HOUSE OF LORDS

Select Committee on Science and Technology

Corrected oral evidence: Off-site manufacture for construction

Tuesday 1 May 2018

4.35 pm

Watch the meeting

Members present: Lord Patel (Chairman); Lord Borwick; Lord Hunt of Chesterton; Lord Kakkar; Lord Mair; Lord Maxton; Baroness Morgan of Huyton; Lord Renfrew of Kaimsthorn; Lord Vallance of Tummel; Baroness Young of Old Scone.

Evidence Session No. 4 Heard in Public Questions 24 - 29

Witnesses

Mark Farmer, CEO, Cast; Steve Radley, Director of Policy, Construction Industry Training Board; Mark Reynolds, Chief Executive, Mace; Dick Elsy, CEO, High Value Manufacturing Catapult.

USE OF THE TRANSCRIPT

This is a corrected transcript of evidence taken in public and webcast on www.parliamentlive.tv.

Examination of witnesses

Mark Farmer, Steve Radley, Mark Reynolds, Dick Elsy

Q24 **The Chairman:** Welcome to our inquiry and thank you for coming today to help us. It is important that we hear from you. Starting from my left, please introduce yourselves for the record. Please feel free to make any introductory remarks. Mr Farmer, I will start with you.

Mark Farmer: I am the chief executive of Cast, a specialist real estate construction consultancy working primarily in the residential sector but having input and involvement across the construction sector, including infrastructure. I am co-chair of Constructing Excellence and I authored an independent review of the construction sector back in 2016 entitled Modernise or Die.

I am a strong advocate of off-site manufacturing, and no doubt we will develop that further in discussion. Some of the findings of my review from 2016 clearly suggest that developing new ways of designing and building is an integral part of how we are going to overcome the challenge of building new homes in particular but also other critical infrastructure.

Steve Radley: I am director of policy of the Construction Industry Training Board, the industry's training board funded by the levy. We have three primary roles, which are all relevant to this inquiry: supporting the sector to recruit and retain people through careers work, helping the industry to develop the appropriate standards and qualifications, and influencing training and development. This is primarily through three mechanisms, all of which are relevant: partnering with employers, training providers and other organisations; providing funding for companies to train and for programmes; and carrying out research. Increasingly, a lot of our research is looking at future opportunities and future skills.

Mark Reynolds: I am the Chief Executive of Mace Ltd. Mace is a privately-owned consultancy and construction company. In addition, I am part of the Construction Leadership Council, responsible for Skills work stream. I have also been a part of the Project 13 executive group responsible for integration. I started my career nearly 40 years ago as a 16 year-old as what we would now call an apprentice. I have worked on a number of high-profile projects such as Heathrow Terminal 5 and London 2012, where we were the delivery partner.

Since becoming chief executive of Mace in 2013, we have grown organically from a £1 billion company to a £2 billion company, increasing our international revenues from £100 million a year to £600 million a year and investing over £40 million a year since 2015 in R&D projects. Today, we employ 6,000 people across 40 countries over five continents and, as well as being an owner and a CEO, I would class myself as a practitioner of lean and modern manufacturing methods of construction.

Dick Elsy: I am the chief executive of the High Value Manufacturing Catapult. Our job is to develop advanced manufacturing technologies and

processes for the high-value manufacturing sector, characterised by complex and high-volume manufacture, aerospace, automotive, rail, defence, and food and beverage. We were approached 18 months to two years ago by the Construction Leadership Council, following Mark Farmer's report, to understand how the disciplines from high-volume and high-value manufacture could be transferred into the construction industry for productivity gain and to meet the targets set in the strategy document *Construction 2025*.

Since that time, we have helped to develop technology route maps with the Construction Leadership Council and to develop the recent construction sector deal. While doing that, we have engaged with leading construction companies and their supply chains on many projects to demonstrate what is possible, including the use of digital tools and information management, robotics, automation and, the topic of today, off-site manufacture. These demonstration projects have crystallised the view that the concept of that cross-sector knowledge transfer is fully workable and will lead to the kinds of productivity and cost-improvement gains that the industry needs.

The Chairman: Thank you. What is our productivity level in construction compared to other countries?

Mark Reynolds: The statistics are that we produce between 15% to 25% less than countries.

The Chairman: Which countries?

Mark Reynolds: Germany, France.

The Chairman: Is that solely down to not being able to do more off-site construction?

Mark Reynolds: Partly. It is also partly about efficiencies in health and safety. We have much more stringent health and safety requirements, which slows the process down and certainly makes it far more rigorous. There is an element of having a production-based approach, certainly for design efficiencies, and a system-based approach for materials, components, sub-assemblies and so on.

The Chairman: On the components of productivity gains—you mentioned design and other areas—how much would off-site construction contribute to improving that productivity?

Mark Reynolds: I think it could contribute up to 50% increase and maybe higher.

The Chairman: That suggests that the other areas of design and so on contribute very little to productivity.

Mark Reynolds: Design is an important element. They are all integral. If you design for manufacture, it will improve stringencies on health and safety, because you reduce the number of people on site and the inefficiencies of delivering that on site as well as making it more standardised.

Q25 **The Chairman:** We have heard a lot about the benefits of off-site

construction. In fact, I think we are sold on it after the positive comments that we have heard. What are the barriers? Clearly all of you want more off-site construction. As you have said, Mr Farmer, you are a champion of off-site construction. What are the barriers to more construction being done off-site?

Mark Farmer: There are several barriers. There is a supply chain issue in the capacity and structure of the off-site market as it currently stands. I work primarily in the residential sector, so my focus is on housing and high-density apartment schemes. Currently, the off-site market in the UK is fragmented. It is effectively a cottage industry—it has certainly come from that perspective—where individual businesses have finite capacity. Developer clients and housebuilders who want to engage with that method of building have often struggled to align with the right partners and to understand how their demand can map on to availability in factories. It has been fairly sporadic in matching supply and capacity.

There is also a basic issue that goes to the heart of a key barrier to uptake in off-site. There is a big issue with how we organise ourselves as an industry around procurement with a fragmented model of architects bespoke designing something that is procured through a competitive process that in turn is tendered for by an ad-hoc manufacturing supply chain. It is not the best way of advancing off-site.

If we are going to move forward in off-site manufacturing, there is much work to do on more integrated procurement. There is a big debate about procurement in the construction industry, which has been flagged up by all sorts of other instances in the last 12 to 18 months. We need to move to more collaborative procurement so that design for manufacture and assembly—DfMA—a term you have probably heard several times in taking evidence, can be promoted properly. That is a different and more collaborative way based on trust. There is not enough of that in our industry, so it is a big barrier at the moment.

Mark Reynolds: We also have to look at how projects are funded. If you look at the beginning of the whole process from concept design to developing that into funding, many of the large institutional funders just want to see tried and tested solutions. If they are not proven, it will be a "not invented here" syndrome. We do not have a process of doing prototyping, and as a consequence we learn on the job. Therefore, it is difficult sometimes to get funding if you are trying to do something new. If you are trying to sell that to some clients, it is difficult. As Mark said, it is then about the design process. The traditional RIBA plan of work process which the industry follows does not really accommodate a manufacturing construction solution.

Q26 **Lord Borwick:** I want to talk more about the drawbacks of the off-site manufacture and the barriers. You have mentioned some of them, but are there others that you want to bring out to show why it is not taken up more widely?

Dick Elsy: As an industrialist looking into this sector, because we are bringing the disciplines from automotive and aerospace to the sector, it

requires a mindset change. There is a cultural shift in thinking from this rather sequential approach to a more integrated one. The sorts of things that we are looking at are, for example, the use of digital tools, so there is one version of the truth from the first strokes of the architect's pen on a screen through to the completion of that design, the tendering, the procurement processes, the physical build itself and onward in to the ongoing maintenance of the building there is single database, a constant hand over of baton all the way through that chain.

That requires quite a different mindset, which will be a challenge to accept, but the beauty is that this is ubiquitous in aerospace and automotive. They are used to doing it. The great thing is that the sector wants to change and to learn. I do not see it being a barrier, therefore, and the first-mover advantage people, who I have met through the Construction Leadership Council, are determined to change. There is therefore a strong push to make that cultural shift.

Mark Reynolds: May I add to the point about the successes before we come back to the barriers? Pre-assembly, mechanical electrical plants come in as modules. This has been a huge success in the industry and taken many hours out of on-site labour process and improved safety. The starting point is throwing away the design, which is a traditional design. If a client spends £1 million on design for 30% to 50% to be thrown away in order to start again, they do not see that as an added-value process. You have to accept that you have to move back to move forward in order to make those savings. There are challenges and concerns about developing the designs only to start again and move forward in a different way, and people are reluctant to do that.

Lord Borwick: One of the problems is that it is such a diverse industry. We are asking these questions not only about housebuilding but about multi-storey office buildings as well as hospitals and prisons. They are so utterly different in their funding, their maintenance and the nature of the client. We are trying to come up with questions that are relevant to totally different industries. Is that a fair analysis?

Mark Farmer: Within construction there are lots of sub-asset classes. There are differences in building construction and infrastructure, certainly physical infrastructure such as roads and railways. Social infrastructure is more about buildings, so we are talking about schools and hospitals. Housing is obviously a very clear asset class as is commercial construction—offices, shopping centres, hotels and so on. You need to break it down into bite-sized chunks.

One of the key things here, which Dick and Mark have alluded to, is the mindset shift towards process-led thinking in construction. The construction industry is very unstructured. It has developed an historical model that is not well suited to efficient working. The learning that we can take from other manufacturing based sectors, such as automotive and aerospace—although I do not want to overdo that comparison, it is well worth making—is about process. When you look at all those different asset classes of construction types and apply process to all of them and

recognise the differences in technical build, the design challenges or the rules by which they are built, you can do something very differently.

There is a fundamental shift here, which has been covered several times already starting with the role of the client. A lot of this starts with clients and how they commission their projects. Rather than going to a designer and saying, "I want a design that meets this fairly open brief", a set of rules is established, whether it be for commercial office building or an apartment building, by which it codifies and parametrically defines how you would go about designing that and you enable it. It is like the product-platform thinking that you get in the automotive sector. We can replicate that in construction. Lots of people think it is unachievable, but it is, and I think we are going to get there.

Lord Borwick: Which parts of the industry are perfect for off-site construction and which parts are rotten? My immediate belief is that prisons are perfect for this, but maybe that is to suggest that prisoners do not deserve good architecture.

Mark Reynolds: There are many areas. Prisons is a great example, as are schools, and housing at all levels, be it low-density, high-density. They are all equally important. Mark's point about creating a platform, whether it be a commercial office or a house or a high-rise residential facility, is that it has repetition in it in some shape or form. It is about creating those platform sub-assemblies, components and systems. If you can create something with sub-assemblies and sub-sub-assemblies that come together, it is much easier. You get commonality at the sub-assembly level, which will start spreading across schools and hospitals.

To give you an example, bathroom pods have been very common in high-volume, multi-storey residentials. They were not commonly used 15 years ago. There were productivity and capacity problems. Today, they are used commonly. You now see utility cupboards used commonly on developments. The utility cupboard could be adapted for a school or for a prison. These systems and components can become common platforms. Their advantages are that they are a common product that can be bought off the shelf, used many times and plugged into a building. You can plug into the design, which means that you are using a system-based design rather than a designer designing over and over again from first principles.

Dick Elsy: There is a misconception that this modular off-site construction leads to portakabin cities. The analogy that I would draw is from the automotive industry, an industry that I am familiar with. When I started in the 1980s, every car was different and the industry suffered from every car being engineered differently. Now there is incredible commonality of components and systems in cars. The Volkswagen Group has an MQB platform. This is a single platform, including common parts such as brake systems, axles and engines, which serves four brands and 25 different products. The products all look different. The different brands appeal in different ways, so that architecturally to the consumer they are very different products, but they share this very high common core with all the benefits that Mark has just talked about: high-volume throughput,

high-quality parts and certified bits. It can be made to work. That is the best analogy I can make.

Baroness Young of Old Scone: I am curious about the housebuilding industry, because it seems that with some exceptions it is driven by high-volume housebuilders who have a vested interest in not building very fast. It must be the only part of the construction industry that thrives on going slow. I wonder whether that means that this approach is doomed to failure in the volume housebuilding industry unless—you talked about a change of culture—we get a major mindset shift. Discuss.

The Chairman: I might add that Mr Farmer and Mr Reynolds both have experience overseas. To link with that question, how does that experience compare here?

Mark Farmer: I will answer the question about housebuilding incentive first and then open it up to overseas benchmarks. You are right to say that there is not necessarily an incentive in the private for-sale housebuilder model to move fast. One of the benefits of off-site is speed. We are seeing very clearly, and it has been magnified in the last 18 months, that we have a big issue in this country with quality. It is becoming more apparent that the big housebuilders recognise that that is becoming a reputational and brand risk for their businesses. Even though the speed piece might not fit with their core business model with a risk of having unsold inventory, if they are delivering products ahead of their sales rate, that could be an issue.

Increasingly, there is recognition and evidence of top five volume housebuilders actively looking at off-site manufacturing solutions either through partnership with existing manufacturers or in some instances looking to vertically integrate and set their own factories up. The Berkeley Group is an example of that. Some of you may be aware that Berkeley is building a factory in the Thames Estuary that will be for its own products and pipeline, and that is borne out of the risk. If you speak to its board you will find that it saw the reputational risk from poor quality because of the skills constraints that it is now seeing and the variability of the outcome of traditional build.

On the overseas piece—I think it was mentioned in the previous session—there is no stand-out country that is doing something remarkably different across all parts of housing. There are some well-known examples of single family housing being done in a more manufactured way. Germany is an example of a country that has single family homes that are seen in many respects as premium products, such as the HUF Haus. Many of you will be aware of that. I cannot point to any international exemplar of high-density apartment-led schemes being delivered in a manufactured way. Japan is another example of a lot of single family housing in a pre-manufactured way. We have an opportunity, if we embrace it and do it well and in a considered way, to be an international leader in this market.

Mark Reynolds: To add to the point that Mark raised, this is low-volume, low-rise, which lends itself to setting up an off-site

manufacturing facility. I will take car plant as an example. The analogy is the assembly area and, as you said in the last session, the constraint is that you have to put it on the back of a vehicle and transport it down the road. There is no reason why we cannot create those sub-assembly areas locally in a pop-up factory close to the large-scale development. Low-rise, low-volume is very different to high-volume, high-rise. They are different solutions that do not do the same thing.

On the second part of the question about the situation internationally, if you look at different places around the world, whether it is in the Middle East, which thrives on low wages and lots of people who are not treated in the same environment as they are in the UK, you have to be careful. The quality of the type of work done in different locations in Germany or France is equivalent to the UK, but in Russia they only build a grey box, which is basically blockwork and a façade, and it is left to the individual to plaster the walls, do the electrics and the kitchen and bathroom. It is a very different market. When you compare housebuilding in one country to another country there are different products and different solutions that make a vast difference.

Lord Kakkar: Can you give me a sense of the elements that might be constructed and applied to different types of buildings? What kinds of things could be done on a very large scale, the kinds of things that a pop-up factory might do or indeed the factory that you spoke about in the Thames Estuary might be doing?

Mark Farmer: Lots of methodologies coming forward are applying different solutions. The factory I mentioned in the Thames Estuary that Berkeley is bringing forward is a volumetric solution. The intention there is to three-dimensionally pre-construct an entire apartment or part of an apartment or part of a house. That particular solution will be for houses and high rise. They are using steel so that it has structural integrity to go higher. They are looking at that as part of the core piece of their business plan. That is the extreme end of the pre-manufactured spectrum.

Taking Mark's point about sub-assemblies and the hierarchy of how you pre-assemble parts of buildings, there are certain elements of commonality that will move beyond asset classes such as building structures. Moving towards more pre-manufactured structure that will invariably involve things like pre-casting concrete rather than in-situ pouring concrete, which is highly prevalent particularly in housebuilding.

It is a very labour-intensive part of how we build structures, and it could be broken down into something that is a lot more pre-manufactured and platform designed. As we move into different asset classes and look at the difference between housing and commercial offices, there will be a divergence in the type of sub-assemblies. There will be elements such as engineering infrastructure and risers, staircases, lift shafts and so on that go into the central parts of buildings. There will be an office version, a hotel version, a residential version, and multiple platforms between each of those. As you move into the fitting out, it will become even more divergent, because you only have kitchens and bathrooms in residential;

you do not have that in commercial. It becomes a matrix of options, breaking buildings down into bits.

As Mark also said, there is a big debate as to whether you do it in a central factory, highly pre-manufactured, or whether you use flying factories or pop-up factories, collocated to site, or even, at its most extreme, form the factory environment at the workface. Mark has done that with his own business. It is a matter of technical detail as to how you break it down but the key thing is consistency. Platform approach and commonality, as Dick said, is what they do in automotive, rather than reinventing. I work on many schemes where we might have a 100-unit apartment scheme and there might be 85 different bathroom types. It makes no sense. It is not driving value; it is because of the individuality of the approach to design.

Mark Reynolds: Can I elaborate on that and give you an example? In a multi-storey building of over 32 or 34 floors you could engineer that so that you can get another floor within the building without affecting the overall height, that can be constructed. The building that Mark mentioned was what we call a jump factory where we built a large factory on top of the building. We were able to construct the floor, cladding, walls, structural walls, columns, staircases, prefabricated bathrooms, utility cupboards and service modules, horizontal and vertical, in 38 hours. I have never seen that done anywhere in the world. It can be done and we need to understand how we standardise that and take that forward as an industry and work together.

The client who we worked with bought into the concept. We had some failures on that project and we had some successes. He has given us a similar building and we have taken that lesson forward and on to the next scheme and we will take those lessons into other schemes. The point we are all making is that it has to be engineered at the beginning. It has to be based on a system and sub-assembly base and then you can create that manufacturing. We have not spoken about the skills of the workforce and it does change the mindset of both the management team and the into-the-site installation team because they become an assembly team, which is much safer and much more productive.

Q27 **Baroness Morgan of Huyton:** Can you talk through for us the change of the skill base that you would need for more off-site and the advantages and disadvantages? We know that there is a skill shortage in current construction that arguably is going to get worse because of the age profile and probably Brexit. We know we have a problem but what new skills will be needed and where do we get them from?

Steve Radley: As well as skills challenges there are some big skills opportunities here. If we get the initial entry level training right, whether that is apprenticeships, T-levels or degree courses, we could have a much more productive workforce. There are different roles in construction that would be affected in different ways, and in some cases new roles are being created, but there are some skill needs that are in common, such as team working, multiskilling, quality management, better understanding of digital skills and better communication. Some of these

are regarded as soft skills. If we are developing the training and the upskilling to deliver those skills we have the opportunity to create a much more productive workforce. If it is a better working environment on-site and off-site, it will help the industry in its recruitment and retention challenges because it will be a more attractive industry to work in.

In some cases, there may be benefits for some of the problems that the construction industry faces more than others, such as mental health and, in extreme cases, suicide, because we will be working in a less stressful environment. Another of the advantages of off-site is that you do not need all of the workforce together on one site. You can do the work where the workforce is located, so there is less need for young people to be away from home, living in rented accommodation and so on. That tends to be associated with high levels of stress and, in extreme cases, suicide.

If you look at the specific challenges, it creates new roles for on-site assembly and there is a lot more emphasis on precision, using things like BIM, logistics management communication. If you look more at the off-site environment, people working in the factory, it is about producing those components, fixing, tiling and wiring those and bringing them together into modules and having a better understanding of digital skills and the ability to work in a production line.

At the other extreme, it is about enhancing the role of, say, digital designers. In those cases, you need to understand 3D modelling and have the ability to use modelling to design and test processes and modules. It creates a range of new skill needs and opportunities and what we need to think about is how we build these into entry level training such as developing new trailblazer standards that reflect some of those specific skills but also some of the skills that I have talked about that are in common. We also need to look at the new T-levels, which are going to be coming into force in a couple of years. One of the emphases there is on multiskilling so that, particularly in the first year of training, you get an understanding of a greater range of trades. That will be important for developing some of the skills that we need to make off-site construction more successful.

Baroness Morgan of Huyton: Are the T-levels being developed for modern construction or for existing skills? Who is in the driving seat?

Steve Radley: They will be developed for a mixture of the two. In terms of who is in the driving seat, it is up to employers to work closely with government and training providers to make sure that the right content is developed in training. It is a CITB role to make sure that we have sufficient trainers and assessors to deliver that. One of the key elements is ensuring that we have sufficient employers that are able to provide work placements for three months in those areas. The T-levels we get will be very much dependent on employers getting involved. The T-levels you get will be the T-levels you deserve if you put in the effort to influence them.

Baroness Morgan of Huyton: Is that happening? My impression is that post-2008 there was a complete crash in training and that people have

been reluctant to come back to the table.

Steve Radley: T-levels initially will be fairly low volume. This will be a gradual rollout over the next five years or so. In the shorter term, the primary route for construction to bring people in will be through apprenticeships. We have seen strong growth in apprenticeship numbers in the last few years. While some people have commented that, with the apprenticeship levy coming in, apprenticeship numbers have dropped off in other sectors, they have held up very well in construction. There is an increasing understanding among construction employers that if they are to get the skills they need and to become more productive they need to invest more in training.

Mark Reynolds: I think we need to be honest with ourselves when it comes to training. The industry dropped to something like 7,000 apprentices during 2007 and 2008. It is nearer 23,000 today. There is an aspiration from the Construction Leadership Council and the industry to get that up to 30,000 apprentices a year. There is a reluctance on T-levels because of the demand placing young students in to the workplace for three months, which is a challenge and needs to be addressed by the industry. We should not hide the fact that that has not been resolved yet.

On the question about changing for the future, we have had various discussions among ourselves in the industry about how people adapt their workforce. There are some good examples around, such as NG Bailey, which has taken its business from being an on-site to partially off-site where it has been building modules in its own manufacturing centres. It evolves those skills, so you start as a specialist and evolve into a generalist doing multiple skills. It does not go necessarily for specialist training because it starts off with that specialism. We will see both specialism at the beginning and going into generalisation so that it will be easier in the future. It comes down to how people design things, so they are plug and play designs for manufacture. Dick probably has better references for that from the automotive industry.

Dick Elsy: With all the industries that we serve, and now supporting construction, one of the biggest challenges is advanced skills. The further education colleges are taking apprentices to a certain level. In the industries that I serve they (the apprentices) know how to operate a lathe, but they do not all know all the digital tools and techniques. There is quite a big void above that. We are trying to plug the gap working with DfE, which is a challenge since skills separated from BEIS into DfE, and there is a lack of understanding about these advanced skills. Construction will face the same challenge, but it will join us in being a powerful force in calling for funding principally to put into development of the curriculum and standards and so on. The colleges can then distribute all of that and get on with it. That will be a challenge, however.

Baroness Morgan of Huyton: To what extent has the work been done to demonstrate how the skills need to change? Is that out there or is that quite vague at the moment? Mr Radley, you gave us a load of stuff, but I am not clear whether in 10 years' time, for example, we will need to shift to needing X number of these people and this is how we are going to take

it forward.

Steve Radley: We have done detailed work in this area. We have defined six key roles within the industry and some examples of those are the ones I have talked about already, such as on-site assembly, off-site assembly, digital design, site managers and that type of thing. In each case we are asking ourselves what the new skills are and which of the roles are going to change. For a site manager, for example, there is going to be a lot more emphasis on quality management, behavioural change and getting people to work together effectively. Probably in the more advanced forms of off-site that is going to be a more general manager role where you have the ability to manage from start to finish, from conception to completion of the project.

It is going to require new skills but also the enhancement of existing ones. One of the challenges is to influence the design of new courses. For example, a new digital engineer apprenticeship has been developed. In many cases it is going to be about embedding these off-site concepts in existing courses. For example, Mark talked about DfMA. We need to make sure that is mainstream in a range of digital design courses already.

Mark Farmer: There is a particular piece of work going on for London (Transport for London / Greater London Authority) linked to future homebuilding skills. It is quite a difficult area, because you are trying to forecast future skills needs. They have to be demand-led, so, ultimately, running courses for these new developed skills in the different areas that Steve has mentioned has to be embedded in the fact that employers want those skills.

That, in turn, is reliant on us changing the way that we build. The London work is looking at housing and making projections as to what proportion of our new build housing in London in the future over the five-year timescale will change towards more modern methods and more manufactured approaches. It is quite high level, because you have to model what skill profile that looks like such as how many traditional tradesmen, how many assemblers and logisticians doing different things in different ways, how many DfMA specialist architects will be required.

We are not going to transform our skills base in this country unless it is demand led. That is where the Government's role and some of the policy announcements made in the last nine months about starting to initiate some level of change, where it is within the Government's control, are very important. This is particularly the case with major capex programmes in the five government departments that were announced in the Budget as moving to a presumption towards modern methods.

That is a good start in trying to start shaping the level of demand that the FE-HE providers can respond to, because they know that this is coming from the Government's own programme. Hopefully that will spill into housing and commercial buildings and so on.

Q28 **Lord Hunt of Chesterton:** What wider actions are needed from the Government and from the sector on skills to meet the changing needs of construction? One of the issues seems to be related to the Treasury and

the fluctuations. One of the interesting things that we have heard from Mr Elsy relates to a catapult programme in which you are bringing together vehicles, aerospace and construction. There have been some reports about some catapults being more successful than others. Would you like to comment on the catapult model in this programme? How has that contributed?

Dick Elsy: The catapult programme is about bridging the UK's fantastic science base. We spend a lot of money on the development of science, but we have a market failure in the UK in that we do not exploit enough of it as manufacturing value-add. The job of the catapult programme is to bridge that gap and bring more science through for industrial solutions. The catapult that I run, High Value Manufacturing, has been very successful in doing that.

In the first six years of operation, we have leveraged off £330 million of government funding, a total of £1 billion of R&D activity with some fantastic new processes and new factories built, and inward investment off the back of it. It is a very successful model. We are looking to apply that well proven model in construction, and if we are successful in the construction sector deal bids we hope to provide a place for constructors to come and develop.

Lord Hunt of Chesterton: Is the structural side a separate organisation from the aviation and vehicles side?

Dick Elsy: No, it is all one. We are multisector. We are sector agnostic, although I am describing advanced manufacturing, typically aerospace and automotive, food and beverage, rail and marine. Construction is now joining that. We are uniquely sector-agnostic, so the tools and techniques we use are freely available, because they are being supported by a government contribution to the construction industry. About a third of our funding comes from government.

Lord Hunt of Chesterton: Do the apprentices in construction go and visit the factories?

Dick Elsy: They will be. We have experiments running now with most of the major manufacturers. We have had school children coming to see things being assembled by robots, glass cladding on buildings, the construction of entire roof sections of buildings done robotically. Those are available to see and we have been engaging with youngsters on that. We are at the foothills of developing those techniques, and key to that will be bringing the youngsters and reskilling people to show them what this new world looks like to get them comfortable with it and to get the skills developed. There lies the challenge. We cannot do it all in our facilities because we are busy with delivering the technology.

Lord Hunt of Chesterton: How much of the money for this comes from government and how much from private industry?

Dick Elsy: About a third of the money comes from government to provide core capability, keep the lights on and buy the equipment, and a third from industry for using the equipment and the final third we win on

collaborative projects. The projects have to be innovative, competitive and collaborative to win them. It is a very good model.

Baroness Young of Old Scone: Is there one thing government can do to break this cycle of not having enough skills or not moving fast enough, where people are not firing up to it? When we heard evidence last week, we felt that this thing was stuck in a loop and that nobody could break out of it. If government could do one thing to break out of the loop, what would it be?

Mark Reynolds: I have a couple of suggestions. First, the sector deal is really important to the construction and infrastructure industry. That will be enabler, as Dick says, for the three-thirds approach, so that people then start doing it. Also, HMRC could take a different approach. It is about being an enabler and helping organisations. If you are investing £40 million to £50 million a year in R&D projects, there is no reason why those R&D tax credits could not be increased. For some reason, HMRC has taken a dislike to construction over the last six months and has been more stringent.

The Chairman: Is the construction industry more disadvantaged than any other industry for R&D?

Mark Reynolds: I cannot comment, as I do not work in any other industry.

The Chairman: Would it not strengthen your case if you knew that you were disadvantaged?

Mark Reynolds: Pharmaceuticals do very well, I believe, but other industries get a hard time, such as IT. We probably sit at the bottom of the food chain. Automotive, aviation and pharmaceuticals do very well and have probably been playing the game much better than us over the last 10 years. HMRC should be working with industry on the R&D tax credits and demonstrating the benefits, because there are real benefits to be accrued to industry through doing that.

Dick Elsy: If I have an observation as an industrialist, the Government are a big procurer of construction infrastructure projects to get behind this. I see that the construction industry is determined to change. There are some frontrunners in their determination to change, and I am sitting next to one of them. It is encouragement with the new wave of government construction projects not to mandate but to encourage the use of this new approach. It is a pretty obvious thing to do.

Steve Radley: I would like to underline that point, because there are a lot of things that the CITB and industry can do by way of running careers campaigns to advertise the new roles, to influence training provision and get qualifications right, persuade training providers to put these courses on and help them to develop trainers and assessors. If they do not have the confidence that the work is going to be there all of this will be fruitless. Giving a push to that employer demand side is crucial.

Mark Farmer: Times three on that. Demand planning is at the heart of all this. We suffer from being a highly cyclical industry. It is at the root of

our struggles. We have configured ourselves as a flexible, resilient industry, but with the skills constraints that we have coming forward that is going to be increasingly difficult. Anything the Government can do in relation to their direct spend programme and the National Infrastructure Construction Pipeline is an important piece of that uncertainty. We need to think beyond parliamentary cycles, we need long-term certainty.

In the housing sector it is slightly more difficult, because the only tools in the armoury from the government's perspective is land, but there is still an ability to influence there. From a housing perspective, which is the market I concentrate on, that cyclicality can be a real barrier to people wanting to change the way they do things. If there is any way in which policy can support countercyclical demand stimulation for housebuilding, at least the industry knows that there is a floor of minimum demand that gives some certainty in relation to investment in different techniques in manufacturing.

R&D has been mentioned, and I agree with Mark's point about the HMRC piece on that as well. There is definitely a role for government to initiate and underpin that change, albeit that we still need private sector take up as well.

Lord Vallance of Tummel: Can we take housing, which is relatively simple? I think you mentioned that you have a 50% increase in productivity. You can get improvement in the quality of what is done. Presumably you could also significantly reduce the costs here. I still do not understand why the private sector on its own or some disruptive courageous folk in the private sector cannot do it. I am slightly uneasy about the idea that if the Government did this or that it would all come good. Is there nobody who would break ranks and say, "Yes, we are going to do it. We are going to deal with the lack of vertical integration", or whatever else it may be, "and we are going to cut prices of all this". Can it be done?

Mark Farmer: There is definitely disruption afoot. Regarding the pace at which the private sector moves to this model, I have already mentioned some of the drivers for change, which are probably more negative drivers—people being forced there because of their concerns over their brand or reputation for poor quality work. Those that are not in that mindset will have their hands forced, because there are going to be new players coming in. Some of them will be technology platforms rather than housing, construction or manufacturing platforms with a slightly different approach that can aggregate in a different way in bringing the supply chain together. There is a whole piece on digital enablement in this which is implicit in what we are talking about. It is probably more the subject of the previous panel session. That disruption is coming.

You have already heard evidence from one of those disruptors, which is Legal & General. It is adopting a certain approach, which is not the only approach that can be taken, to disrupting the market. An institutional fund comes in, looks at the industry and says, "We're not going to do it that way. We're going to set a factory up and do it in an integrated way".

There are going to be lots of those kinds of models that will emerge and destabilise the market hopefully in a positive way.

We do not want negative disruption where people feel threatened or businesses go bust because something else has happened. We need competition in the market, we need the market to evolve, but it needs to be done in a positive way so that everyone responds to that in the right way.

Lord Vallance of Tummel: There are economists who say there is creative destruction.

Mark Reynolds: We are at a tipping point in the industry. I played a small part in the Egan report 20 years ago. Digital technology has moved on. Never has the industry been joined up with an MTC with its training body as much as it has through the Construction Leadership Council, through the Infrastructure Client Group and coming up with a number of issues and the same common language. It is about that commonality.

We have seen that even the demise of Carillion had relatively little effect on the industry, and that was the second largest player. The industry needs to move forward together. The disruptive player is not going to change things. There is not going to be a 30% market in the UK for any organisation. The industry collectively needs to move forward in the way that automotive has done; you have a collective system components delivery system where you are all working together.

Q29 **Lord Mair:** I would like to go back to skills, following on from that point. It is very encouraging that the high-value manufacturing is involved in construction and particularly in the context of off-site manufacture and all the things that go with that coming from the manufacturing sector, from the automotive sector and other manufacturing sectors.

On advanced skills, which we have been hearing that young people need to be much more adept at, if there is more off-site manufacture in the construction industry, are there lessons from the automotive sector and the manufacturing sector that help can help delivery of these new young people with these skills?

Dick Elsy: For sure. We have a list of the roles that never existed before and that we now need. Those have been developed by the work that we have been doing with the sector thus far in our facilities. We have talked about digital lead architect, digital design manager and automation engineers to understand how to control the robotics and assembly technicians. We are now looking at tools such as augmented reality to deskill things to project workplace instructions into the workplace. There is an enormous amount of technology that can be applied to that in addition to the physical skills required.

Lord Mair: Do you see one big advantage of that is that young people contemplating coming into the construction industry will be potentially much more fired up by that kind of technology?

Dick Elsy: Definitely.

Lord Hunt of Chesterton: Are there more women? One of the points that has often been made is that women are reluctant to go into the construction industry because of the environment.

Dick Elsy: Software and automation is knowledge-based as opposed to a physical thing, so yes.

Lord Hunt of Chesterton: Is there empirical evidence that it is changing?

Dick Elsy: We always struggle in the technology arena and we are working on it. We are beginning to draw more and more women into our R&D capabilities, so our numbers are going up. The ratios are still not right.

Lord Hunt of Chesterton: So is it 20%?

Dick Elsy: Just over 20%.

Mark Reynolds: Could I give an example of that, because you have raised an interesting point that goes back to the subject of digital. I was on a project recently and we had initiated a whole BIM strategy—I will be quick with this—taking BIM from concept right through to operational maintenance and asset maintenance. We implemented the strategy four months ago and the team were given training three weeks ago. I was sitting with a couple of financiers in front of four people under 25. The BIM co-ordinator was a woman, who was probably between 23 and 25, and she was running the federated BIM model. The guy who was running the site activities was checking everything as in an automotive production line process, so we had things out of tolerance being checked, conformance logged, cleared and moved forward. Everything was tracked through the process. The planning manager was slightly over 25. It was so impressive. The two financiers said to me, "Your people are very young, aren't they?" That is what we have to do. It is a completely different skill set. They went through the normal construction management training and were doing completely different skills in a matter of weeks.

Lord Mair: Who should take the lead on the delivery of those skills? Who should be providing this new generation of bright young people coming into the industry?

Steve Radley: There may be a lesson from the manufacturing sector. In a previous life I worked closely with automotive and aerospace, and I found in those industries that even though the companies were competing with each other, there was a lot more collaboration in identifying what the skills were.

One of the issues in the construction industry is that it tends to have a very disjointed approach to training. One of the key things is for employers to join together and ensure that they are training to common standards, having set out the skills that are needed. With the Construction Leadership Council and the CITB working closely with it, we have the opportunity to get that right. Ultimately, it is up to the employers working together to identify what skills are needed and work

together to influence training providers and people who create qualifications to ensure that those are reflected.

Mark Reynolds: I was a real sceptic of the Trailblazer programme until I joined the CLC and saw the skills. It is quite impressive. When we understand what the Institute for Apprenticeships—the IFA—is trying to achieve and what industry should do in order to develop those Trailblazer programmes for themselves and work together with other organisations, we will become quite a powerful force.

At the moment, we are still finding our way and a bit disjointed. The concept is fine. We need to find a number of ambassadors to drive it through and get some successes. I was talking to someone at a groundworks organisation last week. He had done all the right things, but nobody had helped him to engage with the IFA. That is the missing piece of the jigsaw.

Mark Farmer: On the question about who should drive this, I agree that whatever we do needs to be created with industry. The standards that we set have to be things that the employers are buying into. My only build on that would be that there needs to be a bit of tension around what is coming over the hill by way of new innovations, new things that perhaps the employers cannot see themselves yet. That is where applied academic thinking and forward look as to how technology in particular is moving can be helpful.

There is lots going on, particularly in the artificial intelligence space that I can see having all sorts of impacts. In some respects, that alone might dwarf the movement to manufacturing that we have been talking about. In reality, it will complement it, but there are lots of things coming that might be ahead of the employers' thinking as to how that might be applied in their business. There is a little bit of tension there and that forward look is what is needed.

The Chairman: Gentlemen, thank you very much. Our session has come to an end and we appreciate your coming today. It was an interesting session. Thank you.