITY FOR EVERYONE"

"Smartphones are being used onsite a lot more to collect and store information rather than paper. Whilst it's not the most exciting tech, it does have an impact."

Digital design delivery lead, engineering consultancy

"Site diaries previously on paper and faxed are now on spreadsheets. Workers start to see that they can use a digital diary that populates a lot of things, making their lives easier. This is the first step."

Head of digital and innovation, tier 1 contractor

This research set out to explore the adoption, use and expected uptake of a broad range of digital technologies across construction, including:

- Augmented reality/virtual reality
- Automation
- Drones/unmanned aerial vehicles (UAVs)
- 3D printing
- Artificial intelligence (AI)
- Wearable tech
- Lidar
- The 'Internet of Things'
- Productivity/planning apps
- Data analytics

Further details on what these technologies are and how they can be used is included in Appendix 1.

Building information modelling (BIM), and the mandate issued by the government for its use, has driven much of the move to 'digital construction' in recent years, so much so that BIM is often thought of as being synonymous with digital. However, this research recognises that, while BIM has been an enabler for many of the technologies on the above list, the scope of digitalisation is much wider than BIM as a process and industry needs to consider a wider set of skills.

More and more contractors are using digital technologies to improve productivity and innovate their working practices. The starting point for many was to use portable computers, digital tablets and smartphones for information collection and storage, to reduce the paper used onsite. For some, this has been a stepping stone to more advanced technologies, as staff started to see the benefits of digital and help to find new ways of solving problems.

INNOVATIVE DIGITAL TECHNOLOGIES

"The whole idea of digital simulation has become much bigger over the past few years. Instead of reviewing a 3D model, now you can rehearse these motions before doing them in real life."

Head of innovation, tier 1 contractor

"We've seen some incredible examples of site staff flagging risks or being able to use their expertise and guidance early in the rehearsal and visualisation to flag things that won't work and then make the actual process work more efficiently with less stress."

Head of digital and innovation, tier 1 contractor

"We are looking at VR to visualise the sites to our key stakeholders. This is really valuable because roadworks so often happen at night so it's harder to visit."

Head of innovation, client

"Land surveying is cut down from two days to 20 minutes now that UAVs and drones are being used."

Director, technology specialist

"We're using drones to inspect roofs because they're so difficult to access."

Chief executive, tier 1 contractor

Beyond the more widespread technologies, augmented reality (AR) and virtual reality (VR), drones, automated vehicles and data analytics are the most widely talked about.

AR and VR are being used by some contractors to model, plan and visualise progress onsite, allowing members of the supply chain to reflect on how their work fits together. They also enable clients or stakeholders to 'look ahead' to the end result or view progress without having to visit the site.

UAVs and drones are also increasingly common on sites, used to improve survey data, make the process of surveying more efficient and get safer access to dangerous or hard to reach places.



CASE STUDY

A14 CAMBRIDGE TO HUNTINGDON IMPROVEMENT SCHEME

"The greatest benefit is the amount of time [saved] out in the field. Setting out timber profiles and batter rails is very time consuming. Once the drivers get used to the system, they find it easier and they don't have to keep getting out checking line and level. It's got to be at least five times the speed and the new systems allows us to adopt changes quickly."

Manager, A14 Delivery Team

In its delivery of Highways England's £1.5 billion Cambridge to Huntingdon improvement scheme, the A14 Integrated Delivery Team (a joint venture between Costain, Skanska, Balfour Beatty and designers Atkins/CH2M), uses GPS equipment and 3D control systems to share data from digital 3D models with earthmoving equipment onsite.

Designers and engineers working in the main site offices use software to transmit 3D model data to bulldozers and excavators, in effect telling the machines the depth and width they need to dig, or the height and shape they need to fill. The machines can send survey data back to the office, allowing progress to be measured or visualised.

Most people across the site can already see the benefits in terms of productivity. Engineers spend less time travelling around site to update teams on where to dig, or to convey messages about changes to the design. Machine operators can spend longer in the machines moving earth, as updates and changes are shared digitally rather than in person.

One of the challenges the team has needed to overcome is the volume of data within the 3D models shared by the project design team. First, engineers need to simplify the information transmitted to the machines, removing superfluous data that doesn't relate to the excavation activities – this is much simpler for the control systems to process.

With advances in technology, the team expects things to develop further over time, to either semi-automation or even completely autonomous equipment. At present the machine operators retain control of the machines but anticipate machines capable of operating on autopilot in the future.



"Autonomous vehicles are taking repetitive tasks and automating them, such as laying road ways and excavations."

Director, tech specialist

"Semi-autonomous vehicles will definitely be increasingly used."

Innovation director, tier 1 contractor

Semi-/autonomous vehicles are also expected to be increasingly widely used across sites as a means of doing more dangerous tasks and working more efficiently.

A move towards automated vehicles can include contractors using 3D modelling to help guide plant operators and machinery with greater precision, to within millimetres. Once the model is built and refined, it can be shared with IT platforms on-board the excavators for the operators and is tracked by GPS to ensure everything is done accurately. This can mean fewer operators are required onsite, safety can be improved, and outcomes are better.

WHAT IS DIGITAL INNOVATION?

"We're just beginning to make investments into AI."

Director of innovation, tier 1 contractor

"We've been using BIM mainly because our clients require it. We still have 2D drawings for ourselves."

Business training manager, sub-contractor

"We have longer term ambitions for digital engineering – to enable a digital process from design to delivery."

Partnership and innovation leader, tier 1 contractor

In approaching people to discuss digital skills, and during interviews with them, it became clear that the term 'digital construction' is understood and used to mean different things.

Those who aren't specialists in digital construction don't always instantly recognise the term. Others think it was synonymous with BIM.

Among those who feel confident in their view, and who are able to articulate what they understand by digital construction, perspectives include a full range of ambitions and examples. At one end, some cite the increasing use of digital tablets onsite to collect and share information about daily progress, for example via models or schedules, as a strong example of digital construction in practice. At the other end, some are working towards a complete transformation of their business around digital innovation.

Most knowledge of and familiarity with what digital construction could mean in practice is concentrated among digital construction specialists, such as heads of innovation or digital. Beyond this, awareness and understanding are low.

WHICH TECHNOLOGIES WILL REACH A TIPPING POINT – AND WHEN?

"Digital transformation is needed in construction. It is all to do with improving productivity, communication, certainty, quality and collaborating with clients and the supply chain. That's what we have to be doing."

Head of digital and innovation, tier 1 contractor

"Since joining the industry, it's clear that having a knowledge and awareness of digital is really important. Being able to navigate what different technologies can offer is vital for thinking about innovation and efficiency."

Director of innovation, tier 1 contractor

"Unless we do something with tech to improve productivity, then we're going to have a problem."

Chief executive, tier 1 contractor

"Everyone is doing bits of something. There are a million and one digital things people are trying. It's not that there's one clear step everyone is taking."

Government official

"There are pockets of things happening, but nothing to scale. The challenge is every site is run differently and everyone's trying different things."

Innovation director, tier 1 contractor

Despite variation in the use and understanding of what precisely 'digital construction' means, there seems to be agreement across the industry that there is a need for digital innovation and that it would benefit the sector in terms of efficiency and productivity.

There are some specific technologies that are more frequently used by contractors, consultants and training providers across the industry – most notably drones, AR/VR and automation. There is some anecdotal evidence that people are exploring the possibilities of using other technologies such as 3D printing, the 'Internet of Things' and artificial intelligence, but limited evidence of their use on sites among the range of people approached and interviewed as part of this research.

Significantly, **there is no consensus across the industry on exactly which technologies will become most widely used, or by which date.** There is also considerable disagreement over which technologies are most likely to become obsolete.

The opportunity to use digital technologies is huge – but the scope of what is being used in practice in many cases falls far short of what is possible. The next chapter explores what is holding the industry back.

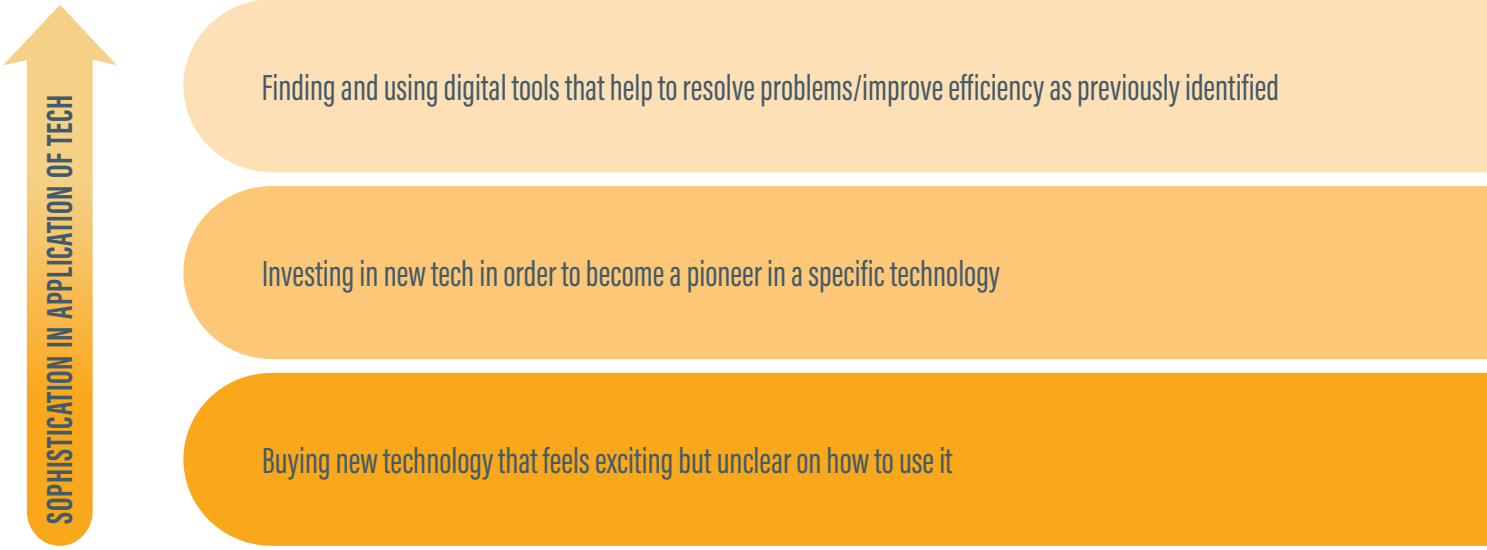
KEY POINTS

- The industry accepts the need for digital innovation and agrees it would bring benefits to efficiency and productivity.
- Digital construction is understood to mean different things by different people.
- More and more firms are using digital technology onsite – most frequently tablets, drones, UAVs and AR and VR.
- There is no consensus about precisely which technologies are likely to reach a tipping point in terms of widespread industry adoption, or when this could happen.



LIMITATIONS IN THE USE OF TECHNOLOGY

Figure 1: The spectrum of adoption of digital technology use



A SPECTRUM OF ADOPTION

"Using digital tech can be like using a phone – everyone can send a text, call, email, which is like 2 per cent of its capability but not everyone is using the other 98 per cent of the phone."

Head of new entrants, tier 1 contractor

"We've just hired a director of innovation to make sure how we use tech is strategically valuable."

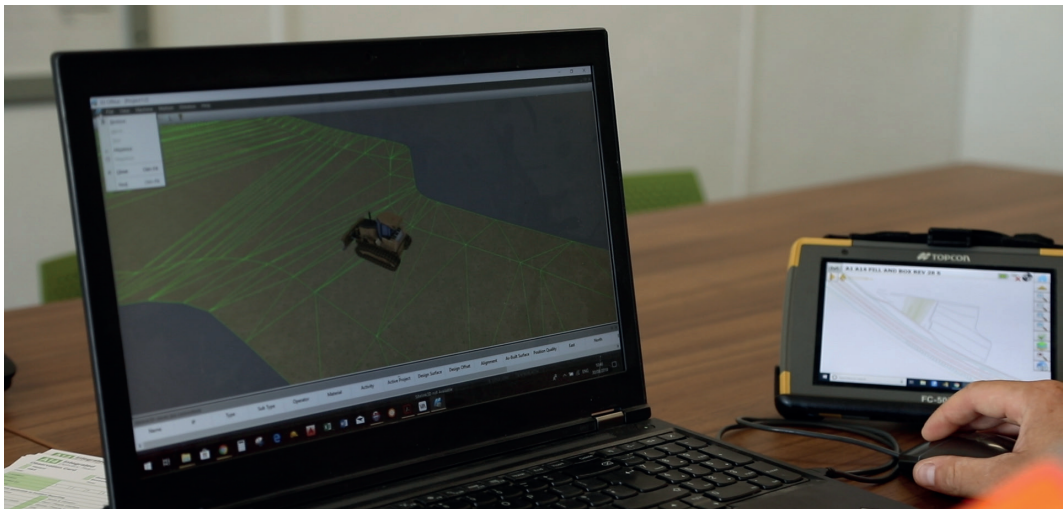
Head of innovation, tier 1 contractor

"Our drones now have an attached infrared camera, so we can use them for photography and so we can use them in other ways and share that idea."

Group learning manager, tier 1 contractor

Among the contractors using new technology, motivations for its use and the ways in which it is being used vary considerably.

Figure 1 above shows different levels of sophistication in how people are applying digital technologies to their work. The organisations that are most successfully integrating technology are those that are using digital tools to solve specific problems. The least sophisticated have a more superficial approach, often buying new technology because it feels exciting, but then being unclear what to use it for. Others see an investment opportunity and are keen to become pioneers in a particular technology so that clients will buy their services or it will help them win work.



"DIGITAL TECH WORKS ON PILOT PROJECTS, BUT HOW DO YOU SCALE IT UP FOR THE WHOLE BUSINESS?"



"To make technology uptake viable you need a client, contractor and design team who are willing to give it a go and trial it on different projects. Trusting someone to deliver on this tech is very difficult."

Director of innovation, client

"Construction has a poor approach to tech selection, tech innovation, tech knowledge. Some tech is bought so short term that you don't even get the return on investment."

Director of digital technologies, tier 1 contractor

Frequently, technology is not understood as a 'tool' to help solve a problem or improve a process. As a result, not only do problems continue and processes remain less efficient than they could be, but the lack of understanding contributes to a vicious circle that limits the best use of technology. If the benefits of a technology to solve problems or improve processes aren't understood, this means they can't be measured, and as a result it is not possible to make a business case for further investment.

Those trying to implement digital construction methods across their businesses are often frustrated, feeling they have to persuade others to take a 'leap of faith' because of a lack of understanding about how technology could – and should – best be used.

In order to justify investing in new digital tools or technologies, spending is frequently focused on technologies that address a specific problem identified onsite. As a result, the technology is often used in a specific context and opportunities for wider usage are not explored. In these cases, its use is generally tactical rather than strategic, limited to solving problems rather than preventing them.

The most ambitious companies recognise the potential for digital tools to help resolve wider problems and/or to improve efficiency and are often at the early stages of transforming their organisations to make this a reality, including considering the skills staff would need to support this.

LIMITED IN SCALE, SLOW TO ADOPT

"Adopting new technology is costly and timely to make sure it works. Only really large businesses or projects that can take that step and make the investment can take that risk."

Chief executive, tier 1 contractor

"Digital is transforming the way we're working. We've been running a centrally led programme for the last five years to prove the value of a digital approach. There's a whole host of things we can think about improving or resolving using digital technologies."

Head of digital and innovation, tier 1 contractor

In many cases, technology being used onsite is not at the cutting edge of what is available in the market. Drones, Lidar, smartphones and tablets are increasingly widely used but are technologies that have been available for some time. Technologies such as robotics, 3D printing or artificial intelligence – if used at all onsite – are generally limited to small pilots or trials, as investment in larger scale innovations is considered too risky.

Making the case for investment in technology is seen as difficult. Several people talked of a 'chicken and egg' type problem where they have to win the work before they can begin to make the case to use a particular technology onsite – and by then it is often too late.

Infrastructure projects with long timescales, big budgets and powerful government clients were often cited as the only or best way to try out or use new technology. Crossrail and Tideway were mentioned time and again as examples.

CASE STUDY

BMB JOINT VENTURE AT TIDEWAY

"Working on a major project gives you an opportunity to speak to people, including those at board level, who are open to new ideas and see the value in innovation."

"Some of the biggest gains have been the intangible [returns on investment]. We spotted some things within the reinforcement design that we were able to resolve sooner. We've got these metrics to feed back to the board to prove that this is worthwhile and not just a gimmick."

Tom Price, BIM information manager at Tideway, BMB JV

Tideway, the company delivering London's super sewer, has backed an innovative scheme to use digital technology to benefit the engineering process at its sites across the city.

Using Virtual Reality (VR), the team delivering the western section of the tunnel – a BAM Nuttall, Morgan Sindall, Balfour Beatty joint venture – has developed a unique piece of kit to visualise the site for the design and engineering teams. This helps them keep in mind the bigger picture of the build and work through key stages.

The innovation funding meant they could acquire a Fulmax VR Cube which has been installed at the Carnwath Road Riverside worksite in Fulham. This free-standing unit allows teams of up to six people stand within the cube to view a VR projection of the project and elements they're aiming to build.

The team have already seen some of the benefits of this VR technology in the design and engineering processes, helping them spot elements that could become problems during the build and resolve them earlier in the process.

KEY POINTS

- Motivations for the use of technology, and the sophistication with which it is applied vary considerably – from tech for tech's sake through to using digital tools to solve and prevent identified problems or improve processes.
- Much of the technology that is being used is well established and not at the cutting edge of what is available.
- Where technology is in use it is often confined to small trials.
- Large infrastructure projects with long timescales, big budgets and government clients were seen as the most viable opportunities to experiment with digital technologies.



WHAT IS CAUSING THE LIMITATIONS IN THE ADOPTION OF TECHNOLOGY?

"WE NEED TO UNLOCK THE POWER OF DATA"



To overcome the barriers to wider and more effective adoption of technology, the industry needs to understand what is causing them. It can then develop strategies – including a focus on skills – to address them.

DOING 'DATA'

"The future is data driven, we need to unlock the power of data."

Director of innovation, tier 1 contractor

"We want a data centre like an F1 team who know everything about the car in every second. We want to replicate this for the construction site."

Head of innovation, client

In interviews about the use of technology onsite or the barriers to its adoption, data and effective data management were identified almost universally as a challenge.

People are enthusiastic about the role data can play in improving efficiency and productivity in construction, transforming their companies and the industry more widely.

But they often feel their businesses need to improve the ways they use data or do 'something more' with it. However, they frequently can't articulate clearly what this would mean in practice.

Data management is often equated narrowly with BIM, and the skills required beyond this for full digital transformation are often not understood. Data is rarely described in terms that cover everything from detailed reinforcement schedules to workplace performance data to energy performance of a building in use.

Some contractors have started to try to collect better data and work with people across the business to share and use the information. Many of these speak highly of the efficiencies that can be gained from this practice and are looking into 'what next' in terms of data management.

"We need more people who are more technically minded, who understand data, data storage, how systems work and talk to each other."

Head of innovation, tier 1 contractor

"The biggest challenges are understanding why we need this [data] and what are we going to do with it? And some native skills like data management are lacking. The industry doesn't have the core competencies to know that data management should be done a different way."

Director of digital technology, tier 1 contractor

But this requires appropriate mechanisms to be in place not only to collect data, but also to analyse it and then feedback the findings. Effective data management of this sort is rarely in place – and misuse or misunderstanding of the term 'data management' more widely serves as a barrier to its implementation.

Asked about the skills needed to support use or adoption, 'data skills', 'data management' and 'data analytics' are cited frequently. Nearly all interviewees feel their businesses lack the right data skills or don't have enough people who 'understand' data or know what to do with it.

Like 'digital construction', 'data' is often being used as a catch-all term, essentially a piece of jargon that is frequently used but not well understood.

CONFUSING LANGUAGE

"Training and competency is my main objective. There is a huge gap around understanding the use of data – the perception is that it's someone else's job."

Digital construction manager, tier 1 contractor

"I am currently refining roles for information management and reviewing a lot of roles to understand what competencies we need. We're trying to spread data management onto people's everyday jobs."

Digital construction manager, tier 1 contractor

For those who understand what 'digital' and 'data management' mean in practice, it's easy to assume that everyone else knows what they're talking about. But it can be off-putting or confusing to people, particularly those in non-digital roles, who don't understand what it means, and don't like to ask.

At the same time, it's also used incorrectly or loosely by other people who aren't clear what it means – further muddying the waters for everyone.

'Data' is used to refer to many different types of information, while 'data management' is used to cover some or all of the collection, storage, sharing and use of data in practice.

Why does this matter? Woolly or poorly understood terminology can lead to uncertainty. If people are not sure what 'data' is referring to, they can't be clear why it is important, what it will be used for, what they – or others – need 'to do' about it, or who should be responsible for its management.

BEYOND WORDS

"There are huge data challenges in the future – generating, streaming, processing it, knowing what is and isn't archivable."

Director of digital technology, tier 1 contractor

"People identify tech that brings value but they don't understand the process of providing data to others, how to use it, what it means. The tech is pointless if we don't get this."

Head of innovation, tier 1 contractor

"The main change in the next few years is people understanding data in a structured fashion – know what they're doing and the costs."

Digital events director

"We only do what is absolutely required of us by the main contractor. We offered BIM 3D modelling because many of the top contractors require it."

Business training manager, sub-contractor

Shared language is essential – but the importance of genuinely understanding what is meant by 'data' and 'data management' goes beyond words.

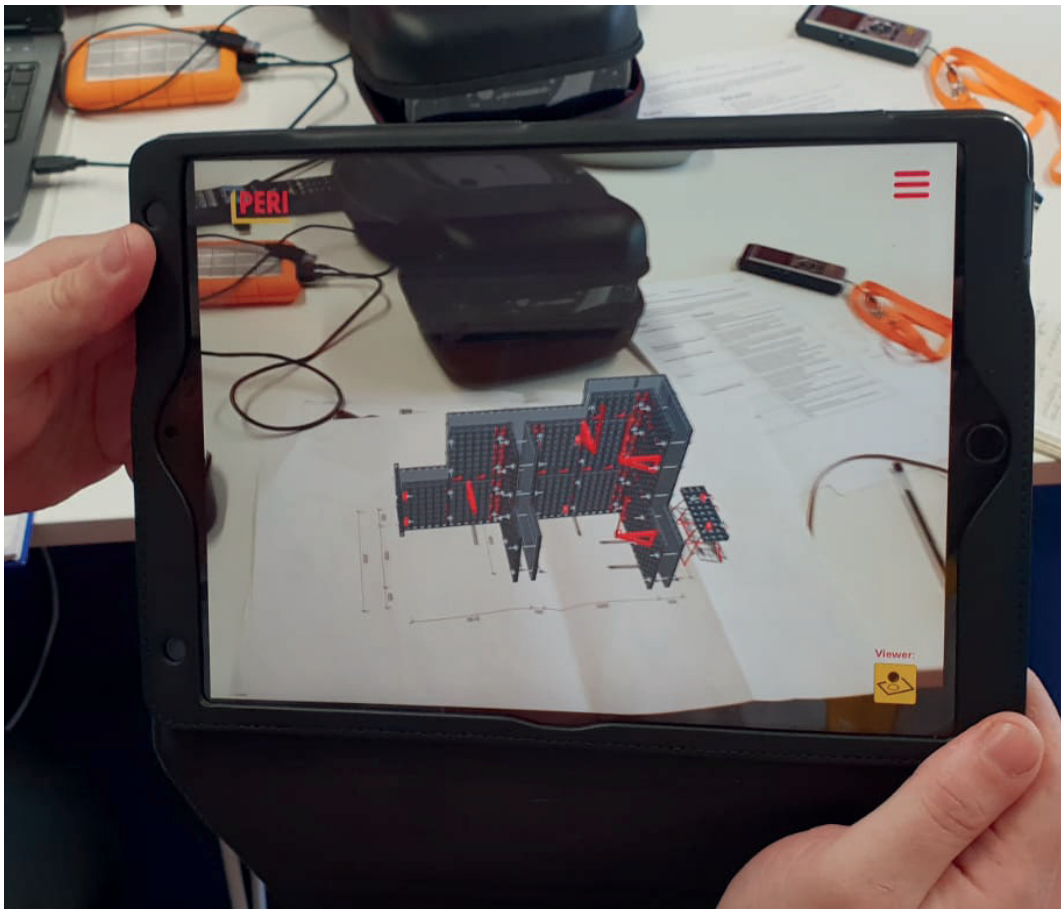
Data and its effective management are the key to widening access to and extracting value from digital technologies. Well organised and processed data enables use of a wide range of technologies as they develop and evolve. Systems can talk to each other; efficiencies can be multiplied.

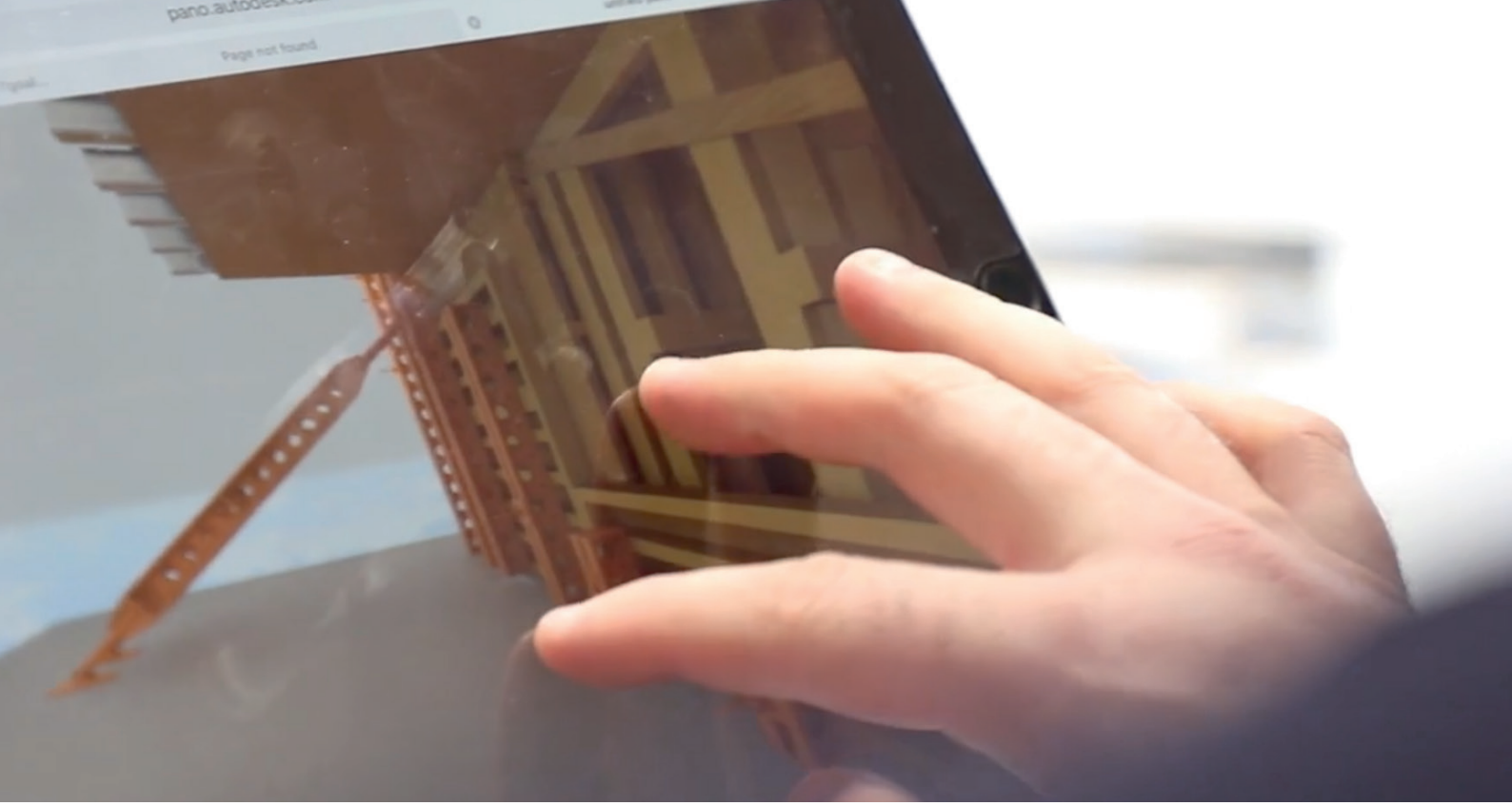
If people don't understand the importance of data management, these potential benefits can be lost.

While some contractors have started to talk about finding ways to work with data, few feel confident that their organisation knows how to collect, store, share or use data well to solve problems strategically. People are often unclear what data they might already have access to or what it could teach them – or what else they could collect.

Without clarity on what 'data' is and what 'data management' involves, organisations aren't taking effective steps to collect and process information about how their sites are running.

As a result, people working onsite are often unaware what data they should be collecting, what the outputs should look like or what else it might be used for – and the technologies in use are not achieving their full potential.





COMMUNICATION GAPS

"A big culture shift was required as well as a technology shift – even getting people to speak to each other in the office, onsite, across different locations, that was tough."

Director and head of global systems, construction consultancy

"It can be challenging trying to introduce tech. A lot of technology is still seen as a gimmick, it doesn't help people know how they can use it."

Digital construction manager, tier 1 contractor

The lack of clarity over data management is commonly heightened by gaps in communication between the people working onsite and those who are leading construction firms. Problems on the ground are not always fed upwards – so not only is technology not thought of as a tool to solve a problem, but the problems themselves are often not known about.

Onsite teams may develop a one-off workaround that addresses an immediate problem but is not communicated – meaning a company may miss an opportunity to identify systemic problems or to share potential solutions.

Effective data management can help businesses identify and communicate problems. It provides opportunities for improvement at both the micro and the macro level – it can help solve a problem onsite or contribute to improving outcomes across the whole supply chain and beyond.

It also helps build the case for digital transformation by contributing information that can be used to make a business case for investment.

CASE STUDY

HIGHWAYS ENGLAND

Highways England operates, maintains and improves England's motorway and major trunk road network. There are three underlying imperatives that guide all its activities: safety, customer service and delivery of projects and programmes.

Digital skills and data-based decision-making are recognised by Highways England as critical to its future success. It has recently appointed a chief data officer and is preparing a data and information strategy to optimise use of its data assets. Opportunities include the better use of asset condition data to predict and optimise maintenance programmes, and the development of a network traffic simulation tool – a digital assistant to real-time operational decision making, such as how many lanes to close on a smart motorway in response to an incident.

One of the company's challenges is driving take-up of digital tools and techniques through a tiered supply chain, where it can't dictate exactly how work is carried out. To improve this, it has designed a new procurement approach for its major projects, which enables suppliers to build longer-term relationships with its own supply chain.

Highways England is keen to try out new applications of digital tools in construction using its Innovation Designated Fund to fund trials. In future, these could include use of wearable technology to feed data about the location of site workers back to a data hub, which could send an alert if they step outside the safe working zone.



COMPETING PRIORITIES

"I need money to get things done and I need to get that money wherever I can. I have to compete for and justify my budget internally and I need to make use of all opportunities externally as well."

Innovation director, tier 1 contractor

"Internally it needs to be seen as an imperative to the organisation. You need good leaders for this. It's not just the head of digital, head of innovation, etc. It needs to be seen as an organisational imperative."

Head of learning and development, design consultancy

"A big client needs to make a more concerted effort to bring on innovation. But clients need to trust that contractors can use it well to deliver the building"

Director of innovation, client

"A lot of 50+ men don't get it, they are fearful of it, so won't use it."

Head of new entrants, tier 1 contractor

"We've often been amazed at how technologically savvy some of the older guys, in particular the older site managers, can become quite quickly with a bit of support."

Head of digital and innovation, tier 1 contractor

Other barriers that prevent technology being better used or used more widely are as a result of assumptions that are often misguided.

At a company level, digital construction is often perceived as competing internally with other priorities, for example health and safety, profit or the avoidance of risk – instead of being seen as a means to help achieve these objectives.

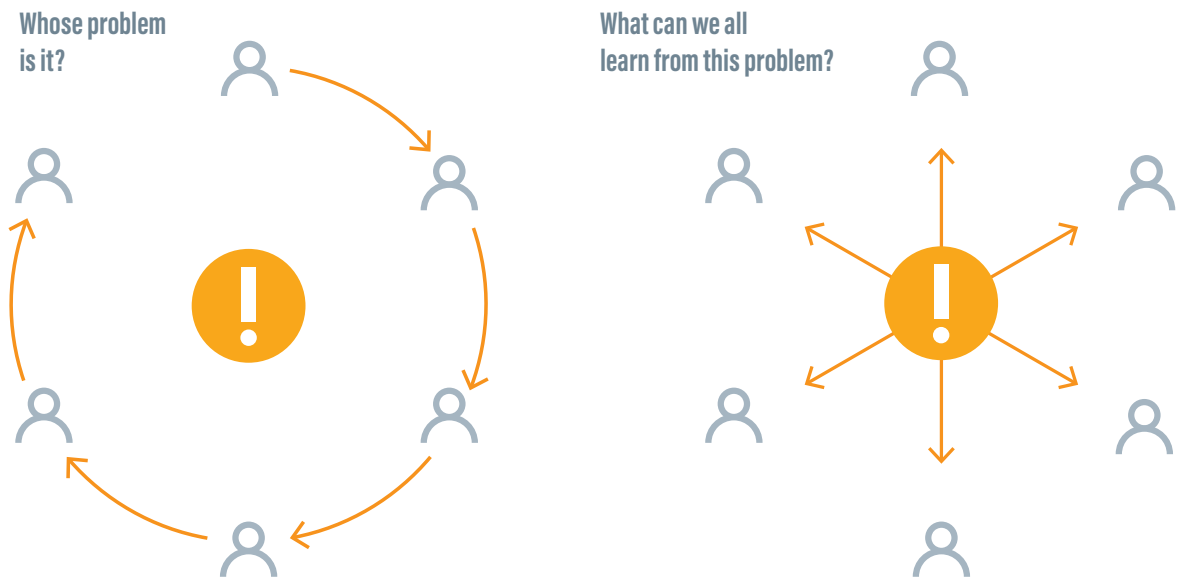
Low profit margins tend to discourage organisations from trying new ways of working, and people working in digital roles describe relentlessly having to compete for budget or corporate attention, using up time and focus which could otherwise be used to innovate and implement technologies.

Several say they often have to resort to workarounds – such as asking clients to demand digital skills on projects so they 'have to' deliver them – rather than achieving buy-in throughout the organisation.

Assumptions about the ability of the workforce – particularly older workers – to take on new digital tools or develop digital literacy mean that sometimes it isn't even attempted.



Figure 2: Relationships between contractors, subcontractors and suppliers



PASSING ON PROBLEMS RATHER THAN SOLUTIONS

"There isn't always knowledge of what has worked well on certain projects and why. The knowledge isn't carried forward. The industry really needs to know what they should be repeating – not just hoping for the best."

Strategist, supplier

"We have hundreds of projects ongoing at any one time. How do we change the way of working across them all and share learnings from across them all?"

Head of digital transformation, engineering consultancy

Going beyond individual companies, supply chain relationships generally do not incentivise investment in skills or innovation. Too often they concentrate on passing on problems – and this discourages supply chain members from learning from things that have gone wrong.

The relationships between contractors and sub-contractors are often built around financial risk aversion, which results in avoiding ownership of problems (see figure 2). The lack of ownership means there is limited motivation to invest in developing new skills or systems. This issue is accentuated by transient staff as flexible contracts across sites don't incentivise personal and professional development within the workforce.

Often neither problems, nor best practice for solutions, are shared across the supply chain, meaning that lessons aren't learnt from the process of integrating technology onsite.

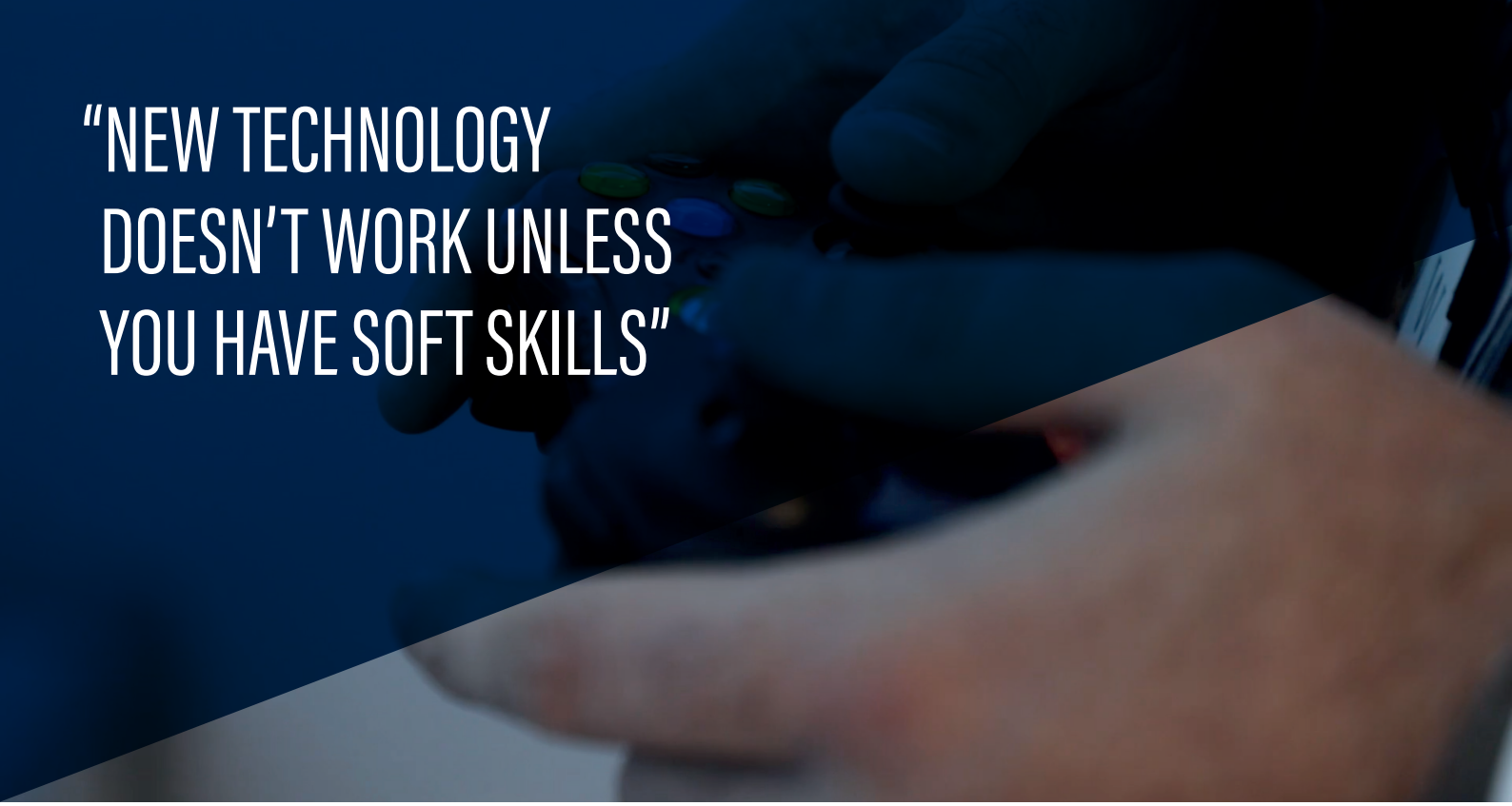
In addition, innovation is often not carried forward from one project to the next even by the same contractor – often because the culture on a different site doesn't support it. Individuals might have digital awareness and skills and then not be encouraged to use them on the next project, where there is a different culture, a different client, different partners or supply chain or a transient workforce.

KEY POINTS

- 'Data' and its effective collection, communication and management is central to digital transformation.
- But genuine understanding of what data management is and what it involves is limited.
- This matters because without understanding what data is, what it can do and how it should be managed, the industry cannot learn from its mistakes, make the improvements it needs or harness the power of technology to solve problems – all of which are required for digital transformation.
- Gaps in communication between sites and senior management can prevent technology being seen as a tool to solve a problem.
- Within companies, digital innovation is often seen as competing with other strategic priorities, rather than a means to support them.
- Supply chain relationships based on avoidance of risk or passing on problems do not incentivise investment in skills or innovation.
- Contractors often don't or can't carry innovation forward from one project to another.



WHAT SKILLS WOULD HELP OVERCOME THE LIMITATIONS AND ENABLE THE INDUSTRY TO MOVE FORWARD?



The previous chapters set out the technologies that are most widely used at present, the barriers to wider and better adoption of technology, and the underlying causes of those barriers.

The next question is: how can the industry overcome these barriers? Digital upskilling is at the heart of what is required – and this requires a fresh approach to assessing the skills needed and the training and learning and development to deliver them.

FOSTERING KNOWLEDGE AND FLEXIBLE MINDSETS

"It's not so much about the technologies but more about upskilling the individual to think differently and work out how they can relate with the technologies."

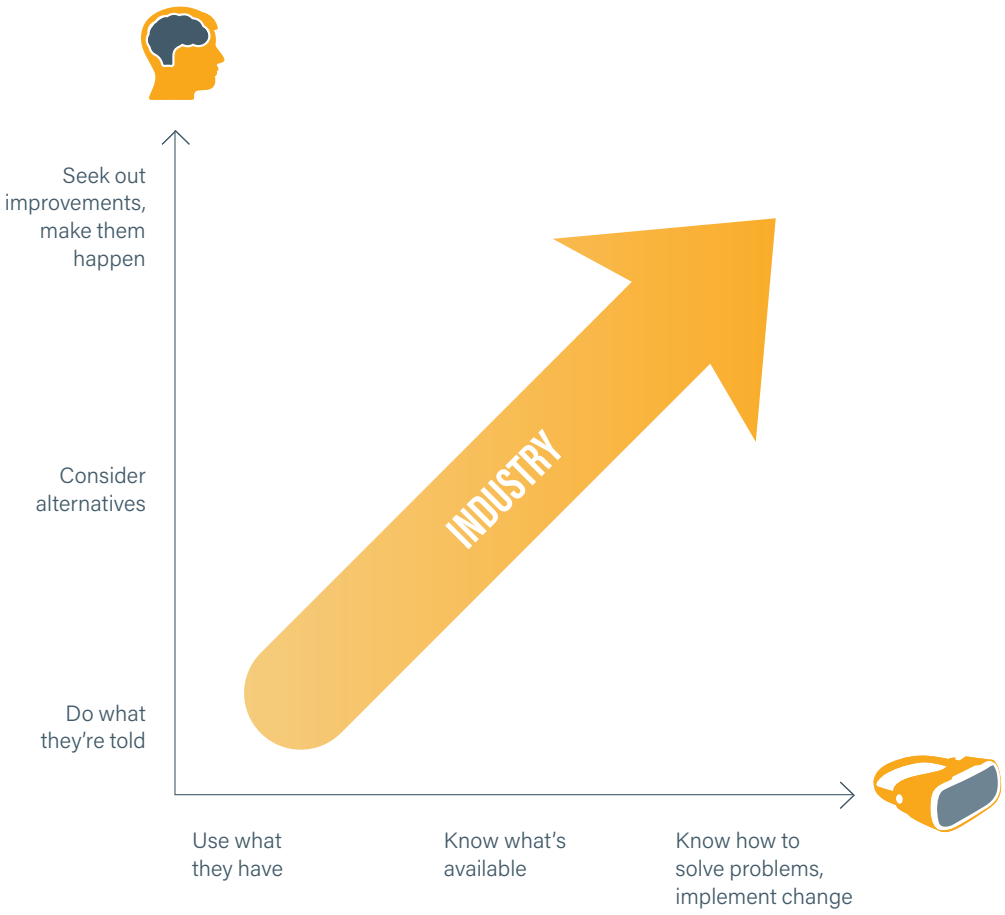
Head of learning and development, tier 1 contractor

There is widespread agreement that it is less useful to train people in skills to use specific technologies, than to **focus on helping the industry and its workforce develop the competencies that will help them adopt and adapt to technology.**

Individual technologies themselves could become obsolete. Meanwhile those that survive and become more widespread are likely to become increasingly intuitive to use.

However, the softer skills and competencies that are needed to underpin technology adoption and use go beyond individual technologies, and therefore bring wider and longer lasting benefits, to both individuals and their employers.

Figure 3: The two groups of competencies needed to push the industry forward



Flexible mindset

- Curiosity
- Problem-solving
- Creativity
- Emotional intelligence
- Communication

Understanding tools and data

- Knowledge of how specific tech works
- Range of tech available/ being developed
- How data can support tech development
- Collecting, storing, sharing, using data

"The industry should not be looking at teaching drones, BIM, etc, it should identify the core underlying skills that people need to have and then apply these to problems as they appear. They need a set of skills that people can use to solve problems."

Government adviser

The necessary competencies can be considered along two spectrums. Digital transformation within construction companies requires both a flexible mindset, and an understanding of digital tools and data.

As demonstrated by figure 3, employees need to be able to:

- **Think creatively about problems and their solutions:** be able to articulate clearly exactly what problem needs solving and thinking beyond what they have to hand about solving it.
- **Understand how to use digital tools:** have an awareness and some knowledge about a wide range of digital platforms and hardware.
- **Assess which tools to use in which circumstances:** be able to assess a wide range of options to find a resolution and identifying when the right tool isn't available.
- **Manage the data that flows to and from the use of these tools:** have an understanding of different types of data and what can be collected, how to share this and what implications it has.



Having a flexible mindset is characterised by having and displaying skills, behaviours and competencies including curiosity, problem-solving, creativity, communication and emotional intelligence.

An understanding of tools and data means knowing what technology is available and what it can be used for, as well as being clear about why and how to collect, store, share and apply the data that supports it or arises from its use.

Bringing together the two sets of competencies detailed above creates the conditions for technology to be used well. What's more, the softer skills these competencies include would help address some of the structural and cultural barriers to wider adoption of technology.

Better communication, problem-solving and creative thinking could reduce inefficient practices within companies and improve working relationships across supply chains.

HOW CLOSE ARE CONSTRUCTION FIRMS TO THIS KIND OF THINKING?

"We need to make sure that the new [computer scientists] we have hired have the training to bring them up to speed with how a construction company works."

Group innovation and knowledge manager, tier 1 contractor

"We're going to need those with analytical problem-solving skills, and with creativity. But it's not just construction that needs these people, it's everyone."

Innovation director, tier 1 contractor

"We are sending our graduates and apprentices as 'tech savvy' people onsite rather than having them in the office. We're using the skills that they already have alongside more traditional people."

Head of digital and innovation, tier 1 contractor

"Human and people skills are becoming much more important. Technology and software does not mean you can collaborate better."

Head of innovation, tier 1 contractor

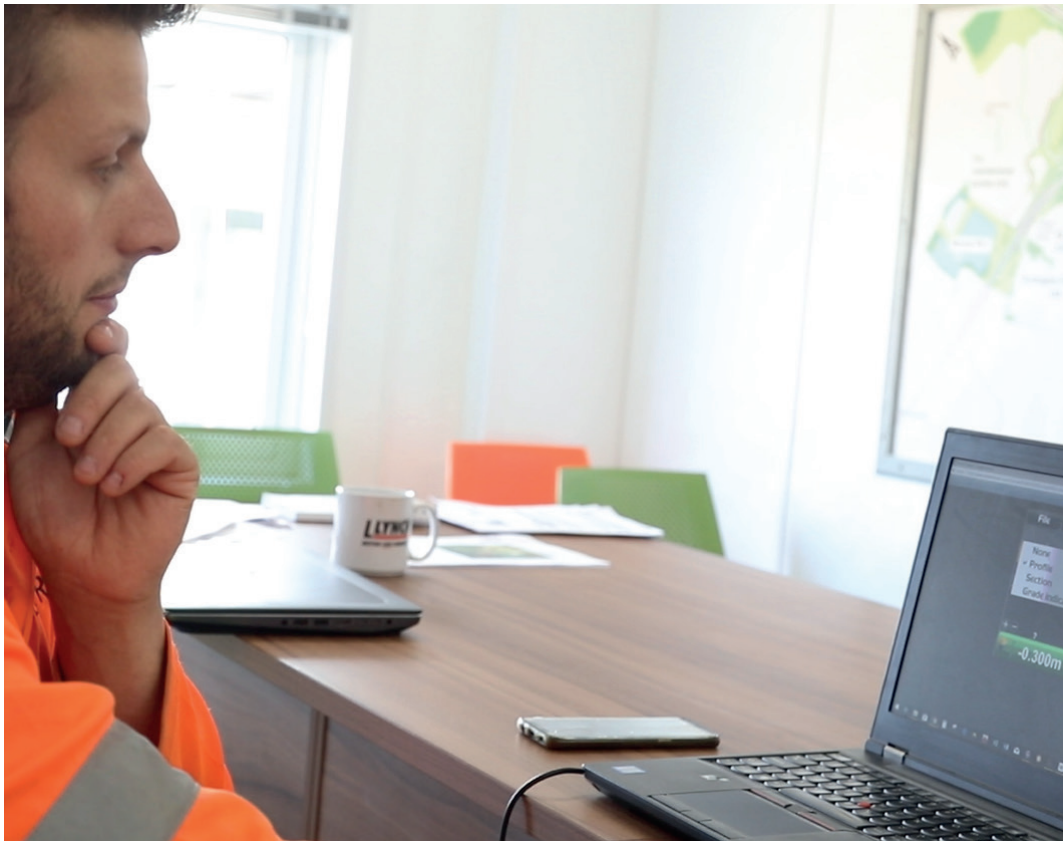
"Flexibility and agility are needed as a skill – taking on board new tech and being open to it. Learning new skills to work with technology and its maintenance. The construction industry doesn't have the core competency to know that things could be done in a different way."

Director of digital technology, tier 1 contractor

Many contractors and consultancies know they need staff who could make better use of technology – and some explicitly recognise that this doesn't just require specific technical skills, but new ways of thinking and working – a wider set of competencies that enable people to adopt technology appropriately, adapt to its use and continue to iterate the ways in which it is used.

To fill gaps in their workforce, some firms are attempting to recruit people with these competencies from outside the sector or targeting school leavers or graduates with different learning backgrounds than those typically recruited from by the construction industry.

Research participants from several companies described seeking out computer science graduates or trying to recruit people with creative or problem-solving skills. However, they recognise that they are competing for these people with every other industry that is going through digital transformation. There is often a lack of clarity about exactly who they need, where they are going to find them, or how they would 'persuade' them to join the industry.



HOW FAR ALONG THIS PATH IS THE INDUSTRY?

"If people need a lot of training, is it really the right thing to be doing? So many technologies are simple and intuitive to use – do they need training?"

Head of digital and innovation, tier 1 contractor

"You can't just buy a piece of tech and then get magical adoption in a company – you need a different approach."

Digital director, tier 1 contractor

"[Developing competencies for digital construction] is not an area that HR deals with. We look after internal training in terms of soft skills."

HR adviser, tier 1 contractor

"Digital is very much about the human interaction with technology – our focus is on upskilling the human element to interact, embrace and take away some of the fear." "

Head of learning and development, tier 1 contractor

"From my perspective the skills that I think have the most impact on improving our operational delivery are things like emotional intelligence, agility and flexibility in decision making and creativity."

Head of learning and development, tier 1 contractor

Those with responsibility for innovation know their businesses need to think about skills and training differently – but they don't necessarily know how to go about it.

By contrast, many people with responsibility for learning and development are not aware that digital construction will require a whole range of competencies, including softer skills such as communication and creativity. With some notable exceptions, directors and senior managers working in HR recruitment or talent and development teams were reluctant to take part in this research, either implicitly or explicitly conveying that talking about digital upskilling was not a priority for them.

Those HR leaders who did engage appreciate the necessity of softer skills among their workforces if their businesses are to successfully utilise and integrate digital technology.

This included at leadership and management levels. It is recognised that construction companies typically promote people into management based on their practical aptitude or professional experience, and often don't train them to develop their people management, communication or creative thinking skills.



"New technology doesn't work unless you have soft skills. How do you communicate about the technology being used?"

Head of talent, tier 1 contractor

"We're on a journey to take the learning, particularly the responsibility for learning, out of the hands of the learning and development function and put it into the hands of the individuals or the employees."

Head of learning and development, tier 1 contractor

"We can't afford to have high attrition, this was the primary driver of having a soft skills agenda and using those skills around technology is a bonus."

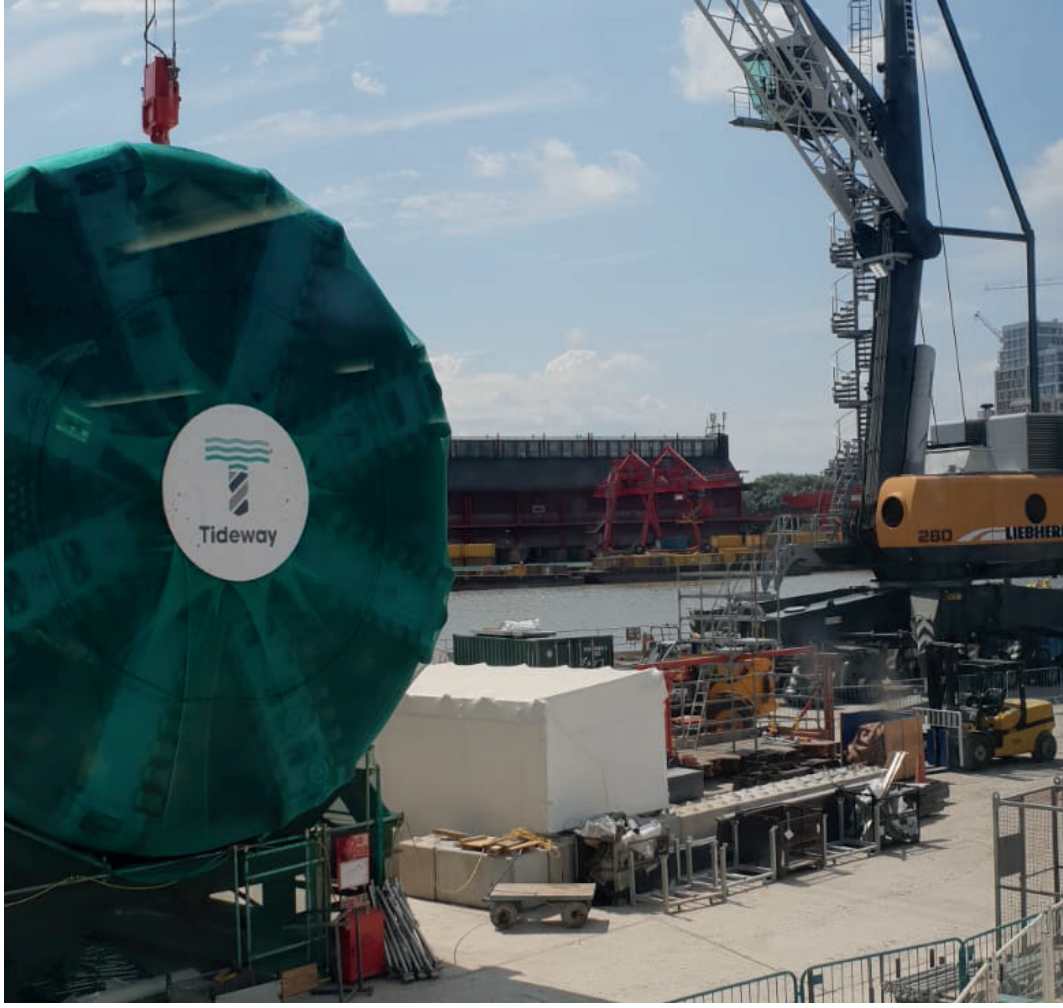
Head of talent and development, tier 1 contractor

"Talent build is a slow process. You need to have the mentality of slower investment but the industry tends to be short term in its view."

Head of learning and development, design consultancy

"Naturally our engineers become our project leaders and directors. But actually that's almost through default rather than design. We have focused very much on functional capability without providing the breadth of capability."

Head of training, tier 1 contractor



Some major contractors and consultancies have developed or are in the process of developing their own digital competency frameworks, but they are in a minority. Where this kind of work has been undertaken it has usually been an iterative process over several years – and is not yet complete.

Those leading these changes describe how developing softer skills can be a challenge for construction, as they require a long-term attitude to investment in people, which is at odds with the frequent focus on short-term outcomes.

But where businesses do start to think specifically about skills such as creativity, problem-solving, communication and flexibility, there are benefits that go beyond the development of digital technologies.

The way companies are training their staff in softer skills is often different from traditional training in the construction industry. Firms are using a mixture of 'bite-sized' or e-learning modules and putting a greater emphasis on individuals taking responsibility for their continual development.

CASE STUDY

MACE 2022 BUSINESS STRATEGY

One of the key priorities in Mace's 2022 business strategy is to develop its people with the skills they need to continue to deliver in the future. As the workplace continually changes and technology advances, Mace is not just focusing on the technical and digital skills required but also on soft skills. It believes that combined, this broad spectrum will enable teams to embrace change and realise the benefits of technology and innovation.

Having previously focused on enhancing leadership skills, Mace is now broadening its development focus to include a wider variety of soft skills. Relevant across the business, people will have greater access to development opportunities to focus on skills such as planning, problem-solving, collaboration and communication. It believes that this vital skill set make a team work best and will equip individuals and teams to embrace new technology, improve digital capability and steer innovative ways of working, now and in the future.

At entry level, some contractors are also trying to embed basic digital skills in apprenticeships.

CASE STUDY

LAING O'ROURKE, TRAILBLAZER APPRENTICESHIPS

"Trade apprentices do not need to be able to design using a model, but they need to be able to get into a model, be able to navigate within a model and to extract the information that they need"

"These are very basic skills – for the generation we have coming through, they have those capabilities. It's about giving them the opportunity to use them."

Alison Lamplough, head of skills and training, Laing O'Rourke

Laing O'Rourke has led on the development on a number of trailblazer apprenticeships for construction, working with other construction employers and CITB.

Alison Lamplough, head of skills and technical training at Laing O'Rourke, says employer groups within construction have built digital capabilities into a number of proposed standards for core construction trades.

In her opinion, digital capabilities should be built into every apprenticeship, whether they are using digital technology or not – and providers of apprenticeships should not be able to teach without digital models.

TRAINING PROVIDERS ARE STARTING TO THINK ABOUT SOFTER SKILLS

This research specifically sought out training providers offering training in digital skills and using digital technologies, to better understand how they have engaged with the industry and the challenges and successes they have experienced in adapting their offer.

Some training providers are trying to find ways to embed digital competencies, attitudes and softer skills through their teaching practices to establish norms around digital proficiency and practice.

Most of these are quick to identify the importance of transferable skills, identifying flexibility and problem-solving as crucial. To this end, many are openly targeting and looking to develop a next generation of construction workers who have more creative mindsets. One training college is actively looking to attract students with creative backgrounds who are more likely to have skills applicable to 3D modelling than those from traditional engineering backgrounds.

Providers and colleges are aware that younger people's perception of the construction industry needs to change if it is to be more appealing to them.

CASE STUDY

"No one talks about speed or processors or RAM anymore –it's about what you can do with it."

Ian Heptonstall, director, Supply Chain Sustainability School

THE SUPPLY CHAIN SUSTAINABILITY SCHOOL

The Supply Chain Sustainability School provides free online and face-to-face training resources for construction companies in the supply chain, funded by CITB and the school's 77 partner organisations. These partners include clients, contractors and tier one suppliers, which share the common goal of upskilling the supply chain.

Training is offered in sustainability, offsite, BIM, Lean and management. Members complete a self-assessment to receive a personalised action plan. Technology features in some of the resources, and the school plans to develop more content around technology in future.

Ian Heptonstall, director of the school, believes it is down to technology suppliers to make technology as simple to use as possible. He says the focus should not be on the technology itself but rather what it can be used for.

He sees the Supply Chain School's role as helping to showcase how technology is solving problems, and demonstrating how businesses in the supply chain can go about adopting technology themselves, for example how they develop skills to make the business case.

CASE STUDY

DUDLEY COLLEGE OF TECHNOLOGY

At its new £12m Centre for Advanced Building Technologies: Dudley Advance II, Dudley College of Technology provides a full-range of programmes to boost professional and technical skills in the sector through higher professional level apprenticeships and technical upskilling via shorter training programmes for people who are already working in the industry.

The curriculum focuses on using digital technologies to deliver learning across disciplines including: building services engineering, civil engineering, construction design and building information modelling and environmental technologies.

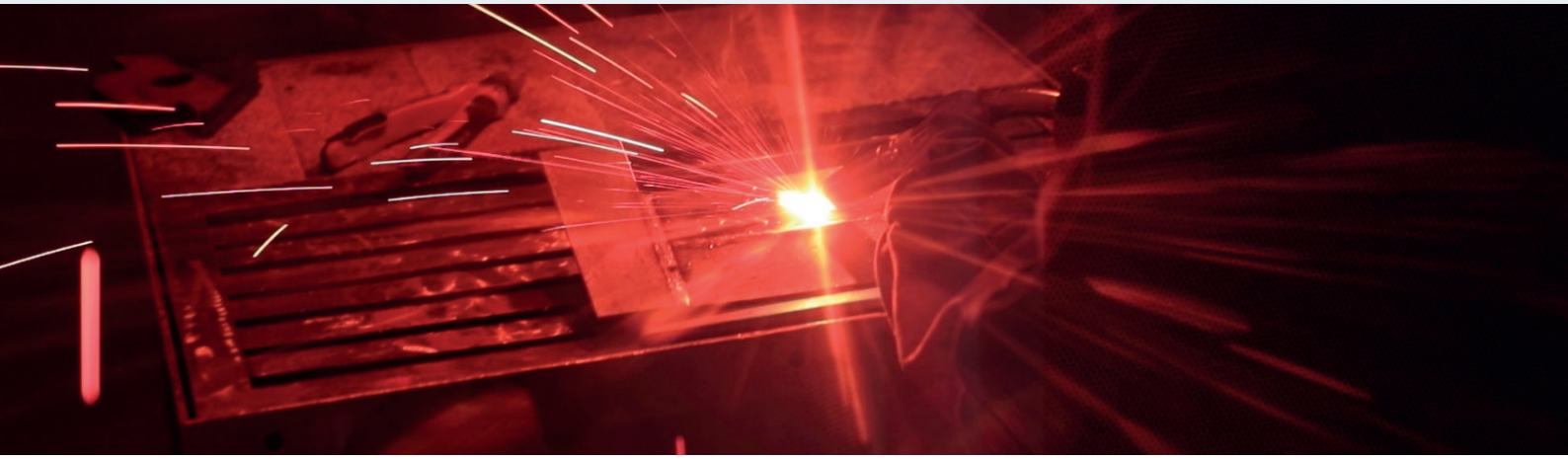
Training involves using drones for surveying on actual sites using virtual reality to master skills such as welding and making use of 3D printers to prototype objects. Students have access to a range of digital technology, including an Oculus lens, a Gear 360 camera and HoloLens for exploring mixed reality.

Advance II has a four-storey high 'hangar' where students are taught the practical know-how required for fabricating and assembling buildings using the latest available technologies.

Teaching staff are encouraged to develop their expertise outside of work and are sent on training courses to keep their knowledge up-to-date. This is supported by a wide number of industry partners who provide professional updating and knowledge exchange in return for use of the facilities.

Employers are encouraged to work with the college to help ensure the curriculum is both future-focused and equips students with the skills the sector currently needs.

Staff see their mission as being both to work with, and transform the sector.





COMPARISON WITH OTHER SECTORS

In many ways, the journey that construction is on with digital technology mirrors the experiences of organisations working across other industries as they also aim to integrate more innovative, digital tools into existing practices. Some other sectors, like finance, are further down the road, but many seem to be in a situation similar to construction[6].

Across the board, most recognise the potential impact of softer skills and flexible mindsets that allow teams and employees to find reasons to use technology, means of integrating it and ways to adapt their working practices around it.

6 Government is also pushing for digital upskilling across the whole economy: UK Digital Strategy 2017, UK Gov – https://www.gov.uk/government/publications/uk-digital-strategy/4-the-wider-economy-helping-every-british-business-become-a-digital-business. And see: Digital skills and inclusion - giving everyone access to the digital skills they need. HM government. 2017. https://www.gov.uk/government/publications/uk-digital-strategy/2-digital-skills-and-inclusion-giving-everyone-access-to-the-digital-skills-they-need

RELATED SECTOR

IMMERSE UK

Set up in 2016 by Innovate UK's Knowledge Transfer Network, Immerse UK is a special interest group which brings together industry, researchers and research organisations, the public sector, entrepreneurs, innovators and end users to support the UK in becoming the global leader in applications of immersive technologies.

In its 2018 report 'The immersive economy in the UK', Immerse UK identified skills shortages as one of the biggest challenges facing the sector. Businesses reported concerns around the supply of skills from education too, with one company stating that they "needed graduates to come on stream with the right skillset, but, in a period of rapid innovation, they also needed people who were knowledgeable about conventions but also flexible".

The report said it was difficult for educational institutions to design appropriate curricula due to uncertainty around what skill sets are needed and where these gaps are – which requires further research.

There is currently no single body leading on immersive technology skills within the UK, but Immerse UK, in conjunction with its industry advisory board and relevant skills organisations, is looking at ways to address the issue. Immerse UK has also recently promoted Creative Skillset's consultation on national occupational standards for immersive technology in film, TV and games. Immerse UK is hoping these standards could inform or be adapted to serve other sectors.

RELATED SECTOR

HEALTH AND SOCIAL CARE

The King's Fund, an independent charity working to improve health and care in England, recently released a report to help the health and social care sector better adapt to digital transformation, with a focus on the necessary skills within the workforce. Sector-wide adoption of digital technologies and the necessary change in working practices to support this have been discussed for a long-time as valuable in terms of patient outcomes and experience as well as information management and efficiency.

The King's Fund visited a series of NHS trusts that had started to implement large-scale digital change, integrating a range of technologies and data management into their working practices. It gathered information and observed practice to produce a series of lessons and recommendations.

Like construction, the industry has a challenge with data. For health and social care, this focuses on sharing patient information to enable decision-making and support options. This is difficult from a legal perspective and technically – getting software across organisations that speaks to each other. Some of the things that have been learned about adopting digital in health and social care include:

- Where change has happened, it hasn't always been driven by senior leadership, but by passionate and capable middle-management who are open to new ways of working and inspire others to try something new.
- Levels of risk aversion are similar to the construction industry, focused on the impact of any change in practice on patient care. This means there is some hesitancy around implementing new digital ways of working.
- The language of digital technologies has been equally challenging in health and social care, sometimes requiring key staff, or 'digital champions' to actively translate and simplify some of the technical language for clinicals and care workers.
- Tight budgets across the NHS can mean that digital projects can be driven by short-term concerns and limit what could be possible in terms of digital adoption.
- The most successful NHS trusts invested in their people, training them to work more effectively with digital tools and motivating them to find challenges that could be resolved with a digital solution.

RELATED SECTOR

BRITISH RETAIL CONSORTIUM

"For the most part the jobs we're talking about don't necessarily exist. We expect the future of retail to be more cross-functional, drawing people in with different specialities and capabilities to deliver the required outcome."

"While the industry is in the midst of transformation we hope the framework will support people to understand what skills and capabilities are needed without necessarily knowing what the specific role is."

Fionnuala Horrocks-Burns, employment and skills policy adviser, BRC

As part of its Better Jobs campaign, the trade association for UK retailers has been exploring the future of retail from a workforce perspective, considering the skills and capabilities employees will need as the industry changes.

This has included exploring the digital skills needed by individuals and the businesses they work for, from the confidence and skills needed to use tablets in front of customers, to the specialist data analysis skills required to manage information about consumers and supply chains. Having identified a gap in the evidence base, the BRC has started gathering information on digital skills among the retail workforce via its surveys of employers and employees.

Like construction companies, retailers face challenges recruiting people with specialist digital skills. To tackle this, some retailers have set up central city 'hubs' to help attract people who might not consider the retail industry a leader in digital technology or want to work in an out-of-town head office. The BRC is working to help its members communicate the digital opportunities.

The consortium is also developing a career framework for retail, which considers how the ongoing transformation of the industry will impact the skills, capabilities and behaviours of colleagues. This includes, but is not limited to, digital skills and capabilities. They expect the framework to be relevant to people considering a career in retail, those working in retail who are considering their next career steps and retailers' HR teams who are mapping out learning and development processes or reviewing roles.

KEY POINTS

- There is agreement that it is less useful to train people to use specific technologies that could become obsolete or increasingly intuitive to use, than to focus on developing the competencies that will help them adopt and adapt to technology.
- Digital construction requires new ways of thinking and working – both a flexible mindset and an understanding of digital tools and data.
- Some firms are attempting to recruit people with these digital competencies from outside the sector – but they are not always clear exactly what outcome they are trying to achieve.
- Managers with responsibility for digital or innovation understand that their businesses require different skills and competencies – but don't necessarily know what to do about this.
- Some managers with responsibility for training/learning and development at larger contractors and consultancies are developing competency frameworks in line with this thinking.
- Training providers are finding ways to embed these attitudes, competencies and softer skills through their teaching practices.
- Other industries are experiencing similar challenges trying to understand when and where to integrate digital technologies in practices and processes.



SHARED GOALS TO CLARIFY SKILLS NEEDS AND OPPORTUNITIES



"I'M SURPRISED THAT AS AN INDUSTRY WE DON'T HAVE A COMPETENCY FRAMEWORK"

"It was first about tech adoption and now this has moved to people and competency. We shouldn't just be looking at tech – it's more about digital awareness."

Digital director, engineering consultancy

Despite enthusiasm for and engagement with the idea of better integrating digital technology from people in a range of roles within construction, there is still confusion and uncertainty about how to move forward. This report has set out the need for more soft skills, a flexible mindset and creative thinking – all of which are broad concepts.

The industry needs more coherent goals around what everyone should be working to achieve and greater clarity around the skills that are required and should be expected at different levels.

Here we set out the components of an overarching framework for understanding the digital skills and competencies that are needed at different levels and in various parts of the industry.

SCALE OF DIGITAL COMPETENCY

The scale of digital competency on the next page sets out six levels of capability in using technology at work. Starting from no experience of using technology, it builds up to knowing how to use the technology to solve a specific problem (figure 4, scale of digital competency).

The scale was developed firstly by reviewing other digital skills frameworks being used across a range of industries, such as finance, health and technology[7]. This was combined with analysis of the interviews with experts and digital leaders within construction alongside further reading and understanding of how digital technology is used more widely (such as consumer products)[8].

This scale should act a starting point for the construction industry. It could be used at an industry-wide level to map out workers' competency levels or it could be used by an organisation to assess its employees or supply chain workers – and then to consider where it wants them to be.

7 See: 1) The Digital Competence Framework for Citizens with eight proficiency levels and examples of use. European Commission. 2017. https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/digcomp-21-digital-competence-framework-citizens-eight-proficiency-levels-and-examples-use; 2) Essential Digital Skills Framework. The Tech Partnership. 2018. https://www.thetechpartnership.com/basic-digital-skills/basic-digital-skills-framework/; 3) SFIA Plus in detail. British Computer Society. https://na.bcs.org/upload/pdf/sfiaplus-us-pack.pdf; 4) Through the Looking Glass. Revealing Reality. 2018. https://www.revealingreality.co.uk/wp-content/uploads/2018/04/RR-THROUGH-THE-LOOKING-GLASS-framework-bw-8a.pdf; 5) Which digital skills do you really need?. Nesta. 2018.https://media.nesta.org.uk/documents/Which_digital_skills_do_you_really_need.pdf

8 For example see: Selfie: How the West Became Self-Obsessed. Will Storr. Picador. 2018; iGen. Jean Twenge. Atria Books. 2017; The Shallows: How the internet is changing the way we think, read and remember. Nicholas Carr. Atlantic books. 2011; You Are Not A Gadget: A Manifesto. Jaron Lanier. Penguin. 2011; Mind Change: How digital technologies are leaving their mark on our brains. Susan Greenfield. Rider. 2015.

Figure 4: Scale of digital competency



MAPPING EMPLOYEES ONTO THIS SCALE

"Digital skills need to be taught to site managers... we don't see much point in the labourers knowing how to use things."

Design consultancy

"Builders and labourers don't need to be digitally literate onsite, they just need to know what job they have to do. It's more the domain of engineers and site managers."

Technology and innovation manager, tier 1 contractor

It's possible to consider those working in the industry as sitting along a spectrum, where those at the top of an organisation generally have the most strategic responsibilities, longer-term horizons, wider channels of communication, most autonomy and are largely office-based. Those at the bottom have operational responsibilities, tend to have a shorter term outlook, communicate with fewer people, have little autonomy and are generally site-based. This is represented in figure 5 below.

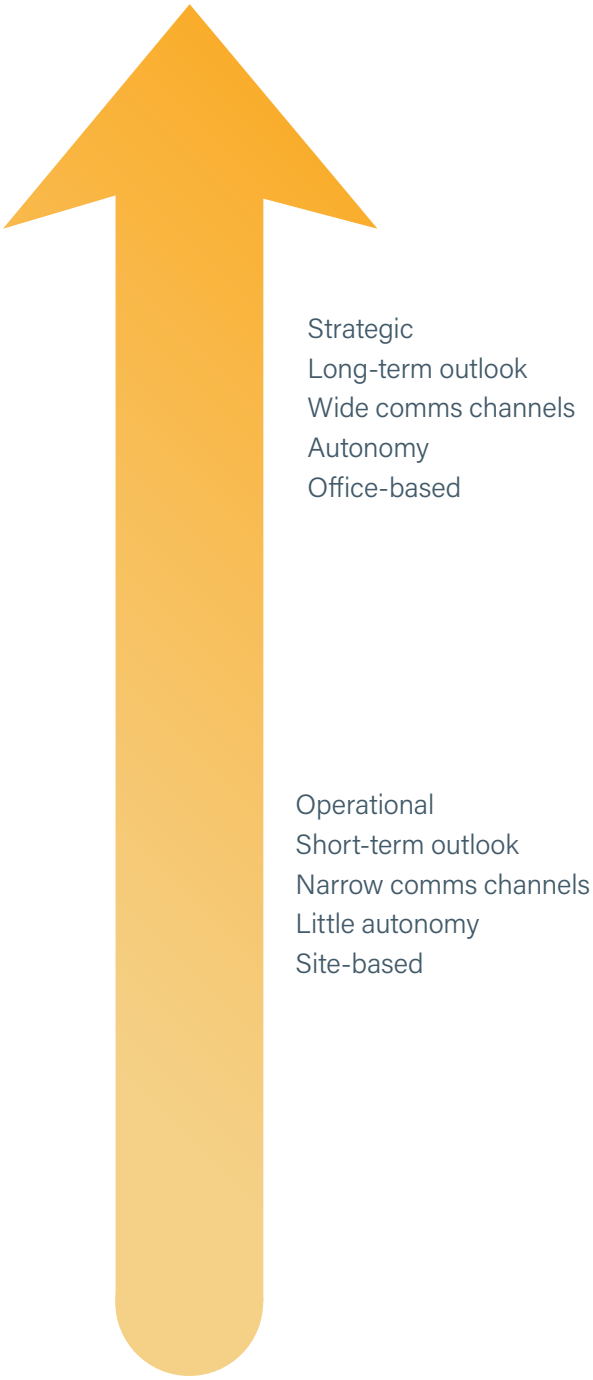


Figure 5: Overview of role characteristics at different levels

"We need to realise that everyone needs a basic level of understanding of the technology. We shouldn't be creating islands of innovation but instead bring in the whole community – leaders, managers, juniors."

Head of talent, tier 1 contractor

"One of our biggest challenges now is training soft skills for leaders: what it means to be a good line manager, soft skills behaviour for success, collaborating, networking, planning, problem-solving, leading."

Head of talent and development, tier 1 contractor

Taking figure 5 together with figure 4 helps visualise which groups of workers need additional skills and competencies, and what these should look like.

There are some differences in views about where the focus of digital upskilling should be – but the divergence is not stark.

Generally, the people starting to use and implement technology solutions were site managers and engineers. Managers were also more often the advocates of new technologies.

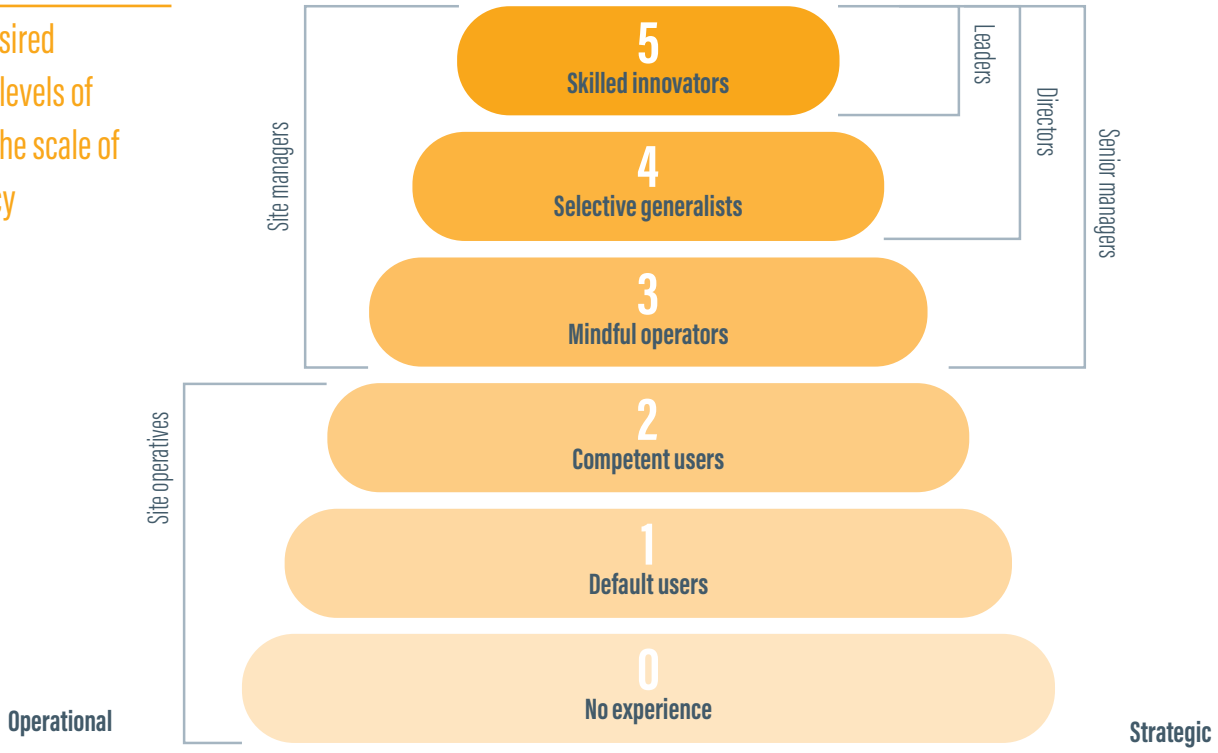
In addition, many site supervisors found they could work more efficiently using 'lower level' technologies such as digital tablets. In most cases technologies did not yet affect the daily tasks of labourers.

Leaders need to understand how technology could be used and what problems it could solve in order to grasp the opportunities offered by digital construction – they can then drive through the required changes to organisational structure, investment in skills and shift in culture.

Managers and operatives will then be empowered from the top to fully develop and apply digital competencies.

Based on these findings, desired competency levels for workers across the industry could look like figure 6:

Figure 6: Desired competency levels of staff across the scale of digital literacy



TRAINING FOR DIGITAL SKILLS

As previously outlined, digital transformation within construction companies requires both a flexible mindset, and an understanding of digital tools and data.

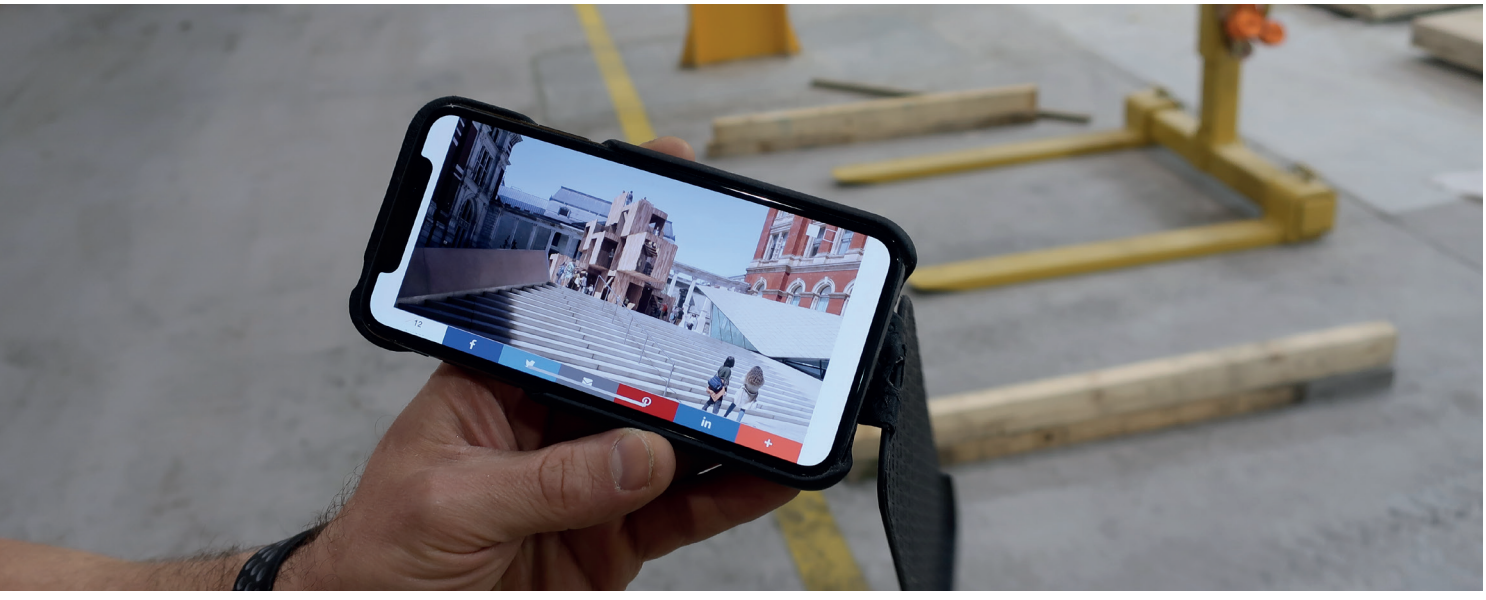
People need to be able to:

- Think creatively about problems and their solutions.
- Understand how to use digital tools.
- Assess which tools to use in which circumstances.
- Manage the data that flows to and from the use of these tools.

Training needs should therefore be considered against both the competencies required and the outcomes that are desired. These scales can be used to map where people are in terms of competency levels, consider where they need to get to, and agree what training will help them get there.

For example, as illustrated in figure 7 (right), the industry might need a lot of workers with a basic level of digital competency. At these levels, the priority is likely to be to move them 'up' a level or two, so they are a 'competent users'. As the industry requires a lot of competent users, some may be closer to the x axis than the y axis, or vice versa.

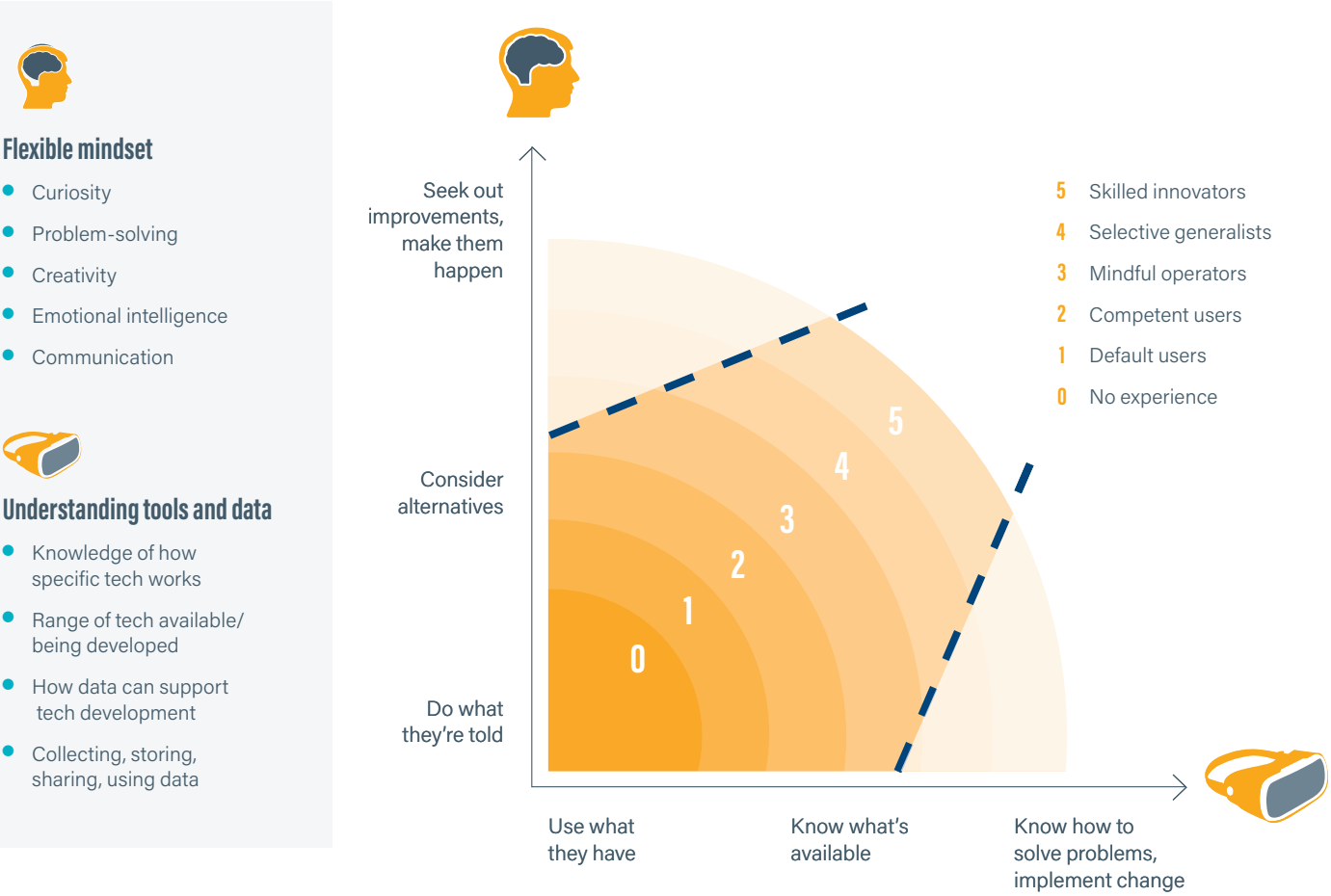
The dotted blue lines in figure 7 indicate how training should focus the skills and knowledge of workers at different levels. For example, the industry can afford for some of its level 2 'competent users' to have a better-developed flexible mindset but a slightly weaker understanding of tools and data – and the other way around.



However, once workers are required to operate at a higher level of digital competency – say level 3 and above – those workers need to have a blend of both sets of skills and competencies. It is not desirable for the industry if people's competencies are too far over towards one axis or the other. In figure 7 we can see that the red lines show that the skills of employees in levels 3 and above need to ensure they have training that develops both their flexible mindset and their understanding of tools and data.

From these scales and spectrums, next steps could include creating a more detailed framework to map out what individual occupations and activities need to be able to do. This would allow those with responsibilities for designing and delivering training courses to explore what elements they can deliver.

Figure 7: Spread of skills in different roles



KEY POINTS

These scales and spectrums enable CITB and the industry to consider:

- How workers can be supported and trained to develop appropriate mindsets and an understanding of tools and data.
- What messages need to be targeted towards different levels within an organisation, e.g. site worker, operational manager, director.
- How strategic teams can or should be more involved in understanding the benefits technology can bring and considering investment.
- How operational teams can be helped to identify problems that technology can help solve.

Next steps could include creating a more detailed framework to map out requirements or expectations for individual occupations and activities.



CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Most people in construction agree that digital innovation can bring benefits to their onsite processes in terms of efficiency and productivity, and that the industry needs to take a leap forward in its adoption of digital technology.

Contractors, consultancies and clients are **increasingly using technology,** particularly onsite tablets, AR and VR, drones and semi-automated machines. But the scope of what digital could be used to achieve in construction is vast and, at present, the industry is far from realising the full scale of the opportunities.

The most sophisticated businesses see **digital technologies as a tool** that can help them resolve problems or make gains onsite. Others purchase technology and then hope to find a use for it. Many are still not using technology widely at all.

There are a number of **barriers** that limit the industry in taking up more digital technologies onsite. Many are confused by what digital construction is and what differences it could make in practice. There is no consensus on what specific technologies will be used most widely, making it difficult to focus efforts and interest. Those leading on digital construction experience a daily challenge in making the case for technology, which is often seen as being in competition with profit, risk management or health and safety imperatives.

The industry's understanding and use of data is mostly limited to BIM, with only a few starting to look beyond this narrow perception of data management at what data their organisation could be using in decision-making and how they should be collecting, communicating and organising it.

Without **understanding data**, what it can do and how it can be harnessed, the power of technology will not be realised. This is exacerbated by cultural or structural habits that hold back supply chains from sharing learning and feedback.

There is consensus that to move forward, the industry must think beyond equipping its workforce with the skills to operate specific types of technology. Instead, digital upskilling must focus on developing **digital competencies at all levels** – leadership, management and site workers – to better adopt and adapt to technology.

Developing flexible attitudes, creative and problem-solving mindsets and a range of other softer skills alongside an understanding of technology and data could help the industry take great strides in its digital transformation – and potentially reduce some of the cultural and structural barriers to its uptake.

This report sets out some tools – **digital competency scales and spectrums** for the industry – that outline how workers can be supported and trained to develop the required mindsets and understanding.



RECOMMENDATIONS

CITB has a vital role in taking this further – but will require the support of employers, industry bodies and the government to make the most of the opportunities.

Based on the findings from this research, it is recommended that CITB, industry and other stakeholders work together towards the following outcomes:

- Using the digital competency scales developed from this research, the industry agrees common goals and a plan of action to increase digital skills in line with ambitions for digital transformation throughout UK construction.
- The current and future workforce has the right digital skills:
  - Business leaders are equipped with the skills and knowledge to implement digital technologies, processes and competences in their business, including changes to HR activities.
  - Digital competence requirements across the built environment sector are standardised and embedded in qualifications, training and employer HR planning.
  - Training is available and undertaken to deliver standardised competencies across the sector, both as part of formal qualifications and continuous learning.
- Industry can compete with other industries to attract and retain specialist digital roles.

The next chapter sets out the CITB's response to these recommendations.



CITB'S RESPONSE



Stephen Radley
Policy Director, CITB

It's clear from the findings set out in this report that the industry has a huge opportunity. However, the skills challenge is sector-wide and stretches from the boardroom across the supply chain. So we need to take act now with the support of industry and government.

We believe that this research can be a starting point for change that begins with a common definition of digital skills and agreement on where we need to get to. Below we set out what we as CITB are going to do to achieve the recommended outcomes and what we would like to see industry, Construction Leadership Council and government do to support.

Supporting industry to agree common goals for digital skills

A fragmented understanding of digital skills and who needs what is holding industry back. The digital competency scales presented in this report provide a framework to agree priorities. We will work with industry, including hosting roundtable discussions, to achieve consensus on digital skills goals and a plan of action to achieve them that garners cross-industry buy-in.

We recognise that this skills challenge is not isolated to construction. The government, through its UK Digital Strategy, has outlined relevant skills initiatives. We intend to work with government, including the Department for Digital, Culture, Media and Sport, to identify how **relevant policies, initiatives such as the Digital Skills Partnership and cross-sector knowledge can be leveraged to support construction** and vice versa.

The ambitions for skills are dependent on sufficient demand from industry for digitalisation. A commitment for skills needs to be supported by a drive from the **Construction Leadership Council to promote industry uptake of digital technologies** in line with Construction Leadership Council targets. This could include wider sharing of the benefits of digital adoption and best practice examples of use.

There is also a role for clients, in particular government as a major procurer, to **promote the right contractual conditions and project structures** that support successful innovation and investment in skills, for example Crossrail, Tideway and the Project 13 initiative.

Funding and influencing to drive widespread digital competencies

The research shows that to ensure the workforce has the right digital skills, skills interventions need to be targeted at different levels. This needs to start at the top; equipping leaders with the know-how to digitise their businesses and create the right conditions for a digitally competent workforce.

The wider workforce, both existing and future, needs to be equipped with role-specific and generic competencies.

CITB will use its funding and influencing activity to deliver interventions that will support these needs – from leadership programmes to standardised competencies and training for the supply chain. Funding will be directed to industry initiatives that deliver wide scale and ongoing impact.

We will also use our ability to influence industry stakeholders, government and the training sector to drive uptake and commitment to the activities. **Industry and government also has a role here to ensure that competencies are reflected in relevant apprenticeship standards** and T levels.

A unified industry approach to attracting the top digital talent

Finally, in line with the definition of competencies, industry needs to agree what specialist digital roles it needs and how they will be used.

Once it has done this, it will need to develop common messages and work on campaigns to 'sell' the industry to the required talent. This is likely to include emphasising the sector's ability to make a difference to society, or the opportunity to work in a job with tangible results and a potentially major impact, but it will also need industry to consider whether it will require a culture shift to make construction a desirable industry to join and stay with.

CITB will work with the Construction Leadership Council Skills workstream to ensure industry career campaigns build in messaging and activities to attract new digital skills. We will also scope out the potential to work with other sector bodies to generate awareness of opportunities.

There is no question that the industry needs to upskill and recruit new talent to make the most of the huge opportunities digital technologies hold for UK construction. It's not too late – but it won't happen on its own.

We are excited about the industry's digital future, and as the training and skills board we know that future depends on the people who work in the industry.

We are keen to begin working on the transformation required – led by an industry motivated to modernise.



APPENDICES

APPENDIX 1: METHODOLOGY

The potential range of digital technologies that could have been included within this work is considerable. The scope was refined based on initial research into the technologies that are most frequently discussed by industry and appeared to be in use on some construction sites at present. These included:

- **Augmented reality/virtual reality:** Augmented reality is an interactive experience whereby computer-generated images and information are overlaid onto the real-world environment. Virtual reality is a fully computer-generated experience taking place in a simulated environment to provide an audio, visual and other sensory interaction that enables people to interact with the environment around them.
- **Automation:** This includes onsite robotics and semi-/autonomous vehicles – whereby often driverless vehicles are capable of sensing the environment around them and navigating without human input. They can programmed to fulfil certain tasks and some require an operator.
- **Drones/unmanned aerial vehicles (UAVs):** Drones (UAVs) are small aircrafts that don't have a human pilot, instead using a ground-based controller to direct the aircraft. They can fly either under the remote control of someone on the ground, or autonomously by programming onboard computers.
- **3D printing:** 3D printing is any of various processes in which material is joined or solidified under computer control to create a three-dimensional object.
- **Artificial intelligence (AI):** In computer science, AI is described as any device that can perceive its environment and take actions to achieve a specific goal.
- **Wearable technology (e.g. exoskeletons):** Wearable technology refers to electronic devices that can be incorporated into clothing or worn on the body as implants or accessories.
- **Lidar:** Lidar is a surveying method that measures distance to a target by illuminating the target with pulsed laser light and measuring the reflected pulses with a sensor.
- **The 'Internet of Things':** The IoT is a network of and inter-connected devices that are able to connect, collect and exchange data between them.
- **Productivity/planning apps:** This includes mobile device tools that help workers view or capture data to manage workflows, track progress, plan work, monitor risks.
- **Data analytics:**Data analytics is the process of examining data sets in order to analyse behavioural data and patterns, usually with the aid of specialized systems and software.

The approach to exploring how these technologies are used on construction sites was qualitative and iterative. It started with a scoping phase to understand the overarching trends across the construction industry in terms of digital technologies and perceived skills needs. Alongside desk research, which included news articles, academic papers and industry reports (bibliography available in appendix 2), 15

digital and technology experts were interviewed from construction and other relevant sectors to help develop an overall picture of technology adoption and digital skills across the industry and provide the basis for questioning during the core of the fieldwork.

This fieldwork included 30 depth interviews (either over the phone or in-person) to investigate the experiences of construction businesses when integrating digital technologies into their onsite practices and the implications for their workforce and skills. Alongside this, there were five fieldwork visits to employers using these technologies, observe how it worked and was used in practice, and speak to people onsite about how it had helped them.

The goal of these interviews and site visits was to explore both attitudes towards technology and its role in construction across the whole of the UK, as well as the experiences of trying to implement these technologies onsite and the key barriers to further uptake. The focus was on companies that were using or attempting to use technology at present – the leading edge in terms of industry adoption of digital construction methods – as this was where the greatest insight could be gained.

Understanding these elements helped further examine and analyse the implications for the workforce and skills. Interviews covered how any skills gaps were currently being filled, including training, sub-contracting specific practices and hiring staff from outside construction.

Sampling

Interviewees included worked across 35 organisations, consisting of:

- **10 tier 1 contractors**
- **3 subcontractors**
- **2 clients**
- **4 training providers**
- **2 trade bodies**
- **4 construction/engineering consultancies**
- **5 technology specialists of different sorts (suppliers, digital consultants, digital comms/events)**
- **1 academic**
- **4 related worlds**

Staff who were interviewed typically held management positions in digital and innovation but also included staff working in talent and workforce development.

From our analysis, it became apparent that the industry was keen to develop new digital skills but faced a series of barriers which made them currently unable to do so efficiently.

APPENDIX 2: BIBLIOGRAPHY

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REVEALING REALITY

Study prepared by Revealing Reality from a commission by CITB.

The views expressed by research participants are their own and do not necessarily represent those of their employers.

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Revealing Reality
Revealing Reality is an independent insight and innovation agency.

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