



Construction  
Leadership  
Council

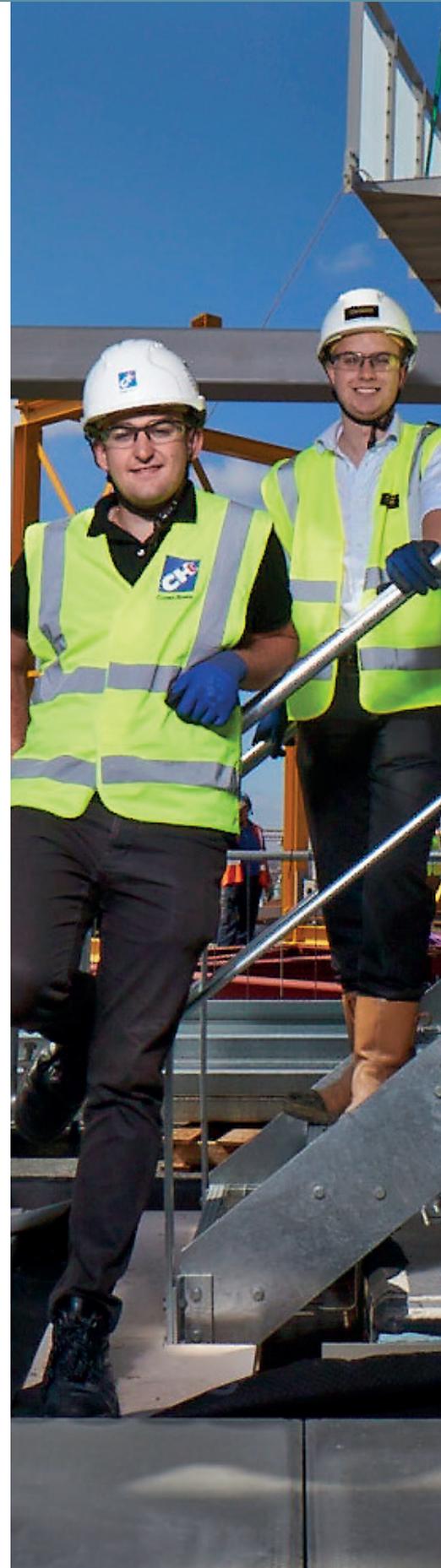
# Future Skills Report

June 2019



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# Foreword



**Mark Reynolds**  
Chief Executive Officer,  
Mace



**John O'Connor**  
Group Commercial Director,  
Laing O'Rourke

*The construction sector is changing. The demands placed on our built environment, coupled with revolutions in digital technology and well-documented geo-political factors, will challenge the sector to improve at a great pace. Against this back-drop we must seize the opportunity to actively challenge the poor image of construction, transform sector productivity, advance quality, and create a truly sustainable and diverse industry.*

The Construction Leadership Council Skills Workstream has worked with the government, industry, educators, and trade sector bodies in order to anticipate and outline our 'Industry Future Skills Needs', resulting in a suite of actions to ensure that our sector will have the skills needed to deliver society's future construction and infrastructure requirements.

There is already a significant amount of activity across the sector which is seeking to address the future skills challenge. We therefore worked to understand and consider this activity, with the ambition to seize upon the 'once in a generation' opportunity that the Construction Leadership Council now brings to the construction sector in partnership with UK Government.

In addition to anticipating future skills needs we must not lose sight of the skills crisis that faces the industry roles of today. We must therefore continue to support traditional trades that maintain and construct our historic built environment, whilst also ensuring that we evolve by adopting technology and developing a more productive, attractive, and inspiring industry where future generations can enjoy rewarding and progressive careers.

Delivering on the actions contained within this report will require commitment from all related parties, large and small, as we seek to collectively drive the agenda forward for the future benefit of everyone engaged in the construction sector. Our sector contributes nearly 10% to the economy of the UK and is a critical enabler that allows other industries to play their part, as the Government seeks to deliver upon its Industrial Strategy.

We thank all those who have contributed to this work, and who have engaged so positively with the process by giving up their valuable time to provide us with the information and evidence upon which we could develop this report, and the associated actions.

We do not under-estimate the scale of the task ahead, and continued collaboration by all stakeholders will be required in order to accelerate the pace of the future skills changes required to transform our industry. However, embracing and delivering the exciting actions outlined within this report will drive a fundamental change to the sectors existing skills base and culture – and get us all 'fit for the future'.

# Executive Summary



*The construction sector reaches every corner of the United Kingdom and touches each of our lives. It is fundamental to our economy as we invest in our future: building the homes we live in, the schools and hospitals we rely on, and the offices, factories, and transport and energy infrastructure that keep the wheels of industry turning.<sup>1</sup>*

## **The importance, demand and opportunity for a more productive construction industry is clear.**

The industry has historically been fragmented, and many reports have encouraged change which has been slow to materialise. The extent of the sector fragmentation is recorded in the Government Construction Strategy 2016, which reported that the industry was dominated by a staggering 956,000 SMEs which accounted for 99% of businesses in the sector. Construction 2025 suggested that the industry's customer base was even more fragmented with much of the sector's workload coming to it on a 'one-off' piecemeal basis.

We do however have two concurrent reasons for optimism: The Construction Leadership Council (CLC) is in place, unifying the many businesses that comprise UK construction; and a compelling sector deal has underlined the Government's commitment to improving the industry more clearly than ever before. This presents a significant Government, client and industry commitment to deploy and execute a future skills plan that will underpin the future of this vital sector.

How we seek to capitalise on this **exciting opportunity** is the focus of this document.

This document sets out the skills required for the future, and clear recommendations to deliver the 'Future of the Industry' plan, as detailed by the CLC Skills Workstream in July 2018<sup>2</sup>. There are fundamental changes needed to support the new horizon of skilled construction professionals and industry conditions to deliver sustainable change.

We conclude from our consultation that the skills required for the future of construction fall in to the following categories; of which a), b) and c), constitute a positive move towards deployment of Smart Construction\* methods (see definition on p.4)

- a) Development of more widespread **digital skills** to underpin future, collaboration and productivity improvements within the sector. This must be coupled with ‘digital leadership’, meaning that executives and managers across clients, contractors, consultants and the supply chain are committed to resourcing and delivering their projects digitally<sup>4</sup>.
- b) An increase in **technical skills** to enable deployment of Smart Construction methods during all stages of a projects lifecycle: project initiation, design delivery and operation. This will allow projects to be developed with manufactured products in mind from project inception; rather than designing traditionally and converting the design later.
- c) Development of the necessary **collaborative skills** to enable individuals to work effectively across teams to plan and to communicate and deliver digitally-enabled Smart Construction projects. As projects become more complex and demanding, the industry will be required to work more closely together than ever before. The transactional and isolated behaviours of the past counteract progress in an increasingly complex and interconnected industry.
- d) Maintaining and enhancing **traditional skills**. These skills will remain in demand as they already face skills shortages and they are essential in maintaining and extending our existing built environment.

Unfortunately, the industry has traditionally been held back due to well documented market failures: put simply, much of the industry does not make enough money, or, where money is being made, it does not feel confident it will stay profitable into the future in order to allow long term investment. The consequence is underinvestment in training and development, in innovation and in raising productivity<sup>3</sup>.

There are three headline actions arising from this report that will have a positive effect on the industry and that will support investment in the right skills; the actions are summarised as follows:

- 1** This report calls for clients to agree to a code of employment where those who contribute to a project are directly employed, thereby ensuring that it is in the employer’s best interest to train their staff and benefit from their improved productivity.
- 2** Create an environment where Smart Construction methods are encouraged through early design and procurement processes, thereby creating the demand for skilled employees which in turn drives employers to invest in training, Smart Construction techniques and behaviours.
- 3** Industry qualifications and training content is updated to include Smart Construction techniques and behaviours with funding made available to accelerate adoption.

1. <https://www.gov.uk/government/publications/construction-sector-deal/construction-sector-deal>

2. <http://www.constructionleadershipcouncil.co.uk/news/clc-skills-workstream-publishes-their-strategy/>

3. <http://www.cast-consultancy.com/wp-content/uploads/2016/10/Farmer-Review-1.pdf>

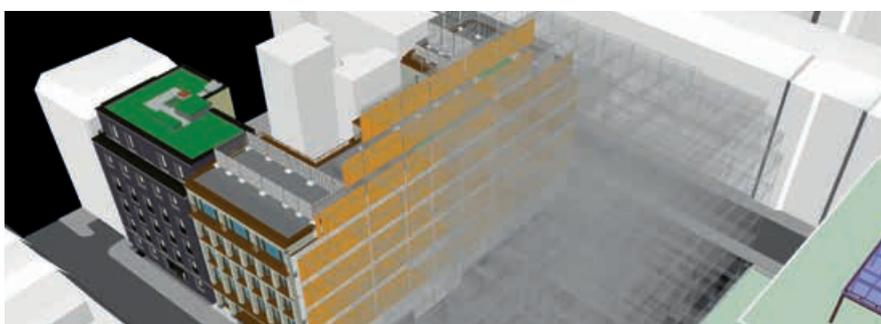
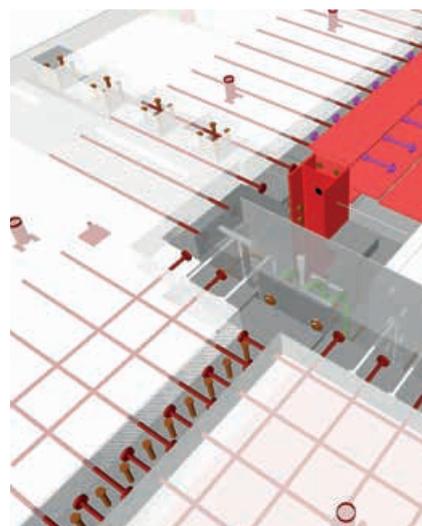
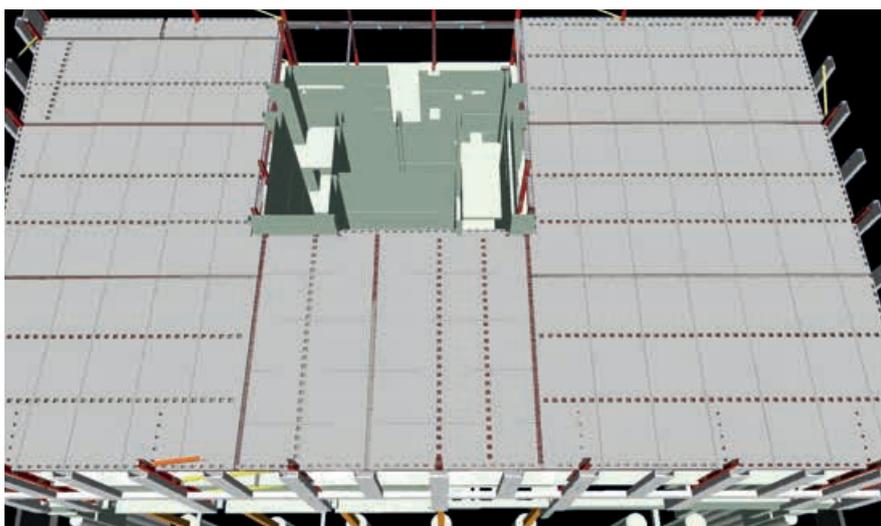
4. Phil Wilbraham, Heathrow Airport Expansion Director

# Executive Summary

*We have structured this document to underpin the logic behind these actions. We have also outlined clearly the commitment needed from government and industry on each action, as this collaboration will be the key to unlocking the potential of our industry, and improving sector productivity.*

## **\*What is Smart Construction?**

Smart Construction is the design, construction and operation of assets achieved through collaborative partnerships which make full use of digital technologies and industrialised manufacturing techniques to improve productivity, minimise whole life costs, improve sustainability and maximise user benefits<sup>6</sup>.



6. <http://www.constructionleadershipcouncil.co.uk/smart-construction-guide-and-case-studies/>



# Background to this report

*We are in the early days of one of the greatest construction programmes in our history, from delivering more homes that people can afford, to major infrastructure projects. This infrastructure pipeline represents more than £600 bn of spend over the next decade, including at least £44 bn for housing. The pace of this change, and the size of this opportunity, demands a construction sector that is the best in the world.<sup>7</sup>*

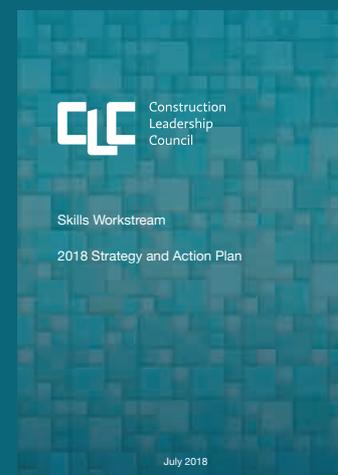
The Construction Leadership Council (CLC), on behalf of the Government, is implementing the Construction Sector Deal and driving industry improvements, rising to the challenges outlined above. Within the CLC, the Skills Workstream is seeking to prepare the UK industry for it to become the best in the world and deliver the ambitions of UK construction by ensuring that it has the necessary skills to achieve this. The CLC Skills Workstream has identified strategic action areas that are necessary to underpin the future of the industry and leverage the significant productivity gains that could be generated by Smart Construction methodologies. These are:

1. Attract, recruit and retain (including training)
2. Apprenticeships
3. Future industry needs.

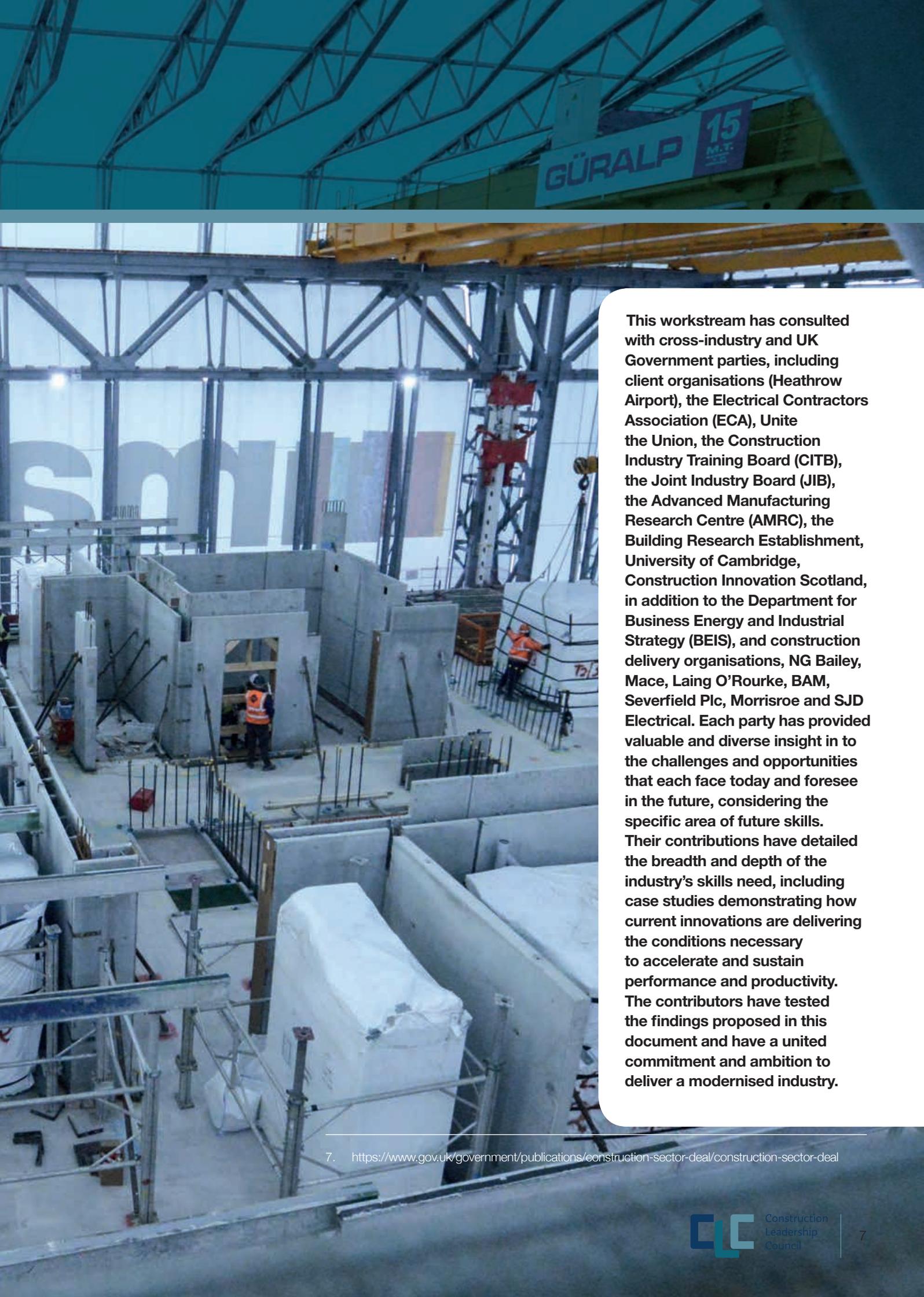
This report focuses on future industry needs, which specifically includes: influencing procurement strategy and policy, new technology and Smart Construction; skill development; and collaboration with bodies such as CITB and the Electrotechnical Skills Partnership (TESP) on future skills research programmes. All of these areas are covered in the research and key actions arising from this report. Relevant extracts from the CLC Skills Workstream 2018 Action Plan are contained within Appendix 1.

This report details the skills required by the future construction industry and the actions needed to deliver sustainable change. It covers future skill requirements; barriers to developing and embedding new skills and working practices; and key actions, designed to generate and sustain success in order to achieve the overall industry ambitions.

**Appendix 1 – see page 25**  
Skills workstream  
2018 Strategy and Action Plan  
(July 2018)



**The CLC Skills Workstream identified strategic action areas necessary to underpin the future of the industry and leverage the significant productivity gains that could be generated by digital and smart Construction methodologies:**



This workstream has consulted with cross-industry and UK Government parties, including client organisations (Heathrow Airport), the Electrical Contractors Association (ECA), Unite the Union, the Construction Industry Training Board (CITB), the Joint Industry Board (JIB), the Advanced Manufacturing Research Centre (AMRC), the Building Research Establishment, University of Cambridge, Construction Innovation Scotland, in addition to the Department for Business Energy and Industrial Strategy (BEIS), and construction delivery organisations, NG Bailey, Mace, Laing O'Rourke, BAM, Severfield Plc, Morrisroe and SJD Electrical. Each party has provided valuable and diverse insight in to the challenges and opportunities that each face today and foresee in the future, considering the specific area of future skills. Their contributions have detailed the breadth and depth of the industry's skills need, including case studies demonstrating how current innovations are delivering the conditions necessary to accelerate and sustain performance and productivity. The contributors have tested the findings proposed in this document and have a united commitment and ambition to deliver a modernised industry.

7. <https://www.gov.uk/government/publications/construction-sector-deal/construction-sector-deal>

# Vision of Future Skills Needs

The mandate for change for the UK construction sector is clear, with the industry facing an acknowledged skills crisis, a shortage of traditional trades, and an unfavourable demographic profile, (with circa 30% of the UK construction contracting workforce estimated to retire in the next decade), making the current labour intensive traditional business model unsustainable. These numbers are likely to worsen following the UK's departure from the European Union, with around 8% of the UK construction workforce being non-UK nationals, mainly from the EU / EEA.

These factors coupled with poor public perception of careers in the traditional construction industry present a vital case for the construction industry to modernise its methods, skills and reputation. It is a huge opportunity for construction to re-brand itself with satisfying careers that engage Smart Construction digital technology and diverse talent.

It is well documented that this transformation journey is one that has been progressed successfully in other industries such as the automotive sector where there has been a 'step change' in safety, productivity, quality, and sustainability for the benefit of the sector. For the construction sector to replicate such a transformation journey a more collaborative approach to delivery will be required in order to drive smarter more productive design, manufacture and assembly solutions. It is evident that the deployment of digital collaboration is accelerating across the sector, with an enhanced focus on Smart Construction methodologies.

Against this back-drop we can outline a vision for future generations of UK construction sector talent whereby:

***“The sustainable construction industry of tomorrow will demand digitally literate, multi-skilled, diverse and highly trained installation and assembly practitioners capable of operating in different environments, and technically proficient professionals capable of managing product integration and complex logistics aligned with the ability to collaborate, and to co-ordinate both site installation technicians and facility based manufacturing teams.”***

**”**

**“**

***...this scenario has never been faced by UK construction before and could be a capacity shrinkage that would render the industry incapable of delivering the levels of GDP historically seen. Just as importantly, it would undermine the UK's ability to deliver critical social and physical infrastructure, homes and built assets required by other industries to perform their core function”<sup>8</sup>***

8. <http://www.cast-consultancy.com/wp-content/uploads/2016/10/Farmer-Review-1.pdf>



# Digital skills

## Appendix 2 – see page 32

Investment in new skills will ensure UK construction continues to innovate



**NG Bailey's focus is not just on the traditional skills at the core of their services – such as mechanical and electrical engineering – but on the development of digital and other technical skills that are required in a modern construction environment.**

## Appendix 3 – see page 36

BIM in practice upskilling programme



**Free events: The BIM in practice programme will deliver 19 seminars, workshops and conferences offering a range of information suitable for all levels of BIM understanding.**

**Flexibility: Learn in your own time with a new e-learning platform allowing users unlimited access to all of our bespoke online learning videos.**

*The advent of the fourth industrial revolution sees society moving towards an era of technology being inexorably integrated into the way we live and work.*

This technological change requires all sectors to understand how they can accelerate the adoption of technologies into their operation<sup>9</sup>. The construction sector is no different. There are a range of technologies already available, such as: cloud computing, artificial intelligence (AI), machine learning, autonomous vehicles, 3D printing, robotics both on and off site, and sensors, all with an ability to transform the industry. Our sector will require people who are more digitally literate and collaborative than has been expected or necessary in the past. This requirement has been recognised in part through the creation of a digital engineering technician apprenticeship, however the majority of newly developed apprenticeship standards do not have digital skills defined as a learning requirement.<sup>10</sup> In addition, results from a recent industry survey demonstrate that available technology is recognised, yet is not being adopted.<sup>10</sup>

A future operating model, for major construction projects, will require fully-interactive building information modelling capability from concept through to asset operation and decommissioning. Such major projects will have embedded Smart Construction methodologies with fully automated manufactured products and multi trade sub-assemblies which result in minimal site works and lead to increased productivity. Technology is being developed to achieve these goals, however this is only providing limited pockets of excellence from early adoption.

Technology, software and capital equipment is commonly developed independently, which increases the complexity and integration of these independent systems. As complexity increases, so too does the interface arrangements, data usage and storage requirements, which are challenging current technology, infrastructure and skill levels. Industry can respond in two ways: firstly, by developing closer relationships with technology, software and equipment providers to simplify system integration and to reduce risks; and secondly, to retrain, or employ, professionals from outside of the industry to manage systems integration and data sciences. In order to respond, we must have people with enhanced digital skills.

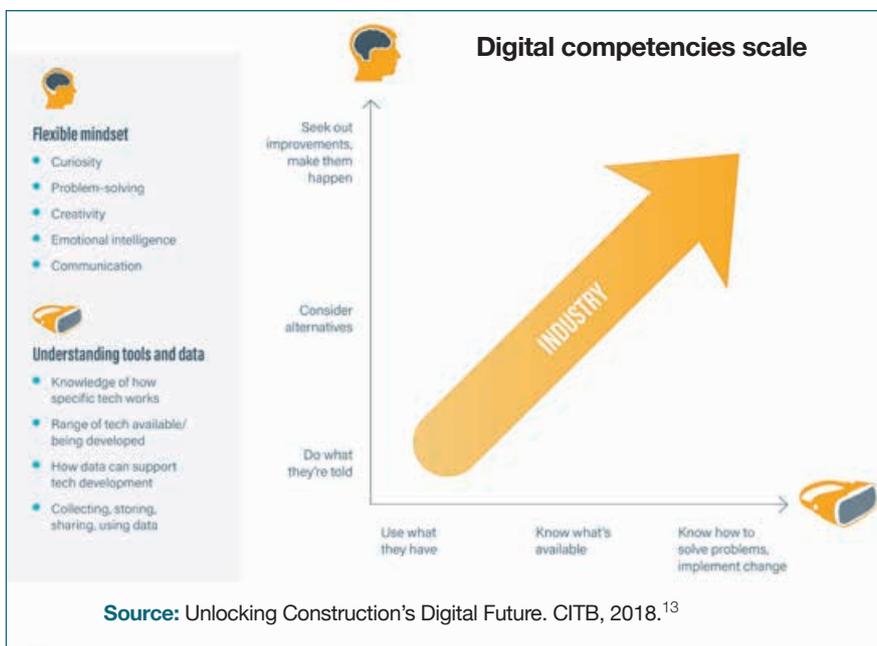
9. World Economic Forum. White Paper. The Next Economic Growth Engine. Scaling Fourth Industrial Revolution Technologies in Production. Jan 2018. [http://www3.weforum.org/docs/WEF\\_Technology\\_and\\_Innovation\\_The\\_Next\\_Economic\\_Growth\\_Engine.pdf](http://www3.weforum.org/docs/WEF_Technology_and_Innovation_The_Next_Economic_Growth_Engine.pdf)

10. New Civil Engineer in Association with Bentley Insights. Winter 2018

11. Imagining Construction's Digital Future, McKinsey Global Institute, June 2016 <https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/imagining-constructions-digital-future>

It is estimated by McKinsey that the adoption of digital and manufacturing technologies could create up to 90,000 skilled jobs related to the digital design of buildings in the UK<sup>12</sup>.

CITB research on digital skills identifies that having knowledge about digital tools and data as well as a creative/problem-solving mind set is essential for the entire workforce; this is illustrated in the graphic below previously published by CITB:



The CITB digital skills research identifies, that the desired level of 'digital competence' varies across the construction sector by role and position and that it is particularly important for leaders to understand and adopt digital ways of working. This research also underlines how behaviours and our ability to communicate, collaborate, think critically and creatively are all key enablers for working in more innovative and productive ways. Building on this research, CITB is investing with industry to create the conditions for digital transformation, focusing on:

- equipping organisational leaders to deliver digital change
- standardisation of digital competence requirements across the built environment sector
- digital upskilling through new resources and capability

Digital skills development also has generational differences, with new entrants generally more equipped to work intuitively with technologies than those nearing the end of their careers. This requires industry to respond by developing a competency framework for digital literacy across the workplace.

Professional bodies and institutions, with industry, have a pivotal role in driving the future skills agenda and adjusting the requirements of professional recognition and all qualifications (including apprenticeships, T-levels and other higher education qualifications) all to create forward momentum by embracing new technologies. Digital upskilling is required of all roles within construction, from commercial to engineering, clients to suppliers, and across all trades and grades irrespective of experience.

Many organisations are already recognising the need for change. Examples of which are how NG Bailey have supported experienced team members to retrain in digital skills to improve individual career opportunities and their business performance (Appendix 2) and the Construction Scotland Innovation Centre who are delivering extensive training opportunities in Building Information Modelling to increase understanding of the benefits and participation (Appendix 3).

12. McKinsey analysis for the Construction Leadership Council (source Stephen Good, Construction Innovation Scotland).

13. Unlocking Construction's Digital Future: A Skills Plan for the Industry: CITB 2018.

## Technical skills



*The delivery of Smart Construction projects, and our ability to leverage the benefits of offsite, automation and digital technology requires delivery teams to perform more installation, assembly and co-ordination activities when compared with the more traditional physical construction approach.*

The future industry will demand digitally literate, multiskilled, highly-trained installation and assembly technicians in addition to existing professional and leadership roles such as engineers and project managers who are able to operate in different environments, managing complex logistics with the ability to lead site and manufacturing teams. For example, construction managers may be split between factory and site, be required to understand the end-to-end process and use the digital tools that can help them optimise delivery, as well as manage high-performing, multidisciplinary teams<sup>14</sup>.

Smart construction starts with the skills, knowledge and behaviour of all parties particularly those involved in strategic planning, concept design and detailed design, and their understanding of options that lend themselves to Smart Construction methodologies to enable and embed such approaches in project decision making from an early stage. The range of skills and knowledge required is wide reaching and includes such things as design detailing, offsite engineering concepts, loading and assembly considerations, componentisation and the benefits of design standardisation.

This requires industry to work with established training providers to upgrade their existing offering and develop new upskilling routes aimed at both existing employees and new entrants. Several institutions are well positioned to develop and deliver these requirements such as the exciting work being undertaken by Construction Scotland Innovation Centre, the Advanced Manufacturing Research Centre at the University of Sheffield, and the Cambridge Centre for Smart Infrastructure and Construction at the University of Cambridge (see detailed examples in appendix 3 and 5). However, it is important to ensure that the overall activities for industry are co-ordinated across institutional boundaries to maximise our opportunities. It is proposed that industry bodies such as the CITB and TESP, through their research and development activities, work with industry and cross-industry institutions to develop the qualifications and upskilling routes necessary to address the future industry needs.

Recent CITB research<sup>15</sup>, on how innovation and technology will change the construction industry workforce indicated that the greatest impact will be on existing traditional trades. Greater levels of automation often leads to more multi-skilled roles. For example, offsite construction may require a single role to undertake plumbing, tiling and electrician duties, supported by automated processes. The proposed shift towards Smart Construction and the need for higher assurance in major project delivery is likely to increase the current low barriers to entry, thereby accelerating consolidation across the industry and trade occupations. It is envisaged that higher entry requirements will deliver material benefits to clients and end users through improved productivity, quality and added value outcomes.



**The 2017 CITB report on offsite construction skills found:**

*Without intervention, a lack of offsite training provision is one of the biggest potential drags on exploiting the growth of offsite construction and the same is true for the broader requirements and needs of moving towards Smart Construction.*

It is essential to recognise that traditional skills continue to play a vital role in the construction industry, as a large proportion of projects consist of refurbishment, extension and maintenance of traditionally built buildings. These skills must continue to be supported and enhanced to underpin activities such as maintenance and renovation of our historic assets and for construction projects more suited to traditional methods.

- 14. CITB Research 2017: Faster, Smarter, More Efficient: Building Skills for Offsite Construction
- 15. CITB 2018: Evolution or Revolution report



**Appendix 4 – see page 37**

FUTUREquipped college innovation programme



**FUTUREquipped, the largest college innovation programme in Scotland, is a pilot that has trialled ways that colleges and Innovation Centres can work together to support workforce development to better meet the needs of industry, as well as to support business innovation.**

**Appendix 5 – see page 38**

CLC Future Skills Report  
Case study: Pro' education



**The Construction Engineering Masters programme is a degree offered by the Department of Engineering in association with the Judge Business School at the University of Cambridge delivered in the Laing O'Rourke Centre for Construction Engineering.**

## Collaborative skills



It has been long established that collaboration underpins high performance and will be an essential skill necessary to deliver future Smart Construction projects. Traditional procurement, project delivery models and the industry structure does not foster collaboration and therefore introduces inefficiency, creating an aversion to innovation and the poor rates of technological progression we have witnessed in recent history. The construction industry needs to prioritise non-technical skills and performance-enhancing behaviours alongside improved technical and digital skills to create positive, collaborative, solutions-based environments. There is a reliance on commercial mechanisms to engender collaborative working practices, however they can only go so far. Individual behaviour is a critical influencing factor determining project success, whether an alliance, enterprise (Project 13), or any other form of relational contract. Historically, the sector has been adversarial by nature, and has been poor to prioritise behavioural skills training to mobilise cultural change. Therefore, it is essential that we establish a new mindset and different ways of working.

There are signs that this is already being introduced into public sector procurement; see the quote from a 10-year Highways England Framework pre-qualification document:

***Cultural alignment: sophisticated alliance models require embedded cultural and people alignment that can only be achieved over a longer period through relationship management and coaching.***

In addition to developing the professional collaboration skills of those already participating in the industry there is a need to strengthen work readiness in people entering the workplace – particularly direct entrants from full-time education. Work readiness schemes must support people to integrate quickly by understanding the context of the industry and to have personal resilience to enable them to manage in a volatile, uncertain, complex and ambiguous environment. They will also require skills to build and maintain relationships; and understand how they can apply their technical knowledge, all of which will help demonstrate how their contribution supports the industry's potential. It is important therefore for education providers to include work readiness requirements in curriculums at every level of the education system. As with digital skills, it is equally as important to embed behavioural skills in to all qualifications and development activities to target everyone from new entrants to leadership.

CITB research into industry culture and performance-enhancing behaviours, due in 2019, will help to define the opportunity and importance of investing in non-technical skills and behaviours, and will inform next steps for collaborative industry action.

# Traditional skills

It is essential for traditional skills and knowledge to be maintained to ensure we can continue to preserve and extend our existing built environment and historic assets. There is an opportunity to continue to evolve traditional occupations and incorporate Smart Construction methods, materials and techniques to enhance safety, quality and productivity.

There are already examples where traditional skills and materials have been augmented with Smart Construction techniques and methodologies to deliver innovative solutions, such as the Tate Modern Extension, and the renovation of Battersea Power Station<sup>16</sup>. Both projects have demonstrated how traditional materials and methods can be re-engineered to increase off-site production, on-site productivity and deliver a high-quality product, whilst also improving the safety of the people involved in delivery.

In addition to re-engineering the use of traditional materials and methods, there are examples of new technologies and modern equipment being used to enhance the productivity and safety of traditional construction activities such as exoskeletons being employed to minimise workers' exposure to manual handling activities and the harm they can cause.<sup>17</sup> In addition there is evidence of an increasing use of BIM and technological solutions which capture data to evidence quality and completion requirements ready for asset handover, maintenance and operation. Another example, where tradition meets modern practices, is Historic England where they are proactively promoting and protecting traditional skills to ensure that there are sufficient skilled people to maintain our heritage structures who are also using modern digital technologies to catalogue historic assets and develop comprehensive digital records to support asset management and excellent asset stewardship.<sup>18</sup>

Given the significant proportion of micro and small and medium sized enterprises (SME's) involved in traditional project delivery, maintenance, refurbishment and facilities management, all of whom are essential to the whole asset life cycle, it is critical that their digital skills are developed to support ongoing participation in an increasingly digital environment. To complement digital skill development, it is of equal importance for these businesses to have access to innovation hubs<sup>19</sup> and funding so they can develop ideas and acquire knowledge in order to support the wider aims of the industrial strategy and where their - normally fragmented - contribution can be co-ordinated to drive deeper industry change.

As previously mentioned in the technical skills section it is anticipated that as off-site manufactured products increase so too will the requirement for multi-traditionally-skilled specialists. A further example is how it will be possible for offsite concrete product production to be undertaken by multi-skilled workforce members able to perform formwork, steel fixing and concrete placing activities all within a controlled environment. As the industry moves increasingly towards offsite manufacturing, we expect to see an increased requirement for such multi-skilled workforce members with a basic level of digital skills.

It is necessary for industry, with training boards and providers to work with the full cross section of the industry to develop future skills which complement the need to retain and enhance traditional methods.



16. Innovative solutions were developed by Swift Blockwork <https://swift-brickwork.com/project/tate-modern/>
17. <https://www.newcivilengineer.com/exoskeleton-vest-supports-manual-lifting-work/10039798.article>
18. <https://historicengland.org.uk/research/agenda/research-theme-inform/>
19. <https://transformingconstruction.org.uk/>

# KONECRANES Actions

*There are intrinsic factors within the UK construction industry which currently affect skills development and changes to working practices. Through the Construction Leadership Council and industry stakeholders we plan to address:*

- The fragmentation of the industry and improve collaboration
- Encourage and support direct employment and investment in skills development
- Promote procurement practices that support long term investment in people.
- Work with the CITB and TESP to develop high quality training provision for Smart Construction methods

The following key actions are therefore considered necessary to create the environment that unlocks the sector to deliver the future skills requirements identified in this document.





# Actions



## 1. Create a sustainable employment environment where increasing numbers of people are directly employed throughout the construction industry.

**CLC Skills Workstream Action:** *Influencing procurement strategy and policy to encourage reduced numbers of workers not in direct employment.*

Clients are driving demand for better quality, integrated, faster, more cost effective, environmentally friendly solutions. This in turn, challenges industry to innovate, fuelling the need to explore the deployment of Smart Construction methods and reap positive lessons learned from the aerospace and automotive manufacturing sectors. To do this, employers must have a vested interest in the people they employ, and it needs to be in their best interest to understand their skills and prepare them for the future of construction. This is unlikely to be the case for projects that rely on high levels of self-employed staff. Direct employment is already mandated on several public and private major infrastructure projects, often to reduce risks associated with delivery certainty, reputation and quality as direct employment is reported to overcome skills shortages, spiralling labour costs, poor productivity and quality performance, avoiding low uptake/ resistance to new work processes and technology.

Direct employment allows an organisation through training and investment, to have a highly engaged and competent workforce which, when combined with Smart Construction, delivers increased productivity and higher value that can be sustainably re-invested in future innovation and skills development. Direct PAYE employment also simplifies taxation.

In addition to the benefits above, it is vital to recognise the positive benefits that changes could have on employee health and wellbeing through secure employment and driving a sustainable working culture supported by the reliability and predictability of Smart Construction methods including an increase in factory-based working. The feasibility of widespread direct employment is proven by large organisations operating competitively in this industry today, often driven by individual principles that encourage direct employment, investment in people and sustainable employment<sup>20</sup>.

*“ Heathrow Expansion will build on the great development work completed at Heathrow over the last two decades by continuing to ensure that all construction colleagues are directly employed to drive improved health, safety, wellbeing, quality and productivity. This will be a cornerstone of our Heathrow Expansion Programme.”*

**Phil Wilbraham,  
Heathrow Expansion**

20. Unite the Union and Electrical Contractors Association contribution, quoting Marsden, D. (1999), *A Theory of Employment Systems: Micro-Foundations of Societal Diversity*, Oxford: Oxford University Press and Gospel, H. (1992), *Markets, Firms and the Management of Labour in Modern Britain*, Cambridge: Cambridge University Press.

21. Office for National Statistics

**This report therefore calls for clients to agree to a code of employment, to level the playing field, where those who contribute to a project are directly employed, thereby ensuring that it is in the employer's best interest to train their staff and benefit from their improved productivity.**

This is a key action of this report, as we cannot hope to train the workforce of the future if they are not employed and familiar to the organisations that benefit from their capability.

The construction sector must meet the increasing expectations of clients who are not prepared to settle for the fragmented offerings of the past. A fundamental issue with fragmentation and cyclical industry patterns is that it drives low levels of direct employment with just over 40% of construction workers being self-employed (see figure 1) and over 40% of employers not providing training (see figure 2). These factors will affect our ability to mobilise a competent workforce with the skills necessary to deliver future industry needs.

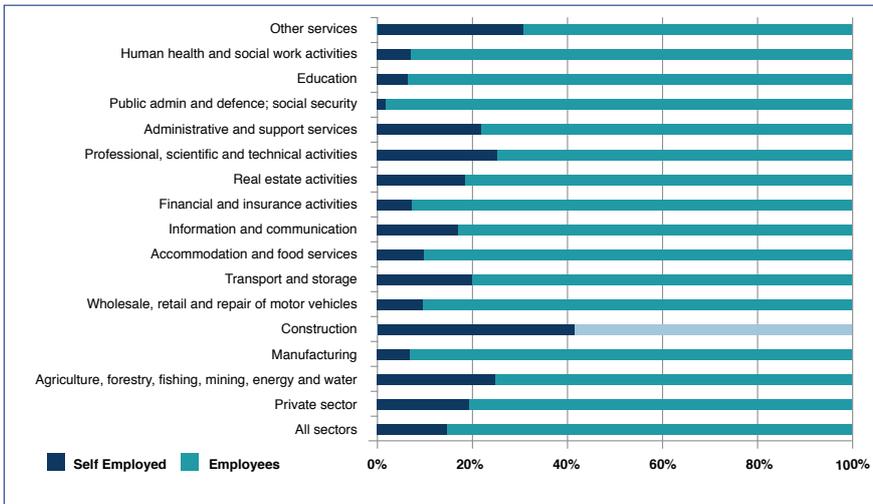


Figure 1. Self employment across industry sectors (May 2019)²¹

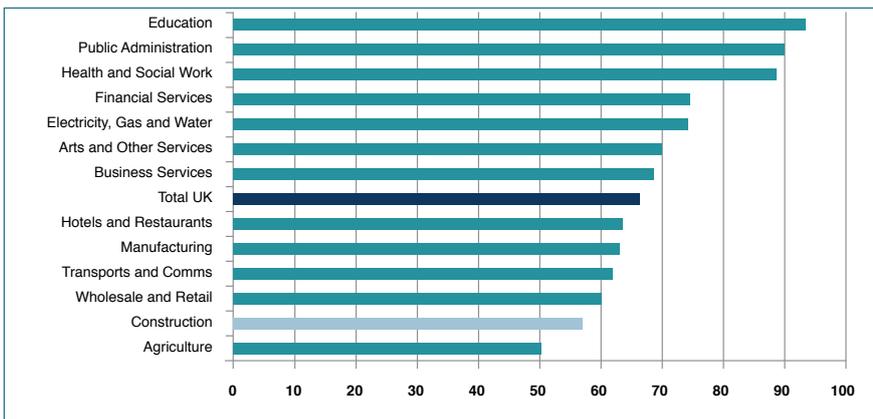


Figure 2. Proportion of employers providing training, by sector (2015)²¹

**1.1 Industry can respond by increasing people in direct employment and reinforcing this throughout their own supply chains.**

**Proposed measure:**  
% of Direct Employment by Contract.

**1.2 Clients and Government can encourage industry by changing procurement requirements, in the public and private sector, to demand direct employment.**

**Proposed measure:**  
Number of contracts / tender actions, as a percentage of all contracts let, which contain scoring criteria to incentivise direct employment (at head contract and throughout the supply chain).

*“A directly employed workforce benefits from structured investment in training and development. Personal development is career orientated as opposed to project focused. This results in more competently trained employees with a wider range of skills”*

**Steve Fox**  
**Chief Executive Officer**  
**BAM Nuttall Ltd**

**2.1 Industry can respond by increasing investment in their approach to Smart Construction, such as delivering the latest training and engaging with local innovation hubs that increase accessibility to new technologies for the industry's supply chain.**

**Proposed measure:** Measure the value of all industry training delivered for training activities related to Smart Construction techniques and behaviours.

**2.2 Clients can support by implementing design and procurement evaluation criteria for both public and private sector projects to stimulate consistent demand for Smart Construction.**

**Proposed measure:** Number of contracts / tender actions as a percentage of all contracts let, which contain scoring criteria to incentivise Smart Construction (at head contract and throughout the supply chain).

- 2. Create an environment where Smart Construction methods are encouraged through early design and procurement processes, thereby creating the demand for skilled employees which in turn drives employers to invest in training, Smart Construction techniques and behaviours.**

***CLC Skills Workstream Action:** Influencing procurement strategy and policy to encourage the use of new technology and Smart Construction to unlock productivity gains.*

The procurement approach adopted by clients can significantly influence which methods and employment models are deployed. It is recommended that clients invest in collaborative tendering processes with scoring matrices structured to favour those willing to deliver Smart Construction solutions. Bid evaluation criteria reinforces the intention and expectations of the client and focuses the energies and efforts of a bid team to collaborate, embed digital technologies and leverage industrialised manufacturing techniques to benefit end users and reduce total expenditure, further encouraging innovative solutions through procurement delivers significant value to clients and end users by improving quality, productivity and savings in both time and other areas such as carbon reduction. An example is the time saving generated on Crossrail by Laing O'Rourke at Liverpool Street Station. See the full case study at Appendix 6.

Using scoring criteria in this way has yielded success on projects such as the Anglian Water @one alliance which delivered significant asset decarbonisation and a reduction in overall CAPEX and TOTEX spend. Models such as this could be adopted by other clients as the future operating state.

Coupled with tender scoring criteria, the choice of contract is also influential and it is recommended that relational forms of contract are selected over more traditional adversarial forms to support the collaborative arrangements necessary to underpin Smart Construction.

- 3. Industry qualifications and training content is updated to include Smart Construction techniques and behaviours with funding made available to accelerate adoption.**

***CLC Skills Workstream Action:** Skill development, cross sector collaboration and research.*

Where technologies supporting Smart Construction and industry advancement have been developed, recent research has highlighted that adoption and market uptake is slow due in part to the risk-averse nature of the industry and poor knowledge transfer. As occupations change and the associated competencies diverge from traditional trade definitions to more multi-skilled and behaviour-led requirements, there is a need to look at how the education system and funding arrangements (e.g. CITB grant allocation and apprenticeship levy) are equipped to adjust and support these changes encouraging all standards and qualifications have appropriate future skills content.

Initial actions related to each of the skills required for a sustainable construction industry are outlined below:

#### Digital skills:

- Industry must follow the lead of other sectors (e.g. medical) and develop collaborative relationships with technology, software and equipment providers to enable fully integrated technical solutions to be developed and deployed with an accompanying upskilling package.
- Training bodies to work with industry to create and invest in data sciences training, at all levels, to enhance the sectors capabilities in systems integration and digitisation.
- Training bodies to work with industry to develop a digital literacy framework to address the future needs of the industry.
- Professional institutions, training providers and industry should develop and deliver qualifications and mandated continuing professional development activities that accelerate understanding and deployment of digital skills.
- Deliver the recommendation of CITB's 2018 research report 'Unlocking Construction's Digital Future: A Skills Plan for industry' to equip organisational leaders to deliver digital change and develop new resources and capability for digital upskilling.

#### Technical Skills:

- CITB research and development activities can support industry and focus on identifying and mapping new standards and qualifications with accompanying funding frameworks to address future technical skills demands e.g. trade conversions.
- Supported by CITB research and investment, the industry should work with training providers to ensure that the skills needed for Smart Construction can be developed while growing industry capability for maintaining and improving existing built assets; traditional buildings in particular.

#### Collaboration Skills:

- CITB, with industry, to develop a suite of funded training opportunities to engage all of industry in an accelerated behavioural change programme to increase professional collaboration.
- CITB should work with government, industry and training providers to build on the Construction Skills Fund to design and deploy a common work readiness scheme for all new entrants, initially focused at direct entrants from full time education.

As well as these theme-specific actions, there are several cross-cutting activities which form part of these actions, which are the need to:

- Embed new knowledge, skills and behaviours in to all existing standards and qualifications. This should include professional evaluation of their membership criteria.
- Emphasise the importance and prominence of behavioural requirements in standards and qualifications.
- Drive behavioural skills during the early years of education.
- Bring training providers and employers closer together to understand needs and develop appropriate learning outcomes.

#### Traditional Skills:

- CITB with micro and SME organisations to develop a suite of funded training opportunities to develop the complementary skills necessary to enhance traditional delivery; digital, technical and collaboration.
- CITB with micro and SME organisations to research which occupations, when combined, provide the most production benefits to identify and develop suitable standards and qualifications to progress the main multi-skilling routes.
- Provide micro and SME organisations consistent and funded access to innovation hubs and innovation incubators to accelerate deep industry change.

### 3.1 Industry must respond by developing and executing upskilling and training for Smart Construction methodologies.

**Proposed measure:** Number of training opportunities developed by industry, and supported by relevant training boards, which contain content for Smart Construction.

### 3.2 Clients can support by demanding evidence that industry is training their people in smart construction techniques.

**Proposed measure:** Establish tender scoring which specifically evaluates supply chain investment in Smart Construction techniques and behaviours.



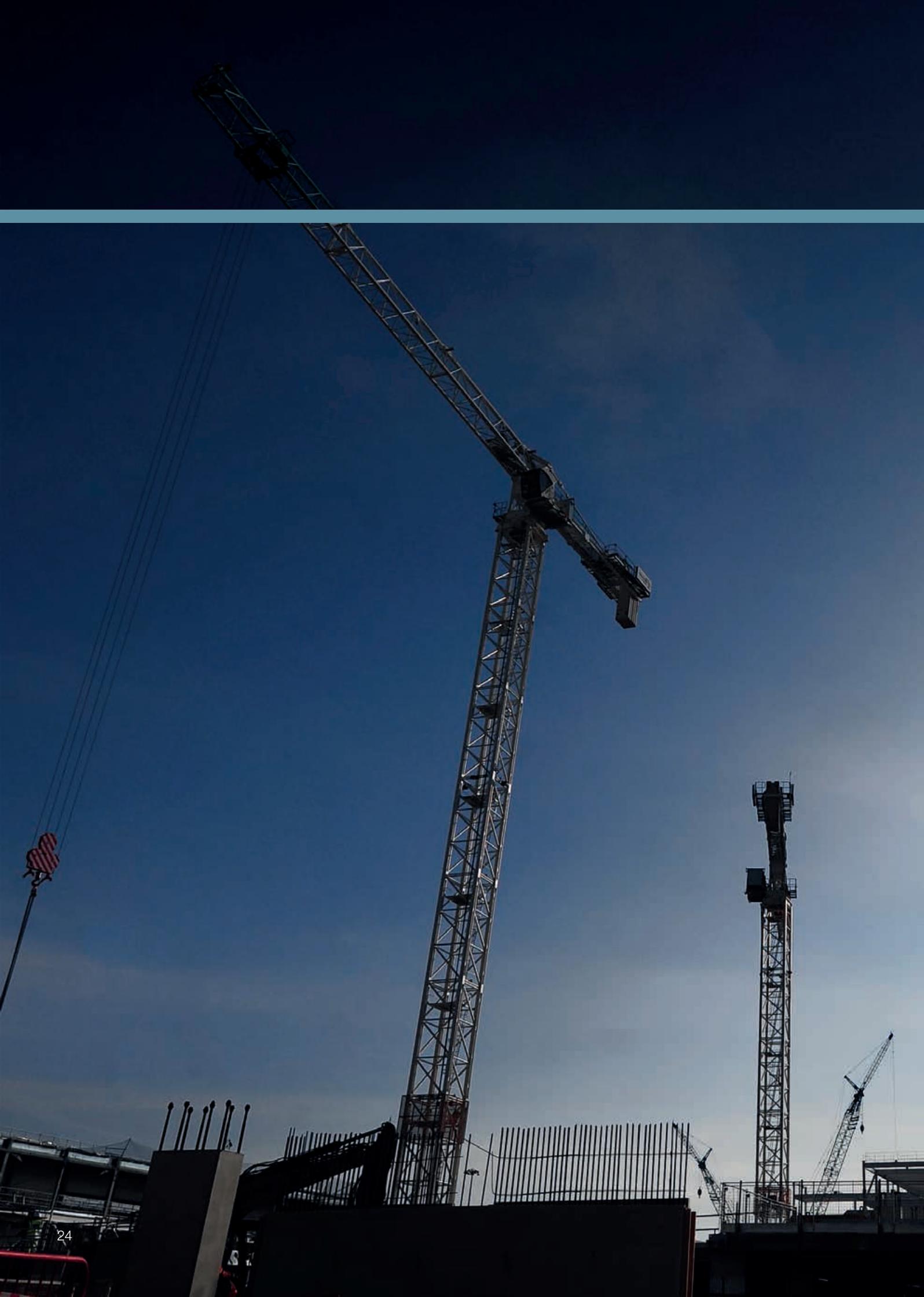
# Contributors

## Contributors

### The CLC would like to thank the following contributors:

The University of Cambridge, Heathrow Airport, Unite the Union, the Construction Industry Training Board (CITB), the Electrical Contractors Association (ECA), the Joint Industry Board (JIB), the Building Research Establishment (BRE), the Advanced Manufacturing Research Centre (AMRC) in Sheffield, Construction Innovation Scotland, in addition to the Department for Business Energy and Industrial Strategy (BEIS) and construction delivery organisations, NG Bailey, Mace, Laing O'Rourke, BAM, Morrisroe, Severfield Plc and SJD Electrical.





# Appendix 1

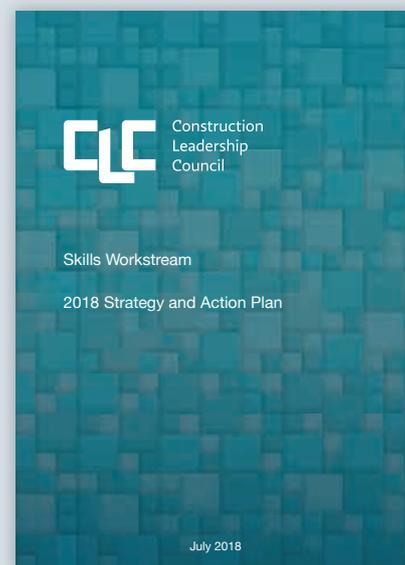
## Skills workstream

### 2018 Strategy and Action Plan (July 2018)<sup>22</sup>

The CLC Skills Workstream identified three strategic action areas necessary to underpin the future of the industry and leverage the significant productivity gains that could be generated by digital and offsite construction methodologies: Smart Construction.

These are: attract, recruit and retain; (including training); apprentices and future industry needs<sup>22</sup>. This report looks in specific detail at the future industry needs, which identified a further nine specific actions areas:

1. Influence central and local government procurement strategy and policy
2. Agree the contribution that new technology and Smart Construction can make to improving productivity
3. Develop programmes to re-train the workforce
4. Ensure that skills are taught using a blend of modern teaching techniques
5. Define the research needed by industry to support the change agenda
6. Digital skills
7. Industry culture and productivity
8. Research the skills needed to deliver future requirements
9. Encourage action to reduce the number of workers not in direct employment



22. <http://www.constructionleadershipcouncil.co.uk/news/clc-skills-workstream-publishes-their-strategy/>

# Appendix 1

## Relevant future skills extracts from the CLC skills plan (July 2018)

# Introduction

The Construction Leadership Council and the CITB will assist and facilitate the UK Construction Industry, through its leadership, to successfully attract and retain the workforce it needs. This will also support the development of the required skills within the industry to deliver the UK's built environment requirements in the short, medium and long term.

The CLC Skills Workstream will engage with the supply chain to support the activities detailed in this plan. It will also take a holistic view of the opportunities and challenges across construction and work with all key stakeholders, such as industry, education, government and training providers to make sure they are working together to achieve a common purpose.

The Construction Sector Deal outlines the strategic actions which government and industry are committed to delivering. Through collaboration we will ensure the construction sector grows and develops a workforce capable of delivering housing, infrastructure and wider industry needs to 2025 and beyond.

These are key objectives for one of the largest and most important sectors of the UK economy. In 2016 the wider construction sector, including contracting, product manufacturing and associated professional services had a turnover of around £370bn; it contributed £138bn in added value to the UK economy, representing 9% of UK value added; employed around 3.1 million workers, or around 9% of the UK workforce and exported over £8bn of products and services.

## Challenges and Opportunities    Actions for industry

### To deliver this plan, the sector must overcome a number of challenges.

In addition to the impact of demographic change, the sector struggles to **recruit and retain** the workers it needs. The Construction Industry Training Board (CITB)<sup>1</sup> estimates that the sector will need to recruit and train 158,000 workers between 2018-22, c.31,000 per year.

The industry has a unique opportunity to change and become **more productive** and establish a **more sustainable** construction sector. **Adopting digital and manufacturing technologies** will help to promote the change agenda and develop a skilled workforce with new capabilities and deliver high quality, well-paid jobs throughout the UK.

CITB's 2017 Migration research<sup>2</sup> found that over half of employers who have any non-UK workers are concerned about the impact of potential future restrictions on their recruitment. Yet the industry does not yet have a **co-ordinated approach to promoting construction careers**, to attract potentially talented employees to the sector. It also lacks **diversity**, for example 86% of construction workers are male and 95% are white. The consequence of this is the loss of skilled and talented employees to other sectors and lack of diverse thinking.

The number of apprenticeships is growing, up from 18,290 in England in 2015 to 21,460 in 2016 and remaining at this level during 2017.<sup>3</sup> Good progress but below the industry's need for more workers and for the specialist and broader skills it will need in the future. Employers need to collaborate with other partners to develop the Trailblazer standards that underpin training in the skills needed for the future.

We must also work with government to **make the Apprenticeship Levy work better for construction** – ensuring funding reaches the SMEs who deliver the majority of construction apprenticeships, particularly in trades.

Other challenges include: coordinating a diverse industry to send out clear messages on construction careers, provide more meaningful work experience, engage with the new T Levels in Construction, and ensure training providers understand and respond to its needs.

The Sector Deal provides an opportunity for everyone to collaborate on a coherent plan that addresses these issues.

Developing a plan through collaboration is not enough. Supported by a reformed CITB providing strategic leadership on skills, the industry must work together to train, attract and retain the modern, efficient workforce it needs by:

- Co-ordinating work on the development of Trailblazer standards for apprenticeships; prioritising these and working with the Institute for Apprenticeships to secure approval.
- Working together to increase the volume and quality of work experience opportunities.
- Developing a co-ordinated approach to promoting construction careers under the banner of Go Construct.



The number of apprenticeships is growing, up from 18,290 in England in 2015 to 21,460 in 2016 and remaining at this level during 2017

<sup>1</sup> CITB – Construction Skills Network 2018–2022 – published January 2018  
<sup>2</sup> CITB – Migration and Construction: The view from employers, recruiters and non-UK workers – June 2017  
<sup>3</sup> Apprenticeship Statistics: England, Parliamentary Briefing Paper Number 06113, 25 January 2018

# Appendix 1

## Relevant future skills extracts from the CLC skills plan (July 2018)

### CITB Future Industry Insight and Investment Timeline

#### Strands and Milestones



**DIGITAL:**  
unlocking construction's digital future



**OFFSITE:**  
building capacity for offsite training provision.



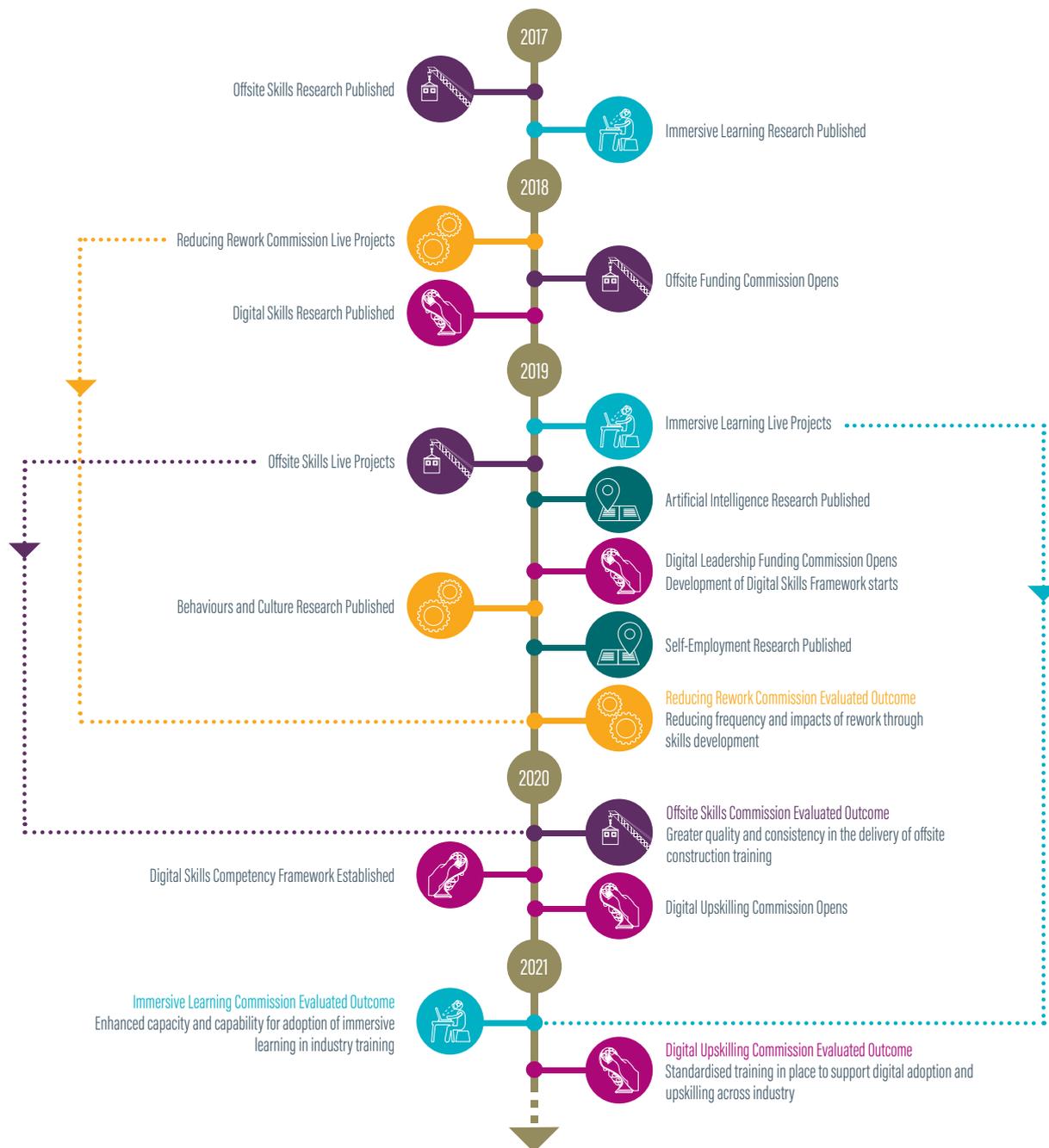
**PRODUCTIVITY:**  
investing in skills to improve industry productivity.



**IMMERSIVE LEARNING:**  
make more innovative training approaches available to industry.



**OTHER RESEARCH MILESTONES**



## 6. Future of the Industry

### Overview

Investing in the future skills required by digital construction and offsite construction could generate significant productivity improvements. These will underpin reduced costs and project delivery times, increased quality and better environmental outcomes. It will also support the recruitment and retention of a more skilled workforce.

To realise these opportunities, industry, government, training providers and other related organisations must be able to access the right evidence. This will:

- Support the development of a shared understanding of the opportunities available and help to galvanise the actions required by all parties to realise them.
- Ensure that the industry's careers campaigns are forward-looking and reflect the full range of opportunities available.
- Help those responsible for standards and qualifications, including CITB and training providers to better understand construction's future skill needs and respond to them quickly.
- Provide CITB with the intelligence to target its funding.

### Specific actions

- **Influence central and local Government Procurement strategy and policy** in relation to construction and infrastructure to include clearer expectations that projects are delivered using smart construction.
- **Agree the contribution that new technology and smart construction can make to improving productivity** over the next decade and the actions required by industry, CITB and by government to make this happen.
- **Develop programmes to retrain the workforce** with the skills to support the future industry needs to embed and maximise the use of digital technologies and smart construction.
- **Ensure that skills are taught using a blend of modern teaching techniques**, including developments such as simulation, virtual and augmented reality as well as exploiting developments in contextual learning for core skills.
- **CITB Future Skills research:**  
CLC will agree with CITB the development of research to highlight the potential scenarios for construction employment level in different occupations should the industry start to make more progress and move further towards application of new technologies and smart construction. This would seek industry agreement on what is achievable in the next decade, analyse the implications for the level of construction employment and the occupational mix and set out the actions required to make this happen.
- **Digital skills.** Review which types of digital platforms and tools are most widespread, now and in the future and where there is the most potential for uptake in construction. Analyse the skills, knowledge and behaviours needed to support their use and greater adoption and what forms of training intervention are most appropriate.

- **Industry Culture and Productivity.** Improve the understanding of the link between industry culture, individual behaviour to improve productivity. This will include reviewing:

- To what degree are individual behaviours influenced and shaped by industry culture and can this be influenced through training?
- How is the identified need for more flexible skills sets and behaviour change being supported by industry's supporting infrastructure (Associations, Professionals Bodies, and Awarding Organisations). What more can be done?
- Are silos in industry culture and infrastructure a barrier to behaviour change?
- Looking at behaviour change in other industries and how it's been achieved.

- **Research the skills needed to deliver future requirements** whilst considering impact of technology and smart construction development.

- **Encourage action to reduce the number of workers not in direct employment**, especially false self-employment which is a clear barrier to employers investing in training. Industry needs to collaborate to encourage all public and private sector clients to consistently mandate direct hire practices in their supply chain.

In all areas of the above research areas, CITB will work with the CLC to agree the implications of its research for CITB's careers, standards and qualifications and training and development work and its funding support and for action by industry and by government.

# Appendix 1

## Relevant future skills extracts from the CLC skills plan (July 2018)



Construction  
Leadership  
Council

[www.constructionleadershipcouncil.co.uk](http://www.constructionleadershipcouncil.co.uk)

c/o Department for Business, Energy & Industrial Strategy  
1 Victoria Street, London, SW1H 0ET Tel: 020 7215 6476  
Email: [construction.enquiries@beis.gov.uk](mailto:construction.enquiries@beis.gov.uk)



## Appendix 2

# Case study: Investment in new skills will ensure UK construction continues to innovate

**Although the UK construction sector is worth £370bn a year and employs almost 10 per cent of the total UK workforce, we lag behind many other sectors when it comes to productivity.**

According to the Department for Business, Energy and Industrial Strategy, over the past 22 years annual productivity growth across the construction sector has been 20 per cent lower than for the UK economy as a whole.

One of the key factors impacting productivity is skills.

We all recognise we have a skills shortage, which needs to be tackled not only through recruitment but in upskilling hundreds of thousands of employees across construction.

At NG Bailey, we have recognised that challenge and are addressing it throughout our business, in terms of the way we recruit, retain and retrain colleagues. We spend more than £3m a year on training and development.



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*Offsite Manufacture recently celebrated passing 1,000,000 RIDDOR free working hours – a huge achievement!*

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Offsite manufacture is a particular focus for NG Bailey. The standardisation of design and manufacture has many advantages, but we are also applying a number of new technologies that bring additional benefits to a project whilst accelerating the learning of our workforce. These include the use of simulation and visualisation applications (such as 3D perception) and pre-engineered components.

The benefits of adopting Smart Construction, and a 'design for manufacture' approach (using digital technologies such as BIM), are clear, but they require investment across the sector in three key areas.

Firstly, if we are to fully reap the benefits of offsite manufacture through improved productivity, better quality of product and increased safety, we need to focus on recruiting people with the requisite skills or investing in training those individuals to develop the skills that are needed. It's costly, but without it the UK will lag behind its global competitors.

Secondly, delivery organisations and end clients need to look beyond the 'norm' when it comes to procurement. A more collaborative approach with specialist sub-contractors and changing the focus from lowest cost to best value, will ensure that Smart Construction and designing for manufacture become standard practice across all types of construction, however complex.

Finally, we need investment in education, particularly in the funding of school's careers advice, which was withdrawn in 2012. Without face-to-face advice, pupils are denied access to the full range of exciting academic and vocational options available – such as apprenticeships.

Only by focusing on all three areas – recruitment, procurement and education – can we continue to meet our industry’s challenges over the next decade and beyond.

At NG Bailey, our people are the backbone of the business - our focus of attracting, recruiting and retaining the very best people sits at the heart of our people strategy.

An example of this is our onboarding process at Offsite Manufacture. Our pre-employment screening includes a series of tests focused on a candidate’s manual dexterity and 3D perception. These skills are then harnessed and weaved into bespoke training modules – including translating flat 2D information into 3D built modules in a real-world environment, via a kit of parts. This approach ensures we provide the trainees with hands on experience and knowledge, so they join the offsite manufacture assembly line quicker and at a higher competency level – they truly understand the part they play and the value they add in delivering an exceptional solution.

Training doesn’t stop once the employee hits the assembly line, our employees then embark on a 13-month Business Improvement Technique course, that sees the employee gain a relevant qualification.





## Mick Whaley Senior Project Engineer

**Mick has been with NG Bailey's specialist Offsite division for six years, having worked with the business as a welder for more than 15 years.**

A qualified engineer, Mick, having seen the benefits an offsite solution can bring to a project took an opportunity to join Offsite Manufacture and began his learning of DfMA. He is now a Senior Project Engineer within the Offsite Manufacture team.

"I generally have an input in the early stages of a project, to incorporate innovative offsite manufacturing products into the design and engineering processes to ensure maximum benefit," says Mick.

"My background in welding and fitting large pipework on site has been of huge benefit in my role, even though I am now working in a controlled factory environment my previous site-based experience means I have the vision of how things work on site. In fact, my onsite experience and the training I've had since joining Offsite Manufacture has given me a well-rounded vision of what I do and how it makes a difference – I know first-hand the challenges faced onsite.

I have particularly enjoyed learning new skills. I am still learning, and we have a comprehensive learning and development programme that enables me to develop my skills and career within NG Bailey.

"The use of digital technologies, such as BIM, and operational technologies like Navis play a key role in my day-to-day work, allowing us to integrate with site teams via live modelling. By using technology, we effectively build the project in the virtual world before we step foot on site – this approach allows us to rehearse the installation and highlights clashes allowing them to be resolved thus avoiding costly on-site rectification.

"I am lucky that my role gives me the best of both worlds: working with a great team at Offsite Manufacture, and then liaising with the on-site teams to incorporate those bespoke offsite elements on a wide range of exciting and innovative projects."

## Mark Wooding Senior BIM Coordinator

**Mark has been with NG Bailey for more than 20 years, and for 18 years he has worked in the group's Offsite Manufacturing facility.**

Having started out on the shop floor helping assemble prefabricated M&E modules, Mark was offered the chance to move into the CAD office, where his knowledge of shop floor assembly helped in his new role. He has committed to and undertaken various recognised building services qualifications that have led to him advancing his career in the business, to be where he is today, as a Senior BIM Coordinator.

"Technical drawing is something I have always been interested in, and it is really satisfying to see what you have drawn on screen come to life on a project," says Mark.

"Probably one of my proudest moments was working on the 130m long heavily serviced link corridor at Birmingham New Street Station. It was a challenging project, so it was a very proud moment for me to finally see it being installed.

"New technologies play a key role in my work. I need computers capable of opening large Revit models, while others are working on the same model. I also use Skype on a daily basis – sharing screens with colleagues helps to solve issues quickly without having to commute."

Mark has benefited from CIBSE's online learning modules, such as hot and chilled pipework systems and ventilation design.

"Working in Offsite is challenging and rewarding," he added. "For anyone who enjoys collaborating with people with different skillsets and having the vision to come up with bespoke solutions to challenging situations, I would highly recommend it."



# Appendix 3

## Case Study: BIM in practice upskilling programme

*The BIM in Practice programme of support has been designed to raise awareness of the opportunities Scottish construction companies can realise through BIM Level 2. It demonstrates the benefits that can be achieved through knowledge sharing, collaboration, innovation and best practice.*

*The programme is designed to support businesses from their initial awareness of BIM to the continuous development of their BIM journey, offering support at all stages. The programme, which is jointly funded by Scottish Enterprise and Construction Scotland Innovation Centre, includes:*



**Free events: The programme will deliver 19 seminars, workshops and conferences offering a range of information suitable for all levels of BIM understanding. Includes training seminars on:**

- BIM Level 2 Awareness
- BIM Level 2 Sector-specific Implementation
- BIM – Understanding Client Requirements
- BIM for Design Teams
- BIM for Contractors
- BIM for Manufacturers
- 6 x Digital Construction events

**Flexibility: Learn in your own time with a new e-learning platform allowing users unlimited access to all of our bespoke online learning videos. Includes e-learning modules on:**

- BIM for Business Leaders
- BIM Level 2 Sector-specific Implementation
- BIM Level 2 Implementation

**Expertise:** Access to resources and industry experts to answer all of your burning BIM questions no matter how complex the issue.

**Collaboration:** Join our online BIM discussion forum to connect with like minded professionals and share ideas.

- BIM Discussion Forum LinkedIn Group – 207 members

**Across the programme the targeted participation is set out below – the programme is on track to achieve this:**

- 740 Companies Attending Events
- 800 Registered Views of E-learning Presentations
- 500 Members of Online Collaboration Platform
- 500 Unique Visitors to FAQ library



## Appendix 4

# Case Study: FUTUREquipped college innovation programme

*FUTUREquipped, the largest college innovation programme in Scotland, is a pilot that has trialled ways that colleges and Innovation Centres can work together to support workforce development to better meet the needs of industry, as well as to support business innovation. It is supported through the Scottish Funding Council's College Innovation Fund.*

The programme, co-designed and led by the Digital Health and Care Institute (DHI) and the Construction Scotland Innovation Centre (CSIC), and supported by the Data Lab and Censis, has brought together three sectors that don't normally collaborate: health and care, construction and ICT.

FUTUREquipped is a large-scale collaboration project with 13 of Scotland colleges participating in the programme. The project consisted of three workstreams:

- **Workstream 1:** Upskilling college lecturers in emerging innovations;
- **Workstream 2:** Exposing college students to innovation and emerging technologies in the real world of work (follows WS 1);
- **Workstream 3:** Supporting college-business innovation (parallel to WS1 and WS2).

While the Healthcare and Construction sectors lag behind other areas of the economy in digitisation, a profound digital transformation is currently taking place in these areas. In addition, both sectors find themselves facing serious skills shortages. Teachers need to know what the

future will look like in order to ensure that students are equipped to work in digitally enabled environments.

The theme of the project is **future skills for future housing**. The key areas explored in the project have included technology-enhanced health and care, augmented/virtual reality design and build, advanced construction and offsite technologies, and sensor technology and the use of data.

FUTUREquipped is a pioneering, innovative and interdisciplinary project, where each partner has contributed their respective areas of expertise. CSIC has offered insights into digital, robotic and offsite construction technologies at their Innovation Factory in Hamilton, Scotland. As well as expertise on digital health and care innovation, the DHI gave participants access to their newly launched Demonstration and Simulation Environment, developed for testing and showcasing existing technologies and simulating the integration of these with data flows in health and care. DataLab and Censis provided insights on sensor technology, IoT and data. In addition, the project has brought in a wide range of specialists and expert speakers from industry, the government, HE and FE and the third sector.

FUTUREquipped has a 12-month project which completed in February 2019. The project has offered colleges, innovation centres and businesses a unique opportunity to collaborate and learn across disciplinary borders. Project participants include:

- 13 Scottish colleges
- 27 teaching staff from colleges
- >130 college students
- 9 business partners



# Appendix 5

## Case study: Professional education



UNIVERSITY OF  
CAMBRIDGE

*The Construction Engineering Masters programme is a degree offered by the Department of Engineering in association with the Judge Business School at the University of Cambridge delivered in the Laing O'Rourke Centre for Construction Engineering. This two-year part-time course is targeted at emerging industry leaders. The course aims to enhance knowledge and leadership skills with the expectation that participants will return to their respective companies trained as agents of change to redefine the way in which the infrastructure of society is created. The content covers consideration of business, policy and project delivery. It is oriented towards broadening the skills base of participants, combining professional education with producing industry-applied research.*

Participants conduct individual research projects relevant to the construction sector, applied to real-world problems, typically identified through the participants' professional experience. Four recent examples of dissertation research relevant to the theme of "future skills" is provided below<sup>1</sup>:

### **Digital competence for a digital era: A construction design-sector practitioner perspective<sup>2</sup>**

This study highlights that digital competence is much broader than operational skills: it encompasses a combination of competence attributes, underpinned by intelligent problem-solving that applies digital solutions and data concepts to fulfil outcome needs. From reviewing a small sample population of design practitioners, the study suggests only one-in-three practitioners achieve an advanced digital proficiency rating, indicating that the UK design community is not yet fully equipped to leverage opportunities presented by a digital transformation. **It is suggested that business managers focus efforts on raising practitioner proficiency specifically in problem-solving and data literacy.**

### **The susceptibility of structural engineering to automation and its potential implications for the future of the profession<sup>3</sup>.**

Considering the era of the Fourth Industrial Revolution industrialisation, this study assesses the potential for automation in structural engineering. It determined that between 21% and 66% of the tasks within the profession are susceptible to automation, depending on various scenarios of adoption of artificial intelligence and automation technologies. **It is suggested that a solution to automation is to create new multidisciplinary roles to maximise uniquely 'human' characteristics, focusing on higher value, non-routine tasks.**

- 
1. [Access to the cited research may be requested via cem.admin@construction.cam.ac.uk](mailto:cem.admin@construction.cam.ac.uk)
  2. Robson, K. 2018
  3. Patilla, R. 2018
  4. Redman, J. 2018

## BIM in higher education in the UK and future industry requirements<sup>4</sup>

Given the rapid adoption of BIM processes and technologies, the industry is facing a skills shortage and research shows that higher education institutions (HEI) worldwide are reacting slowly to the construction industry's BIM skills requirements. There is little to inform construction industry firms about new graduates' BIM skills and even less describing how firms will need to confront this skills gap to meet industry trends up to 2025.

This study involved interviews with industry professionals and academics and a survey of UK HEI course leaders about the future BIM progression and current state of education respectively. It found that undergraduate BIM education focuses on teaching BIM modelling software and is varied with regards to how this is placed in context of industry practice. It concludes that undergraduates are generally not provided with an opportunity to work collaboratively in cross-discipline teams to prepare them for the workplace. **The study recommends that firms focus on collaborative training with their supply chain, focusing on data management and contextualising BIM rather than the modelling technology itself.**

## Understanding how 3D vs 2D design information influences skilled operatives' productivity<sup>5</sup>

With the advancement in affordable mobile computing systems, viewing construction information in 3D space on a construction site has been viable for several years. Yet, this technology is still broadly overlooked for use by construction operatives. By analysing empirical data collected during a series of field trials, this research determines differences in the performance of fabrication operatives when using 3D vs 2D design information. The findings suggest that 3D design information allowed the most efficient use of working time, the least number of errors and the quickest time to completion. However, the improvements were slight when the whole population was considered without any demographic grouping. Further analysis based on certain participant traits suggested that **3D design information formats could compensate for low spatial cognition and significantly improve younger and less experienced participant performance.**



5. Corlett, B. 2018

## Appendix 6

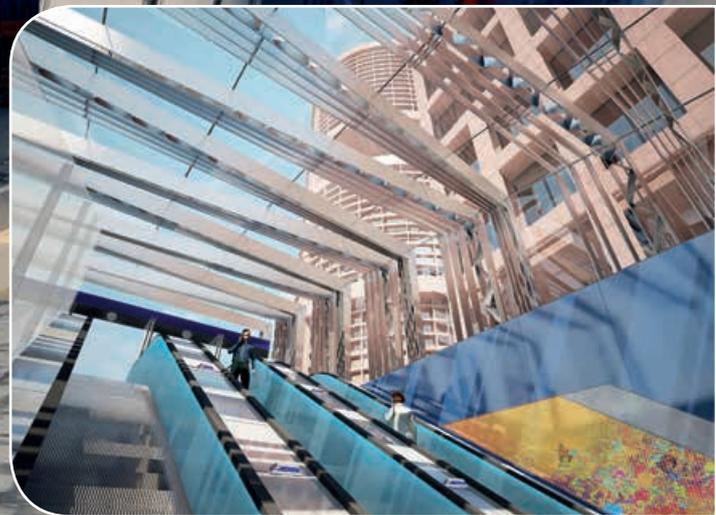
### Case study: The potential of offsite manufacturing in infrastructure: Crossrail

As part of the Crossrail programme, Laing O'Rourke has delivered Tottenham Court Road and Liverpool Street stations. While both stations had similar scope, the similarly sized 450 metre platforms were built using very different methods, the former relying on traditional insitu methods and latter applying Design for Manufacture and Assembly (DfMA) solutions, where 460 precast concrete elements were manufactured at Explore Industrial Park in a controlled factory environment.

The offsite approach delivered an 11-week programme saving, with a reduction in people required to work in an underground environment and the associated elimination and mitigation of occupational health risk. The comparison of the two approaches offers evidence of faster delivery, improved health and safety, and, ultimately, increased productivity.

**41-week** construction period at Tottenham Court Road versus **30-week** construction period at Liverpool Street.

**57 skilled operatives** required to deliver the in situ installation at Tottenham Court Road versus **seven people on site**, and **27 people in the factory** to deliver Liverpool Street.





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