

# Digitising Health and Safety

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With thanks to Zane Ulhaq, Associate Director, Atkins

## White paper

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DISCOVERING SAFETY

# Foreword

I always believe that data has a strong part to play in how we make our decisions for our infrastructure. It therefore baffles me how we have continually disengaged in the standardisation of our processes and data schemas to yield the benefits of effective data management.

Health and Safety (H&S) has lagged behind most of the construction sector's subareas as it is complexified with contractual and legal requirements as well as cultural issues. However, better H&S requires better planning which echoes improvements across areas such as duration, cost and assurance of delivery.

The added effort usually required in standardisation for the utilisation of data is becoming easier than before with the emergence of Extract Transform Load (ETL) assisting techniques/ technologies and enhanced data literacy. This means doing more with our H&S data is becoming a reality with some organisations leading the charge.

3D Repo's SafetiBase is a clear and sincere attempt to tackle this problem, promoting the standardisation of H&S data with methods of application in project-based environments. Atkins has been at the forefront of development of SafetiBase and continues to develop this out further with 3D Repo to benefit the wider industry.

In time, we hope to be able to bring partners of the industry together to help tackle this problem together with the Discovering Safety Programme. This white paper successfully tackles some key topics and serves as a great preamble to the emerging work and report on a H&S data institution for the UK of which 3D Repo and Atkins' work is the foundation.

- **Zane Ulhaq**  
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# Introduction

Over the past three decades, the construction industry has invested heavily in training and cultural change programmes aimed to eliminate the risk of injury and harm to people at work. And that investment has worked: there have been significant reductions in death, injury and accident rates from the late 1980s. Yet over the last five years, those downward trends have faltered.

“Accident and ill health rates have hit a plateau,” says Gordon Crick, Health and Safety Executive’s (HSE) Technical Lead for the Discovering Safety Programme whom 3D Repo interviewed for this white paper, along with Zane Ulhaq, Associate Director at Atkins.

“The number of people dying and getting injured remains the same.”

In 2019/20, the UK construction industry killed 40 people, equating to a fatal injury rate of 1.74 per 100,000 workers, almost four times the all-industry rate. And every year, it injures 61,000 people<sup>1</sup>. The HSE, the UK’s government agency responsible for the regulation of workplace health and safety, estimates that the total cost of work-related injury and ill health for construction was £1.2bn in 2018/19 and led to 2.1 million lost working days.

It would be easy to blame construction’s two-tier nature for these statistics; the grouping of a multi-billion-pound infrastructure programme in the same

sector as a one-person roofing business. But even on our most high-profile projects, where health and safety are undoubtedly prioritised, there are incidents, accidents and sadly even fatalities. The industry needs a step change; technology offers the opportunity for that change.

The COVID-19 pandemic has boosted the pace of construction’s journey towards wider digital technology adoption. The need to find new ways to keep people safe so that they can continue to work – and keep the UK’s economy going - has encouraged the take-up of new technologies on-site and in the design office. Virtual meetings around 3D models have become the norm by necessity.

Certain parts of the industry have already made great progress in health and safety risk management and control. Greater collaboration can only help with that. But the challenge remains that early risk identification, and mitigation, are still dependent on the expertise and experience of those around the screen. A smaller project or company, with fewer resources, may not be able to field a diverse enough team at the design and planning stages.

We need to find ways to harness the knowledge and experience of the experts around the table and make it automatically available when new assets are being designed. We need to harvest and analyse data collected through monitoring, wearable tech and equipment operation and feed it back to the design process.

In this white paper, we look at the challenges faced by the industry as we set out on this digital journey. And we shine a light on programmes and projects which are leading the way.

# Industry and government drive to improve health and safety

Sometimes it takes a major upheaval to induce true change. Today, the construction industry is facing a sea-change on three counts: the COVID-19 pandemic, the Hackitt Review, and the rise of digital technology.

The Construction Leadership Council (CLC), which brings together key industry and Government organisations, demonstrated the power of pan-industry action during the pandemic, with its clear and current guidance on safe site practices. The CLC's vision<sup>2</sup> to create 'a safe and sustainable built environment, delivered by a world-class industry', is underpinned by the need for both digital change generally and the digitisation of construction health and safety.

Meanwhile, the Government has signalled a definite move away from the Egan-driven lower cost, faster delivery mantra<sup>3</sup> to an emphasis on investing more time upfront to deliver greater value during an asset's operational life. This ethos is embodied in the Construction Playbook, a guide for Government procurers, published in December 2020<sup>4</sup>.

"There's a shift underway – probably part of the Grenfell effect – in the way that we view the construction phase," observes Crick. "Now it's seen much more like an episode in the life of a building. There's much more of a move to integrate information, and the interest in the long term value of building safety information is growing."

The Building Safety Bill<sup>5</sup>, published in July this year in response to Dame Judith Hackitt's review of Building Regulations following

the Grenfell fire<sup>6</sup>, underlines the need to understand and uphold design decisions and product selection throughout a building's life – the so-called 'golden thread'. Data, and its effective management, is the glue that can hold the thread together.

The value of data for health and safety risk management was recognised by the 2018-published Publicly Available Standard, PAS 1192 Part 6 Specification for collaborative sharing and use of structured Health and Safety information using BIM<sup>7</sup>. The PAS, which is currently being updated, recognises the potential that BIM has to allow collaboration and communication between different users and stakeholders across all phases of a building or structure.

All these forces for change are pushing at an open door. Major construction players have long been committed to change in this domain with programmes such as Balfour Beatty's 'Golden Rules', Laing O'Rourke's 'Zero Harm' and Amey's 'Target Zero'. Change through digital technology is already underway, with successive major infrastructure programmes – Crossrail, Thames Tideway and now HS2 – pushing further each time. However, it's important to maintain consistency across these programmes to maximise value and benefit for the whole industry.

# Whose responsibility is it anyway?

The Construction (Design and Management) (CDM) Regulations were created back in 1994 to answer this question. Subsequently revised in 2007 and then in 2015, the aim of the regulations is to ensure that designers consider the impact of their designs on later phases of work.

The CDM Regulations set out who has responsibility for what. But on all but the simplest of projects, there are many complexities and interfaces which muddy the water. One of the criticisms levelled at the CDM Regs over the years has been that it has created more bureaucracy without adding much value – or really getting the message across to designers.

“There’s a real cultural issue around the way designers think,” observes Crick. “They are very focussed on the job in front of them: creating a design that meets the various technical standards. Too often, health and safety risk is not their job, they will leave it to the health and safety experts. We are trying to change that culture to one where designers in construction automatically consider early and fundamental ways to improve health and safety for the long term, through design choices.”

One of the challenges for younger designers, says Crick, is that they spend less time than ever on-site, with the major engineering institutions no longer requiring site experience for someone to become chartered. Digital technology, using 3D and 4D visualisations, offers a way to bridge that gap, he suggests, because it demonstrates the physical impact of design decisions.

“People in the engineering space grow with their battle scars,” says Zane Ulhaq, an associate director at Atkins who has been seconded to the Discovering Safety programme. “Reviewing data from past projects allows them to accelerate their learning without consequences, learning from the collective’s experience.”

Several groups should take responsibility for health and safety over the early phases of a construction project: designer or architect, health and safety practitioner, digital practitioner and contractor. But rather than these parties working collaboratively, there is demarcation of responsibility which can



be particularly problematic at the interface between project phases.

Clients must shoulder their share of the responsibility, says Crick, providing adequate resource and time to plan properly. In the design phase and then on-site, the culture created by the Leaders and Principals in the project is vital, so that anyone feels empowered to speak up about potential risks – something which is rare in practice, says Crick.

What data offers the industry is the chance to become much more logical and clinical about the way that construction safety and health risks are identified and then prevented. This is the mission for the Discovering Safety programme (see page 9). But for this new approach to take hold, a culture shift must run alongside the technology adoption process, moving away from a culture of blame to one of discovery.



# How can digital tech help to improve health and safety?

Digital technologies are already effecting positive changes to construction health and safety. These range from immersive virtual reality training for scaffolders<sup>8</sup>, to wearable devices that monitor fatigue<sup>9</sup>, to robots that carry out dangerous or repetitive tasks<sup>10</sup>. Artificial intelligence (AI) offers huge opportunities, for instance, training machine learning algorithms to spot hazards on site<sup>11</sup>.

For construction design and planning, the move from 2D designs to 3D and now 4D has hugely increased the opportunity for multiple stakeholders to communicate around a model. For those not familiar with engineering drawings, 4D visualisations offer a far more accessible way to understand what a building or facility will look and feel like in operation.

The use of federated models aids clash detection and allows different disciplines to work together. 4D models force clarity on the fuzzy interfaces between sequences of work and enable risks and problems to be discovered and dealt with in front of a screen.

Now the big opportunity comes from tying outputs from these many technologies together, making better use of the huge quantities of information created and collected on projects. "We can use digital tools to find better ways of managing our

information," says Ulhaq. "At the moment we are in a position where we don't know what the value is of this thing we have so much of."

The goal is to find ways to store and access information from both projects and professionals. While the last decade has seen the introduction of more formal 'lessons learned' processes at the end of major projects, which often result in huge reports or multiple spreadsheets, accessing the relevant information for future projects can be a haphazard process.

Creating a searchable lessons learned database for health and safety risks was the goal for those who developed SafetiBase (see box below). By assembling all stakeholders around a 4D model, health and safety considerations throughout an asset's life can be taken into consideration and tracked. The information generated is structured and available through the cloud for other projects to benefit from.

There are opportunities to go further, collecting live safety hazard information on-site and transferring that into databases to inform future design. For instance, hazard intelligence system PLINX, which combines physical tracking devices on plant and people with data capture, can transfer its data into SafetiBase to inform future project planning and design<sup>12</sup>.

# Barriers to improvement

Successfully managing health and safety is about successfully managing risks – which in turn comes down to the way that contracts are set up to allocate risk.

Under many contractual arrangements, it could be commercial madness to propose a totally new sequencing of works to reduce a safety hazard.

“Smaller firms can have a better grasp of risk and the need for collaboration than companies who rely very heavily on lawyers,” points out Crick. “A lot of experienced people will be very happy to reach a good compromise; they see a problem and say: ‘let’s work through it.’”

Our regulatory framework imposes limitations too. Infrastructure projects must already have an outline design in place before gaining consent under the Transport and Works Act, which means that some elements and sequencing are set in stone. This is a challenge that Transport for London has been trying to counter with its Innovative Contractor Engagement process – for example on Bank Station Upgrade with Dragados - where a contractor and its supply chain is employed even before planning consent.

The other challenge with current contractual relationships is that they do not encourage or enable collaboration. “We are not contractually set up to share information,” says Ulhaq.

“We need to find ways we can adopt a more community-based environment on our projects.” Even projects with alliance-style arrangements, where openness is encouraged in the name of the greater good, cannot maintain that ethos when the going gets tough, with parties reverting to their old adversarial ways, observes Crick.

Crick believes that construction clients must be active in solving these problems. A focus on lowest cost and fastest delivery schedules misses the value of delivering an asset that is safe in both construction and operation for the long term. Where clients invest in early planning for health and safety – which means deploying the necessary time and resource at the front end of a programme – there tend to be multiple benefits.

“If you plan the health and safety well enough, the likelihood is that you will improve your programme delivery and cost as well because planning tends to benefit all three areas quite nicely,” says Ulhaq.

## SafetiBase: Now health and safety risks are an integral part of BIM

SafetiBase was developed collaboratively by a raft of industry partners including 3D Repo, Atkins, Mott MacDonald, Balfour Beatty VINCI, Laing O’Rourke, Costain, Bentley, HS2, Tideway and others. Funded through i3p and Innovate UK, SafetiBase stores structured health and safety risk data in the cloud.

SafetiBase allows users to identify and manage health and safety risks within a 3D model. Because it uses a common schema, it can be used to benchmark project safety performance and easily share lessons across disciplines. As it is a fully integrated element of the 3D Repo platform, users

from any discipline, skill level or location can easily collaborate to mitigate risk in the context of the 2D/ 3D or 4D model.

Users can draw on previously identified health and safety risks to inform the identification and mitigation of risks on their projects. A user on the 3D Repo platform can drop pins onto the 3D model, complete various information fields and apply a risk rating, which will be updated as mitigating measures are applied. The system records the issues that have been considered, actions taken and who has responsibility.

SafetiBase has been designed to conform with PAS 1192-6:2018: Specification for collaborative sharing and use of structured Health and Safety information using BIM.

# Discovering Safety

Discovering Safety is an ambitious programme, funded by the Lloyd's Register Foundation and being delivered by HSE and various partners. Spanning multiple industry sectors, its goal is to find new ways to harness and mine the wealth of health and safety information we already have – and to use that globally to reduce accidents.

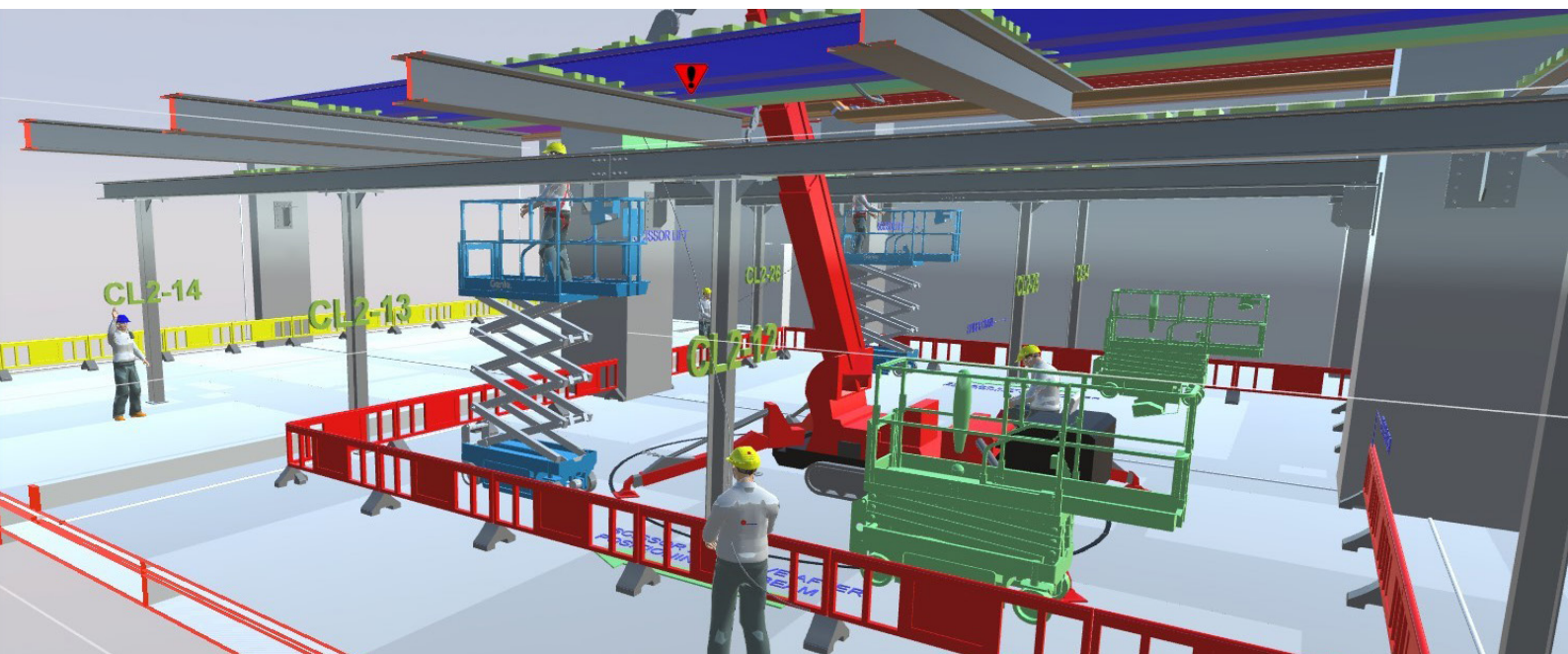
With 15 workstreams currently underway<sup>13</sup>, the projects in the Discovering Safety programme range from how to work better with leading indicators to Industry 4.0 implications for health and safety, to specific problem areas such as confined spaces, diving and working with cement. One of the workstreams, creating a Construction Risk Library, has involved the use of 3D Repo's SafetiBase as a proof of concept for safety risk data sharing.

Now into its third year, the early phases of the Construction

Risk Library project have seen SafetiBase deployed on pilot projects with AstraZeneca, Atkins, Faithful & Gould, Heathrow and Multiplex. The next step will be to involve a larger number of companies and projects.

"We want practitioners and companies to join our community of practice and interact with us more dynamically," says Crick.

The Construction Risk Library workstream will also feed into other workstreams such as those looking at leading indicators; trying to predict what the risks will be, rather than looking backwards using data about what has already happened. Another workstream is looking at how to anonymise and generalise data – which is vital if companies and projects are to feel secure in sharing their information. Longer term, lessons learned around managing safety data in construction will be transferred into other sectors.



## Case Study: Gammon focuses early on health and safety

Having used the 3D Repo platform and the SafetiBase risk and risk treatment database, Gammon Construction is looking to share its expertise with other players in its region. Based in Hong Kong, Gammon has formed a strategic partnership with 3D Repo which will see the contractor's digital innovation arm, Digital G, promote 3D Repo and provide support to users in the Hong Kong, Singapore and Macau regions.

Ryan Wong, a senior construction manager on the £490m Advanced Manufacturing Centre project in Hong Kong reports that asking safety questions in a 4D environment expanded to discussion about quality and constructability.

"Some of the queries would have been picked up later, such as has specialist plant and equipment been procured? How is it going to get in and out? Where will it be stored?" he says. "The proactive 4D workshops picked these items up early, saving us time and potential complications down the line."



# Case study: AstraZeneca spots risks early

Global pharmaceutical company AstraZeneca is one of the pilot companies for Discovering Safety and its Construction Risk Library workstream. Its use of SafetiBase on a project at its 4,000-person site at Macclesfield has demonstrated some of the benefits that a data-led approach to risk identification and mitigation can deliver.

The project, which began in January 2021, involved the construction of an extension to an archive and quality assurance building. By using SafetiBase, the project team was able to identify risks that otherwise would not have been picked up until later, according to David Ayres who is responsible for the 60-to-100 projects that are undertaken at the Macclesfield site each year.

“To date, we have identified 40 risks on this project which would not be obvious to the people doing the work,” says David. “We have also been able to accelerate the programme which has saved time. As a result, we have put in place a quality process that demonstrates good value for money.”

Among the risks identified and treated early with the help of SafetiBase was racking placed too high and plant on a roof, which was moved to ground level. The 3D model also aided communication with subcontractors bidding for packages of work, says Ayres.



# How can data help us to improve health and safety?

The challenge facing the industry around health and safety data is that we are only ever looking at a small part of the picture at any one time – and it is a picture based on what has already happened, rather than what might happen next. A project may be focussing on falls from height or manual handling, for instance, when the biggest risks at that time involve something completely different.

“The main issue facing the industry around health and safety is a disaggregated approach to the management of health and safety information across our sector,” explains Ulhaq. “We need to be data-driven rather than just experience-driven.”

Open libraries of data about construction health and safety risks, and how to tackle them, would help solve this problem. Key to the usefulness of such libraries would be the way that the information is structured so that it can be searched, analysed and deployed.

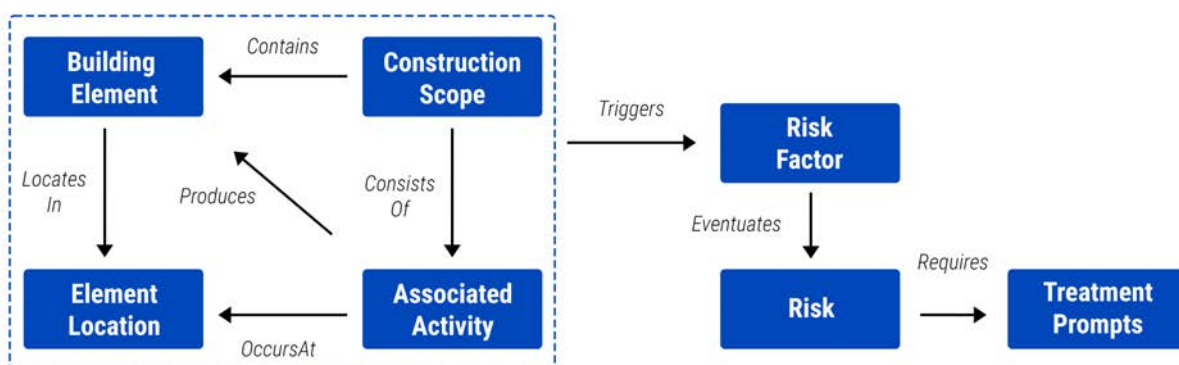
Structuring data is important because it helps people to understand safety risks in new ways. For instance, a designer

may look at statistics around slips and trips when carrying objects and dismiss it as a contractor competence issue. However, looking backwards with the aid of structured data, the designer might understand how fundamental changes – such as introducing modular elements or resequencing – could avoid those journeys having to be made altogether.

Discovering Safety has created a structure that classifies information according to four descriptors: construction, building element, element location and associated activity. From these, a risk factor is generated, together with the risk category and possible treatment options (See chart below).

“We are establishing a new ontology or a new way of thinking about risk,” says Crick. “By putting that structure on it, we are able to reinforce the relevance of the risk factors to the designer and ultimately to link it to incident rates. Without this structure, it can be difficult for inexperienced designers to understand why a risk category is relevant to them.”

## Construction Risk Library Model



# The future of health and safety

Aside from the challenge of removing health and safety risks from construction sites and operational assets, there are other, interdependent hurdles that the construction industry is facing.

The big risk is that these hurdles could lead to an increase in health and safety hazards – unless we harness digital technology to drastically change the way things are done.

Construction has a lack of people with the right skills and experience, due to the ageing demographic of its workforce and the reluctance of young people to enter the industry. We need many new homes, delivered fast, to stave off the country's housing crisis. And we need new skills – in design, construction, and refurbishment – if we are to help the UK meet its climate change commitments by reducing lifetime carbon footprints in our built environments.

Digital technology can help the industry rise to these challenges – and is already doing so. In preparing people to work on-site, for instance, visualisations communicate safety and health information far more effectively than verbal presentations and PowerPoint slides. On-site, the use of BIM caves enables expert input from those practitioners who will physically be carrying out the work (see box below).

3D and 4D BIM can also aid the uptake and coordination of

offsite construction and hybrid forms of construction, where elements of buildings and structures are manufactured as modules and transported to site at the right time. Reducing the number of activities and people required on-site reduces the risks at interfaces and can clearly reduce the likelihood of accidents and incidents, something that can also be achieved through using robots, such as those being trialled on HS2 to help move tunnel segments<sup>14</sup>.

These and other applications of digital technology mean there will be more and more data that could be mined and analysed to provide deeper insight and better outcomes. Next level data management practices combined with the deployment of artificial intelligence will help deliver that.

With all these elements of the jigsaw coming together, the central piece in that step change the industry is striving for is the ability to design out risk and uncertainty before a project ever starts on site. The next ten years will see these changes taking place. With commitment and leadership from central and local government, that change can be accelerated.

## HS2: 4D informs and involves site workers

Site workers on Balfour Beatty VINCI JV's (BBV) HS2 projects will get far greater insight into what awaits them on-site – including, crucially, the potential health and safety risks – thanks to a new immersive 4D learning technology from 3D Repo and Mission Room to improve site safety.

The technology, cloud-based SafetiBase 4D, developed by BBV and innovative tech company 3D Repo, sees site workers enter the Mission Room, which creates a four-dimensional, 360° virtual version of a BBV construction site on HS2's Area North.

The idea is simple: that workers can view the actual state of works on site and how things will progress in the near future, using the project's 4D model. Visual communication is more effective than traditional methods and removes any language barriers.

Site staff can view the model in a three-walled BIM cave and discuss sequencing, safety hazards and interfaces before constructing those elements of the works. As well as tagging any newly spotted hazards, users can view those that have been identified previously alongside any changes made to reduce or mitigate those hazards.

# Getting started with digital health & safety

The industry needs a step change. Technology offers the opportunity for that change.

**Contact 3D Repo to find out how to make  
your construction project safer**

Email: [support@3drepo.com](mailto:support@3drepo.com)  
[3drepo.com](https://3drepo.com)  
[discovering-safety.com](https://discovering-safety.com)

# References

1. Construction statistics in Great Britain, 2020 (hse.gov.uk)
2. <https://www.constructionleadershipcouncil.co.uk/wp-content/uploads/2021/03/CLC-Strategy-2021-Final.pdf>
3. [https://constructingexcellence.org.uk/wp-content/uploads/2014/10/rethinking\\_construction\\_report.pdf](https://constructingexcellence.org.uk/wp-content/uploads/2014/10/rethinking_construction_report.pdf)
4. <https://www.gov.uk/government/publications/the-construction-playbook>
5. <https://www.gov.uk/government/collections/building-safety-bill>
6. [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/707785/Building\\_a\\_Safer\\_Future\\_-\\_web.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/707785/Building_a_Safer_Future_-_web.pdf)
7. <https://shop.bsigroup.com/ProductDetail?pid=000000000030347710>
8. <https://scaffmag.com/2018/02/gkr-launch-groundbreaking-immersive-vr-scaffolder-training/>
9. <https://www.bamnuttall.co.uk/news/smart-cap-technologies/>
10. <https://www.bouygues-construction.com/blog/en/nos-innovations/robotique-chantiers/>
11. <https://www.winvic.co.uk/news/digital-first-contractor-winvic-set-to-develop-ai-enabled-software-to-send-personal-site-risk-alerts-to-team/>
12. <https://3drepo.com/connect-and-protect-with-plinx/>
13. <https://www.discoveringsafety.com/>
14. <https://mediacentre.hs2.org.uk/news/hs2-boosts-safety-and-efficiency-with-innovative-robot-for-chiltern-tunnelling-machines>



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Guiding clients through their existential crises, focusing on data-based solutions including data strategies and solutions, digital transformation and digital twins.