

ICE response to Infrastructure and Projects Authority call for evidence: Proposal for a New Approach to Building

February 2019

Construction and infrastructure are risk-averse sectors. Their fragmented supply chains act as a disincentive for investment; indeed, the construction sector has the lowest spend on research and development than any other sector in the UK, estimated in 2016 to be running at just 0.1% of its output.¹ Consequently, there are problems in getting innovative products to market and scaling up production. Many existing business and financial models are not fit for purpose in being able to effectively deliver a DfMA approach. As outlined in the Construction Sector Deal, there is a need, then, to diversify and improve delivery models, strengthen supply chains, as well as enact behavioural change in businesses and individuals. Here there are clear links to Project 13 and the work of the Infrastructure Client Group.

About ICE

1. Established in 1818 and with over 92,000 members worldwide, ICE exists to deliver insights on infrastructure for societal benefit, using the professional engineering knowledge of our global membership.

ICE response

2. Our submission to this call for evidence covers questions 1 to 7, with a primary focus on the changes required to procurement, business and delivery models in order to best enable a P-DfMA approach. Questions covering security, standards and Intellectual Property are not the core domain of ICE; specialised organisations are better placed to provide solutions to these issues.

¹ Construction Leadership Council, [The Farmer Review of the UK Construction Labour Model](#) (2016)

3. The response has been informed by and developed in consultation with individuals who are experts in DfMA, both ICE members and non-members. This included a roundtable discussion hosted by ICE that was attended by senior stakeholders from the client, contracting, advisory and tech sectors.

Summary

4. In order to encourage the adoption and implementation of the P-DfMA approach, each relevant government department must first examine its own technical standards – including space standards – and determine where commonality can apply in order to rationalise the number and types of components required.
5. The benefits of the Infrastructure Client Group’s Project 13 approach must be considered. This would enable long-term relationships and closer collaboration, allowing suppliers and advisors to better know their customers and adapt and develop appropriate methods and products for their needs. Engaging the supply chain earlier and more strategically will also allow better scoping of the potential application of those methods, increasing the chance of successful and productive deployment.
6. The government’s ambitions should be enforced through a mandate, similar to the BIM Level 2 mandate in 2016, implemented across relevant projects and programmes and defined by a set of guiding principles. This can take the form of a concept being developed, trailblazers being run to demonstrate benefits and identify efficiencies, a rollout of the approach to early adopters, followed by wider adoption and the concept ultimately becoming business as usual.

Q1: How can the government best encourage the adoption and implementation of this approach in its capital programmes?

7. The benefits of DfMA include cost savings, increased productivity, better quality control, reduced waste and carbon emissions, health and safety improvements and greater collaboration between clients, contractors and suppliers.^{2 3 4} Despite this, the industry has failed to adopt changes that will deliver the benefits DfMA provides. The reluctance to change is a product of existing business models and risk aversion within the construction industry, as well as from clients themselves.⁵
8. Traditional procurement models tend to perpetuate traditional solutions. These models separate the design and manufacturing processes, limiting the opportunity for DfMA application in the first instance, and are increasingly being seen as a risk transfer model rather than one that places responsibility with

² RIBA, [RIBA Plan of Work 2013: Designing for Manufacture and Assembly](#) (2016)

³ Bryden Wood, [Platforms: Bridging the gap between construction + manufacturing](#) (2018)

⁴ Trinder L (2018) [Design for manufacture and assembly: its benefits and risks in the UK water industry](#), *Proceedings of the Institution of Civil Engineers – Management, Procurement and Law*, 171(4): 152–163

⁵ ICE, [Improving approaches to risk in the built environment sector](#) (2018)

the right party to drive innovative solutions.^{6,7} Existing models also lack the capability to open source standard components and systems from multiple providers. Competitive tendering-led procurement models tend to provide clients with less clarity over what they are actually procuring as the more detailed stages involving the supply chain typically become the reserve of the contractor.

9. There are a number of different approaches that have been used by clients and other organisations across the public and private sectors to encourage adoption of DfMA:
 - Some have adopted the ‘positive discrimination’ approach with varying degrees of success. For example, HS2 began with a mantra that works carried out would be done via off-site construction, with traditional used only where off-site was not appropriate.⁸
 - Early involvement with an engaged client works well where sufficient trust exists to allow the contractor to shape the scheme with their professional team to ensure it has been considered with a DfMA solution in mind. In this sense, it is also much easier to convert an off-site conceived solution to a traditional one, as opposed to the other way around.
 - Shifting procurement to an outcomes-based specification also helps proliferate DfMA practices. Over time, DfMA can help in further developing digital assembly and machining capabilities, as well as reducing the cost of component parts.
10. In order to encourage the adoption and implementation of the P-DfMA approach, each relevant government department must first examine its own technical standards – including space standards – and determine where commonality can apply in order to rationalise the number and types of components required. Having a consistent and streamlined set of standards and components in this way would enable the market to respond more effectively, particularly if the industry is brought into the process early. A framework approach to procurement across appropriate programmes can also provide a further incentive for transformation throughout the supply chain.
11. The call for evidence document is right to highlight the need for further research to design, test, provide assurance for and develop the components, standards and practices needed to support the P-DfMA approach. This stance should extend throughout the implementation of the new approach, alongside a recognition that such a major change will require investment and take time to fully develop. By iterating the programme and learning from prototypes, efficiencies can be found that deliver better whole-life value and higher-quality outcomes.
12. In order to accelerate the uptake of DfMA, government should drive change through a combination of support for supply chain development through the Transforming Construction strand of the Industrial

⁶ Walker, P *Concurrent Engineering in Construction Projects: Procurement, contracts and conditions of engagement within a Concurrent Engineering context* (2007)

⁷ ICE, [Innovation: Stepping up the industry](#) (2015)

⁸ Construction Manager, [£17bn HS2 plans off-site route to procurement](#) (2013)

Strategy Challenge Fund as well as a visible pipeline of work through the P-DfMA proposal to provide a degree of certainty.

13. We believe government should avoid a situation where tenders presuppose that a DfMA approach will be applicable on every project or programme. This approach can stifle innovation in other areas, while potentially also leading to a 'race to the bottom'. A clear set of guiding principles, which outline the types of projects most suited to a DfMA mandate, is required to ensure this situation is avoided.

Q2: *Within your organisation or sector what changes are needed, including in relation to technologies, skills and commercial models, for this approach to succeed?*

14. The traditional construction delivery model sees flexibility during the build process to the point where items and components – and often more – are able to be changed or substituted while on-site. DfMA is completely different in this respect as the building/infrastructure must be assembled in the way it has been designed. This requires multiple aspects of a project to be considered, finalised and approved at an earlier stage, necessitating the need for a different delivery model and new skills to implement it. The project team must also fully understand and be attuned to the design programme and milestones to ensure successful delivery.
15. Adopting a DfMA approach does not mean that standard or manufactured elements need to be adopted wholesale. It may simply mean harnessing design rationalisation, materials optimisation, just-in-time delivery or logistics planning in order to achieve high rates of productivity on site. Seeking to find the most efficient way to deliver a project inevitably reduces the resources required while improving outcomes. DfMA can be applied to one-off small-scale projects where appropriate, as well as to large-scale projects and frameworks.

Project 13

16. The current business model for construction is not fit for purpose. Poor productivity and adversarial practices lead to poor outcomes for clients and infrastructure users, while the conventional approach to risk and margins often forces clients to pursue the cheapest offer.
17. The Infrastructure Client Group's Project 13, that ICE has been supporting, is an industry wide change programme to move the industry from a transactional business model to an enterprise model, and could play a part in enabling greater use of off-site manufacture and enhanced productivity.⁹
18. The main differences between the new enterprise model and traditional construction are:
 - Reward/profit in the enterprise is based on value added to the overall outcomes, not time spent, with longer relationships between asset owners and suppliers. The relationships

⁹ Infrastructure Client Group, [Project 13](#)

between organisations last over a longer time period, incentivising investment in skills and tailoring of supply chain business models. This, combined with portfolio level scope, will improve productivity through enabling commitment to delivery methods including DfMA and other types of off-site construction.

- There is greater understanding of cost drivers and risk across all organisations in the enterprise, with commercial incentives for collaboration to jointly mitigate risk, not transfer it.
- Establishing a high performing enterprise requires fundamentally different leadership, governance, behaviours and skills to succeed.
- By sharing risk and creating stable project structures, the perception of risk from innovation is reduced, as are traditional damaging adversarial business practises.

19. This change will be enabled by the industry working together to move forward. A sharing of information, case studies and best practice – building the evidence base for change – will help develop industry confidence. This combined expertise would allow development and deployment of DfMA, rather than creating competition across contracts.

20. Specifically, the Project 13 business model will support off-site manufacturing methods, including DfMA, in the following ways:

- **Providing sufficient scope for efficiency, productivity and innovation**, so that suppliers can invest in more productive methods of construction which will pay off across a larger programme.
- **Long-term relationships with closer collaboration**, allows suppliers and advisors to get to know their customer (the asset owner) better and adapt and develop appropriate methods and products for their needs.
- **Integration**, by bringing together advisors and different levels of suppliers jointly to work with the owner the combined expertise can be used to develop and deploy modern methods rather than introducing competition across contracts.
- **Earlier, strategic engagement of the supply chain**, allows better joint scoping of potential application of modern methods, therefore increasing the chance of successful and productive deployment.

Digital

21. ICE's State of the Nation: Digital Transformation report from 2017 highlighted that clients and industry need to become far more 'data-savvy', recognising not just the value of their current data assets, but the long-term benefits from better asset data through its whole lifetime.¹⁰ Standardised design and automation which can be used across a range of projects offers the prospect of considerable productivity gains. DfMA will demand better data, but industry and clients should recognise that better data is valuable in itself for predictive maintenance and better future decision

¹⁰ ICE, [State of the Nation 2017: Digital Transformation](#)

making. This will be a totally different approach for an industry which has historically tended to work from scratch on a project-by-project basis.

Skills and competence

22. In addition to change throughout businesses themselves, new competencies and managerial skills will have to be developed in individuals. Professionals involved in the industry, including civil engineers, will have to orchestrate a collaborative DfMA protocol and help to conceive products for a manufacturing process, as well as know how to integrate them into a design.
23. In addition to these digital skills, DfMA also requires design, logistics, leadership, management and assembly expertise. Managers will need to manage a greater number of variables and diverse teams, bringing together on- and off-site activities. It is entirely possible, going forward, that the industry develops new roles (for example, DfMA Manager or Coordinator) as it has in the case of BIM (Information Manager, BIM Manager etc.)
24. Project team members will also need to deepen their logistics competencies, and there will be a need for leaders and managers to develop softer collaborative skills such as problem solving, team working and communication alongside their technical competencies. This suggests that behavioural development is as important as skills development for education and training providers.
25. A DfMA programme provides a solid base for Further and Higher Education providers to respond to this demand, ensuring that the requisite skills can be developed, but they need to be engaged early in the process to deliver the best outcomes.

Q3: *How should government engage with industry to make sure this approach succeeds?*

26. Lessons can be learned from the Infrastructure Client Group's Project 13 approach, the benefits of which are outlined in paragraph 20. This would support long-term relationships and closer collaboration, allowing suppliers and advisors to better know their customers and adapt and develop appropriate methods and products for their needs. Engaging the supply chain earlier and more strategically will also allow better scoping of the potential application of those methods, increasing the chance of successful and productive deployment.
27. DfMA in construction is not a brand new concept. Government should recognise that there is significant good work already being done where lessons can be shared to help enable a successful and sustainable shift to a P-DfMA approach.
28. As outlined later in Question 5 regarding risks, an initial pilot approach with industry, for example via departmental trailblazers, is needed to help build capacity and develop resilience to enable a wider move towards the P-DfMA approach.

29. There should also be a visible pipeline of work and/or routemap available under the P-DfMA approach to enable the supply chain to grow capacity and invest appropriately.

Q4: How can the benefits of this approach best be measured?

30. There is a need for common, consistent metrics to be utilised across P-DfMA to better enable improvements as the system develops. We would also encourage reporting on the use of the P-DfMA system, published by relevant departments and collated by the IPA at regular intervals.
31. It is also important to have a strategy for benchmarking platform-based approaches against traditional construction across the whole-life performance of an asset.
32. As outlined earlier, there needs to be a recognition across government that a P-DfMA approach will not be at its most refined immediately. In order to achieve the best whole-life value, the approach will require time, investment, resource and collaboration. For this reason, metrics should be weighted towards whole-life value, as opposed to cost.
33. Another benefit that a P-DfMA approach can deliver is greater certainty of cost to a client. Recent examples of cost overruns on major infrastructure projects and a general trend in the industry for gaps between quoted prices and actual cost have highlighted this as an issue. Off-site construction is more predictable in terms of cost, time and quality than traditional delivery methods, and is simpler to compare to other projects in terms of benchmarking. ICE is exploring this issue further and will consider the P-DfMA approach in its research.

Q5: What risks and costs (including hidden and associated costs) would this approach create for your organisation or sector?

34. Clients and constructors typically look to manage risk on the largest projects by contracting with suppliers who have the capacity and balance sheet to give confidence that they will be able to deliver the contract. As an emerging industry, there are still too few DfMA suppliers able to operate at scale.
35. Capacity and resilience must therefore be built up over time. At present, the supply chain – both in terms of equipment and people – is not large or flexible enough to cope and DfMA solutions are likely to be poorly implemented. Therefore, a departmental pilot or trailblazer approach should be implemented in order to build capacity first.
36. DfMA requires engagement throughout the entire supply chain. This is a potentially enormous undertaking, however, a number of clients and contractors, such as United Utilities and Laing O'Rourke, have already embraced DfMA – there are lessons here that can be shared with the wider industry.

37. However, there are inconsistencies in this approach. For example, while precast concrete components and steel beams are typically already in production in various DfMA systems, there is a need for greater engagement with more specialised contractors and others who need to ensure their own components, equipment and technology fit both literally and figuratively into a whole-systems approach. Consideration must also be given to the operation, maintenance and potential replaceability of components once in place.
38. There is also a risk that not all organisations will be open to working collaboratively. For this reason, the government's ambitions should be enforced through a mandate, similar to the BIM Level 2 mandate in 2016, implemented across relevant projects and programmes that are defined by a set of guiding principles. Indeed, lessons can be learned from the BIM Level 2 mandate implementation in order to deliver the most suitable outcome and ensure the industry is ready for change.¹¹ This can take the form of a concept being developed, trailblazers being run to demonstrate benefits and identify efficiencies, a rollout of the approach to early adopters, followed by wider adoption and the concept ultimately becoming business as usual. The mandate should provide a clear date and routemap for when the P-DfMA approach will come into effect. The mandate approach also does not require primary legislation; instead the requirement can be enforced through a general policy direction set by the Treasury or Cabinet Office for relevant departments to implement.
39. The guiding principles should ensure DfMA is not the default on every project or programme, only those where it is highly applicable and relevant, and there is an inherent need for flexibility as the technology develops. This means that alternatives to DfMA, which in some cases may provide better value, are not always excluded at tender stage.
40. A study in the ICE journal *Management, Procurement and Law* on the application of DfMA in the water sector found that there is a need for better DfMA-focused risk management. Existing risk assessments often focus on design and construction and give little thought to long-term asset operation. The study presented a new risk assessment matrix to help evaluate product suitability on specific projects (figures 9 and 10 in the study referenced).¹²
41. Current forms of contract can also be a barrier and create risks – if a DfMA supplier is paid only when works are complete, for example, this can create financial problems for smaller manufacturers in the supply chain. New or amended forms of contracts should be created that recognise the shifting delivery model a DfMA approach would bring.

Q6: *How can this approach best be used to support the economy on a local and a national level?*

¹¹ [Creating a Digital Built Britain](#), Innovate UK & IPA (2017)

¹² Trinder L (2018) [Design for manufacture and assembly: its benefits and risks in the UK water industry](#), *Proceedings of the Institution of Civil Engineers – Management, Procurement and Law*, 171(4): 152–163

42. The productivity benefits of a DfMA approach are well known, with numerous examples of resource, time, quality, safety and sustainability improvements where it has been applied.^{13 14 15} By combining labour and capital more efficiently and at scale, productivity and economic growth, both national and local, can improve and well-paid, highly skilled jobs be created. If the UK is seen as a world leader in DfMA and associated services, there will also be opportunities to export this expertise abroad and further benefit the national economy.
43. The Government's own Construction Sector Deal already outlines that the adoption of digital and a move to off-site manufacturing will strengthen local supply chains and local economics across the UK.¹⁶ Typically, a high proportion of spend is retained within the region where construction and infrastructure work is undertaken. This means that improvements to the performance and profitability of the supply chain can be expected to directly benefit the local economies in which these businesses operate.

Q7: How would current contracting models and building requirements need to change, in order to best facilitate procurement from a product platform?

44. Our position on this has been primarily covered in questions 1 and 2, with regards to the type of procurement approach needed to proliferate the use of DfMA – including as a product platform – and how business and delivery models must change to accommodate a P-DfMA approach. This is repeated in summary below.
45. In order to accelerate the uptake of DfMA, government should drive change through a combination of support for supply chain development through the Transforming Construction strand of the Industrial Strategy Challenge Fund as well as a visible pipeline of work through the P-DfMA proposal to provide a degree of certainty.
46. The traditional construction delivery model sees flexibility during the build process to the point where items and components – and often more – are able to be changed or substituted while on-site. DfMA is completely different in this respect as the building/infrastructure must be assembled in the way it has been designed. This requires multiple aspects of a project to be considered, finalised and approved at an earlier stage, necessitating the need for a different delivery model and new skills to implement it. The project team must also fully understand and be attuned to the design programme and milestones to ensure successful delivery.
47. The current business model for construction is not fit for purpose. ICE and the Infrastructure Client Group's Project 13 is an industry wide change programme to change the business model seeking to

¹³ Laing O'Rourke & Buildoffsite, [Delivering infrastructure with certainty: DfMA case studies](#) (2018)

¹⁴ ICE, [DfMA and the A453 Road Widening project: A new approach to bridge construction](#) (2015)

¹⁵ Mott MacDonald, [DfMA - One of the keys to unlocking a more efficient industry](#) (2015)

¹⁶ BEIS, [Construction Sector Deal](#) (2018)

move the industry from a transactional model to an enterprise model, and could play a part in enabling greater use of off-site manufacture and enhanced productivity as set out previously.

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