trowers & hamlins

Modular construction

Is it time that we started taking modular construction seriously?

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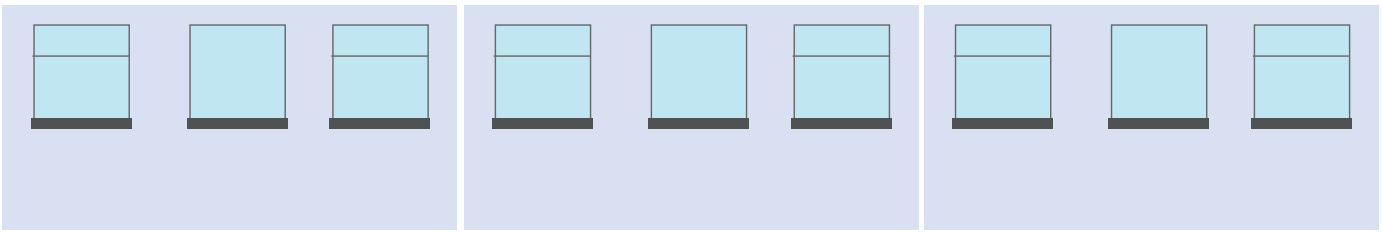
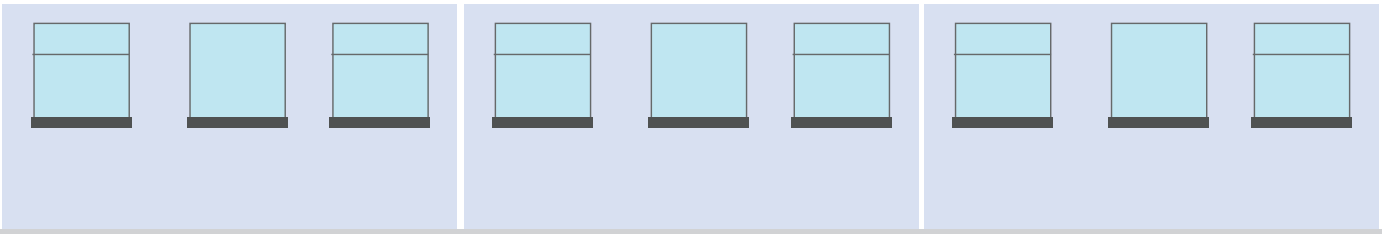


What is modular construction?

"Modular construction is a process in which a building is constructed off-site, under controlled plant conditions, using the same materials and designing to the same codes and standards as conventionally built facilities – but in about half the time. Buildings are produced in "modules" that when put together on site, reflect the identical design intent and specifications of the most sophisticated site-built facility – without compromise."

Modular Building Institute (MBI)



Foreword

Modular construction is not a new term but, in the current climate, has become the buzzword to describe a whole range of methods relating to off-site fabrication, including component, panelised and volumetric systems.

In early 2018, Trowers & Hamlins hosted a roundtable event aimed at exploring the issues around modular construction, entitled "Is Modular the Answer to the Housing Crisis?" The session was chaired by Mark Farmer, Founding Director and CEO of Cast and the author of "Modernise or Die" - the October 2016 Government review of the construction labour market model.

The session was attended by a number of the leading players in the modular and off-site fabrication sector, with representatives of some of the most active organisations in this arena, including The Berkeley Group, Legal & General and Swan Housing Association. Other attendees represented the hotel and leisure (Whitbread, TowerEight), senior living (Castleoak) and education sectors (Net Zero Buildings).

Renewed interest in modular and off-site fabrication has been prompted by the Government's 2017 Budget aspiration that the UK delivers 300,000 new homes per year by 2020; a considerable challenge given the current level of delivery at around 217,000 homes per year. This has moved the issue to the top of the political agenda and prompted discussion about how the market can deliver this ambitious target in the most cost-effective and time-efficient manner.

Trowers' roundtable event addressed issues that went wider than simply increasing supply in the housing market, including innovations in technology, how to maintain quality, requirements for financial investment, the potential for more high-performance buildings, including environmental sustainability, and the socio-economic impact of embracing modular construction.

Modular construction and off-site fabrication are not new concepts and, for the most part, the issues surrounding them are also not new. There have been frequent discussions about an institutional decline in the construction workforce due to various factors including the aging demographic, a failure to attract sufficient new entrants and reducing skill levels. What is clear is that in 2018 the industry is at a crossroads, with the choice and the impetus to break with the past and do things differently.

This is an opportune time to re-examine whether historical barriers are still relevant. With the recent high-profile backlash against poor quality housing, the general lack of affordable housing and the advent of social media platforms that promote a culture of direct engagement and feedback, the industry needs to recognise the potential for reputational risk. Housebuilding has become unprecedentedly politicised and, next to Brexit which is itself an issue, is probably the most politicised aspect on the agenda, becoming a proxy for social inequality.

There is a real likelihood of increased regulation and standards at a time when the industry is facing a declining workforce and a skills shortage. This presents both an opportunity and a challenge. The construction industry remains highly fragmented and there is a need for a fundamentally different approach to how we design, build and procure.

Thoughts from the chair - Mark Farmer

"We are entering a period of time when modular construction is increasingly high on the agenda of an industry struggling with structural skills shortages and ongoing quality problems. To maximise the opportunity of moving to a modular approach, clients require an informed engagement strategy to ensure they maximise the benefits and mitigate the risks of commissioning using 'design for manufacture and assembly' principles. This paper reflects the output of a robust and open roundtable discussion between senior industry stakeholders that has rightly highlighted the importance of the modular industry needing to further mature and embrace change if it is to be truly sustainable and scalable. Some of the key themes explored go to the heart of whether offsite construction's time has finally come in the UK. For it to be credible at scale, it needs to be digitally enabled, consumer and quality led, formally accredited and underpinned by a new set of competencies and skills. The sector also needs to urgently explore improved collaboration and opportunities for inter-operability of different systems and parametric standards to move it on from its current 'cottage industry' status. Ultimately, financiers, developers and consumers will dictate the success of this nascent sector but this report gives some leaders as to where the priorities may need to be."

Roundtable

List of participants

Cast Consultancy	Mark Farmer - Founding Director & CEO (Chair)
Trowers & Hamlins	Paul Bartter - Partner
Castleoak Group	Lex Cumber - Business Development Director
Arithist	Joel Day - Director
Osborne Communities	Andy Doylend - MD
Whitbread Plc	Nigel Graham - Head of Procurement
HTA Design LLP	John Gray - Partner, Head of Production Information
First Home with the Treehaus product	Mary Hurst - MD
Legal & General Capital	David Jones - Modular Integration Director
Trowers & Hamlins	Julian Keith - Partner
Cabot Square Capital	Keith Maddin - Managing Partner
BLP Insurance	Jeff Maxted - Director of Technical Consultancy
TowerEight	Adam Mursal - Founder
Trowers & Hamlins	Christopher Paul - Partner
Swan Housing Association	Geoff Pearce - Executive Director of Regeneration and Development
Castleoak Group	Neil Robins - Operations Director
Net Zero Buildings	Neil Smith - CEO
Berkeley East & West Thames	Karl Whiteman - Divisional Managing Director

> We are at a crossroads for the construction industry and we're feeling lots of chimes for change"
>
> —— Mark Farmer - Cast Consultancy, Founding Director & CEO

> "We need to move the conversation on from the "pre-fab" of old to the "precision manufactured homes" of the future."
>
> —— Paul Bartter - Trowers & Hamlins, Partner











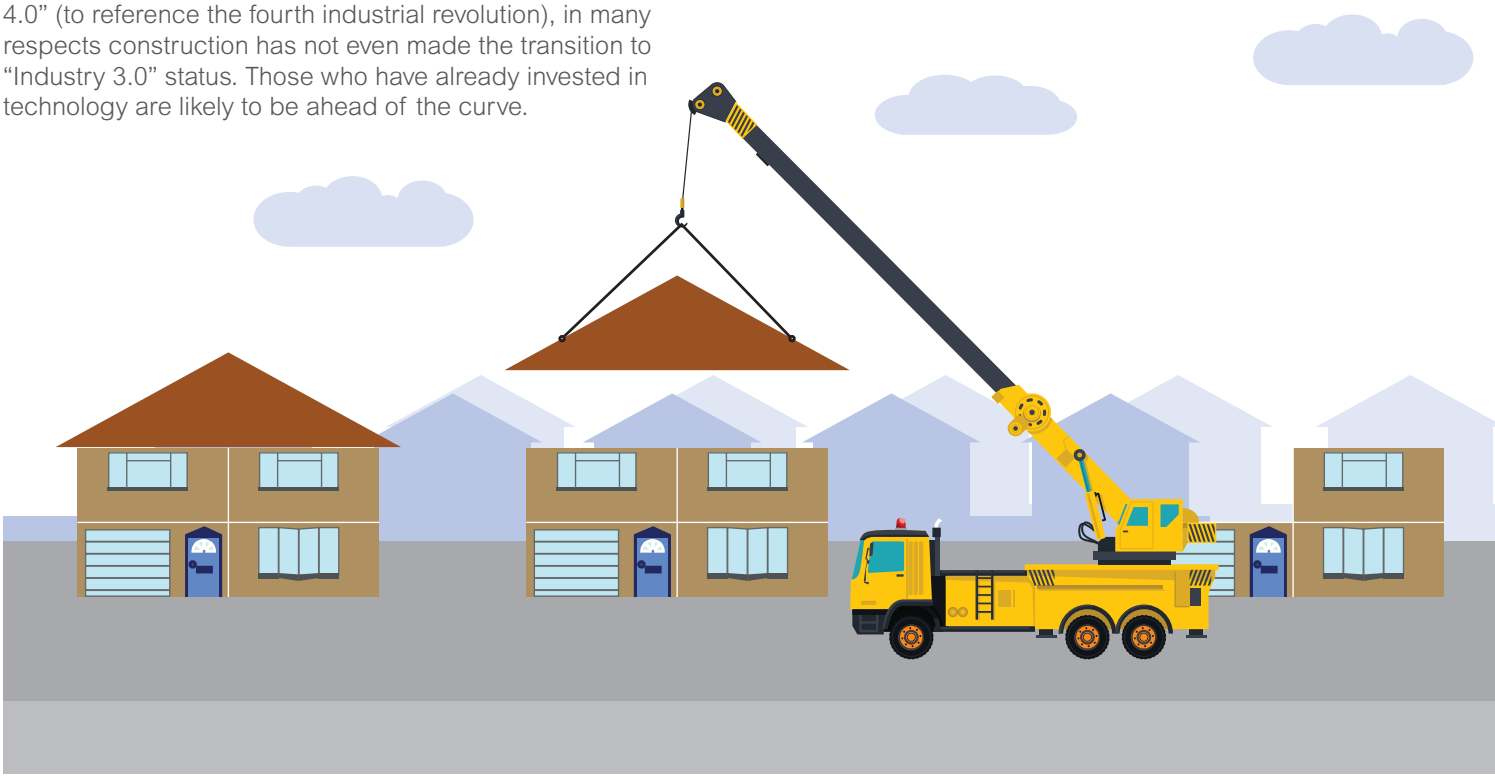

Guaranteeing quality

One key criticism of modular housing is that elements built off-site fail to meet the quality standards expected of traditional on-site methods. Although the image of off-site construction has long moved away from cheap, flimsy pre-fab buildings, many developers still think that modular buildings do not look as “solid” nor as well-designed as traditionally-built structures.

Those who have ventured into the modular market previously are perhaps haunted by experiences of plastic-looking bathroom pods, leaks, defective fire breaks and poor thermal and acoustic performance. These issues have required time and money to rectify prior to completion, meaning the advantages of modular as a faster delivery model are lost.

So what has changed? What will prompt a new generation of developers, funders, contractors, manufacturers and, ultimately, property owners to consider modular as a viable and attractive method of construction? From the people we have been speaking to, one word recurs: technology. Advances in building information modelling (BIM) and 3-dimensional CAD/CAM applications mean that such software can be used to both design the product and to programme the manufacturing processes, leading to a fully integrated supply method. Building tolerances achievable through BIM design exceed what was achievable even five years ago and enthusiasm in the industry about the resultant potential of modular construction is palpable. To paraphrase Mark Farmer from his “Modernise or Die” review, whilst some are already talking about “Industry 4.0” (to reference the fourth industrial revolution), in many respects construction has not even made the transition to “Industry 3.0” status. Those who have already invested in technology are likely to be ahead of the curve.

At Berkeley Homes’ Kidbrooke Village development in Greenwich, whole rows of terraced housing have been constructed at twice the speed of a traditional build and it would be hard to tell that these have been constructed using off-site fabrication. In fact, Berkeley has been so impressed by its experience at Kidbrooke using a third party manufacturer that it has now secured a 165,000 sq ft site in Kent to build a factory that will produce its new modular product; delivering an initial 1,000 units per year for Berkeley Homes’ projects. Berkeley’s decision to invest in its own factory has not been taken lightly, and technology and R&D has been at the heart of that decision. It spent five years developing its own unique product and choosing a fabrication method, resulting in the decision to proceed with a hot-rolled steel manufacturing process for future projects. Berkeley has invested heavily in information technology and stress-tested buildability with its existing supply chain to make sure its modular solution works. Berkeley’s first houses built using off-site fabrication took as long to deliver as traditional houses but meant that, by the time the product came to market, they understood what worked and what did not work. Work has been progressing behind the scenes to perfect the design well before any modular units roll out of the door. Berkeley’s ultimate aim was always that the customer would not recognise that their home was built using non-traditional methods; just to feel that they are getting a product of a higher quality than a standard traditionally-built unit.



Like Berkeley, L&G Homes has injected funds where it matters most. Two years on from its original decision to invest in a modular factory near Leeds (creating a new business and a new product from a standing start), L&G's story feels like one of the industry's successes. Again, the importance of upfront design and investment in technology has been emphasised. Unlike Berkeley's use of hot-rolled steel, L&G Homes' factory houses a "cross-laminated timber" (CLT) lamination plant. Panels are cut using a 100% BIM-compliant process, with a CAD file with the detailed design being automatically converted into a cutting pattern which is cut using a giant 3-D wood-cutter known as a CNC (computer numerical control) machine. The CAD design looks like the instructions for a giant IKEA cabinet and, in much the same way, the volumetric timber sheets are assembled and fully completed in the factory before being transported to site fully formed. L&G feels that the merging of the manufacturing process with construction activity results in a streamlined assembly line process, giving it the opportunity to design out any quality issues without the unpredictability of the "human factor".

It is not just the private sector that is making advances in modular methods. In 2016, Swan Housing Association opened its own factory in Basildon, committing significant investment to modular. Swan's 85,000 sq. ft. manufacturing site also produces CLT and is capable of building up to 400 high quality modular homes a year, including 560 for delivery to the first phase of Swan's regeneration of the nearby Craylands Estate. Swan considers that their modular units are indistinguishable from traditionally built homes and the initial results have been impressive: Swan was awarded the "Best Approach to Modular Construction" award at the 2017 Inside Housing Development Awards. Swan credits this achievement to advances in technology allowing them to design in three dimensions and achieving tighter tolerances than were previously possible.

Whilst the underlying quality of modular housing is an issue that many in the industry have been grappling with for years, the average homebuyer may have a more superficial reaction to the mention of modular homes: aren't they all the same? There is much to do to dispel the popular perception of modular housing, as influenced by most mainstream press coverage, which often uses uninspiring terms such as "pre-fabricated" or "factory housing". The Guardian famously coined the phrase "rabbit-hutch Britain", to describe the recent trend of UK developers bringing smaller homes to market. According to research carried out by the University of Cambridge, the average size of a newly built home in the UK is the smallest in Europe, at just 76 sq m, compared to our next closest European country, Italy at 81.5 sq m. Whilst this research covers all homes (not just those constructed using modular or pre-fabrication) it adds to the challenge modular developers face in overcoming public (mis)conceptions.

Net loss of EU workers to house building and infrastructure by 2020 could be 214,542 in event of a "hard" Brexit

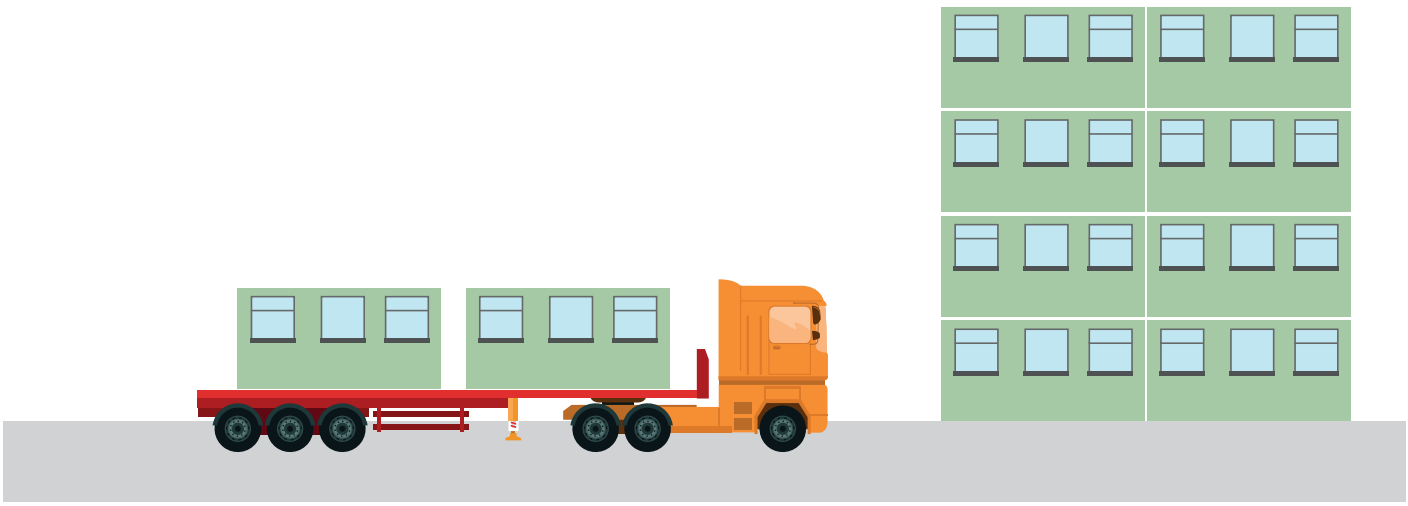
— Arcadis Talent Scale 2017

If a new generation of homeowners is going to be excited by the idea of living in a modular home, then perhaps the new vocabulary of "smart homes" or "precision manufactured homes" should be adopted; terms which imply quality, high engineering standards and the integration of smart features such as climate control, audio-visual equipment and energy efficiency, all of which can be designed, tested and integrated within the factory environment. The controlled environment of a factory allows for automated assembly without the unpredictable influences of weather, temperature and other environmental factors plus reduced human errors. It means that elements (including the M&E and AV required to run a smart home) can be installed and tested before units arrive at site and are exposed to weather. It can also mean that high quality finishes are repeatedly achieved by automated machines rather than having to rely on costly highly skilled labour.

Identity and individuality is more important than ever to a millennial generation raised on the expectation of having products which are tailored to suit their specific, immediate needs. These new consumers, raised on what has been termed the "Trip Advisor" culture of instant feedback, are demanding a living space that both internally and externally, reflects their own individual tastes. For example, Swan's "NU build" manufacturing product allows CLT to be cut and assembled into modules in the factory and then, still in the factory, to be fully fitted out internally to suit a particular scheme's needs, including customisable partitioning, electrics, plumbing, floor finishes, kitchens, bathrooms, even painting and internal finishes.

In fact, it is not just the millennials who have adopted this attitude and are demanding more from their living space. Castleoak, which has acted as development partner on around 200 care homes and 3000 apartments in the senior living market, has found that this sector is equally discerning and is supportive of modular housing provided that it can deliver high quality desirable homes.

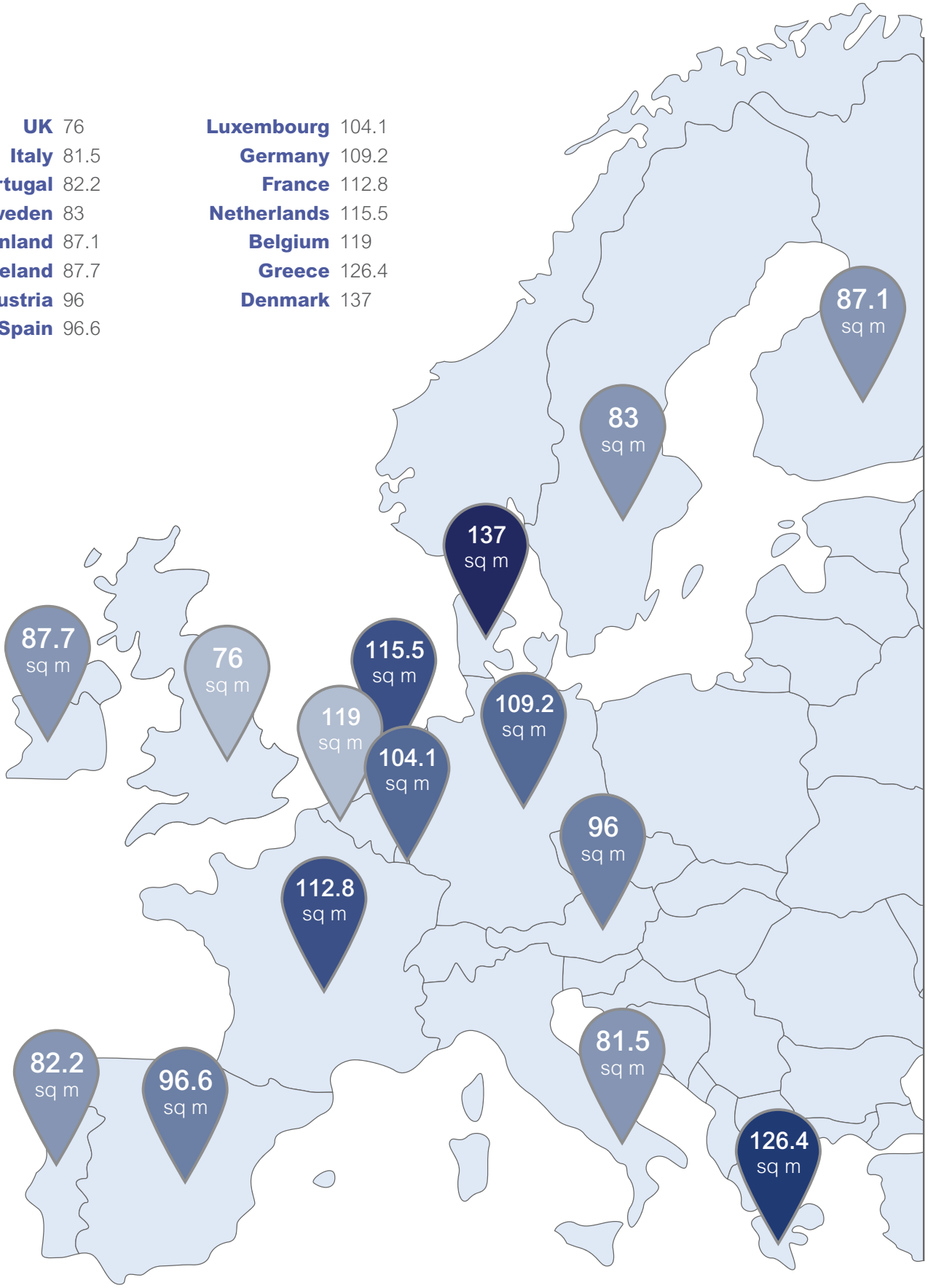
The benefits of a global industry can also be exploited. The UK construction industry is already looking abroad for ideas on how to deliver better quality modular homes. In Japan, for example, advances in panelised construction and a very different planning regime lends itself to customer-led configuration allowing the customer to arrange their living space around their own unique requirements. That is not to say that some UK designers are not already looking to models that allow a bespoke product; allowing buyers to choose internal layout, configuration, colour schemes and finishes (see, for example, Swan's "NU build" product as described above). If flexibility in design around a common Standard can be achieved (see: Standardisation and collaboration: Key to helping modular succeed?), then, paradoxically, even more flexibility should be possible, guaranteeing both individuality and quality.



Average floor space size of newly built homes (sq m)

— University of Cambridge research, 2014

UK	76
Italy	81.5
Portugal	82.2
Sweden	83
Finland	87.1
Ireland	87.7
Austria	96
Spain	96.6
Luxembourg	104.1
Germany	109.2
France	112.8
Netherlands	115.5
Belgium	119
Greece	126.4
Denmark	137



Innovation in contracting approaches

Alongside innovation in design and construction methods, it is fitting that we also take a fresh look at the contractual mechanisms that govern the procurement of modular and off-site fabrication components and ask whether current construction arrangements are suitable. Trowers has been assisting the Construction Leadership Council in examining these new relationships and how to adapt standard forms to underpin long-term strategic relationships. These strategic approaches are essential to deliver the certainty of pipeline required to achieve efficiency and volume supply. Trowers is also working on the development of bespoke building contracts to better suit these new methods of construction.

Much of the conversation acknowledges that co-operation will be the key to delivering projects faster and more efficiently. In addition, given that procurement of buildings may start to resemble a production line, contract forms must reflect the realities and practical challenges of this approach. Certainly it would help to give the parties more comfort around where responsibility lies. The most popular industry standard forms such as JCT, NEC and ICC each have elements that can be adapted to suit the modular construction method, but none of these really address the "factory to finished building" model.

Alliancing contracts may offer one solution, with the benefit of flexible processes, the ability to contract with multiple parties and obligations to engage with the supply chain. These characteristics make such contracts better suited for modular projects. Publshed contracts include the ACA Project Partnering Contract PPC2000 and the Framework Alliance Contract FAC-1, which can be used to formalise the overarching relationship between single or multiple clients, contractors, manufacturers and suppliers.

Many forms of building contract cater for "off-site" materials to be procured in a fairly simplistic way; some concession being made to the fact that advance payments may be made and some performance or payment security is provided (usually by way of an on-demand payment bond). The philosophy underpinning many of those provisions is the delivery of simple items, such as pallets of bricks, rather than a complicated unit with M&E, plumbing, technology, etc which may be paid for in any number of instalments before delivery to site. In these cases, additional provisions are required.

Design

As attested by the attendees at our roundtable, even before a modular project reaches the factory stage, millions of pounds will have been invested in the design of the product (see: Guaranteeing quality). For the most part, the clients, consultants and modular providers who have made this upfront investment will require robust rights in respect of the intellectual property (IP) in the finished product. Most standard copyright clauses approach this in an understandably simplistic way; IP in the product remains with

the creator but the client is given a copyright licence to use the IP for all purposes connected with that project and that property. It is unusual for the client to have a wide-ranging right to use the designs for a number of projects, or for its new "brand" of housing development across multiple sites. Equally, it is not simply a matter of vesting all IP in the client, which would be impractical for the modular providers and designers who will have invested significantly in developing their own existing IP in the process. One solution is to define the "pre-existing IP"; being that which the factory owns in its stock design, granting a licence to the client and the designer. The client or designer would then own (from day one) the copyright in any project-specific IP developed from the stock design and would grant a narrower IP licence to the modular provider to enable it to use those designs simply to manufacture that product for the client. Ownership of this unique element of the design would allow the client to roll its modular designs out for other projects and/or to other modular providers without limitation. It would also be entitled to assert its moral rights over the finished product and to brand it as part of its modular delivery business.

Factory manufacture and sign-off

Once in the factory, there are a number of legal issues to consider that most standard forms do not address. Although some forms anticipate that the client may visit, inspect and even test materials on a contractor's, sub-contractor's or supplier's premises, none of them contain a bespoke inspection and sign-off regime that suits the modular process. There may be several key stages even within the initial manufacturing process that the client, or more likely its representative/agent, will want to attend and certify. Creation of the basic modular "box" unit, installation and commissioning of the plumbing, M&E and technological elements, sign-off of internal finishes, sign-off in batches or against a single benchmarked unit, sign-off of fire safety and building control elements; all of these elements are deserving of inspection and sign-off in the factory in the same way as a client might wish to do so on-site. This may sound potentially disruptive to the manufacturer's programme, but if these key stages are properly defined and managed, this will drive better practices and avoid the "doomsday" scenario where the parties only identify a defect when the module arrives on site, potentially months into the process, with the defect replicated in multiple modules. These sorts of processes will also help to put funders' minds at ease, giving reassurance in respect of the payments they are advancing to the developer/borrower to fund this most risky and high-value package of works.

Vesting and step-in

Another "doomsday" scenario to be considered is where the modular provider has gone out of business or is otherwise unable to deliver. Vesting is one obvious answer - ensuring that the units and other modular elements being produced, once paid for, are the property of the client and are set aside and clearly marked as such, meaning that if the modular provider goes bust the client can take positive action to reclaim goods that rightfully (and, more importantly, legally) belong to it. This works well in situations where the goods in question are fully complete, but it is less helpful when talking about a half-finished bathroom pod or 25 per cent of the precision-cut CLT panels required to build a complete house. In those circumstances, seizing materials that are bespoke to a certain factory and project will be of limited assistance. Vesting is also subject to additional risks and issues of enforcement where the factory is abroad, especially outside the EU.

Step-in rights are often raised as a potential solution to the breach or insolvency of the modular provider but it is difficult to envisage in practice how multiple clients (each with competing interests in running the factory to produce the units for their own developments) would manage the process when it all goes wrong. Put simply, they cannot all step in and operate the same factory at the same time. The answer may come in the form of a new industry standard practice, whereby each client signs up to a "participation and co-operation" deed. Given that one would expect any modular provider to have a manageable number of orders at any one time, a new client could be joined into the multi-party deed by a supplemental participation deed. Such an agreement could operate where the modular provider is running into difficulties; giving early warnings of any issues to all the then-current clients who could then convene to mutually agree a nominee to take over the running of the particular factory, either finishing the current production run and then shutting down or, if completing the orders would be sufficient to "jump-start" the business, operating it for a future order book. Each of the participants could mutually agree to fund the remaining orders in order to help all existing orders be fulfilled. This approach would be at the top end of the co-operation that the Construction Leadership Council and others are seeking but could well if properly structured and in a natural progression of more collaborative contractual approaches (such as the FAC-1 form of contract).

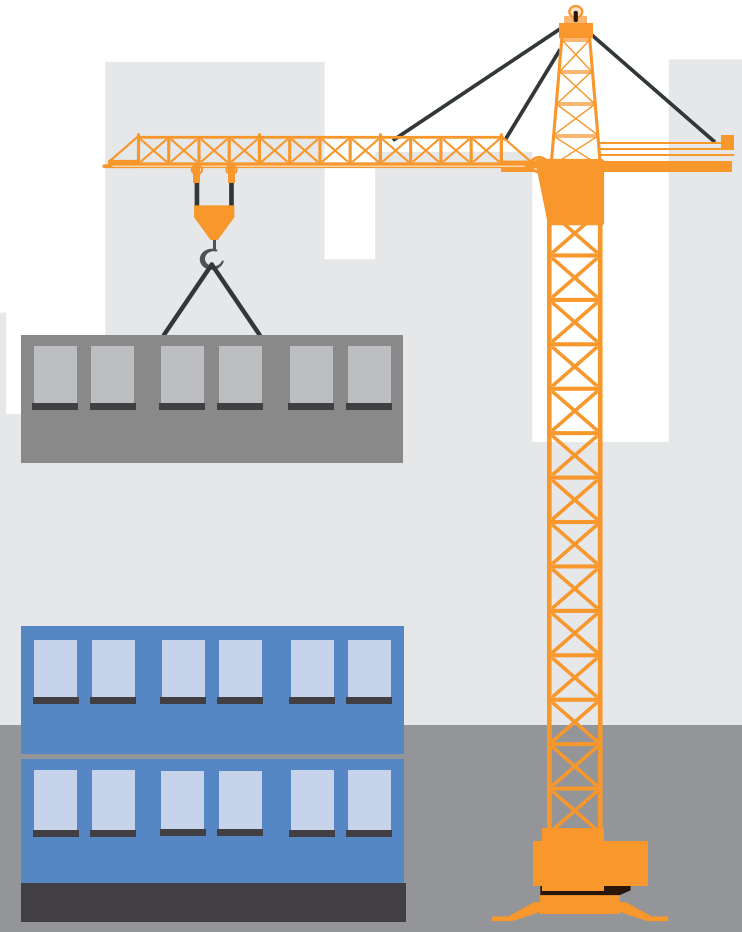
Transportation and insurance

Once modular units are ready for delivery, there is the added risk factor of making sure they are not lost or damaged en route. Contracts will need bespoke provisions setting out obligations to adequately pack and load the modules and procure insurance for their transportation and any off-site storage. This goes beyond the usual obligations to procure Contractor's All-Risks, public liability, employer's liability and professional indemnity insurance and specialist advice should be obtained to ensure that the logistical risks associated with the off-site construction model are covered. In addition, clients should consider whether they wish to control delivery of modules to site (perhaps on a call-off basis) and whether shipping details should be provided upon the modules leaving the factory, especially if being shipped form abroad.

BOPAS

Whilst housebuilders are familiar with warranty schemes offered by companies such as NHBC, Premier Guarantee and Building LifePlans, many warranty providers have typically been nervous about off-site and modular construction. That is set to change with the introduction of the Buildoffsite Property Assurance Scheme (BOPAS). BOPAS has been developed by BLP, along with Buildoffsite, The Royal Institution of Chartered Surveyors (RICS) and Lloyds Register. In doing so, they have tried to address one of the major criticisms of the fundability of off-site schemes by creating a scheme of assurance in consultation with the Council of Mortgage Lenders and the Building Societies Association. The aim is to demonstrate to those that will be lending against "innovatively constructed properties" that they will be marketable for future purchasers for a minimum of 60 years. Developers will have the ability to subject their scheme to a durability and maintenance assessment and then have the scheme accredited so that they can market the property as being assured by BOPAS in the same way that other latent defects schemes have become the market standard in traditional construction projects. Purchasers and lenders will be able to check each scheme registered with BOPAS by consulting a web-enabled database containing details of assessed building methodologies, registered sites and registered/warranted properties. Building contracts and appointments which previously required contractors to comply with the requirements of a latent defects insurer will need modification to reflect the requirements for BOPAS accreditation.

These are just a handful of the issues that will need to be addressed in the contractual arrangements with modular providers. The Construction Leadership Council and Trowers are continuing to develop our thinking and working with clients to progress this vital element for the success of modular construction.

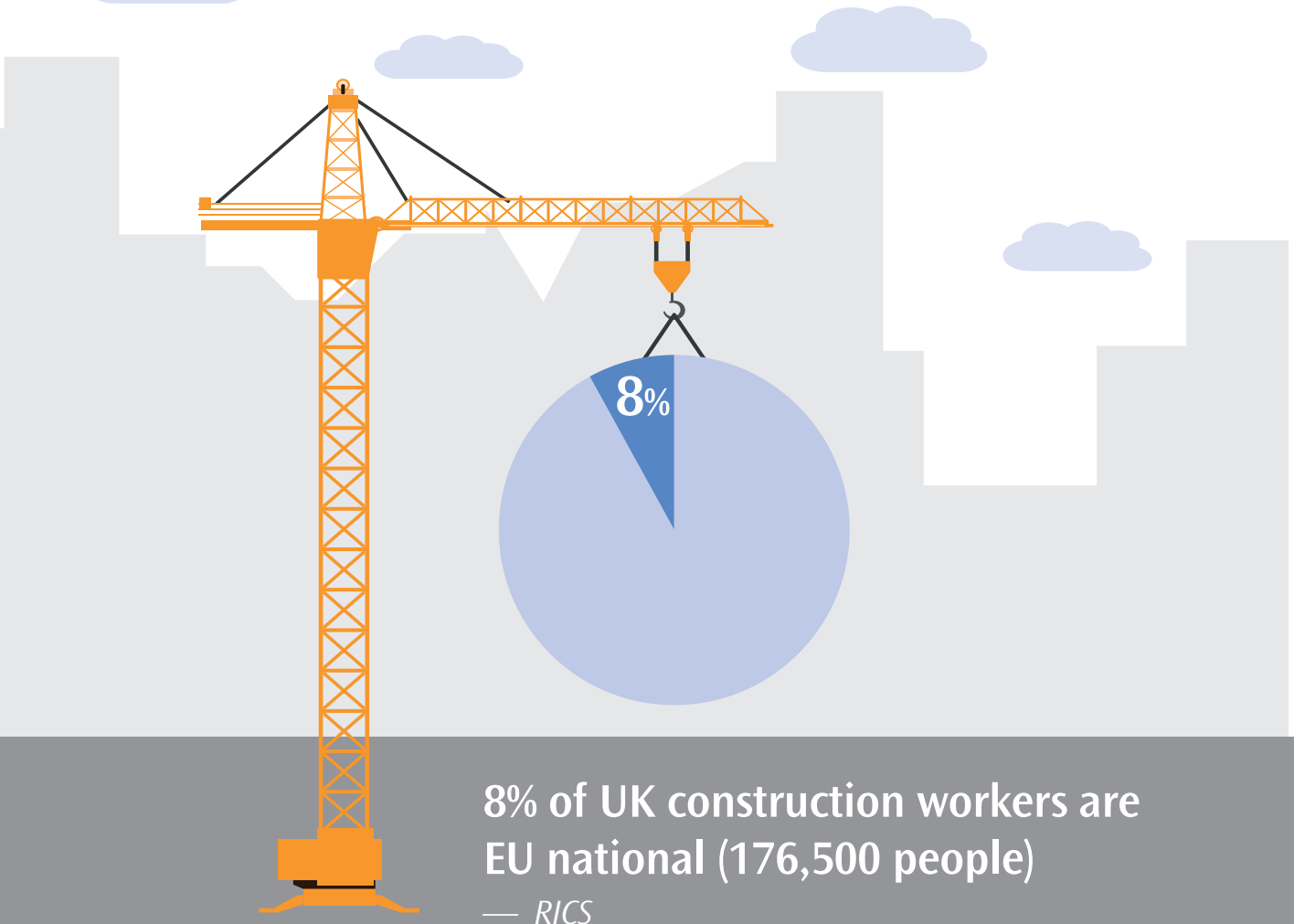


Two thirds of housebuilders are investing in modular

— Lloyds Bank Housebuilding Report 2018

Britain must recruit over 400,000 people each year to deliver in line with housing and infrastructure need, equivalent of one person every 77 seconds

— *Arcadis Talent Scale 2017*



8% of UK construction workers are EU national (176,500 people)

— *RICS*

Standardisation and collaboration: Key to helping modular succeed?

The benefits of standardisation in an industry such as construction are clear for all to see. In November 2017, as part of its Innovation in Buildings workstream, the Construction Leadership Council published a report which identified the following key actions for unlocking the "supply and demand conundrum affecting the provision of additional housing adopting smart construction":

- aggregate demand within city regions and (Homes England (HCA as was) programmes to provide visibility to the supply chain of future volume requirements, including moving to long-term (three to five years plus) strategic partnerships and contracts to progressively improve performance and capacity managed collaboratively between client and supply chain stakeholders;
- standardisation of requirements/specifications including the development of industry level guidance and common standards supporting enhanced quality; and
- enabling achievement of this strategy through revised procurement guidance and model forms of contract, with appropriate measures to manage risk investment and reward collaboratively and transparently.

As noted above, Trowers and Kings College London are supporting the Construction Leadership Council on its research into the model form of contract and advising on strategic and project considerations. In respect of the first two key actions from the report, we have found that those in the wider industry who consider that modular construction could be the "new normal" do not believe that large scale, volumetric delivery is possible without a collaborative and standardised approach. This would allow all factories to produce manufactured elements for any scheme and any client.

HTA Design, who have recently obtained planning permission for two of the tallest modular towers in the world at 101 George Street, Croydon, have been working with the British Standards Institution to develop the "Modular Design Standard". HTA believe that many developers are knowledgeable and enthusiastic about the benefits of going volumetric, but are hamstrung by fears around committing too early in the design process to a particular manufacturer.

In order to assist these "enlightened-but-cautious" clients, the Modular Design Standard aims to identify and standardise the key design parameters that are vital to a successful modular design. It is not intended that this Standard will dictate the design that must be applied, but the aim is to advise on the range of values that can be readily achieved by the supply chain. The ultimate aim is for designers to be able to design to this Standard in a manner that HTA describes as "system agnostic", whilst the supply chain can tailor their systems to cater for the range of options within the Standard. This should give developers added confidence to commit to modular, safe in the knowledge that they retain the ability to choose the manufacturer.

This will particularly assist smaller developers; those who do not have millions of their own money to invest in the development of innovative modular technology. Homes England have been promoting modular and off-site fabrication as a potential solution to deliver the Government's pledge of achieving the construction of 300,000 homes a year by 2020, up from the current level (to March 2017) of 217,000 homes per year (Lloyds Bank Housebuilding Report 2018). Homes England is now in charge of a £3billion Home Building Fund designed to "provide loans for small and medium enterprise builders, custom builders, offsite construction and essential infrastructure" and this could be the catalyst the industry needs to encourage SMEs who have traditionally found it difficult to benefit from these modern methods of construction.

Currently, for those smaller developers who do not have their own dedicated factory, there are independent modular providers supplying modular products to anyone willing to book time in their facilities. In the UK, the likes of Elements Europe, Walker Modular, Yorkon and Vision Modular have been delivering modular systems for years and now many developers are also looking abroad to suppliers from mainland Europe and beyond. There is much discussion of international suppliers, although concerns about payment for off-site materials, shipping risk and quality remain. Cross-border arrangements make it harder for clients to review the progress of the assembly, risking quality issues when modular elements finally arrive on site. Although international suppliers may offer cost savings, the additional costs of international flights and for on-the-ground representatives need to be considered.

There is a feeling that the introduction of the Modular Design Standard could genuinely be a game-changer for these "enlightened-but-cautious" clients and modular providers, as well as the funders who have traditionally been reluctant to embrace modular projects. Having an industry-wide common standard will allow the design and procurement of these types of systems to be carried out within a framework with which developers and funders are already familiar. It will also break the link between the methodology and individual suppliers - reducing the perceived high risks associated with early commitment to a particular methodology (required in the design stage), as provided by one particular provider. If there is a break in the production, the developer can simply switch to an alternative provider with far less disruption than is currently the case.

A paradox of the standardised approach is that it should lead to greater diversity in the finished product. Once common Modular Design Standard is in place, there will be even more scope for flexibility within modular developments and opportunities to take account of customer's expectations of a tailor-made home that suits their own individuality. The opportunities to share the benefits of innovation for greater social aims beyond simply putting a roof over our heads.

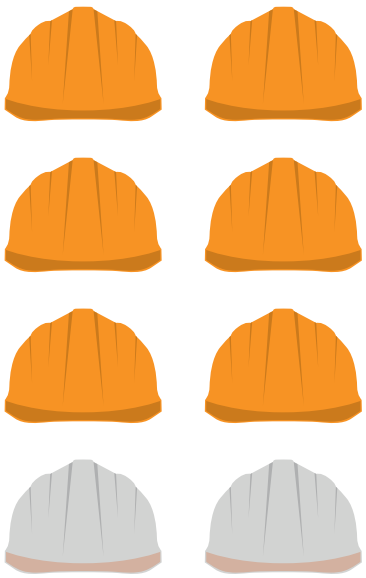
These considerations are important to the modern homebuyer, whose outlook is not limited to aesthetic considerations when choosing their home. Deeper feelings of social responsibility impact on people's home-buying choices, in a way that would have been unthinkable 20 years ago. Issues such as sustainability and the environment are important and people are far more aware of the materials that go into building their home, and what comes out of it. Following on from Trowers own ongoing analysis into the social value of developments entitled "Highly Valued, Hard to Value: Towards and Integrated Measurement of Reals Estate Development" in 2016 we have recently published the second part of this research - "The Real Value Report" (produced in collaboration with RealWorth). This new report looks at the link between financial returns and creating buildings and places in which people and communities thrive. Real estate projects have to be both financially beneficial to the investor, and generate sufficient long-term societal benefit for those who experience the development. Through this research it is evident that there are wider factors to consider beyond the immediate issues surrounding construction that will benefit all parties involved in the long term.

Proponents of modular construction frequently highlight the greater sustainability performance of modular homes. Although the concept of the carbon neutral home has been criticised as unviable on a large scale, through modular delivery, environmental performance can be greatly enhanced. Tighter tolerances lead to the delivery of an airtight home with resultant efficiencies in heat exchange and insulation. HTA estimates that, from sourcing materials, transporting them to site, assembly on site, emissions and use of demolished and recycled materials, the carbon footprint of modular construction techniques results in a reduction of about 60% compared to traditional construction techniques based on a 45-year life cycle.

It is clear that standardisation has the potential to benefit an industry that historically has not been good at sharing knowledge. One good example of collaboration (albeit not a modular project) is the Studio Dundee project in Scotland, part of the Dundee Waterfront masterplan. Despite the involvement of seven of the largest off-site manufacturers, all of whom are competitors, they have adopted a collaborative approach. The project itself is using traditional construction, but it is seen as a benchmark for the sharing of data, such as carbon emissions arising from its design, construction, use and demolition over a notional 45-year lifespan, and is exactly the type of data-sharing model that people are hoping could be adopted for modular construction.

This sort of data-capture could work to evidence the efficiencies offered by the modular industry so that clients and advisors can make informed decisions about delivery, in a market where currently there is simply not enough data publically available. Some of the reluctance to invest in modular arises as a result of this lack of available data and the challenge to the industry is how to get that data out there and share it.

The ultimate aim would be collaboration on delivery; with any client being able to source their modular elements from any modular provider. Despite many clients' view that their modular product is unique, many developers working in the sector believe that the modular systems are broadly comparable. Collaboration will help to alleviate the challenge that the construction industry will face in keeping the order book full in a modular factory, allowing competitors to share overspill. Arguably this is the biggest challenge to the success of modular but, if resolved, could be the driver for the industry to work in a truly 21st century way.



25% decline in the available workforce by the end of the decade

— The Farmer Review 2016

Skills shortage: Where will the labour come from?

One of the key issues facing the construction industry is how to redress the decline in the numbers and skills of the existing workforce. Alongside the challenge of Brexit, with an expected exodus of a large proportion of the foreign workforce back to the EU, we have an aging workforce that is not being replenished; and the younger generation not seeing construction as an attractive career.

Figures published by the Royal Institute of Chartered Surveyors in March 2017 estimated that 8% of the UK's construction workers are EU nationals, accounting for some 176,500 people who could be at risk if the UK does not secure access to the EU Single Market. A more recent report published by Arcadis in February 2018 stated that the industry as a whole could suffer a reduction of as many as 214,000 workers in the event of a "hard" Brexit, by 2020. The true figure is, of course, a matter of statistical and political controversy, but Brexit undoubtedly exacerbates a problem about which the industry was concerned even before the EU Referendum vote.

At the same time, in its Construction Skills Network Forecasts 2017–2021, the Construction Industry Training Board predicted that for the period up to 2021, whilst construction output is anticipated to grow at an average of 1.7% (just below the 1.8% expected average GDP growth), average construction employment, is expected to grow at just 0.6% over the same period. This is lower than in the recent past and below the 1.1% predicted for the 2016 to 2020 period a year ago.

How are we going to build the homes that we need, let alone the infrastructure and business premises needed to support our economy, with a declining workforce? Modular construction could offer part of the solution for a number of reasons. In a competitive recruitment environment, the career of a construction worker travelling out to site in inclement weather is losing out to the more comfortable existence of an office job. Those who are keen to be involved in a technologically progressive industry but without the upheaval of a job being constantly exposed to the elements and travelling to a new workplace for the next project might be attracted by working in a modular factory.

From an industry perspective, workers need not come from existing construction jobs, but can come from a wide manufacturing background. Modular construction may not require highly skilled workers; with the production line allowing a smaller number of highly skilled supervisors and the more routine tasks being undertaken by low-skilled labour or, a solution that more and more developers are considering automated machines. With labour having been identified by many developers and contractors as one of the greatest challenges to delivering the volume of housing that is required, increased automation is seen as a viable solution. This would potentially solve the problems of both skills shortage and quality. It would represent a shift in outlook from thinking of houses built using construction methods to a more manufacture-based approach with the supply chain actually being an assembly facility.

Berkeley Homes is one developer that has placed a greater emphasis on automation than they had originally intended, and have discovered that this had a significant impact on cost. Berkeley felt that their current systems used too much labour and that this could be improved by utilising increased pre-manufactured modular construction techniques throughout the supply chain.

There is a feeling that the construction industry needs to take an entirely different approach. It shouldn't be taken for granted that traditional construction skills will be transferable. Those working in the factory environment will require further training, and production line approaches should enable new ways of working. L&G estimate that less than 5% of its staff at the L&G plant are from a construction industry background, with a much higher majority coming from manufacturing.

And what of Brexit? Such innovations need not necessarily be UK-based. In a global market, the move to modular will inevitably involve more international players. Whitbread plc, the group best known for its leisure and hospitality portfolio (which includes the Premier Inn hotel chain), has explored a range of design solutions and suppliers - from Chinese shipping containers to factory-built modules. Modular is a good fit for their business, given the aim for standardisation of hotel rooms across its portfolio. Whitbread's experiences are interesting – through a process of elimination, it has developed its preferred modular solution and supply chains to a point where they can play a significant part in the expansion of its hotel business. Whitbread's experience suggests that the hotel industry as a whole is not investing enough in construction. Whitbread estimate that they build 45,000 new hotel rooms a year traditionally. On paper this lends itself to using modern methods of construction but the investment simply is not there at present. Previous attempts within the leisure industry to utilise modular construction involved using a well-known modular manufacturer who subsequently went insolvent due to lack of demand, which is symptomatic of the lack of commitment to modular in that sector.

The new possibilities offered by the global marketplace means that maximum flexibility in the labour force can be achieved. In a market where some developers have estimated that more than 60% of their costs are labour-related, modular construction should help reduce the labour content. The use of foreign-based and semi-skilled labour for the major elements of a factory-constructed project means that labour can be sourced at a fraction of the cost, with the more expensive, skilled labour being engaged towards the end of the project for sign-off.

Final word: The Trowers view

As can be seen from the issues explored in this report, and as was evidenced by the attendees at our round table, there is significant optimism that the industry is now finding solutions to the challenges that have blighted modular construction and off-site fabrication in the past.

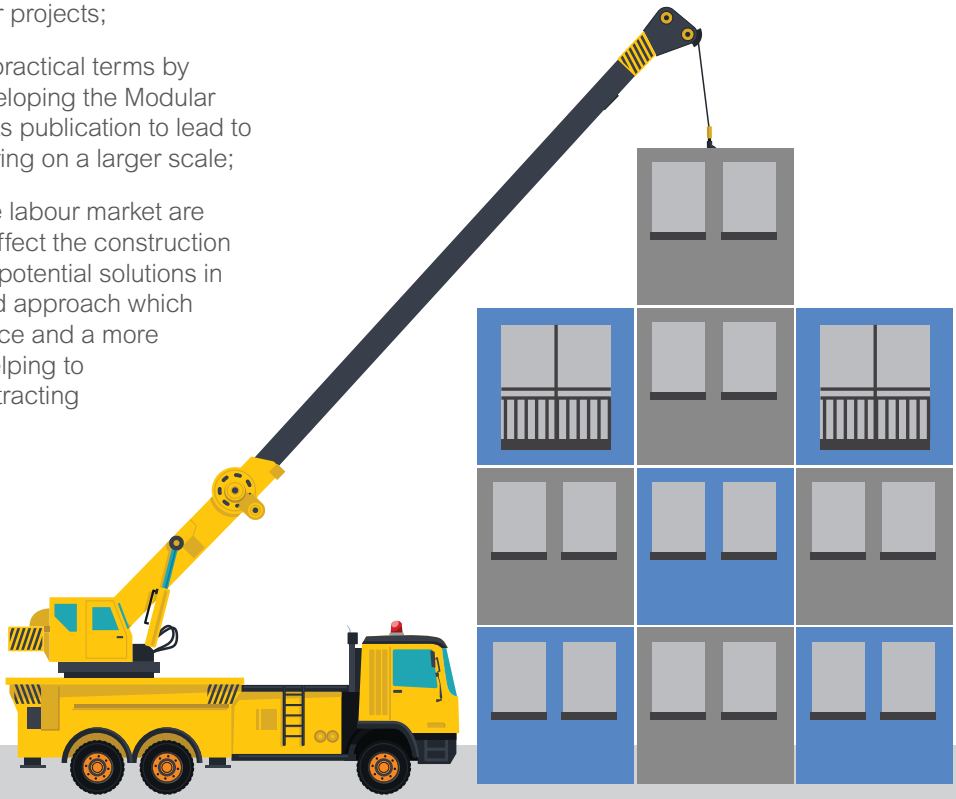
As well as the political impetus behind adopting modern methods of construction, a number of leading developers have now taken up the baton and invested significant time and money into making modular work. The UK is creating an environment where this approach to construction is becoming more commonplace and hopefully will soon be viable for small and medium-sized developers as well as the big players. The investment that has been traditionally lacking is now available both through government channels as well as the private sector and we anticipate that in the next five years the work that has been done behind the scenes will start to pay dividends.

In this report, we have examined a whole range of issues surrounding modular and found that:

- advances in technology and a new approach in upfront design and automation have led to a better quality of product than was available previously;
- new forms of contracting will not only help to regulate the parties' legal relationship but should also encourage new, more collaborative ways of working and can address the risks that have traditionally made funders nervous about finance for modular projects;
- collaboration will be facilitated in practical terms by the work being undertaken in developing the Modular Design Standard and we expect its publication to lead to collaboration and information sharing on a larger scale;
- finally, the challenges that face the labour market are not easily overcome, and do not affect the construction industry in isolation, but there are potential solutions in adopting a modular, factory-based approach which can tap into an alternative workforce and a more attractive working environment; helping to lessen the impact of Brexit and attracting new recruits into the industry.

On 29 March 2018, the House of Lords Science and Technology Committee launched its own inquiry into off-site manufacture for construction and is inviting submissions aimed at answering the question of why the construction industry as a whole has not experienced the improvements in productivity seen in other sectors. The hope is that this will prompt further changes to Government policy, particularly around public procurement, that might facilitate increased use of off-site manufacture.

For its part, Trowers is continuing to drive thinking around these issues in order to contribute to an environment where modular and off-site manufacture can succeed. We are planning further publications and roundtable events to monitor the development of the issues examined in this report, as well as broadening the conversation to address a whole range of issues flowing from these discussions. Our aim is to facilitate education in these modern methods of construction and we continue to welcome ongoing contributions from anyone who has input they would like to share.



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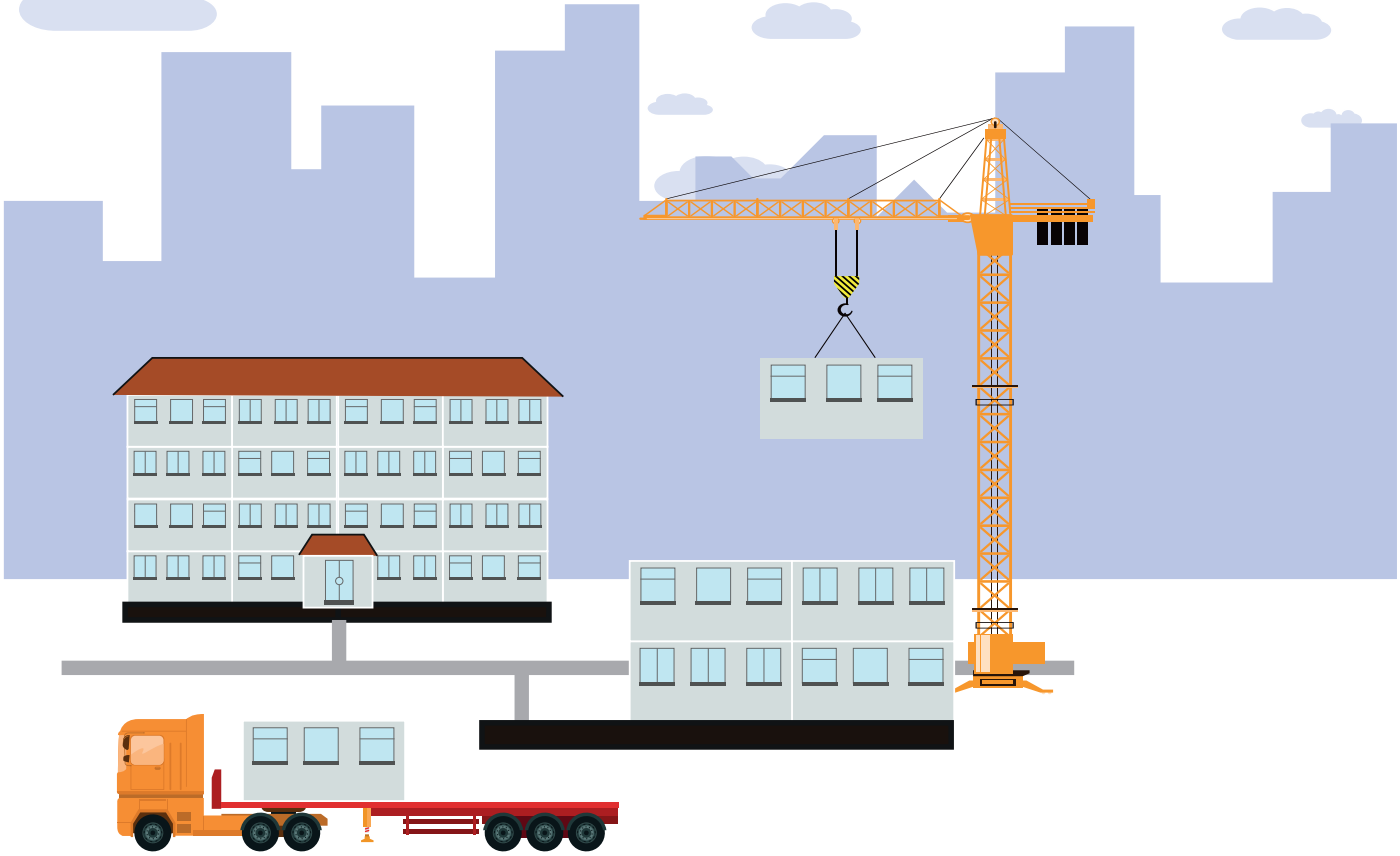

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