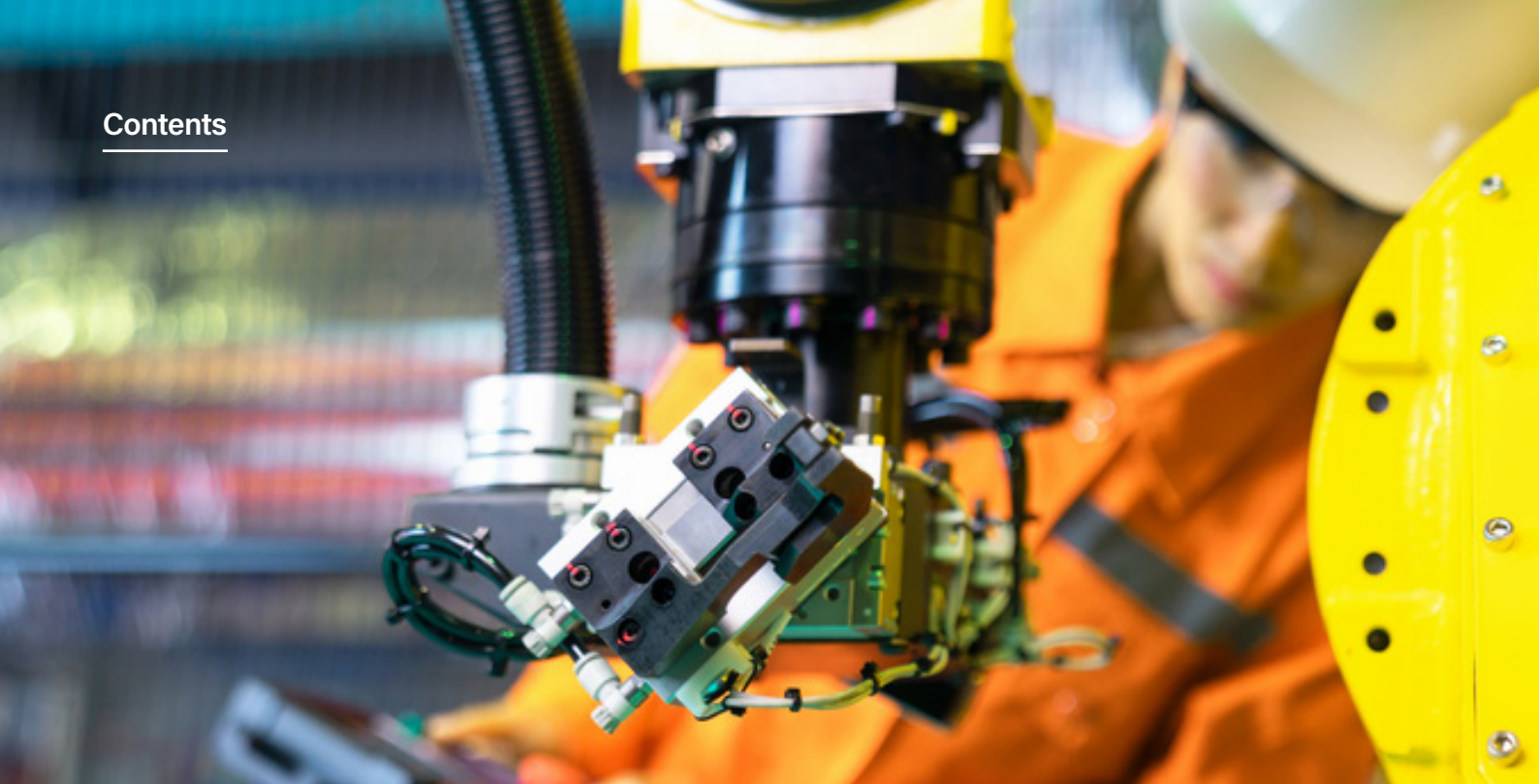


A photograph of a man in a white t-shirt and khaki trousers operating a large, orange and red industrial robotic arm in a factory setting. The man is holding a handheld device connected to the robot. A large, semi-transparent purple circle is overlaid on the left side of the image, containing the title and subtitle text.

# A CHALLENGE AND AN OPPORTUNITY:

Artificial Intelligence  
and Automation in the  
Construction Industry



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The coronavirus pandemic, Brexit and the decarbonisation agenda are radical, game-changing forces that are already reshaping our society. In turn, they are changing the way the industries that drive our economy must function if they are to stay fit for purpose.

One of the biggest industries in the UK, employing over 2.7 million people and contributing 8% of output, construction is central to the economy. As such, the industry will be key to the rebuilding effort required once the current crisis is over.

But COVID-19, Brexit and decarbonisation are not the only engines of change in today's world. Technological innovation is advancing at an ever-more rapid pace and, for our industry, some of this innovation will revolutionise what we do and how we do it.

A new cohort of workers with new skills will be required, while the existing workforce will need to adapt and, in many instances, retrain.

This is an enormous challenge. But it is also an enormous opportunity to open construction to a broader, more diverse set of people, able to apply themselves to build the infrastructure and homes we need for the 21st century.

Indeed, if anything, the pandemic has acted as a catalyst for technology driven changes to the construction sector that have been taking place – albeit slowly – over the past decade.

Progress over the past 10 years has been driven in large part by the widespread adoption of Building Information Modeling (BIM). And while BIM has served as a great demonstration of the transformative power of technology, it is likely that more widespread digitalisation, automation and artificial intelligence (AI) will be the technologies that help the sector make the next leap forward.

The Construction Leadership Council's (CLC's) *'Roadmap to Recovery'*, published in June 2020 identified the adoption of digital and manufacturing technologies – such as the use of offsite or 'modern methods of construction' (MMC) as key to what it called the 'reinvent' phase of the recovery from the Covid-19 pandemic. The CLC predicted that adopting these technologies at scale could be worth as much as £15bn per year to the industry through increased efficiencies.

In the CITB's strategic plan for the next five years, we also identified the development of digital skills and processes, including automation and offsite manufacturing, as key ingredients to modernising the sector and its workforce.

But how far along the path to a more technologically enabled industry are we? How prepared is the workforce for the potentially seismic changes that are to come? And what role can CITB play in making sure the sector is up to the challenge?

To answer some of these questions CITB has carried out a major research project, combining data from a survey of 1,500 employers with qualitative research involving focus groups and in-depth interviews.

Our findings reveal that the construction sector has so far produced an uneven approach to AI and automation, with larger companies and those in certain sub-sectors much more ready to adapt to the demands of new technology. But they also show that the sector is gearing itself up for the challenges it faces.



Even before Covid-19 effectively brought the global economy to a standstill in spring 2020, construction was facing a period of unprecedented change.



The decarbonisation agenda will require an enormous effort in terms of both investment and training. According to the UK Green Building Council, the built environment as a whole, accounts for 40% of the UK's total carbon footprint. And while it's hard to establish an exact figure, it is estimated that an annual investment of between £15-25bn could be required in properties and infrastructure if we are to meet the Government's 2050 target of net zero emissions.

In addition to this, safety has never been higher up the agenda for construction. This is not just about the workers' health – both physical and mental – but also about the safety of the finished product. The ongoing Grenfell Tower inquiry has shone an unforgiving light on safety and procurement practices in parts of the industry and has demonstrated the urgent need for change. At the same time, the cost of fire remediation work for residential developers post-Grenfell is growing all the time.

AI and automation can play a part in addressing all these challenges.

### Decarbonisation

Achieving net zero will challenge the construction industry in a number of ways. These challenges will not only need organisation and invention but will also require us to become more efficient. Office for National Statistics (ONS) data from 2018 cites UK construction as the least productive in the national economy, a full 20 percentage points lower in terms of output per hour than the UK average.

Increased digitalisation, better data collection and the use of machine learning technology can help in two ways: it can help decarbonise the construction process itself but it can also help address the huge maintenance and improvement challenge that the industry faces as the race to retrofit gathers in the lead up to 2050.

AI, particularly where it is used to produce better data-led decision-making, is a proven booster of productivity. On a macro level, this could involve project management systems that use AI to predict how likely projects are to be completed on time. At a more granular level, wearable trackers can help enhance logistics and the management of onsite activity to improve safety and enhance productivity.

### Post-Grenfell safety

It's also clear that the Grenfell Tower Inquiry will result in new safety requirements for tall buildings. This is another area in which increased and better use of AI and data management has the potential to make a huge difference.

Increased use of sensors, for example, could greatly improve the monitoring of structural integrity, while better recording and use of data will help pinpoint issues with components and materials and identify which buildings might be affected.

If Grenfell proves to be a wake-up call for construction, AI is likely to become one of the key tools to help it modernise itself. And with the draft Safety Bill likely to place an increased onus on the maintenance of accurate records, improved data collection and sharing will become even more vital.

### Safety and automation

Safety should always be the primary focus for any contractor – large or small. This was the case before COVID-19 hit, but the pandemic has made it even clearer.

The automation of some processes – whether in the context of modular construction, offsite or MMC – will contribute to a safer environment for our workforce. In its *Roadmap to Recovery*, the CLC identified the implementation of the 'presumption of offsite' in public sector jobs and the increasing use of offsite in the private sector as key actions for reinventing the sector. This will help not only to deliver a safer environment, but also to reduce the sector's carbon footprint.

There is something of a virtuous circle at play when it comes to automation in construction. It can lead to a safer working environment and, as a byproduct, a more efficient delivery of projects. Meanwhile an improved safety record will also help to attract more people with more diverse skillsets into the industry, again helping to boost productivity.





## Kier: nPlan

**Tier one contractor Kier is working alongside Cambridge University and software developer nPlan to develop and use software that detects patterns in task performance and schedule adherence based on data from previous projects.**

nPlan's AI program uses this data to assess the likelihood that individual tasks within an overall project plan will be delivered on time and how that assessment will impact the overall project timescale. The programme plays a key role in identifying risk and helping clients make decisions around commissioning.

**The program demonstrates the key role that collaboration can play in helping contractors and clients make better use of data.** That's because contractors that sign up to use the software agree to share their data with the developer so that the AI algorithm can learn from data on as many projects as possible and improve future performance.

Kier is using the tool to monitor projects and appraise delivery plans proposed by clients. Fellow major contractors Costain, The BAM Group and Skanska are also investigating the possibility of using nPlan.

It is hoped that the program can provide more certainty for clients but also better financial security for contractors at a time when margins are tight and the economic future of the sector is uncertain. If widespread adoption follows, nPlan could reduce delays on large or high-profile projects and in doing so improve the image of the construction sector as a whole.



There are already many examples of employers using AI and automation technologies to improve the way they work, drive efficiencies and deliver better outcomes for employees and for clients.



## Sublime consortium: Augmented Worker System

**Augmented software specialist Sublime has worked with a consortium of industry stakeholders to develop the Augmented Worker System (AWS) – a platform that uses AR technology to improve several aspects of site management.**

AWS is a great example of collaboration being used to drive efficiencies. It is being developed by Sublime along with Laing O'Rourke, the Advanced Manufacturing Research Centre at the University of Sheffield, Strathclyde University's Advanced Forming Research Centre and Pinnacle Business Solutions, with funding from Innovate UK.

It is also an example of how a platform-based solution, as opposed to a stand-alone point model, can help solve the twin problems of scalability and change management, and in doing so get crucial buy-in from industry and employees.

AWS explores how various data driven augmented reality (AR) applications can be used across the whole lifecycle of a project by creating a mechanism – or platform – in which they can be integrated and connected with one another and existing software systems.

**The system focuses on six areas of improvement: real time collaboration and engagement; digital guidance; process monitoring and control; smart site and site safety; asset management and maintenance; and through-life performance.** These are, in essence, different working processes where the greater collection and use of data through AWS can enhance efficiency, productivity and safety. Laing O'Rourke has been testing AWS since the start of 2020, and the firm is looking at how it can use the system to improve KPIs.



Our research paints a mixed picture of the construction industry on the adoption of automation and AI technologies. It also shows that different forms of these technologies are expected to have quite varied impacts on construction.



In our survey, which was completed before the pandemic hit, only 3% of employers said they used AI and less than 10% said they used automation or related tools such as augmented reality (AR), virtual reality (VR) or drones. However, there is a good chance that the figures for AI are lower than they should be as AI technology is very often embedded in another program, such as a data analytics or diagnostics tool.

That said, when presented with a longer list of technologies (including more common technology such as WiFi or mobile computing onsite) three quarters of employers said they used at least one, while 14% use more than five.

The survey also found that this group of 'early adopters' of technology were more likely to include medium or large companies, with smaller ones slower on the uptake. Nearly three quarters (63%) of companies with 250 or more employees said they use at least five of the technologies we listed in the survey, but that proportion drops to 31% for firms with 25-99 employees and 15% for those with 10-24 employees. Broadly, the same relationship holds true specifically with AI and automation, which have been taken up more regularly so far by larger employers.

#### Long-term vs short-term

The level of take-up for these potentially transformative technologies tallies with a 2018 report from consultancy McKinsey. It predicted that the near-term adoption of AI and automation in construction would be limited. The areas most likely to see increased take up were identified as:

- VR and AR used to create and compare planning models
- Infrared and laser imaging on drones to create detailed maps of sites and builds
- Sensors to monitor building deterioration and wearable sensors to monitor onsite workers

Although the report was written pre-COVID-19, it is likely that the pandemic and the need for safer working conditions will accelerate the adoption at least of the first two of these technologies.

In the longer term, McKinsey predicts that robotics, assistive technologies and AI will become more commonplace as costs come down and safety issues are addressed.

#### Skills of the future

Whether it is a short-term or long-term process, technologies such as AI and automation are going to change the nature of the construction workforce. The number of jobs currently described as skilled worker roles is likely to decrease over the next five to ten years. In 2017, Mace predicted that there would be a substantial drop off in the requirement for skilled worker roles by 2040, with specialist jobs such as bricklaying and plastering most at risk.

In the shorter term demand for skilled work will continue as the need for quality assurance work, for example, remains. But over the medium term, defined as three to five years, there will be an increase in demand for other roles. These include data analysts, software developers, technology maintenance staff and project managers.

This kind of change, even a few years into the future, will mean that training needs to be adapted in the present to prepare the new generation of workers for what the industry will look like over the next 10 to 20 years. Meanwhile, the current cohort of workers will need additional training to develop new digital skills, with our research suggesting that 50% of the workforce will need retraining in one form or another.

Operatives will need to be trained in specific technologies. However, the fast-paced nature of technological change means that this will often need to be done on the job.

Both new entrants and existing staff will need to be trained to a higher standard in IT literacy and security and in data handling and analysis skills. Our research found that most employers felt these skills would be useful across broad ranges of technologies. However, they will also require systems of accreditation of competence, which may in themselves be digitally based assessments.



## With the skills needs of the sector changing in perhaps a more fundamental way than they have for a generation, CITB has a crucial part to play in helping training providers and employers shape this new environment.

The evidence we have accumulated through this study shows which skills and competencies will be most valuable to employers that are likely to lean more and more on AI and automation in the coming years.

Part of our job is to help shape policy in this area so that qualifications and courses are fit for purpose. This includes using our influence to ensure that college courses and apprenticeship programmes feature modules on the use of new technologies. We also want to see schemes like the Construction Skills Certification Scheme start to include references to training in AI, automation, MMC and other new technologies.

CITB also has a crucial role in promoting construction as a career to an ever-wider group of people, including graduates in disciplines not traditionally associated with construction.

As with all our work, through operating in partnership with employers, further education colleges and universities, our influence can be stronger. Together, we hope we can use our collective voice and network of contacts to guide government policy and regulation to factor in and enable the greater use of technology in our industry.



### What CITB is doing

#### **Encourage collaboration**

In the implementation of new technologies, data sharing will be crucial to help AI and machine learning drive efficiencies. But to get there the industry needs to work together as one to focus on recognising and achieving the priorities that drive the greatest change with the greatest speed.

- In support of this, CITB is working collaboratively across industry and with influential stakeholders to support initiatives that are driving change. This includes supporting work being led by the Construction Leadership Council, the Centre for a Digital Built Britain, the Construction Innovation Hub and others.

#### **Policy and regulation**

Government policy and regulation can support the expansion and development of training to embrace new skills and attitudinal and behavioural competencies.

- By working with governments on skills policy and by continuing to support the setting of underlying standards, CITB will help ensure that future training is high-quality, transferable and relevant for a digitalised industry.

#### **Support the supply chain and SMEs**

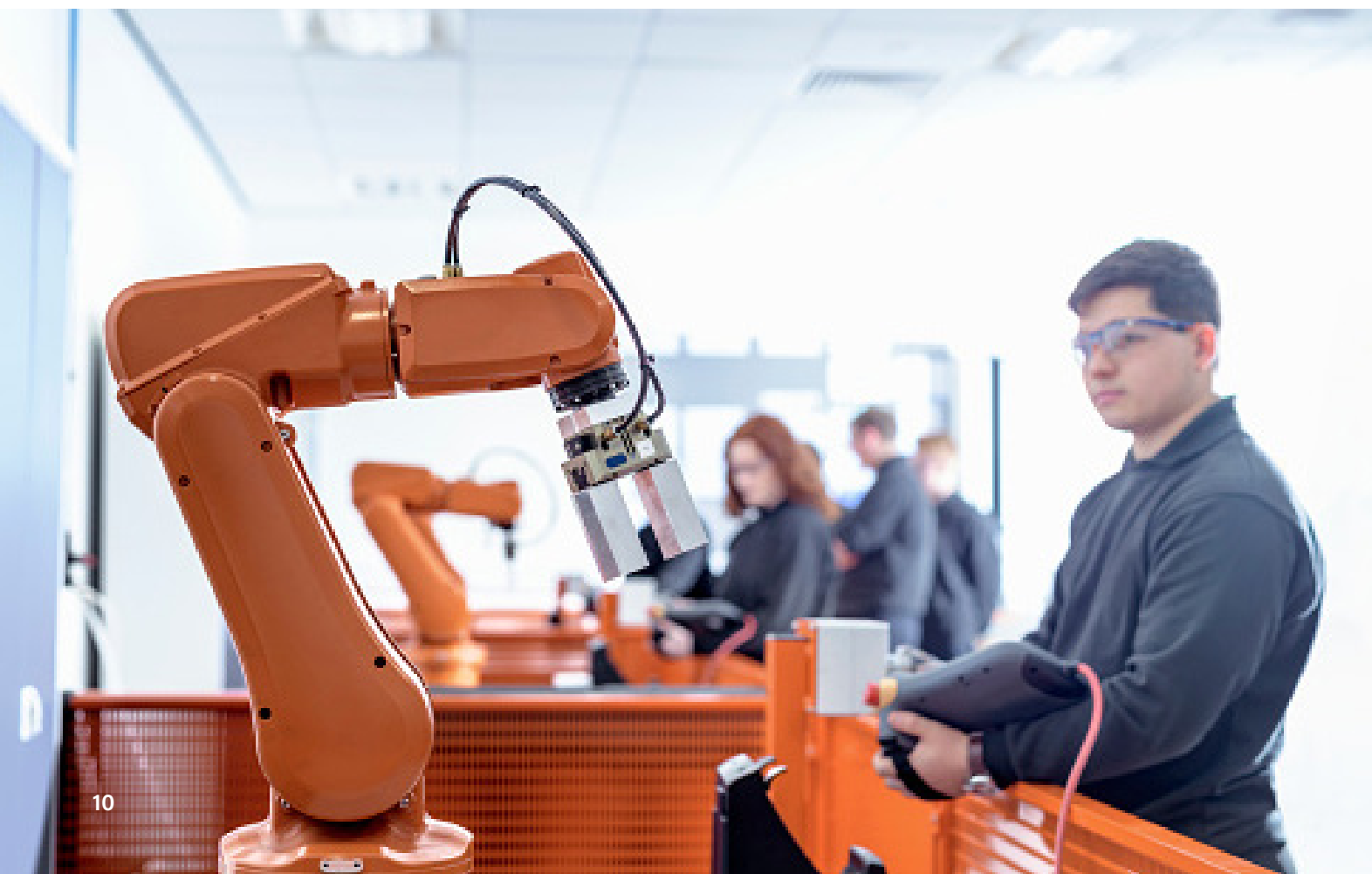
CITB's research suggests there is a mismatch between the use of technology among larger employers and smaller ones. The industry and CITB should work together to make sure supply chains and smaller contractors adopt common approaches to technology. The industry's structure - with a large proportion of micro employers as well as large numbers of self employed workers - sometimes makes adopting new technology and practice difficult.

- CITB is funding a number of pilot projects aimed at providing digital leadership training. Several of these projects focus specifically on the needs of SMEs and the supply chain.

#### **Drive attitudinal change**

AI, automation and other transformational technologies should be seen as essential tools in improving the industry, rather than 'nice to have' additions.

- CITB analysis and forecasting will continue to push for a greater understanding of industry needs and work to identify the opportunities that will guide change. CITB will use this insight to work with other influencers, employers and training providers to maintain the push for modernisation and develop a wider range of competencies for the existing and future workforce to adapt to technological transformation.
- We'll also continue to engage with industry, in collaboration with others, to communicate the potential for, and benefits of, change and the need to bridge the skills gap. The effort made to communicate the CITB report *Unlocking Construction's Digital Future* has already helped promote the need for change.







### Update training courses

Further and higher education providers will need to progressively update training to ensure students understand their role in a data-influenced working environment. This means developing human skills; it isn't about training on how to use a specific technological solution.

- CITB's support for government policy will help with this drive. But we'll also support those who are leading the development of FE and HE curricula. And we'll work with apprenticeship training providers to ensure that apprentices are not left behind, particularly those in specialist skill areas.
- CITB is investing in pilots of new ways to provide training. Provision of training through e-learning has increased exponentially and improved significantly in quality. CITB will continue to support these developments.
- In addition, we are investing in a range of pilots to test immersive learning technologies and that will enable others to develop courses using virtual and augmented reality.

### Review standards and qualifications

Standards and qualifications will need to reflect a workplace that will increasingly incorporate technological developments. More and more workers will need to know when and how to securely use data based systems, sensors, drones, AR/VR and risk-based commissioning.

- CITB has already defined a set of bodies of knowledge that we will use to define the broad categories into which digital competencies fit.
- Our strategy commits to update, by 2025, competency standards for construction. This will include working with employers to develop models of competence (knowledge, skills and behaviours) to provide clarity on what is needed for existing and new employees. This will need to include digital for it to be incorporated into existing training and for new methodologies to be established alongside.
- CITB will also work with other industry and academia to define the competences required by a digitalised construction industry.

### Widen the appeal

CITB has a huge role to play in attracting a new cohort of young people into the construction industry and communicating the diversity of opportunity in construction.

- CITB will support activities (e.g. through initiatives like Go Construct) that will highlight the new roles that are needed and the skills required, particularly STEM skills and the requirement for digital, programming, project management and technological expertise.
- This is expected to increase construction's appeal to a *digitally native* generation interested in working with new technologies such as drones, augmented reality, imaging, data capture and digital twins.

### Invest in short-term courses

Training to adapt the sector to the increased use of AI and automation technologies is both a long- and a short-term project.

- In the short-term, CITB is investing in a number of pilot projects to deliver digital leadership training. These include those that support shorter training courses, often using e-learning, to raise senior leaders' awareness of new technologies and the value they can bring. These courses could also include 'masterclasses' to demonstrate the value of individual technologies.

### Case Study

## Costain: Automated Site Diary



### Costain's automated site diary is a great example of how automation can drive efficiencies for employers.

The idea of the site diary was to improve communication between onsite and back-office workers on projects based on remote or expansive sites. The diary, which is a commercial software application, allows information to be shared quickly regardless of the users' relative locations.

The diary replaces the traditional paper version by allowing data to be gathered on the go and in real time through onsite mobile applications. The software produces progress reports on individual tasks, helping workers share information about onsite issues. Some details – such as weather data, time stamps and location – are added automatically.

**These reports help project managers review progress and understand at an earlier stage where project costs or time might overrun.**

Costain has already used the automated diary on major projects including the Thames Tideway Tunnel, which involved construction across three sites, overseen by a single project manager.<sup>1</sup>

Although it is not mandatory and take up has been patchy, the automated diary has already brought efficiencies for projects on which it has been used. Onsite workers found they saved time by not having to complete paperwork at the end of a day, but instead recording progress flexibly on their mobile devices.

The technology underpinning the site diary application is continuing to be developed and improved, with developers exploring the increased use of AI to help the program better analyse the data it collects. As with other AI programs, it will improve with greater take-up and collaboration across the sector.

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The Construction Industry Training Board (CITB) supports the skills needs of British construction. It attracts talent to the construction sector so employers have an adequate recruitment pool, and encourages employers of all sizes to access the skills training necessary to grow their businesses.