How to win at digital construction using a design for manufacture and assemby (DfMA) approach

Digital construction and DfMA is a journey with Trimble and its expert team on-hand to support at every step.

This eBook is designed to

demonstrate how a DfMA approach will bring benefits to your business offering.

It sets out to:

- Demystify DfMA and demonstrate how DfMA and digital processes work together.
- Introduce the benefits and opportunity this can bring for the customer, through the design team, the supply chain and for the operators and maintenance team responsible for an asset.
- Prove how digital construction software is able to support businesses.
- Reveal the next steps for DfMA and its role in the bigger digital construction landscape.

Table of contents

“Hand on heart, the precast element of V&A Dundee could not have been done in 2D.”

Introduction

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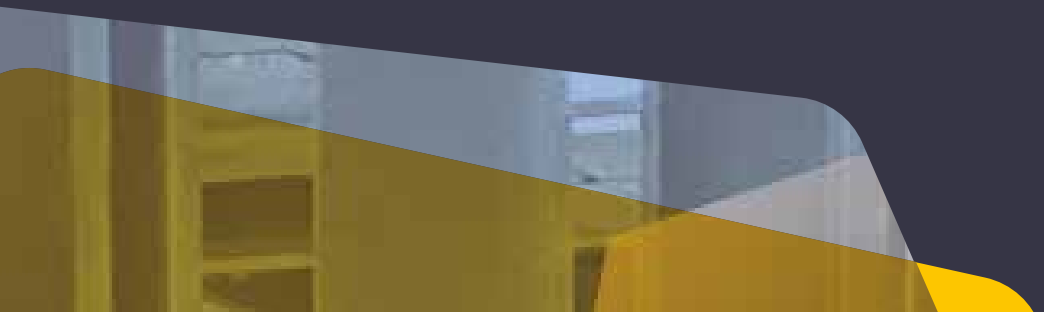
As a company that develops construction and structural engineering software, this is what we're increasingly hearing from the engineers, detailers, fabricators and construction contractors that incorporate Design for Manufacture and Assembly (DfMA) into their digital construction approach – offsite construction is just the start.



It's not simply about 3D models. It's about creating physical assets with a manufacturing mindset, one that takes into account the full lifecycle of processes from design to operations.

This brings much wider benefits for everyone in the construction process and beyond, especially the associated data that comes with it, opening up the opportunity to drive productivity growth, make capital cost and time-saving reductions and develop more modern methods of construction.

UK Government pushing offsite approach with a specific focus on DfMA

Whilst this approach isn't unusual to us at Trimble, our Tekla software has been supporting steel, concrete and engineering customers for many years now, it's one that is gaining momentum with the 2020 launch of several new government initiatives including:

The Construction Playbook
A methodology all government departments must follow to deliver on the ambition to procure for value.

Project Speed
To review every part of the infrastructure project life cycle and identify where improvements could be made.

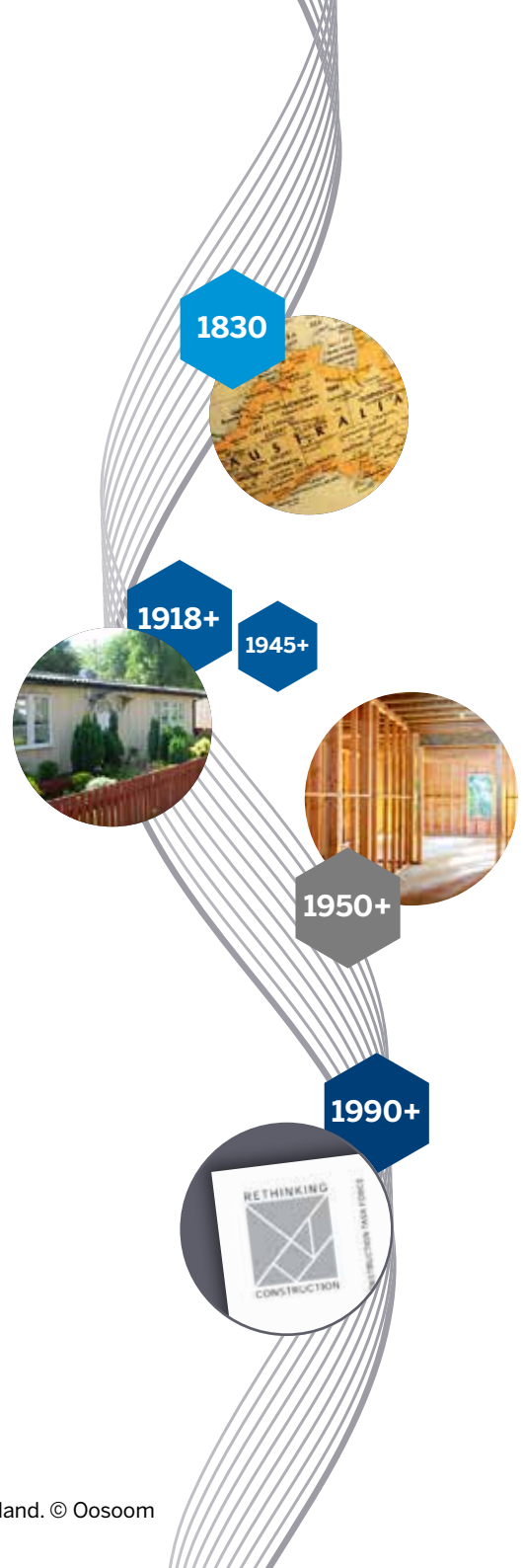
How does a DfMA approach compare with traditional construction?

Traditional construction	Manufacture-led approach (DfMA)
Door leaf, frame and ironmongery installed on site from up to 3 suppliers	Door set complete with ironmongery provided by one supplier
Brickwork laid to the external elevation of a building	Precast concrete panels with brick slips craned into position
6 plus trades construct a hotel bathroom by bringing plant, labour and materials to site	Pre-finished bathroom pod installed on site, service connections via ‘plug and play’ fittings
Traditional classroom constructed over several weeks or months	Complete turn-key classroom delivered and craned onto pre-prepared foundations

Offsite is gaining momentum: The history of offsite and DfMA

If you wander along the path of construction history, it is fast apparent that offsite building is nothing new. In fact, this method of building residential, commercial and retail developments has been around for quite some time.

Follow the timeline to see how modular or pre panelised construction has evolved into digital construction today – it's gaining real momentum.



1830 - First documented prefabricated house
British carpenter John Manning constructed a house to be shipped to Australia for his son.

Post World War I (1918+) and World War II (1945+) *
The start of steel-framed housing, precast concrete, timber and sometimes cast iron building methods.

1950+ The Fifties and Sixties
Enter industrialised building.

1990+ The Nineties
Launch of 'The Movement for Innovation'. Published in 1998, The Egan Report was the first official paper to highlight offsite construction's potential to modernise the British construction industry.

*Wake Green Road, Birmingham, England. © Oosoom Creative Commons.

2005 - National Audit Office
Using modern methods of construction to build homes more quickly and efficiently.

2006 - Barker 33 Cross-Industry Group
Modern Methods of Construction.

2013 - HM Government
Industrial Strategy: government and industry in partnership – Construction 2025.

2016 - Infrastructure and Projects Authority
Government Construction Strategy 2016-20.

2016 - KPMG
Smart Construction.

2016 - Modernise or Die
The Farmer Review of the UK Construction Labour Model.

2016 - RIBA
Plan of Work DfMA Overlay 2013.

2017 - Bryden Wood / Construction Innovation Hub
Delivery Platforms for Government Assets Creating a marketplace for manufactured spaces.

2017 - Bryden Wood / Centre for Digital Built Britain
Data Driven Infrastructure.

2017 - November Budget
'Presumption in favour of offsite'.

2017 - Industrial Strategy
Building a Britain fit for the future

2017 - Industrial Strategy
Construction sector deal.

2017 - Infrastructure and Projects Authority
Transforming infrastructure performance.

2018 - Bryden Wood / Construction Innovation Hub
Platforms - Bridging the gap between construction and manufacturing.

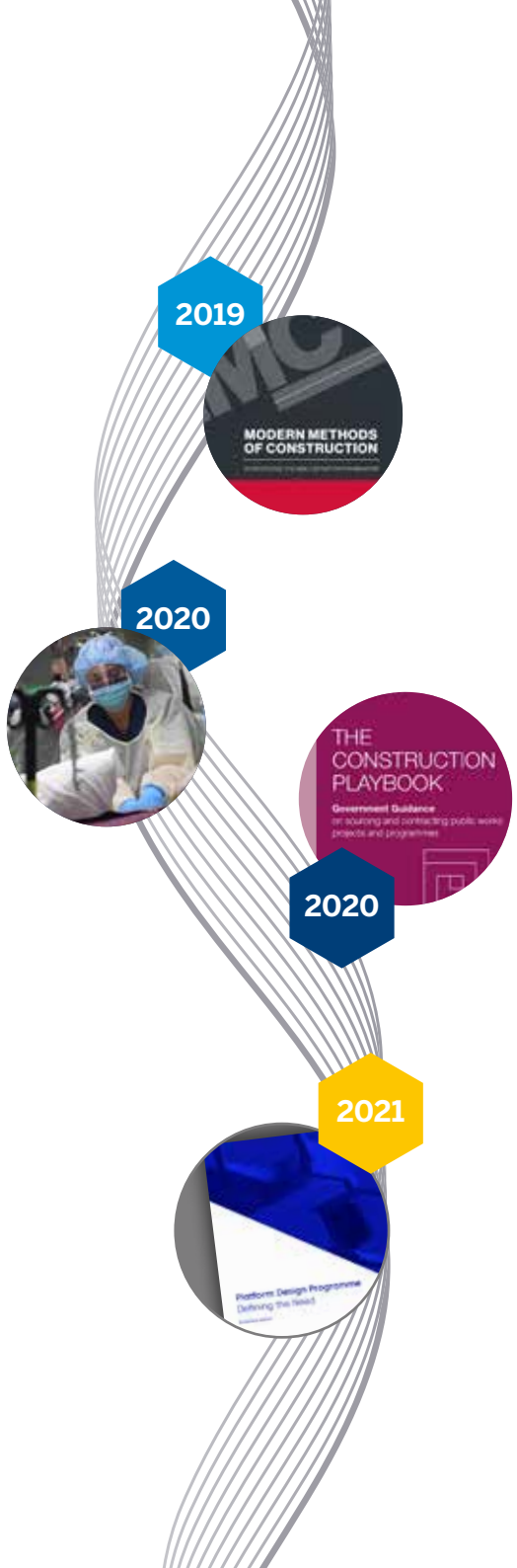
2019 - MHCLG MMC cross industry working group
Modern Methods of Construction, Introducing the MMC Definition.

2020 - Coronavirus pandemic
Delivers NHS Nightingale Hospitals and more.

Jun 2020 - 'Project Speed'
With offsite construction the focus, UK Prime Minister Boris Johnson announces this government initiative.

Dec 2020 - 'Construction Playbook'
Sets out how the Government will work with the construction sector to ensure public sector works are delivered faster, better and greener.

2021 - 'Defining the Need'
The Construction Innovation Hub published its findings in its 'Platform Design Programme: Defining the Need' in 2021.



Today, the benefits of modular construction are evidenced by an array of stylish and sophisticated building projects in countless city skylines. From London to New York, increasing numbers of cutting edge architects are shaping skylines with broad sets of modular approaches from single discipline individual panels to fully serviced and finished houses.

02

Talking the same language

Navigating the world of digital construction can be challenging. There is a lot of confusing, and sometimes interchangeable jargon and acronyms to get to grips with, but the sector is evolving and standardisation is happening.

Here are some key definitions to differentiate the subtleties of the terms used, what DfMA is and how it fits in to the digital construction workflow:

Key definitions

What is Offsite Construction (OSC)?

Offsite construction is the planning, design, fabrication and pre-assembly (wholly or partially) of building elements away from the building site. The completed item is then transported to site and assembled in place, ensuring rapid and efficient construction.

Offsite locations may be permanent manufacturing facilities, or ‘flying factories’ - a factory or a specially created temporary production facility close to the construction site that operates for the duration of a project and then ‘flies’ to a new location to service another project.

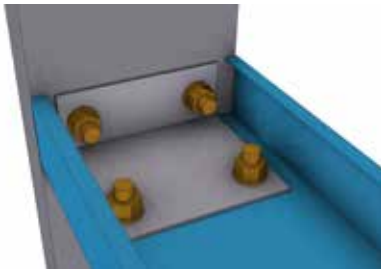
What is Modular Construction?

A process in which a building is constructed offsite in the form of 'modules' or 'pods', with as many external and internal finishes as possible, before being delivered to site and put together.

Large modules used in volumetric construction include units such as hotel rooms, which can be wholly constructed in the factory to form the structure of the building as well as enclosing useable space. Units are fully furnished internally in the factory, including many aspects of finishes, furnishings and equipment. Increasingly, external cladding, particularly glazing systems, is also installed in the factory, although in some instances finishes, such as brickwork, are applied on site.

What is Design for Manufacture and Assembly (DfMA)?

Design for Manufacture and Assembly (DfMA) is a design approach that focuses on ease of manufacture and efficiency of assembly. By simplifying the design of a product, it is possible to manufacture and assemble it more efficiently, in the minimum time and at a lower cost. [1]



Cleated design consisting of three parts and four bolts.

Simplified design consisting of two parts and two bolts.

[1] https://www.designingbuildings.co.uk/wiki/Design_for_Manufacture_and_Assembly_(DfMA)

What's the difference between Offsite and DfMA?

– it's all in the A for Assembly!

Businesses use the term DfMA as interchangeable with offsite, but it is not. DfMA isn't the same as offsite construction, or even offsite manufacturing.

In its crudest form a block is an offsite product, but laid by traditional means on site, so it is not DfMA. For it to be, then the block must be incorporated into a precast concrete panel, cast offsite in a factory environment to engineered tolerances and then erected on site, bolted into place to fit first time to those same tolerances to form the envelope of a structure. Something that is DfMA is definitely offsite, but this does not necessarily work the other way round.

It takes the process further: from construction to assembly. Assembly is an engineered manufacturing process that includes:

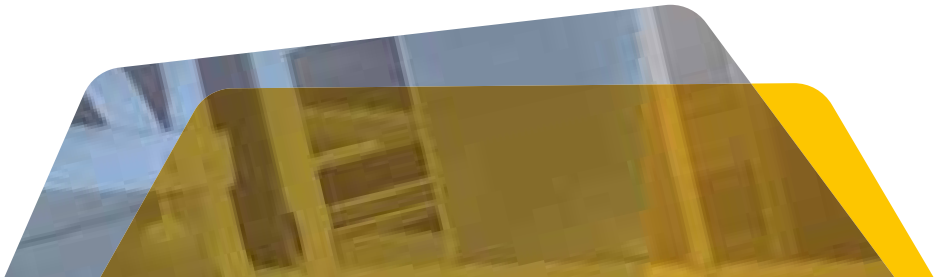
- Correct first time products and components
- Accurate manufacturing and assembly tolerances

Add Design to the Assembly process and it becomes patently clear why Building Information Modelling (BIM), a subset of the wider aims of digital construction, and DfMA are such ideal partners. Design, an inherently virtual process, can be carried out digitally to ensure that the component, module, asset are defined and detailed in accordance with the customer requirements, tested for manufacture, coordinated for assembly and approved, virtually, by all the necessary stakeholders first. These are all basically BIM processes too - virtual design, stakeholder engagement, agreed product data, clash management, construction rehearsals and the issue of appropriate operational data.

But what are the benefits of DfMA?

This quick overview provides an idea of just how DfMA can benefit everyone involved in the construction process:

- 20%–60% reduction in construction programme time
- Greater programme certainty
- 20%–40% reduction in construction costs
- 70%+ reduction in onsite labour, with subsequent improvements in health and safety
- Focusing skills where they are needed
- Better construction quality
- Better environmental outcomes, including reduced waste
- Fewer queries from site



How aware of these terms and their benefits is the construction industry?

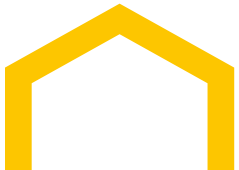
The structural disciplines within the construction sector in which Trimble operates have been able to use a DfMA approach for many years now, benefitting from the constructible design and analysis models they can create using Tekla software and the ability to then export the data to automated manufacturing machinery. Today these companies are advancing further, with their use of new, innovative technology, such as robotic welding and assembly, materials information systems and mixed reality solutions.

The industry as a whole has been slower in its uptake but it's changing. Construction is modernising and Tier 1 contractors are embedding digital construction and DfMA into the way they work.

The reality is DfMA and its use in offsite construction is also adopted at very different levels. In more advanced sectors such as hotels, fast food retail and healthcare, where modules and pods are manufactured offsite to a consistent quality and assembled rapidly on site - it's almost a case of 'plug and play'. We've all seen those McDonald's outlets appear in just days.

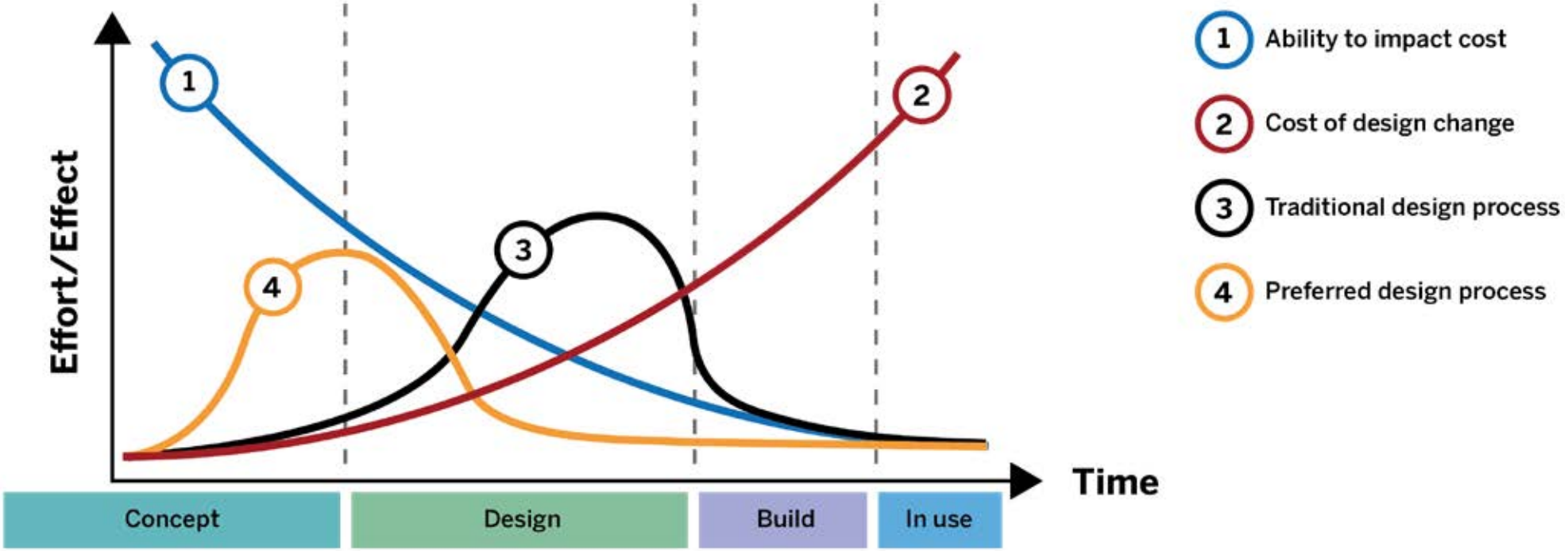
At the other end of the spectrum, there are plenty of construction projects that are more than missing a trick when it comes to recognising the benefits of DfMA.

Clients and their consultants too often fail to present a well-considered design before moving to procurement. This means the benefits of DfMA are lost in a constantly evolving and changing design development process as on-site works progress.



Think the MacLeamy curve.

This diagram shows how frontloading the design effort can keep cost down. The more developed an architectural project becomes, the more difficult it becomes to change.



So why is this still happening?

Clients are advised badly by their design teams - often because the designers don't understand DfMA or see it as limiting creativity – this is an out-of-date belief – we've moved away from post war prefabricated housing.

Embracing a DfMA approach will be a challenge for architects and engineers who don't have manufacturing expertise, yet critical to the success and longevity of the industry going forward. This is by no means unachievable though.

For businesses looking to develop this approach, it's an opportunity to attract young talent. Once the preferred software route is established, the younger digital savvy employees can work alongside more experienced engineering and construction team specialists to knowledge share – a great way to unlock the power of DfMA and develop a business' digital construction culture.

Let's talk more about Design for Manufacture and Assembly (DfMA), and how it can enhance construction outcomes.

Trimble takeaways

1. BIM and DfMA are ideally suited because both focus on early design engagement.
2. Early design engagement and delivery reduces cost and waste.
3. DfMA does not stifle design creativity.

How to incorporate DfMA onto your construction project

03

Here, we explain the principles and stages of DfMA and how you can benefit from taking this approach.

DfMA Principles

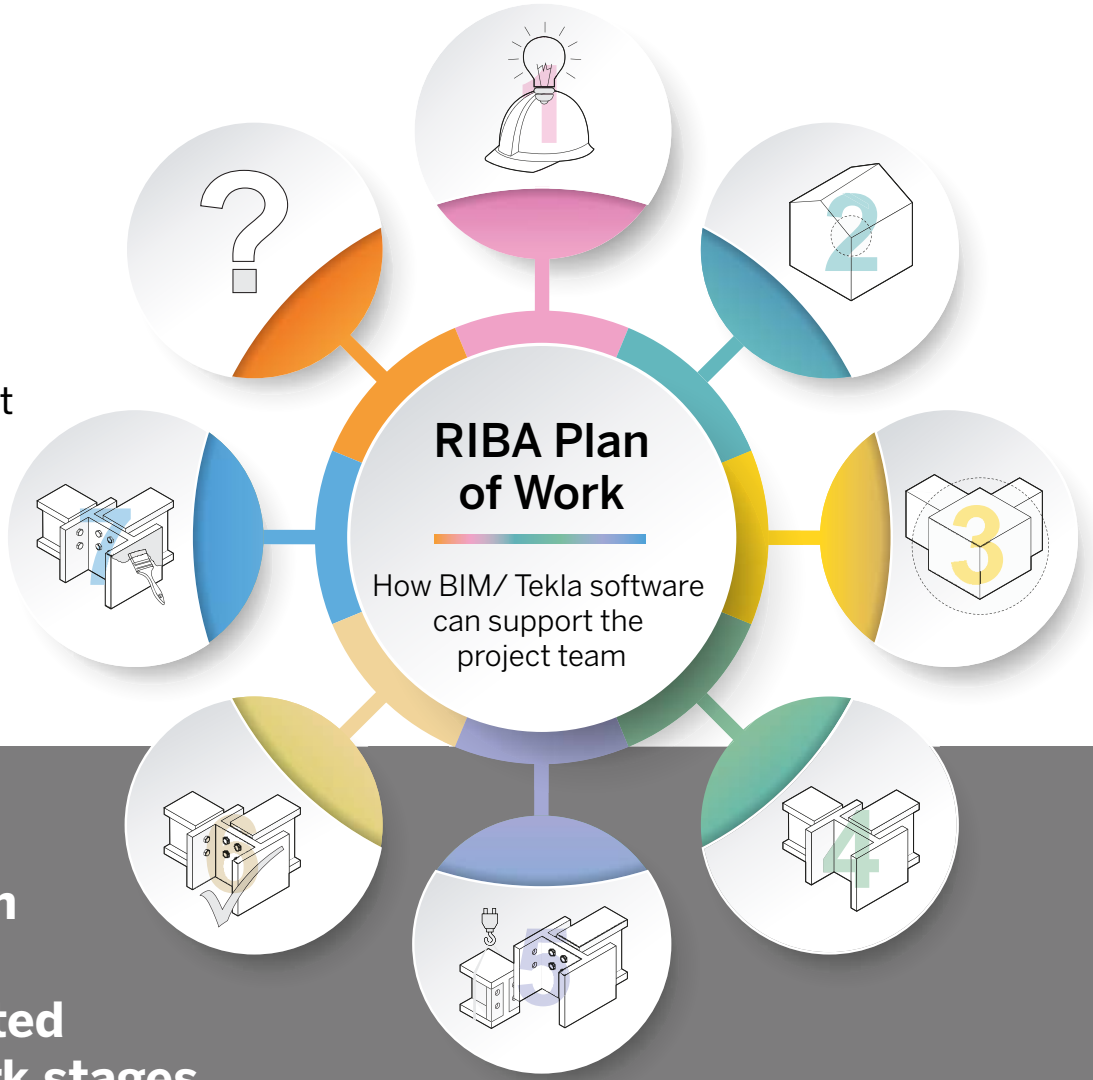
As the Designing Buildings WiKi explains, in a similar approach to lean construction, applying DfMA enables the identification, quantification and elimination of waste or inefficiency in product manufacture and assembly. It can also be used as a benchmarking tool to study the products of competitors.

To demonstrate how these principles of DfMA might work on a construction project, we've applied a real-life example and explained how BIM software, like Tekla, can assist a project team.

DfMA principle	Real-life example	Example of how Tekla software can support the project team
Minimise the number of components	When crane lifting capacities are the only limiting factor, larger and more complex parts can be manufactured in the factory removing the need for complex component assembly on site.	Use Tekla Structures to provide the centre of gravity to complex assemblies giving confidence to installation teams.
Design for ease of part-fabrication	Simplifying precast concrete elements helps with de-moulding after casting. Similarly, steel connections can be designed to ensure that fixing tools can be utilised.	Tekla Structures allows structural frames to be split down into the necessary components for ease of fabrication.
Tolerances of parts	Code compliant design ensures that tolerances are adequately considered in the design of components. Closer tolerance manufacturing in a factory environment eliminates waste too.	Detail fully constructible models with millimetre accuracy in Tekla Structures, ensuring components fit together when assembled on site.
Clarity	Asymmetric fixing arrangements ensure that components can only be installed in one way to avoid costly errors.	Components with designed-in lifting points ensure that they are lifted into place the right way up.
Design for ease of assembly	Light steel framing can be detailed with crimped ends and rivet fittings to avoid the need for threaded fasteners on site. Health, safety and environmental improvements too.	A Tekla Structures model, transferred to Trimble Connect can then be used to build up a sequence of views to show the correct assembly sequence.
Eliminate or reduce required adjustments	Factory-manufactured offsite components can be produced to closer tolerances removing the need for flexible components or shims.	The Tekla Structures model data can be transferred to fabrication machinery, ensuring the model accuracy is not lost when the information transfers to the production line.
Better whole life performance	The ability to deliver the full technical design improves the quality of the product. Level of Information Need can be delivered that offers clear maintenance information where needed.	A fully constructible Tekla model-based data set allows whole life value to be considered based upon full details of the design and fabrication.

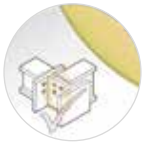
How does DfMA mirror recognised ways of working?

To see how DfMA slots into the whole construction process, it's worth taking a look at the RIBA Plan of Work 2013 Designing for Manufacture and Assembly, published in September 2016 by RIBA in conjunction with the Offsite Management School. The document set out to encourage architects (and the wider industry) to engage with offsite manufacturing and assembly. By providing this 'DfMA Overlay' to the Plan of Work 2013, the industry has been given a great resource that shows how digital processes and offsite manufacturing can and should be linked together.



For the purposes of this eBook and to make it relevant to the sectors in which Trimble operates, below is a table to demonstrate how BIM and the associated software support the RIBA Plan of Work stages.

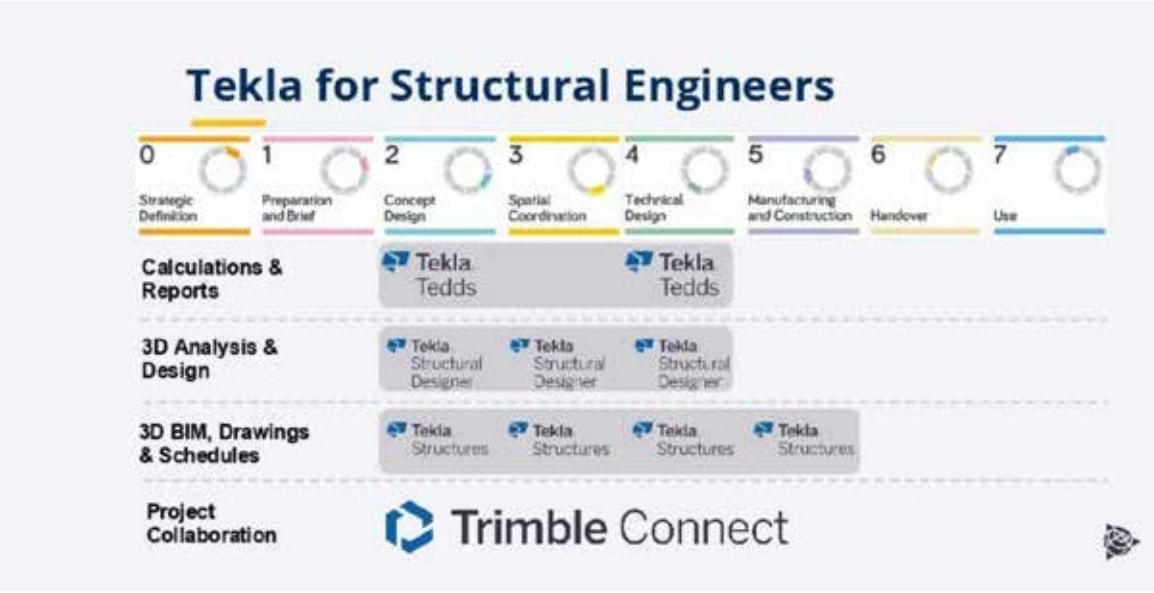
PoW Stage	How BIM/ Tekla software can support the project team
0. Strategic Definition 1. Preparation and Briefing	 Use Trimble Connect to host all the data needed to develop the **Business Case** and **Strategic Brief** – reports, documents, 2D data, 3D models and point clouds. Models can be federated and access rights established.
2. Concept Design	 Modelling in Tekla Structures – provides appropriate Level of Information Need as required by the design team to ensure the design starts with DfMA tolerances. The model can be completed using any materials so changes can be accommodated easily without the need to switch modelling platforms.
3. Spatial Coordination	 With materials defined, the Tekla Structures model can be developed further to the appropriate Level of Information Need and the outputs shared via Trimble Connect. Reference models from all disciplines can be imported into Tekla Structures for a coordinated design. Accurate quantities can be exported to support the development of cost information for the project.
4. Technical Design	 Unlike other software packages, Tekla Structures can develop details seamlessly to create that "as will be built" design. Open BIM capabilities allow for the continued use of other discipline models to be coordinated. Multiple 3D models and 2D drawings can be federated in Trimble Connect to provide insights before manufacture commences; clash resolution processes to be conducted.

PoW Stage	How BIM/ Tekla software can support the project team
5. Manufacturing and Construction	 Tekla Structures models can be exported to all major manufacturing formats to allow for fabrication and manufacture directly from the model. Crane lifting plans can be developed and rehearsed in Tekla Structures. On site Trimble Connect can be used to check up-to-date information in real time, sequencing of the works checked and progress monitored and recorded.
6. Handover	 Appropriate handover information can be shared via Trimble Connect to allow for the accurate maintenance of the asset in Stage 7.
7. Use	 The data set, hosted in Trimble Connect, can be added to over the life of the asset - thus preserving the data for the lifetime of the asset.

Unfortunately, DfMA isn't always adopted because it's not considered at the right time. Looking at the RIBA DfMA overlay to its Plan of Work, it is at Stage 2 that a project should align itself to DfMA. This avoids the traditional contracting mind-set of 'appoint late, buy even later'. A behavioural and cultural change that involves a more collaborative process will ensure DfMA outcomes in construction are successful.

Adopting BIM first gives individual parties and the wider team a perfect opportunity to roll out DfMA as one of the BIM processes on a scheme.

Structural steel fabricators, precast concrete manufacturers, modular offsite manufacturers already work this way and try to drive adoption, but those organisations responsible for going down the DfMA route – designers, customers, end-users and principle contractors – can be reluctant at best.



Trimble takeaways

1. DfMA fits within the recognised RIBA workflow framework.

2. The decision to go down the DfMA route needs to be made early in the design process.

3. At each stage of the process, BIM tools such as Trimble Connect and Tekla Structures improve design and communication - unlocking a wide range of benefits associated with the manufacture and assembly of products .

Case studies: DfMA in action in the construction sector

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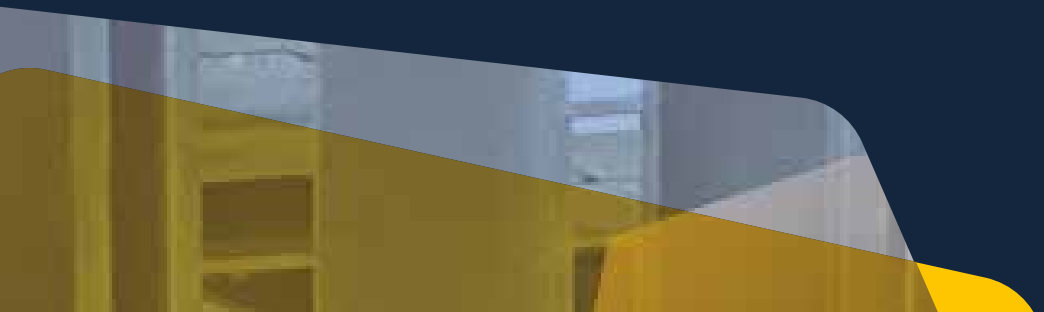
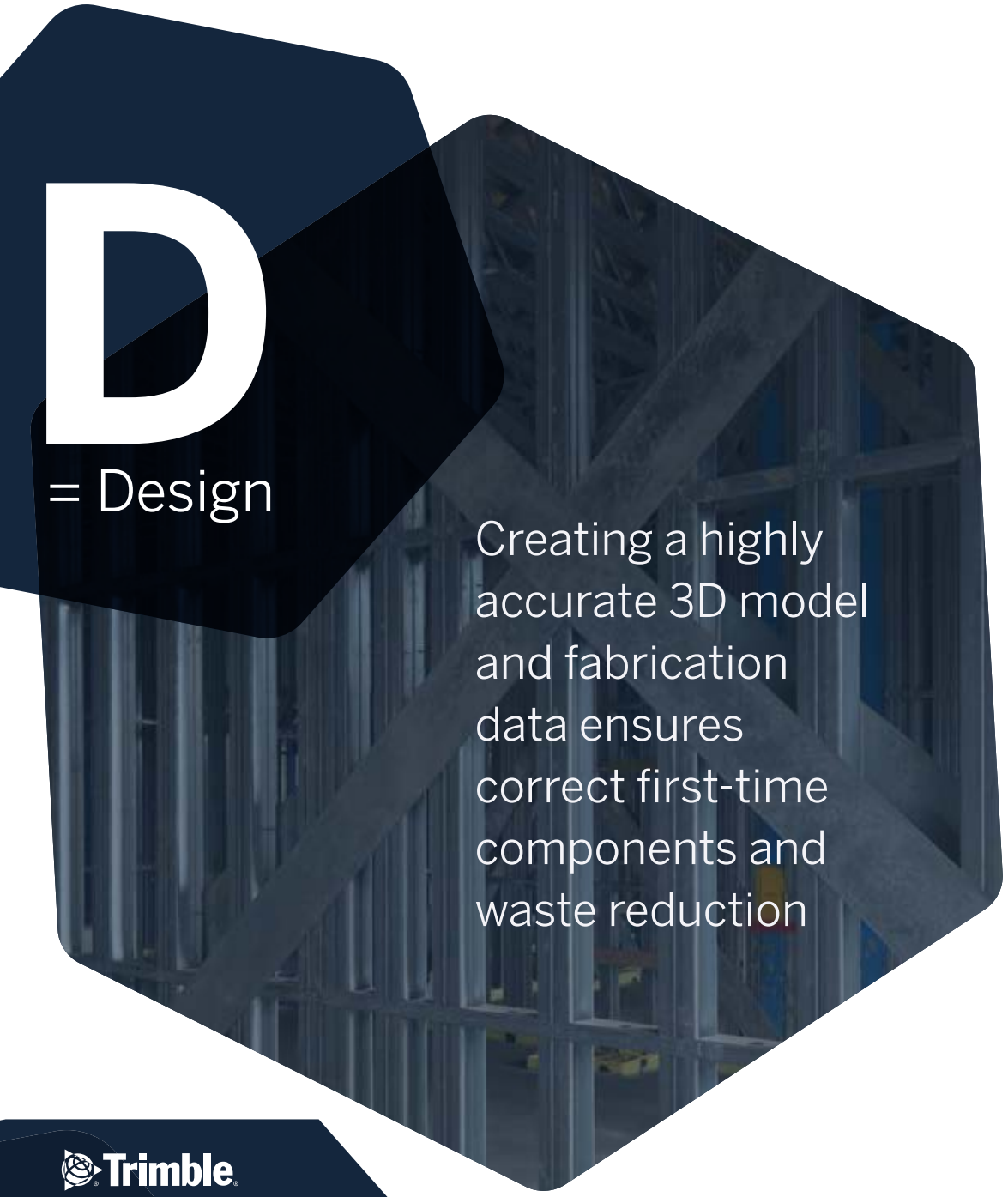
There are certain sectors of construction that are advanced in DfMA including timber, decking and curtain walling as well as of course the sectors Tekla clients operate in - structural steel, concrete and rebar.



Inherently designed and developed for manufacturing, Tekla software is especially suitable for offsite products and projects. Taking each element of the DfMA process, here are some of the successful ways Tekla software has supported clients.



Materials like steel, used for light steel framing - a growth area in volumetric and panelised offsite - and concrete, both require highly accurate model and fabrication data. If this is not available the speed, quality and efficiency benefits of offsite methods are lost.

The use of intelligent, information-rich 3D digital construction software and its associated clash checker facilities within the process, allow design issues to be solved upfront in a digital environment as opposed to on site.

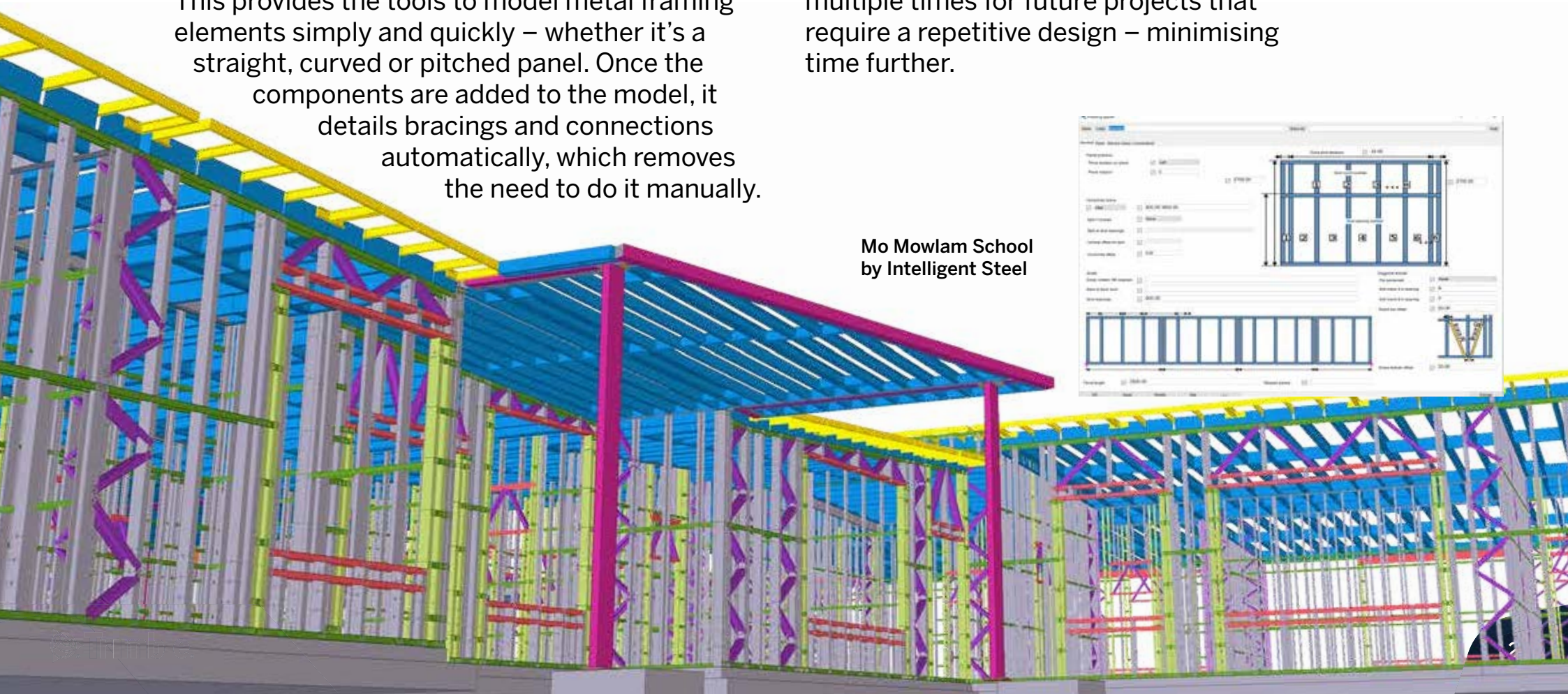
For example, tolerances on modular projects tend to be quite tight and clashes with welds and natural tolerances in section sizes constantly need to be checked. Openings for windows and doors often present issues too, as they typically require special construction details, additional strengthening, jambs and headers, all of which impact the form of the modular panels.

The ability to detail to the highest Level of Definition (LOD) means design challenges can be diminished or even mitigated.

Modular builds are inherently based around repetition, which can increase the amount of time spent in the drawing office – especially when being designed in 2D. One way the Tekla team has assisted with light metal framing panel detailing is its series of light metal framing components that are available in the Tekla Warehouse library. This provides the tools to model metal framing elements simply and quickly – whether it's a straight, curved or pitched panel. Once the components are added to the model, it details bracings and connections automatically, which removes the need to do it manually.

If a window or doorframe is added to the panel, the software also automatically strengthens the opening too.

In addition, once the panels have been designed, they can be stored within the software in order to reproduce them multiple times for future projects that require a repetitive design – minimising time further.



Mo Mowlam School by Intelligent Steel

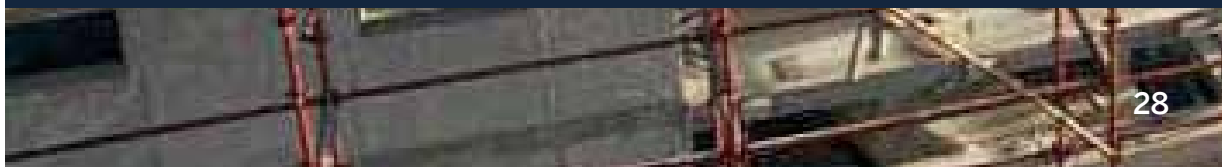
Reduced programme from 20 to 16 weeks and design errors by 80%

O'Reilly Concrete

"Tekla Structures is a very clever piece of software, as you can view the future development in a 3D model and identify and correct all design clashes. It also finds potential sections where the design could be improved, which is not possible in 2D, as well as helping to split a building into precast elements, create accurate drawings and help you to manage transport, the erection of the building and all of the design processes."

"In fact, we managed to reduce the programme of Adamstown from 20 weeks to 16 weeks and reduced design errors by 80 per cent. These savings were made mainly in the design and detailing phase; if the 3D model was correct then the production drawings generated directly from the model, were accurate too. The 3D model also allowed for any late changes to be accommodated easily and update all of the drawings."

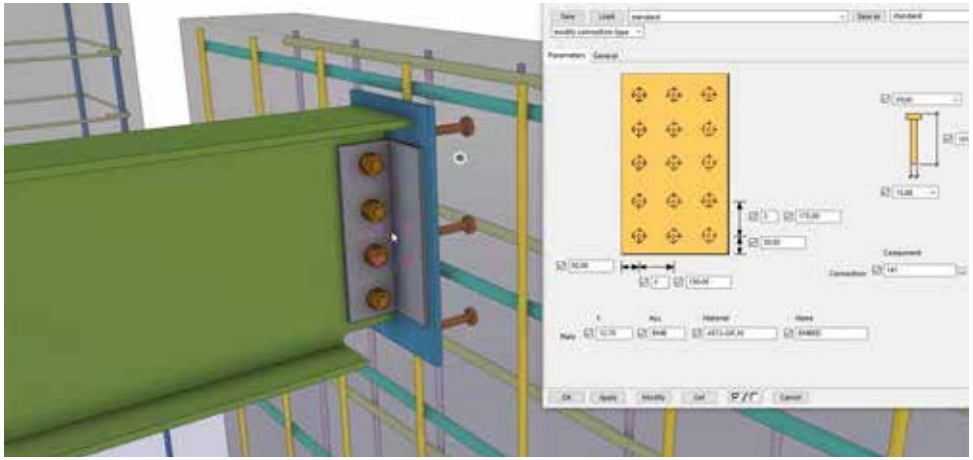
O'Reilly concrete has a long history of using Tekla Software, read their story: *O'Reilly - Saving time and money*



Collaboration and openBIM allow different disciplines to be considered as one

Collaboration with project members and third parties is easy. For instance, steel frames and panels can be fabricated with gaps for MEP fixtures and also link in to architectural, and plant design software through Industry Foundation Classes (IFC), enabling all disciplines to be considered as one – a principle that is key to the DfMA approach.

An architect is able to send their 3D model, even if it has not been designed using Tekla software, to the precaster, who will then be able to create a highly detailed Tekla Structures model with all the embeds and reinforcement. At the same time, the engineer can use the model to assess the structural characteristics of the proposed building, such as wind loading. As the design evolves, fabrication drawings are updated automatically.



Tekla client Intelligent Steel, sums up the use of multi-material digital construction software:

Intelligent Steel

“Tekla software is able to work with a variety of different building materials. For example, while modelling the light steel structure and its connections to the main building, our designers were also able to see the concrete podium level at its exact location in the same model. Working in 3D in this way is far more effective than the previous 2D drawings.”

Trimble takeaways

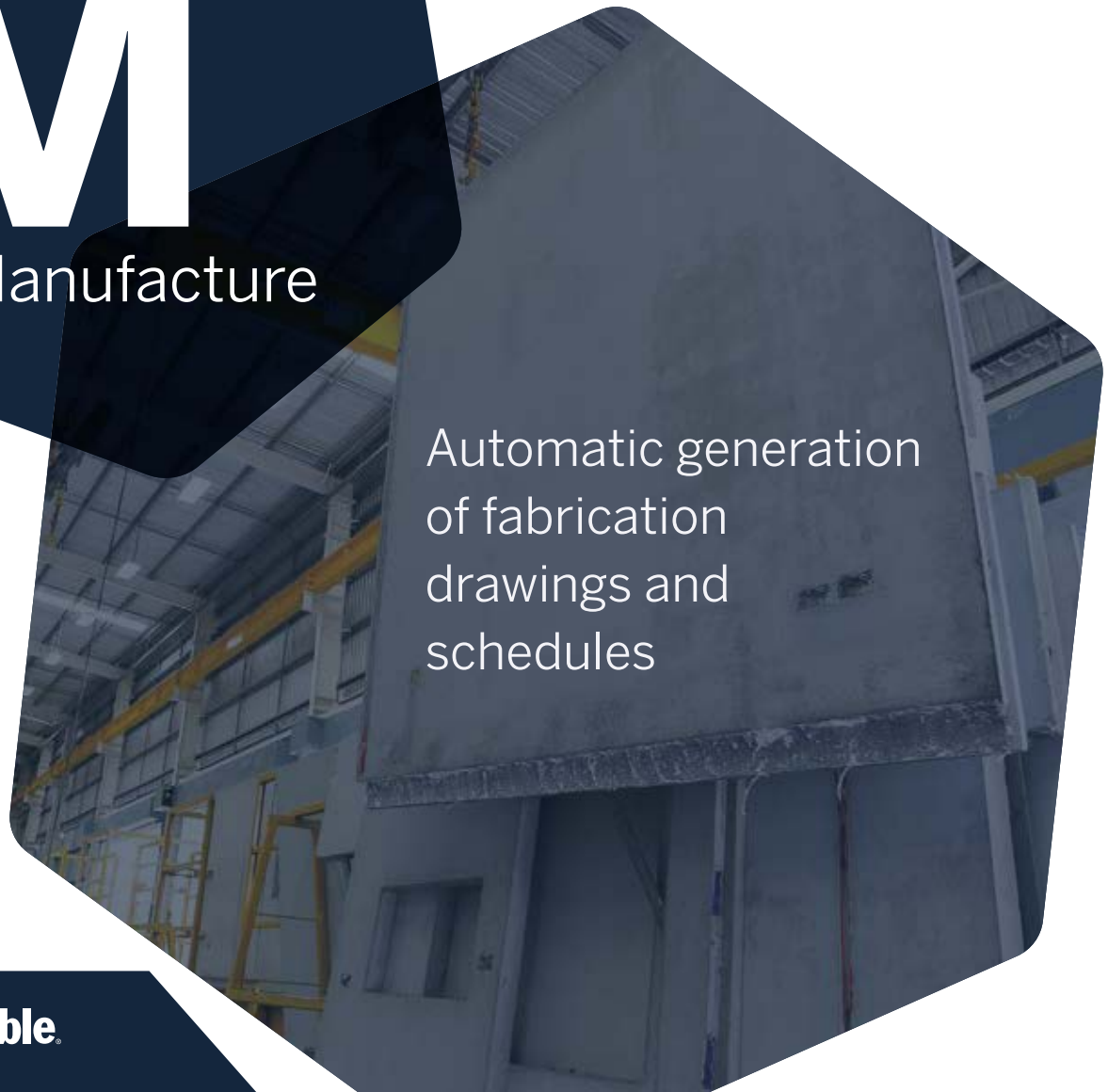
1. Tekla Structures enables 3D design of structures in both steel and concrete.

2. Development of the 3D model and elimination of clashes at design stage ensures high levels of accuracy and delivers significant time savings on site.

3. Sharing models between the design and manufacturing teams increases efficiency.

M

= Manufacture



Automatic generation of fabrication drawings and schedules

The DfMA process takes into account design, manufacture and assembly but how does this link into to the manufacture of offsite elements.

The integration of BIM and a fabrication management information system (MIS) provides intelligent and well-organised information for the entire workflow including real-time fabrication management, data for CNC processing, material handling and enables robotic assembly and welding.

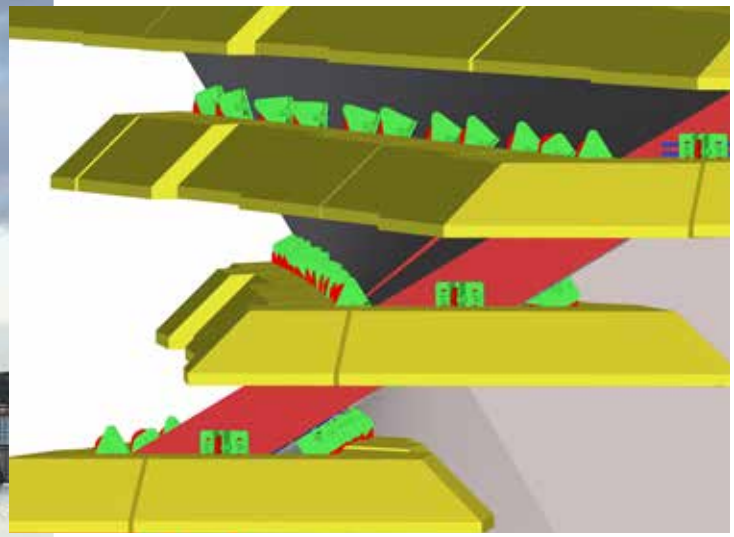
Techrete

With the V&A Dundee, where there are no straight external walls, the challenge of designing, manufacturing and installing the 2,400 precast concrete panels that bring this geometrically complex design to life was a challenge and as Techrete said:

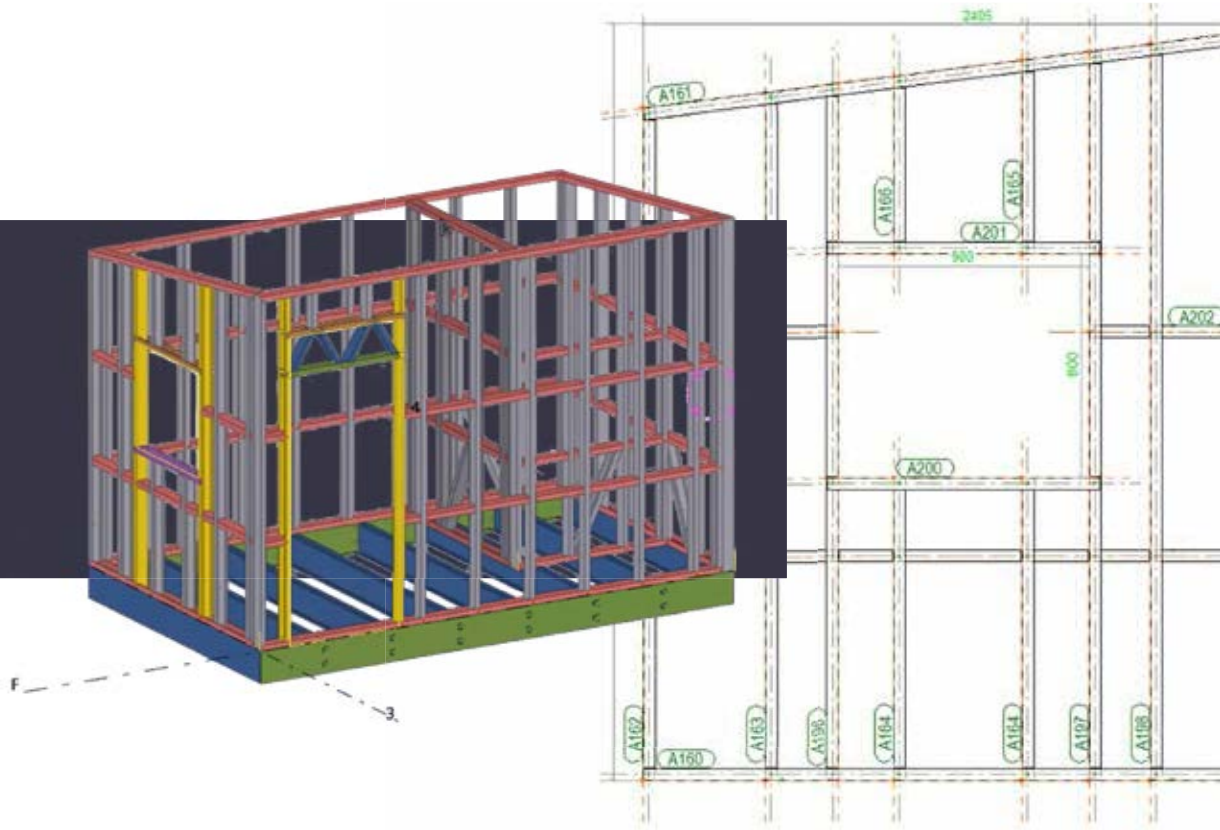
> "Hand on heart, the precast element of V&A Dundee could not have been done in 2D. Trimble's Tekla Structures is intelligent software that suits our manufacturing process."

©HuftonCrow

"It allows clash detection, gives weights and the centre of gravity of elements and, generates the fabrication drawings and rebar cutting schedules. This minimises errors, conflicting detailing documents and inefficient information transfer, which can waste material and resources and cause costly rework in the detailing department, factory and on site."



Increasing the speed, efficiency and accuracy of the project and fabrication process



Intelligent Steel

Simplifying is what DfMA is all about and with a tight time schedule and many site limitations, the scheme needed a building solution that would deliver pace and innovation for Intelligent Steel.

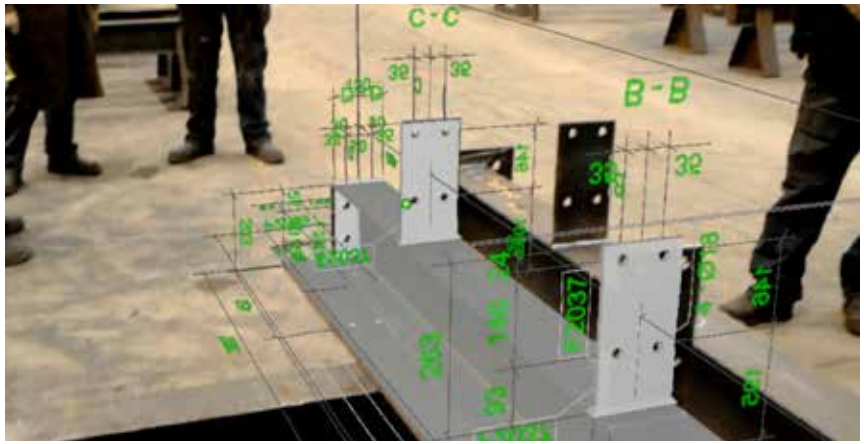
“We phased the different elements, such as the external and internal walls and floors, and then we lotted the delivery phases based on the schedule provided, all by using Tekla Structures. This allowed us to release design data into the fabrication process in line with the delivery programme.

“Furthermore, by using both Tekla Structures and the Howick extension, Intelligent Steel was able to export NC files directly from the model to the fabrication machines, increasing the speed, efficiency and accuracy of the project and fabrication process. The steel-framing machines were able to accurately place all punching and fixing holes, which not only allowed for the frames and trusses to be manufactured with extreme precision but also enabled the frame to be self-locating and jigging, reducing the build-time on site.”

DfMA also involves embracing new technology – in this instance improving manufacturing quality control

Wareing Buildings

Having digitised its workflow from design to on-site assembly, Wareing Building has invested in a Microsoft HoloLens for Trimble Connect for its fabrication shop, as a means of quality control: "We plan to use the HoloLens both in our fab shop as a means of quality control, enabling us to overlay the 3D model on the fabricated steel component to ensure it matches the original specification, and also on site, helping to solve potential design issues or clashes."



Trimble takeaways

1. A Tekla Structures model contains all the data required for manufacture.

2. Drawings can be produced from the model or Tekla Structures can link directly to manufacturing machinery or robots.

3. Tekla Structures can be used for phasing and lotting of work and deliveries.

A

= Assembly

Improving speed on-site and minimising disruption during installation

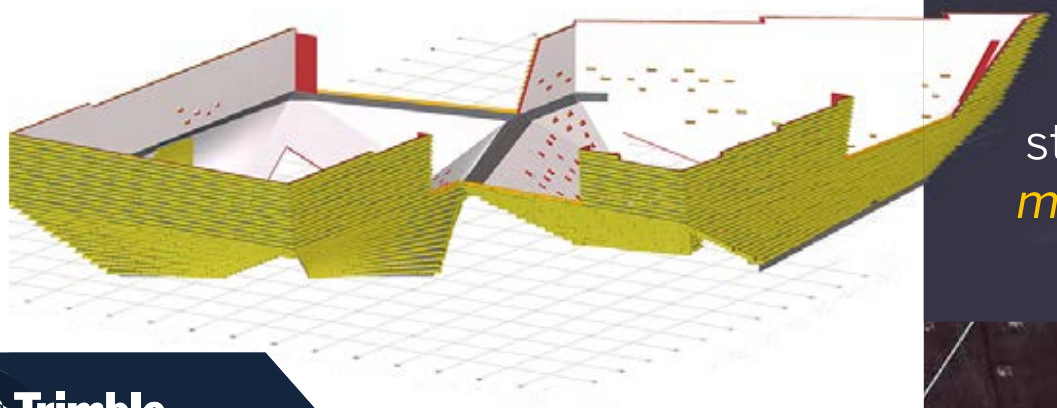
SH Structures

The integration of digital construction software into the DfMA approach has multiple benefits but especially on-site for the installation of the new Telford Central Footbridge as SH Structures explains: “Prior to commencing an installation of this size and complexity, we must first produce a plan that meticulously details our whole assembly method, accompanied by lifting assessments and crane layouts, all of which were aided by the Tekla model. The software enabled us to extract accurate weights of components and the centre of gravity of complex assemblies, including the bridge structure itself; all information that was crucial for optimising crane locations and ensuring an efficient and safe installation.”

Traceability ensures accurate installation

Techrete

Sequencing in construction can also be all-important on-site, especially where complex geometry is involved. With 21 walls and up to 30 plank levels with very little repetition, it was very important to ensure that the manufactured planks for the V&A Dundee were loaded onto the trucks and arrived on site in the defined construction order. Using Tekla Structures, each plank was given a unique reference number, which designated the wall it was on, the level it was at and its position along the row. This also enabled a detailed tracking system from manufacture to final construction, helping to monitor the process and ensure its progress according to the schedule.



Techrete explores the design challenges, read their story: *Complex geometry mastered at V&A Dundee*

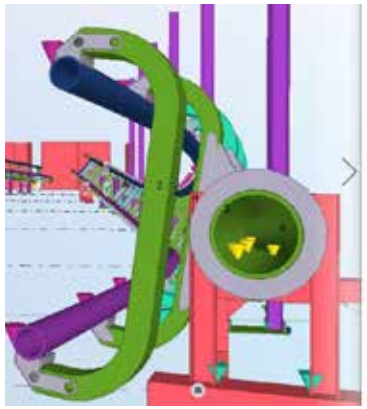
TECHRETE
ARCHITECTURAL PRECAST CLADDING SPECIALISTS

New technologies bring efficiencies onsite

Taziker Industrial

The digital transformation is also starting to allow DfMA to be taken a step further onsite with new technologies like robotic total stations, virtual reality headsets and cloud mapping – all providing opportunity for efficiency gains.

Whilst not a typical construction project, when Taziker Industrial was appointed by Blackpool Pleasure Beach to help renovate and refurbish its infamous The Big One roller coaster part of the process involved taking a 3D point-cloud survey of the site, the data was imported in the data straight into the modelling design



software to model the wider site and simulate crane movements: “Carrying out a 3D survey of the wider site can be hugely beneficial, allowing you to incorporate the context of the whole site into your BIM model and providing you with the ‘bigger picture’. To demonstrate, on a previous Taziker project, also in Blackpool, we were even able to use Trimble’s technology to simulate crane movements and lifts, prior to getting on to site – something that would previously have been impossible to do.”

Point cloud imported into Tekla Structures software.

Having demonstrated how digital construction software can support project teams in the design, manufacture and assembly of products, next we take a look ahead. **So, what's next?**

Trimble takeaways

1. Tekla Structures enables the assembly process providing traceability and easy identification of parts.
2. Digital installation rehearsals facilitate safe and efficient working on site.
3. Weights, centres of gravity, crane positions can all be derived from the 3D model, speeding up the assembly process.

Futureproofing with Tekla Structures

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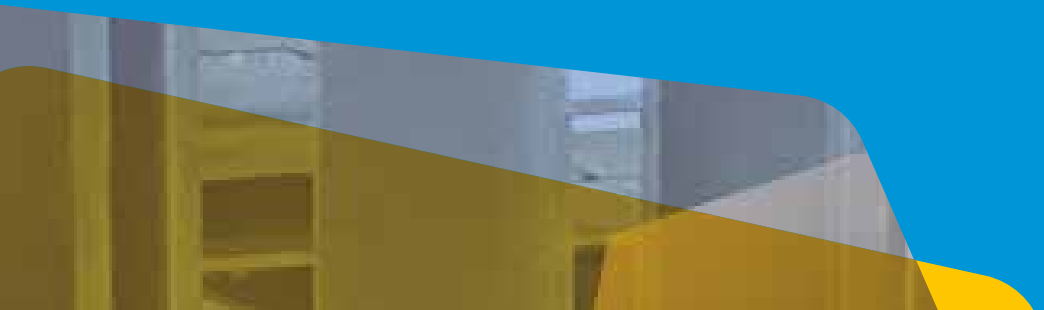
Having consulted with the construction sector, the UK government is driving a DfMA approach as a way to modernise the industry and achieve the public sector's future construction output, pushing offsite construction and standardisation, heavily.



Its aim is to "build better, to build greener, to build faster"; the speed, efficiency and waste reduction benefits of offsite and standardisation are clearly reinforced within its two newly published documents - The Construction Playbook and the National Infrastructure Strategy. These set out how the Government plans to work with the construction sector to ensure the public sector works are delivered.

As a result, already there is an industry move to offsite construction with companies not wanting to get left behind. The very fact that BIM software is often design and manufacturing focused makes it the ideal match for DfMA.

With more and more construction being carried out using a well-structured, data rich, constructible model that is shared by a project team, there are major benefits not just to an offsite manufacturer but also its wider supply chain to re-use this data to reduce waste and improve project outcomes. The data set can be expressed in whatever form is relevant to the organisation wanting to use the data – whether that is 2D drawings, a link to programmes, creating schedules or viewing the project as a 3D model.

As an industry, the data sets obtained will continue to build up, whether this is through the virtual (3D) development of products, bills of materials (5D) or the 4D logistics associated with transportation and delivery, and therefore, become integral to the development of DfMA and the future of digital construction.

Creating standardised designs and a kit-of-parts approach

Using this data as an industry will allow for the opportunity of standardisation. For some, this will require a shift in mind-set so that the design and construction process can be viewed as a whole, not each discipline or sector in isolation.

The government has already identified £35bn worth of the £50bn pipeline of public works as work lending itself to a 'platform' or 'kit-of-parts' approach, whether in whole or in part.

Taking a kit-of-parts approach is a fast and efficient way of delivering construction projects. For it to happen, the public and private sector have to work together with data helping to drive standardised design processes and products.

Unlocking the power of DfMA using digital construction design tools – but how?

Here's where technology can again assist in unlocking DfMA further, as well as contributing to this idea of a standardised approach. Software tools that have parametric design, or data-driven design capability are perhaps ideal for the creation of these standard and repetitive components, helping to free up time for other or more creative tasks.

By using parametric design tools in conjunction with modelling software, designers are able to input the required rules, parameters and design algorithm and have the computer then generate the design output.

According to statistics from an event held at The Institution of Structural Engineers half of attendees admitted to knowing only "a little" about parametric modelling and design. Whilst it's often considered for organic and complex shapes it is equally well suited to standard and repetitive design.

Automation of repetitive tasks and processes – reduces time and resource

Consider a series of steel columns, each identical in form and required to be a set distance apart from each other. With a parametric design tool, such as Grasshopper, you would simply be able to input the required parameters - including the x-axis value - and multiple, identical columns would be automatically generated as an output in the corresponding model, spaced out in accordance with the written script.

A natural progression of this is the idea of computer-driven design. Here, you can push technology further by inputting the required parameters and allowing the computer to automatically generate various different design iterations, in an effort to determine the most optimum and efficient design solution.

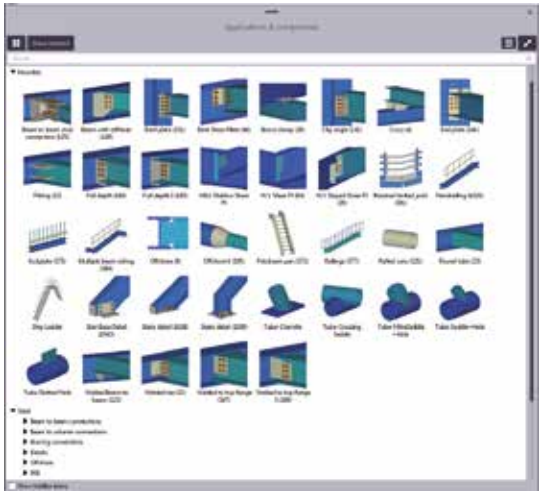
What is Platform DfMA? The next step

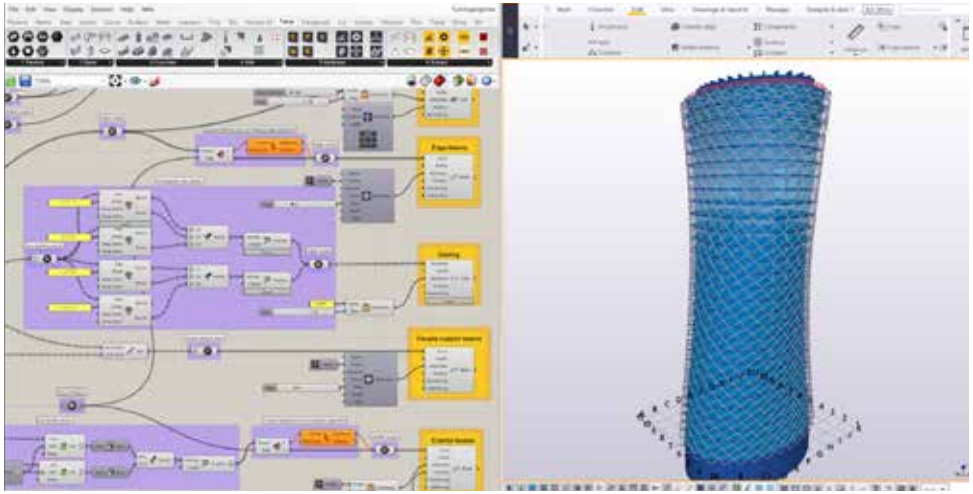
DfMA provides a certain amount of standardisation in building products and components for one project, a platform approach to DfMA known as P-DfMA drives this even further to gain even greater benefits. This kit-of-parts approach is already common in other industries such as car manufacturing and aerospace.

P-DfMA uses a set of digitally designed components across different types of built assets - standardised, repeatable platform systems. Minimising the need to design bespoke components.

The standardisation that the UK government is looking for can be achieved using Tekla software, as various objects, panels and sections, for example, can be modelled and then stored indefinitely, ready to be used on buildings that have similar designs and layouts, such as high-rise multi-occupancy buildings, schools and hospitals.

Tekla can support P-DfMA with its own parametric design capabilities but also by the links to visual design packages like Rhino and Grasshopper.





Conclusion

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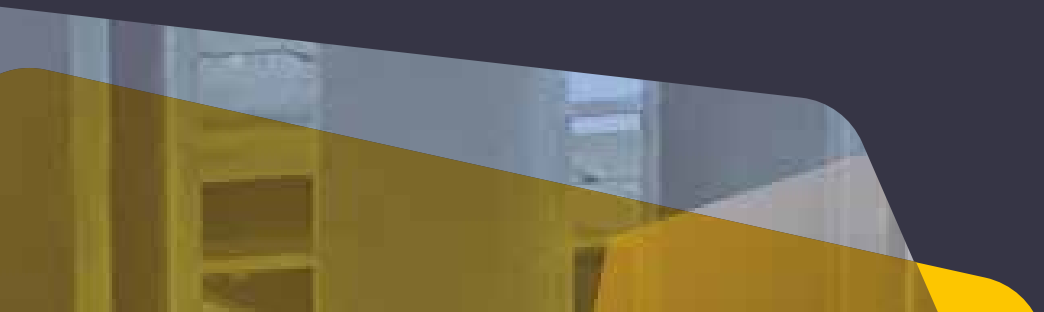
There is no doubt that DfMA and similar is in Trimble's DNA – this approach is not new to Tekla users! We see the efficiency-driving results it brings our customers, daily. What's more, we're willing to learn and develop solutions together.

If DfMA and P-DfMA are truly going to put the UK construction sector on the global map, the importance of connecting people through data and by connecting workflows through software is crucial.



The first step towards embedding a DfMA approach into your business, processes and culture is to review the software you are using. Is your software providing users with an efficient and streamlined process?

For starters, why not take a look at the relationship between design and analysis software, such as **Tekla Structural Designer,** and detailing and draughting software, such as **Tekla Structures**, as an example.

Take your next step and see Tekla software in action...

Book a Demo