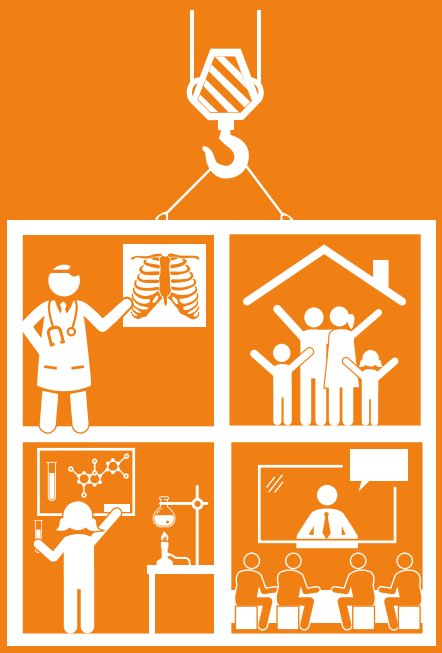
mace

INSIGHTS 2019

TRANSFORMING SOCIETY:

Using construction as a catalyst to deliver change



Mark Reynolds
Chief Executive

Appointed Mace's Chief Executive in January 2013, Mark has been a member of the Group Board since 2001.

His vision is for Mace to lead the industry through innovation, be a major British exporter of construction services, deliver a consistent high quality service to clients and ensure that Mace continues to develop, attract and retain the very best people in our industry.

Mark gained his early experience in the commercial sector on the Broadgate and Ludgate developments in London, later moving on to projects with BAA.

He was the Deputy Programme Director for the London 2012 Olympic and Paralympic Games, reported as the best ever delivered venue in the history of the modern Olympics.

Since 2016 Mark has sat on the board of the widely respected business body London First. In 2017 he was appointed to the UK Government's Construction Leadership Council heading up the skills workstream.

Matt Gough
Director of Innovation and Work Winning

Having joined Mace in 2011 to lead the company's work winning activity, Matt was promoted to the Director of Innovation in February 2017.

His role, owning the company innovation strategy, and helping to embed a culture of innovation throughout the company, is supporting Mace to realise its ambition to be the catalyst for the next evolution of the construction industry.

Matt has supported the top line growth of our construction business from £600m to £2.3bn in 2018, and he played an important role in some of the business' biggest wins during that time. His career started in digital, having studied computing as part of his BA degree, and he is now aligning Mace's interests with the innovation and technology being driven by the digital sector, as part of the transition to Industry 4.0.

Matt is a strategy board member for the Infrastructure Industry Innovation Platform (i3P).

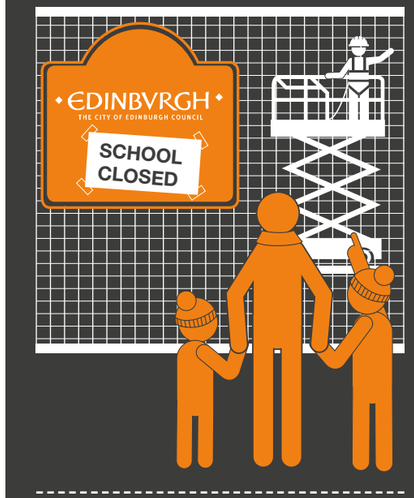
Between 2016-2021 over...

£48.6bn

has been allocated to infrastructure spending on education, health and justice [xvi]

17

Edinburgh schools were closed in 2016 over concerns about the standard of construction used to build them [xviii]



Her Majesty's Prison and Probation Service manages an estate of...

...prisons across England and Wales [xxx]

Over a...

quarter

of prisons in England and Wales were built before 1900 [xxxi]

FOREWORD

Society is on the cusp of being transformed. Our public services, our homes and our workplaces are all about to change fundamentally, as improved data and construction methodologies unlock a new future.

Structures and buildings will be built differently, designed around the user and optimised for how people actually use these spaces and environments. New construction methodologies – the long-heralded 'construction revolution' – are finally beginning to change how and what we build.

That revolution has huge implications for our global society. It will change how our public services are delivered and improve productivity across the world. Cheaper and more effective public services mean more capital available to invest in more facilities, better training or more nurses and teachers. It also means better outcomes; including a healthier, safer and better educated population.

In the UK, the potential productivity improvements could transform how we direct public infrastructure investment. Our huge infrastructure pipeline – more than £400bn of planned infrastructure projects and programmes – could be delivered in a way that reduces costs, improves reliability of delivery and produces better outcomes for everyone.

In order to get there, we need to change how we think about construction delivery and our industry. For years, people have been talking about the coming construction revolution and the transformative impact of so-called 'modern methods of construction'.

In our view, this has led to a stagnated debate. Our entire mindset is wrong. We are too focussed on 'modern methods' and how we embed them. Instead, we need to explore how that impacts the structure of delivery across our entire industry.

We're still talking about bespoke buildings and customised designs rather than platforms and products. We're still trying to understand how faster and cheaper construction processes will affect contractors, architects and clients – but we're looking at it from the wrong end of the telescope.

As we move to a new era of 'Construction to Production', the whole industry will need to adopt a 'product development' mindset. For those with experience in the manufacturing industry, this won't be too difficult; but for those of us who have spent their lifetime in construction it will require a significant change of pace.

In this report, we explore the huge opportunity on offer if we are able to build better buildings to transform public sector productivity – and what we all need to do in order to get there. We lay out seven new policy proposals that we think will be required to turn this into a reality.

Mark Reynolds
Chief Executive

How it can deliver better outcomes in society

Imagine being able to gift a nurse more time to spend treating patients on a hectic hospital ward. Or giving a teacher more time to plan the lessons they will deliver to students. Or allowing a prison officer to dedicate more time to preparing offenders for their release. There is an intuitive link between providing public sector workers with more time to treat, educate and rehabilitate and positive outcomes for our entire society.

Yet there are reasons to believe that public sector workers are likely to have less time in the future. Resources to fund public services are scarce, and tax rises to boost budgets are politically unattractive. Moreover, demand for some public services will increase due to factors like an ageing population, which will require greater amounts of public money to manage.

This is where the construction industry comes in. We can help our public servants to be more productive, which provides the foundation for better outcomes from our public services. But it is not guaranteed, which is why we are writing this report. In the following chapters we explain what needs to happen to catalyse the construction revolution that promises to transform our society.

Buildings, end-users, productivity and outcomes

Increasing the productivity of public sector workers – achieving more for the same level of effort – should be front and centre of policymakers' minds. And in many ways, it is. The use of digital technology, early intervention and service reconfiguration are just some of the initiatives that the government has focused on in recent years to increase efficiency.[i]

One productivity-enhancing measure, however, is almost entirely absent from the debate about improving productivity in the public sector. Using new construction processes to design and manage public sector buildings so that end-user needs are met is rarely discussed. It should have far greater prominence.

There is no doubt that the design and management of buildings influences the productivity of the people who use them.[ii] This is as true of a tech start-up's co-working space as it is of a new hospital. Whatever the context of the workplace, the principle remains the same. Recognising the needs of the people who work in a built asset across its lifecycle will enable them to be more productive.

This is not a flash in the pan management theory. Whether it be Henry Ford's moving assembly line or open plan office culture, thought has been given to how the design and management of workplaces can support workers to be more productive for a very long time.

94,000

(full-time equivalent) vacancies were advertised in hospital and community services alone between July and September 2018 [xxvii]

In 2017-2018 the total operating costs for running the NHS estate in England were...

£8.8bn [xxviiii]

The hope is that productivity improvements in the public sector – whether driven by the built environment or otherwise – mean improved societal outcomes. These outcomes could be a healthier population, a more skilled workforce or safer streets. However, while these outcomes are obviously linked to productivity performance in some way, the direct relationship between them – as we will go on to explain – is not straightforward to measure.

Where the construction revolution fits in

The construction industry is on the cusp of a revolution that will see the adoption of processes that facilitate standardisation and mass production. And – like we have seen in the automotive industry for decades – mass customisation to suit end-users. We can still design and build great public buildings and spaces if the revolution does not happen. Though they will be more costly, less efficient, take longer to build and be less tailored to the needs of end-users.

It is fair to say that a radical change in how the construction industry works – like those we have seen in other sectors such as retail, finance and manufacturing – has been promised for decades. The truth is though, that false dawn after false dawn means that the industry is still stuck talking about a revolution that is just around the corner.

Indeed, boosting public sector productivity with mass-produced buildings that are customised to end-users may sound fanciful to some. Cynicism, understandably, has set in. Yet we believe that the construction revolution is an entirely real prospect in the relatively near future if both the construction industry and government act now.

Why this report is important

This report focuses on how the construction revolution could improve the productivity of those working in our schools, hospitals and prisons. These institutions are the foundations of our society, underpinning our education, health and justice systems. Despite this focus, the arguments made in the following chapters could easily be applied across the public sector (and the built environment more generally).

The rest of this report is structured as follows:

- An explanation of how public sector productivity and outcomes can improve.
- A discussion of what end-users in the public sector want and need.
- An overview of the conditions that will support the construction revolution.
- An analysis of the public sector opportunity arising from the construction revolution.
- Recommendations on how to ensure the construction revolution happens.

Productivity is calculated by measuring how much input is needed to create an output. In public sector terms this might be the number of teachers and support staff (the input) needed to educate a number of pupils (the output); it might be the number of prison officers (the input) needed to guard a number of prisoners (the output).

As already noted, productivity growth in the public sector – producing more output for a given input – is essential if our public services are to overcome the challenges facing them. The UK's 5.37 million public sector workers need to become more productive.[iii] Yet public sector productivity is mired in a pattern of low growth. The average annual growth rate of public services productivity between 1997 and 2016 was 0.2%.[iv]

This subject is also about something bigger than changing the numerator and denominator in a productivity calculation. The inputs public servants turn into outputs are intended to create outcomes that benefit the whole of society. For example, making a nurse more productive on their shift so that they can treat more patients could mean the nation's workforce becoming fitter and happier or time spent in healthy old age being prolonged.

These outcomes are hard to measure because it is difficult to attribute cause and effect.[v] For instance, if we observe a fitter workforce is it due to medical professionals being more productive? Or is it because of a trend towards healthier lifestyles and advances in medical science?

Nevertheless, the public sector productivity effect on public service outcomes is a big part of how we try to understand the societal impact that our public services are making.

The appetite for change

Improving public sector productivity has been a feature of government policy for decades. Although the word 'productivity' itself is not referenced that often, with terms like 'efficiency savings', 'reducing waste' and 'delivering value for money' used instead. Regardless of the language, the point is that the government is talking about reducing the inputs and increasing the outputs that measure public sector productivity performance.

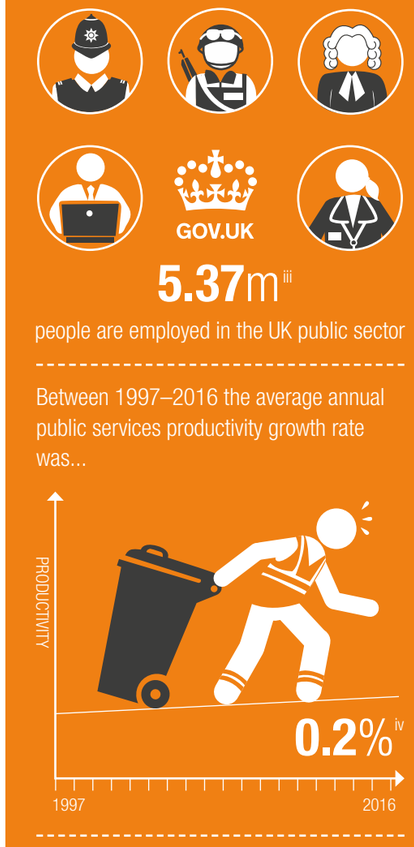
Various parts of government are also looking at how to better measure outcomes. Although, while there seems to be a growing movement towards considering outcomes in the delivery of public services, there has also been warnings that the term 'outcomes' may become all things to all people – that talking about outcomes becomes so generic so as to be meaningless.[vi]

In short, there is a sense that improving public sector productivity and outcomes is easy to talk about, less easy to change.

There are also indications that previous calls to action have been taken less seriously than they should have, and in direct relation to the subject matter at the heart of this report. In 2002 the then government published a report entitled, Improving Standards of Design in the Procurement of Public Buildings. It found that good design:[vii]

- supports improvements in public service delivery; and,
- can contribute to staff recruitment, retention and motivation.

These findings still hold today. And although the government may be able to point to exemplar projects where end-user needs have been recognised, these seem to be the exception rather than the rule.



Measuring change

The productivity performance of a public sector worker has differences to that of a private sector worker. Firstly, the output of the public sector is harder to measure as it is often less tangible – in the private sector the sale value of a product can easily be used as a measure of output, for instance. Secondly, realising productivity gains in the public sector are rarely driven by the forces of competition – private sector firms will innovate and become more productive in order to remain competitive or to stay ahead. Despite these differences, public sector productivity is calculated using the same principle as private sector productivity – measuring how many inputs are needed to create an output. These measured inputs and outputs vary across public services, as do the outcomes that we hope are produced from them

Take measuring the productivity of the education sector as an example. The Office for National Statistics combines three indicators to calculate inputs and combines two indicators to calculate output (see table below).[xiii] Potential outcomes arising from increasing output relative to inputs are given as illustrations.

It is easy to see how the promised benefits of the construction revolution will affect these inputs and outputs. For example, if a new productivity-enhancing public sector building means that staff have more time to devote to students, energy costs are lower and the building has more longevity then the inputs part of the productivity equation will benefit. Equally, if a new productivity-enhancing building allows more people to be educated and to a higher quality then the outputs part of the productivity equation will benefit. Outcomes will benefit by extension.

Understanding how the data needs to change to ensure that the productivity numbers change is all well and good. That is how performance is measured. Behind the data, though, are people – the teachers, nurses and prison officers who deliver public services day in, day out. Understanding them and how they work is essential if we are to give them the tools to be more productive and deliver better outcomes.

Indicators used as inputs	Indicators used as outputs	Potential outcomes
Labour. Such as measuring the number of teachers and support staff and their salaries. **Goods and services purchased by central and local government.** For example, equipment and energy costs. **Capital services.** Quantifying what is provided by an asset into a production process, which in this case is the contribution of buildings to educational outcomes.	**Quality.** Which reflects the educational attainment that the people being educated achieve. **Quantity.** Which reflects the number of people who are educated at various levels of the education system.	**International competitiveness.** A better educated workforce would mean the UK has a stronger base of skills in a post-Brexit world. **Higher pay.** A person with better qualifications can command a greater salary in the labour market.

UNDERSTANDING PUBLIC SECTOR END-USERS

Stand in the shoes of a teacher in a school, a doctor or nurse in a hospital or a guard in a prison. What do you think they would need from the buildings in which they work to make them more productive?

The answer may well differ between two people working in the same occupation in the same building. For instance, two nurses of the same seniority on the same ward may – and probably will – have different ideas on how their workplace could change to make them more productive. Add those working in different occupations in the same building into the mix and the picture would become even more complex.

In other words, productivity-enhancing measures are not an exact science and meeting every end-user's specific productivity needs within a building is impossible. Nevertheless, there are broad themes related to how a building works that we know matter to the end-user. As previous Mace research has argued, an employee's needs relate to both how a building functions (such as the lifts working properly) and how they experience it (such as having access to sufficient light).[ix]

The question for the construction industry is whether it is doing enough to understand the end-users of buildings. And if not, why not?

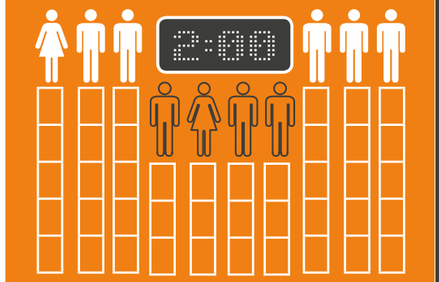
It is easy to see how the construction industry might regard the end-users of buildings as of secondary importance. We know that fragmentation, the itinerant nature of projects, low profit margins and cyclical demand create a disincentive for construction industry to invest in its people and new technology.[x] It could also create a disincentive to spend time and effort to invest in understanding end-users. Doing things as they have always been done is the path of least resistance.

This is not to say that the construction industry ignores end-user needs. It clearly does not. For instance, there is strong evidence to show that home builders do a decent job of meeting end-user needs in new-build houses. 93% of new-build homebuyers are either very or fairly satisfied with the internal design and layout of their new home; 77% are either very or fairly satisfied with storage in their new home.[xi] Although, it should be noted that there are some concerns over the overall quality of new-builds.

Some of this work is in fact already underway. The Government's 'Soft Landings' programme, re-launched in 2014, aims to ensure that feedback from Government clients on the operation and use of a building is captured throughout the construction process. This ensures clients can receive buildings in a state that allows for quicker operations; rather than the traditional and problematic 'hard landings' experienced elsewhere.

40%

of public sector workers stated that they were unproductive for more than two hours every working week because of their workplace environment [xvii]



947,000

people work in state-funded schools in England

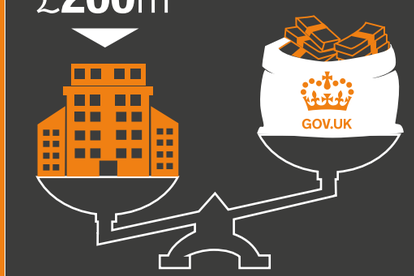
The Government has a vision for a...

50%

reduction in the overall time, from inception to completion, for new build and refurbished assets by 2025

Since 2010, the Government's property department has helped to reduce estate costs by over...

£200m



However, the existence of that programme itself demonstrates that the construction industry lags behind other industries in trying to understand end-users. As is often the case, the construction industry can look to the automotive and aerospace sectors for inspiration:

- There are examples from within the automotive sector that show how 'co-creation' – engaging people who use products to improve the design of them – has moved beyond surveys and focus groups to widespread interaction with customers via online communities, and in particular social media platforms like Twitter and Facebook.[xii]
- Research looking at the approach to design in civil aerospace concluded that design succeeds most when it is driven and informed by customer requirements, which can only happen via collaboration with customers themselves.[xiii]

It should also be noted that the construction industry cannot radically improve its understanding of end-users overnight. Successful end-user engagement requires building and sustaining to realise benefits over time.[xiv] Data collection and analysis will be fundamental to this, telling us how the use of a building changes over time, and allowing building managers to respond in real-time.

Better end-user engagement will mean that in the future we should be able to build hospital blocks that can be flexible about the type of treatment rooms on each floor, and are optimised for different doctor, nurse and patient workflows. We should also be able to deliver new schools or classrooms as quickly as we need them – and in a way that ensures that spaces can be easily repurposed for different types of learning as demographics change.

A better understanding of end-user needs in the public sector will be next to useless if the construction industry cannot build buildings that recognise those needs. The widespread adoption of technological advancements in construction promises that our future built environment can do this.

But this vision will only become a reality if four conditions are met:

1. Breaking entrenched mindsets.
2. Giving end-users influence.
3. Remodelling the construction industry's structure.
4. A move from established construction processes to production process.

There is no pretence that this will be easy. It is, however, necessary if the construction industry is to avoid lamenting a familiar lack of progress in the years to come.

Changing mindsets

Beyond those structural changes, the whole industry needs to change its approach to how we talk to each other, clients, policy makers and the public about our projects and methods.

As a sector, we are only on the first steps of the route towards maturity on innovation. We constantly invest in new solutions or process; but we haven't got an effective model in place to drive broader adoption.

In the manufacturing sector, everyone understands the clear route from the laboratory to product to using a product across a range of projects – but in construction we are not there yet.

In construction we are always designing new buildings in the 'online' environment – by the nature of construction, each project's design process cannot be separated from the overall construction and operation cycle. In other sectors, design is able to happen 'offline' from the wider production process.

To develop a more mature approach to innovation, we need to start thinking about 'offline product development' rather than the current 'online design process'. Product design requires engagement with your clients, their customers and the entire supply chain from the beginning to understand what is possible – and it implies more rigour around testing and design iteration.

Over the page, we have laid out a proposed model for product development in the construction sector, based on the 'Technology Readiness Levels' originally used by NASA during the 1970s. Each innovation or new idea is taken through from investigating the initial concept through to embedding it across the business or programme. We believe that adopting this model across the sector would help to ensure that construction was more effective at developing and embedding innovation.

When it comes down to it, people outside of our sector do not care about the technical metrics we use to talk about projects. They are not interested in 'cost per square foot' or the latest construction innovation. They care about the real outcomes: how many more people can be treated in the next five years; or whether their children will receive the best education.

When we talk about MMC or the latest technology, we need to talk about how it will change the outcomes people care about. Will people be healthier? Will schools produce young adults who are better equipped for the future? Will prisoners and prison guards have access to safer and more secure facilities that will assist rehabilitation and reduce reoffending?

That in turn will help us to move towards a world where clients and consultants are aiming to procure for 'value', rather than cost; which in turn will help to drive more collaborative behaviours and investment in innovation.

Giving end-users influence

A huge amount of time and money is spent carefully specifying materials and equipment for a new building. It is a process that involves the client, architect, engineering team, main contractor and individual suppliers.

By allowing clients to purchase design and construction as platforms we can still allow for design flexibility while speeding up the entire process. That allows us to be more flexible and reactive to changing needs of the end-user.

A key benefit of transforming construction delivery in that way will become a significant catalyst for change; specifically, in how the industry will engage with its customers, and the end-users of the buildings and the built environment.

Product development 'readiness' model

INVESTIGATE	**IDEA**	Unproven concept/first awareness of a need
	DESIGN CONCEPT	Detailed research, early design concepts complete
	PROOF OF CONCEPT	Prototype complete, initial client demonstration and feedback
DEVELOP	**FACTORY TEST**	Factory mock up and test as part of an assembled system
	SITE ENVIRONMENT TEST	Various components tested and validated in the relevant site environment
	WHOLE PROJECT TEST	System/technology installed and tested on relevant project. Proven to be reliable
	MULTIPLE PROJECT TEST	System/technology installed and tested across different project and client environments
EMBED	**BUSINESS MOBILSATION**	System/technology adopted across whole business and/or programme
	BENEFIT TRACKING	Continuous review of operational performance

The reality is that the majority of the people that inhabit our buildings – whether they are office workers, nurses, or residents of new houses – do not have any influence on the design standards that guide how we build.

New sensor technologies installed in smart buildings are already giving design teams and consultants access to significantly more data about how people actually use buildings than ever before. Coupled with smart energy systems and similar technologies, this can help us to build a significantly more advanced model of both the overall lifecycle of a new building and the way it will be used.

In turn, that means we can create buildings that help the people working in them to be more productive, helping to deliver better outcomes for society. Cheaper, faster buildings also free up funding to be used elsewhere, building more offices, doctor's surgeries and schools or just investing more money into skills and training in the health and education sectors.

If we are ever going to be able to achieve that ambitious vision - across design, construction and operations - significant changes, both structural and in mindset, will need to happen across the entire sector.

From construction to production

The term ‘modern methods of construction’ is now used so regularly in discussions about the future of the industry it has almost become jargon.

It is used to refer to everything from laser scanners – adopted widely across the industry – to robot bricklaying machines, which have some way to go before they are in regular use on building sites across the globe.

If we are to understand how MMC could change our society, it is important to define what we actually mean by that term. At Mace, we talk about a major shift in construction delivery that will take us from ‘construction to production’.

Under that umbrella term, we include a number of initiatives, programmes, processes and new technologies. These include standardised products and platforms; volumetric and modular construction and digital construction and design tools that address the outcomes as well as the physical and delivery solutions.

The big idea is that rather than designing a building from scratch over and over again, we will be able to access a standardised set of components, delivered in a way that requires a minimum of on-site construction time and complexity. Once the project is complete, by drawing on feedback from end-users we will be able to incorporate significant improvements into the next iteration of the design.

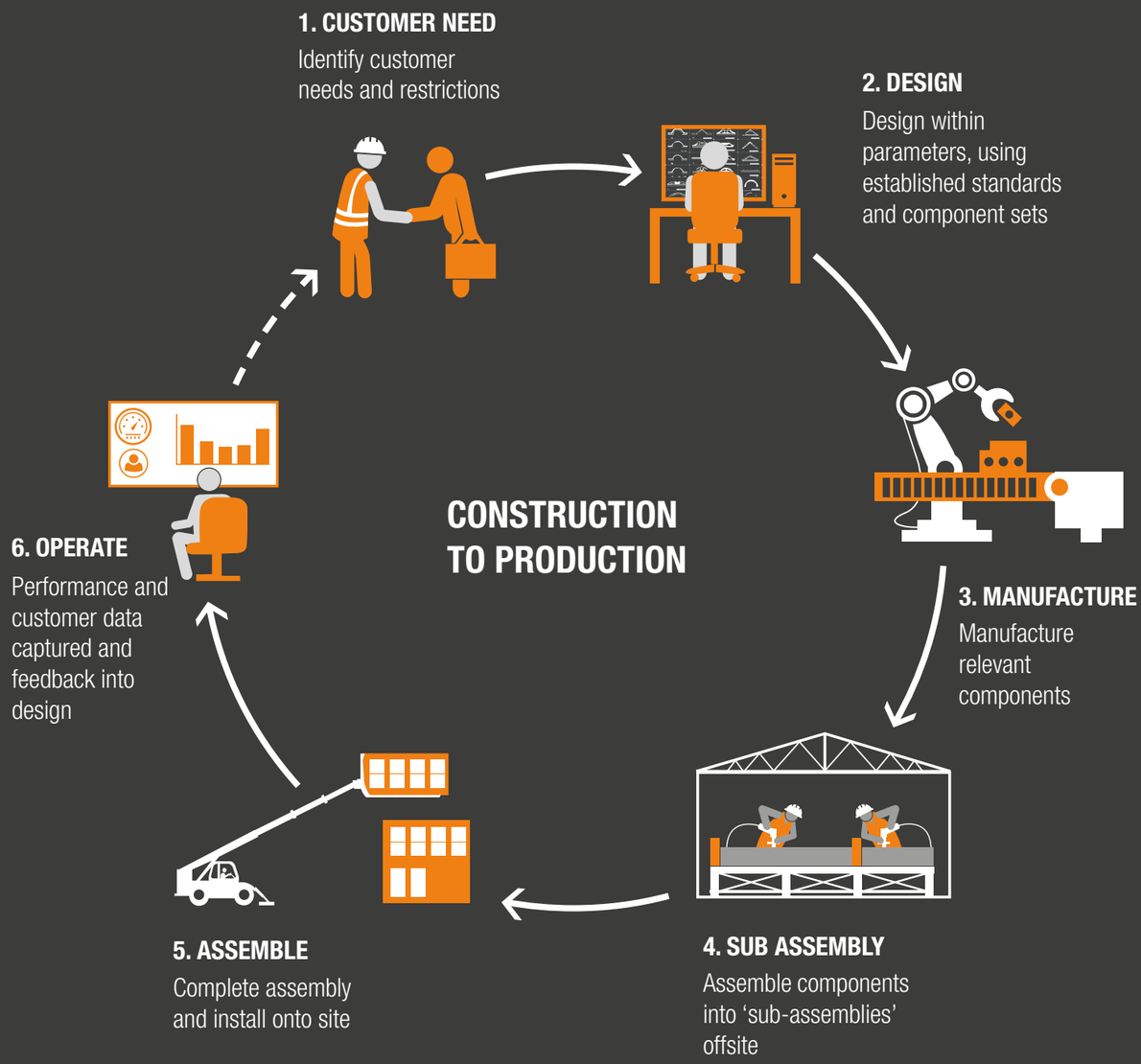
Volumetric and modular	This is where prefabricated units are assembled and transported to site as a fully finished and enclosed space.
Platforms	A platform is a specific area or aspect within a building type. For example, a school may consist of classrooms, a hall and a kitchen.
Products and sub-assemblies	Products in this context refers to specific elements of construction, such as floors and walls. A sub-assembly is a collection of products put together offsite; which when connected together onsite makes up a ‘platform’.

Ultimately, if this vision becomes a reality the industry will produce buildings faster, cheaper and more sustainably, delivering buildings that are better designed for users and transforming the wider project lifecycle in the process.

This means that the whole of a project team – from the client to the consultants to the contractors – have sight of far more of the supply chain, manufacturing process and on-site requirements from the outset. This provides more certainty, lowering project costs and freeing-up capital investment to be used on more projects.

It will also fundamentally change the design process, helping us deliver buildings for our clients that are more flexible and more tailored towards their specific needs. Our buildings will then be more cost effective to manage, with features such as standardised and predictable energy and water requirements.

Finally, when it comes to demolishing a building we will be able to draw on a detailed and comprehensive set of standards to make that process as easy as possible.



Remodelling industry structures

As it stands, the construction industry's structure does not support the adoption of innovative methods or processes – and does not help to embed established tools more widely across the delivery cycle in particular.

With main contractors and supply chain companies locked into uncollaborative contracts that incentivise confrontational behaviours, the effective sharing of lessons learnt and use of innovations across multiple projects is limited. There are already initiatives working to change this, such as the Institution of Civil Engineers' Project 13; but progress has been understandably slow.

The low margins inherent in the major contracting industry also prevent sustainable and long-term investment from construction companies into the kind of innovation that would help to deliver a new vision for the sector.

Without the free cash to invest and with a keen eye on risk mitigation, it is far easier for the big players in the sector to sit on their hands and keep delivering the same methodologies they have for decades.

Alongside that, as the number of construction technology start-ups (ConTech) grows and investment in the industry from venture capital firms builds, it has become increasingly clear that this is an industry where it is particularly difficult for new businesses or operating models to scale effectively. High costs of market entry combined with a natural resistance from clients to trial un-proven methods have meant that many ConTech firms have failed to build a sustainable market share despite a positive initial round of investment.

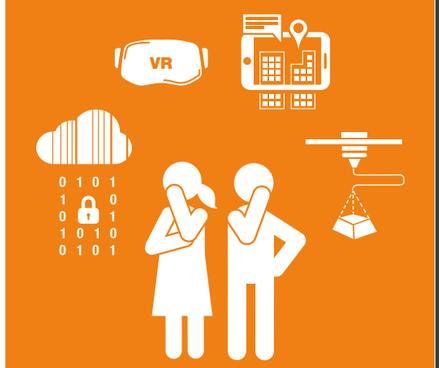
In order to change that, we recommend a number of suggested policy and industry changes at the end of this report that will help to enable innovation and allow the construction sector to leverage emerging new technology more effectively.

The wider sector needs to be prepared for a shift in its operating model. We have not really begun to seriously address how different elements of the sector will be challenged. What is the role of a main contractor in the model? How do architects best design within set parameters? Can a single organisation manage the design and delivery of a complex project from end to end?

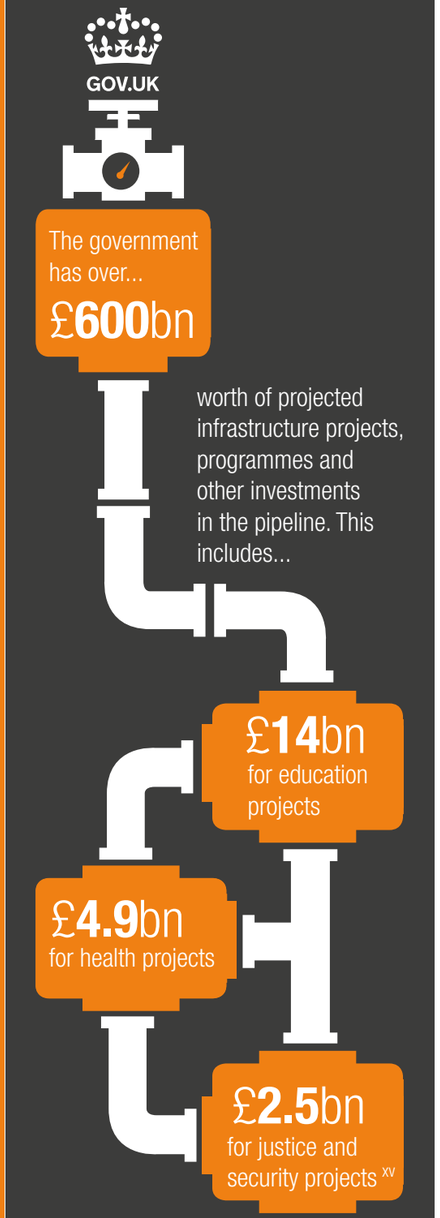
Beyond that, we will need to consider the skills implications. Previous research by Mace has demonstrated the sheer scale of the re-skilling that is likely to be required as we move to the next evolution of the construction industry – more than 600,000 construction workers will need to be retrained by 2024 to keep up with changes in technology.[xxxiii]

More than...

600,000



people will need to be retrained by 2024 to keep up with changes in technology [xxxiii]



The government has over £600bn worth of projected infrastructure projects, programmes and other investments in the pipeline. There is an estimated total pipeline of £14bn worth of education projects, £4.9bn of health projects and £2.5bn of justice and security projects.[xv]

Even during a period of constrained public finances, large sums have been dedicated to infrastructure in these areas – over £48.6bn has already been allocated to infrastructure spending on education, health and justice between the years 2016-17 and 2020-21.[xvi]

These categories of infrastructure spending are part of what the government calls 'social infrastructure', which recognises its importance to society. The aforementioned pipeline provides a sound basis of certainty and scale to fund building projects in each of the areas, facilitating an approach to construction that this report has argued could boost the productivity of public sector workers and achieve better outcomes.

The question is how much more productive can these workers be?

Mace has previously conducted polling to find out how much time people lose to poor design and management of the buildings in which they work. Four in 10 public sector workers stated that they were unproductive for more than two hours every working week because of their workplace environment.[xvii]

We have used the findings from this polling to illustrate how much productive time is lost in the UK's schools, hospitals and prisons. In other words, the illustrations show the productivity opportunity for public sector workers in our schools, hospitals and prisons.

Schools

In 2016, a total of 17 Edinburgh schools were closed over concerns about the standard of construction used to build them.[xviii] While this is perhaps a rare example, it highlights the stark consequences of the construction industry not providing well designed and managed school buildings. The construction revolution could help to ensure that there are no repeats of the Edinburgh scandal.

Indeed, the government has an obvious incentive to build schools more efficiently and at lower cost. Some progress has been made to achieve that. For instance, when presenting the funding allocations for the Priority School Building Programme, the then Education secretary Michael Gove highlighted that new 'baseline designs' had been developed to speed up the process of investing in school infrastructure.[xix] The construction revolution could add further efficiencies to the system.

As highlighted by the Royal Institute of Chartered Surveyors, disruptive construction cannot often happen during term time because of issues around health and safety, safeguarding and the impact on learning environments.[xx] This means that major construction works typically only happen during the narrow window of school holidays.

The construction revolution could deliver far more in these limited timeframes.

When teachers return from their holidays to work in new buildings, they will hopefully do so in environments that make them more productive. Our analysis suggests that if all of the UK's teachers were to work in productivity-enhancing schools it would mean:

- The UK's 545,000 teachers reclaiming almost 50 million hours of time back each year.[xxi]
- This equates to roughly 2.3 hours every week for every teacher, a reduction of roughly 4% of their average working week of 54.4 hours.[xxii]

Hospitals

At a time of increasing demand for NHS and social care services, there are difficulties in recruiting and retaining nurses. Some examples are:

- For the second year in a row more nurses and midwives have left the profession than have joined it.[xxiii]
- In 2017, UCAS noted that nursing was the subject area that had experienced the most significant decline of all undergraduate applications.[xxiv]
- The number of nurses and health visitors in the UK has increased by only 1% while the number of doctors has increased by 12%.[xxv]
- In mental health nursing, the number of nurses has decreased by 12% between 2009 and 2016.[xxvi]

There are numerous factors driving these recruitment and retention problems. The solutions needed to solve them are equally as varied.

Enabling nurses to be more productive would certainly ease the pressure, and also reduce the need to recruit to fill empty job roles – there were nearly 94,000 full-time equivalent advertised vacancies in hospital and community services alone between July and September 2018.[xxvii]

Our analysis suggests that if the UK's adults' nurses on hospital wards were to work in productivity-enhancing hospitals it would mean:

- The UK's 237,000 adults' nurses working in acute, elderly and general care gaining a total of 25 million hours of time back every year.
- This equates to adding 13,500 full-time nurses to the health service workforce.
- The potential to reduce other costs for the NHS – the total costs of running the NHS estate in England alone was £8.8 billion in 2017-18.[xviii]

Indeed, productivity benefits similar to those set out above are already being realised. An example can be found in Wrightington Hospital Orthopaedic Centre where repeatable rooms and standardisation will decrease surgical downtime and give more patients a better experience.[xxix]

Prisons

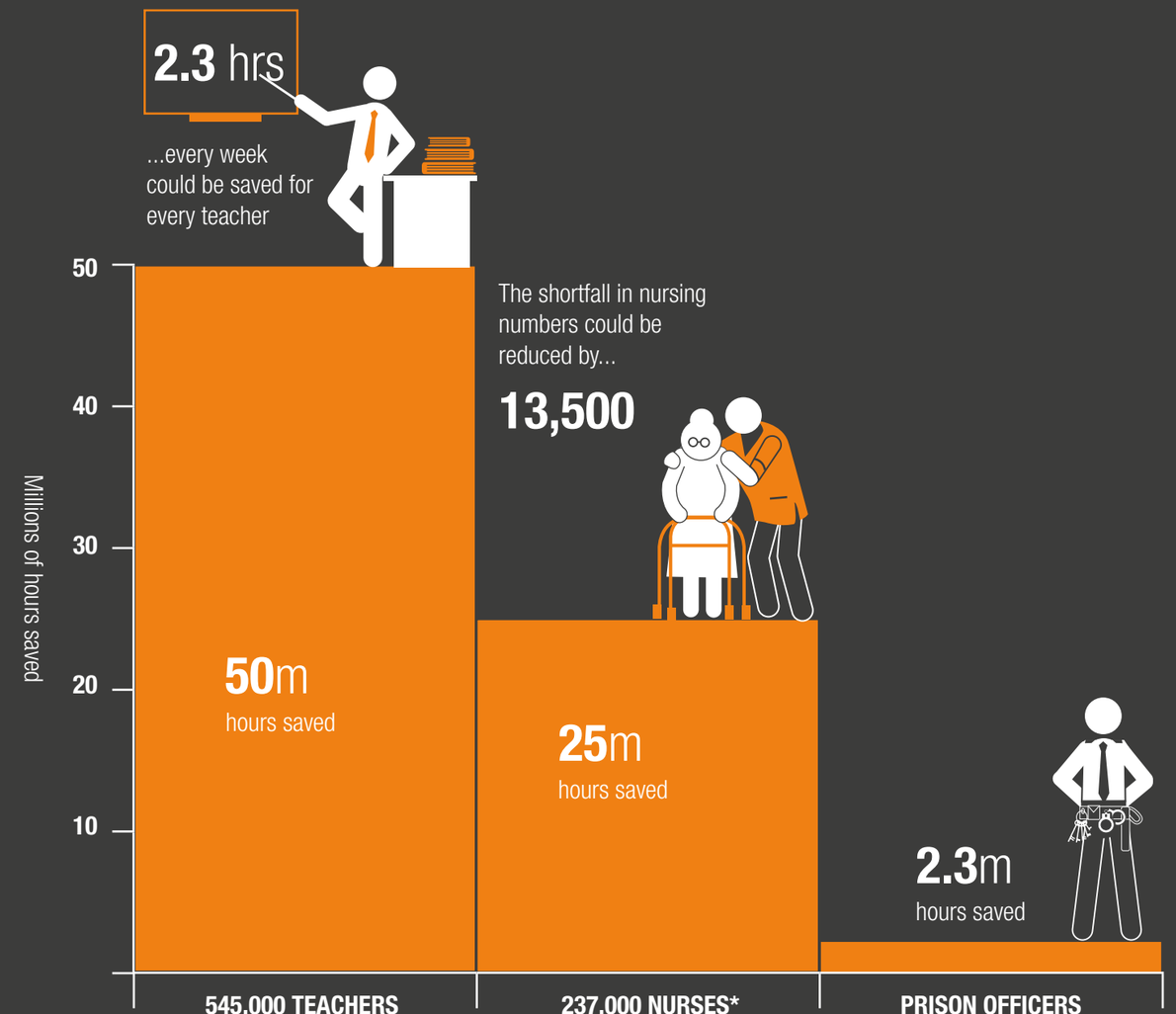
Her Majesty's Prison and Probation Service manages an estate of 118 prisons across England and Wales.[xxx] Over a quarter of them were built before 1900.[xxxi] In a 2016 White Paper, the government argued:

"*The physical environment that many staff and prisoners face on a daily basis is not fostering the kind of culture or regime needed for prisoners to turn their lives around*".

This was the background to the Prison Estate Transformation Programme, which aims to build new prisons, and renovate and reorganise the prison estate.

There is great opportunity to improve the prison estate, but momentum is needed behind the project. Our analysis suggests that productivity-enhancing prisons could provide the England and Wales' prison officers with a total of 2.3 million extra hours of working time a year.

The productivity opportunity for public sector workers in our schools, hospitals and prisons



*adults' nurses working in acute, elderly and general care

The last major review conducted by the government into a subject related to public sector productivity argued that, despite some cynicism about whether change can be delivered, *"…cultures can and do change…we have found frustration with the current approach and, more tellingly, genuine enthusiasm for trying something new and radical and different".*[xxxii]

Mace believes this too. And enthusiasm for something radical and different will certainly be needed if the government is to enable the construction industry to build schools, hospitals and prisons that allow their users to be more productive and deliver better outcomes.

But the construction revolution is by no means a given. The government needs to change its approach to supporting innovation in construction. And the construction industry needs to change full stop.

The recommendations made below will help deliver this change. We do not want to be in a situation whereby we are talking about the same problems in ten years' time. Action is required now.

RECOMMENDATIONS FOR GOVERNMENT

1. Overhaul the funding model for innovation in UK Construction. The current funding model does not incentivise the industry in a way that will deliver the National Infrastructure Commission's National Infrastructure Assessment recommendations or the Government's ambitious targets for the transformation of the construction industry by 2025. Existing funding will be most effective if it is applied to strategic Government investments, rather than delivered in small packages supporting small-scale innovation projects. This can be achieved through the creation of a series of 'strategic innovation challenges' that aim to transform delivery of specific programmes of investment in the built environment. These challenges should focus on improving 'transport and housing for thriving cities' and 'reducing the risk of drought and flooding'. The Construction Leadership Council should coordinate the investment programmes.

2. Create Construction Engineering and Manufacturing Enterprise Zones across the UK. Standardised construction components could be manufactured anywhere in the UK, transforming the geography of construction industry. An Enterprise Zone model would accelerate regional development capability in construction engineering and manufacturing and increasing R&D tax credits for construction from 12% to 20% should be considered as an incentive to innovate. To support the Enterprise Zone proposition, the government should earmark unused or underused urban spaces for pop-up consolidation centres and require local government to identify suitable locations for pop-up consolidation centres in their Local Plans. In addition, government departments should promote the idea of Construction Engineering and Manufacturing Enterprise Zones when they are working with different areas on their local Industrial Strategies.

3. Commit to a guaranteed pipeline of work to gain industry buy-in. The construction industry operates on low margins that are not conducive to new technologies and techniques. In order for industry to invest and innovate, government needs to set out a guaranteed annual capital spend that will survive changes in government. Procurement for the annual capital spend should have a platform approach to design for manufacture and assembly as a requirement. Implementation of this platform approach requires significant upfront investment from the sector for facilities, product design, testing, assurance, and prototyping. The pipeline must be certain, and of a scale and value that guarantees a return after the cost and risk of developing a solution.

4. Fund pilot projects to support proof of concept. Mace has already stated that the industry would benefit from a pilot project to prove that the end-to-end operations of platform approach to design for manufacture and assembly actually work. A pilot programme to learn how to best fund and manage the initial higher capital expenditure costs of offsite construction would help as a trailblazer for future projects. Previous government intervention in the aerospace and automotive sectors has allowed those companies to invest in technologies, IP and projects. We would like to see similar incentives where we can work in a collaborative environment to test new business models, systems, build new supply chains and demonstrate new technology.

RECOMMENDATIONS FOR INDUSTRY

1. The Construction Leadership Council should create a workstream on 'co-creating' public sector buildings and the built environment. The workstream should look at how online platforms could be used to improve public sector workplaces. In addition, it could conduct research into how other industries undertake co-creation in product design (specifically in the aerospace and manufacturing sectors). Work on new co-creation techniques could be augmented by analysing the best methods of traditional approaches to understanding employee needs.

2. Develop an industry-wide product development process and learning platform. In order to accelerate innovation and move towards a 'product development' mindset, the construction industry needs to adopt a standardised process for developing and embedding new ideas, processes and technology. Building on work already underway with the establishment of the Construction Innovation Hub, the Construction Leadership Council should develop and promote a version of the 'technology readiness' model proposed in this report across the entire industry. Alongside this, the model would be supported by a shared learning platform that would help to share data, more effectively capture user feedback and create better outcomes for the sector and society.

3. Industry to form collaborative teams with end-users to support development of the strategic innovation challenges. Over a decade ago, the Office for Government Commerce recommended that every public sector client undertaking one or more capital projects above an agreed threshold should appoint a senior 'design champion' as part of the project. This idea should be applied to the suggested strategic innovation challenges, but with groups of end-users who can articulate their wants and needs from the built environment in which they live and work.

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