



THE DESIGN AND CONSTRUCTION REVOLUTION WITH DFMA ON THE CLOUD

Combining the power of Design for Manufacturing & Assembly (DfMA)
and Virtual Twin Experiences

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INTRODUCTION

DfMA is Design for Manufacturing and Assembly, a methodology that upends the expected ratio of quality/ scope to cost/ time. Take Tallwood House, for example: an 18-story mass timber hybrid building which delivered increased quality and scope to its student residents while being completed 4 months faster than similar projects of less caliber and range.

A new vernacular, novel ways of communicating and connecting are at the heart of the DfMA methodology. DfMA places components on an equal footing with art, revealing that the composer of the process paves the way for craft. Components can be streamlined, manufactured then assembled into modules off-site, with final full product assembly on-site for greater precision, quality, and speed of construction. Unlike a traditional approach to architecture and construction, DfMA transforms handcraft to virtual-craft.

We knew it was coming. Changes in technology and work processes have been underway for decades. New software and collaboration tools are enabling better project outcomes. A key innovation is using the Virtual Twin Experience to deliver projects as industrial products.

It's a **revolution in design and construction**, and it's happening now.

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MODULARIZATION

Modularization is a cornerstone of the DfMA methodology.

In modularization, as many components as possible are designed to be manufactured and assembled as modules in a factory setting. Design and making are defined by process engineering, giving components a value equivalent to art. Modularization simplifies and speeds up construction by shifting the emphasis from project delivery to product development processes. A system of operation that elevates specialized knowledge while eliminating the fragmentation that produces inefficiency when components are built on site.

This means:

- Using Virtual Twin Experiences to enable designers and makers of components and modules to solve problems individually and collectively,
- Leveraging modules to reduce and simplifying the interfaces between assemblies and components,
- Splitting all assembly processes into the simplest possible tasks,
- Automation through the digital capturing of tacit knowledge for explicit reuse,
- Collaborating with subcontractors more efficiently to provide them with agency in the production of modules.

3DEXPERIENCE cloud solutions are based on the convergence geometric modeling (CGM) kernel and Enterprise Knowledge Language (EKL), both of which support the highest level of accuracy, model fidelity and automation. This means architects, consultants, product engineers, material scientists and contractors can **communicate design data straight to manufacturing** with an extraordinary degree of precision.

The resulting modular components or turnkey assemblies make preassembly and on-site assembly remarkably efficient, with fewer delays and unexpected issues. Rather than building a skeleton then pouring out and building the slabs, entire frames made of steel, concrete, or mass timber can be assembled rapidly with components that are precisely engineered and fabricated to fit together like building blocks. This promises to save millions by cutting out live errors and construction problems of all kinds.

The advanced collaborative applications on the 3DEXPERIENCE on the cloud let you design, engineer, manufacture, assemble and consume in order to eliminate construction issues. Let's take a closer look.

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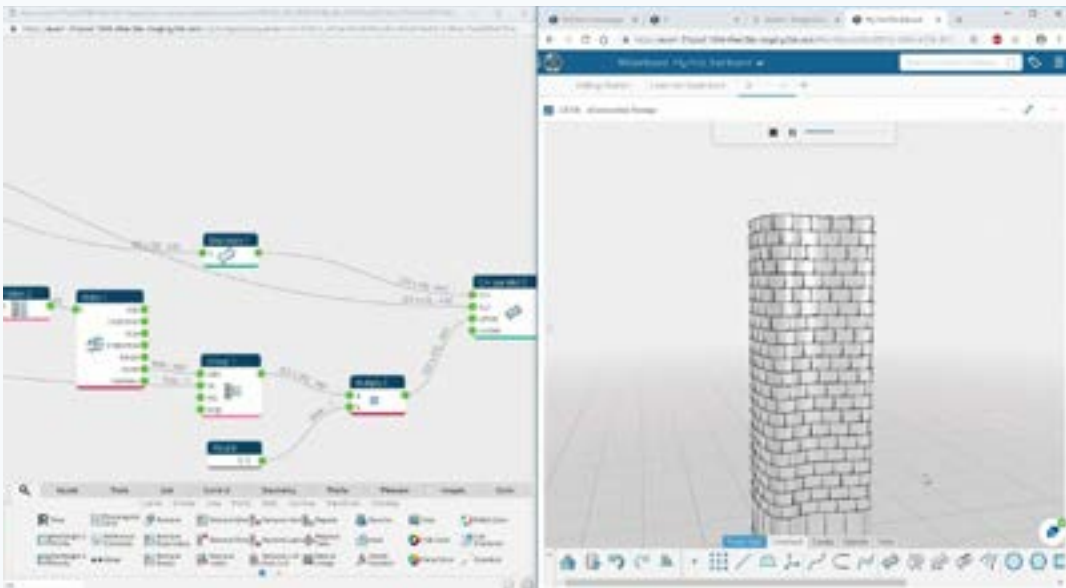
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Everyone involved in a project — architects, engineers, material scientists, manufacturers, contractors, product engineers, consultants and consumers — can work on DfMA models simultaneously in parallel using the **3DEXPERIENCE** cloud platform, with secure access to CAD and project data from anywhere.



The **3DEXPERIENCE** platform on the cloud provides a single source for all models and DfMA product information, with real-time management of a large amount of data in an IFC compliant environment.



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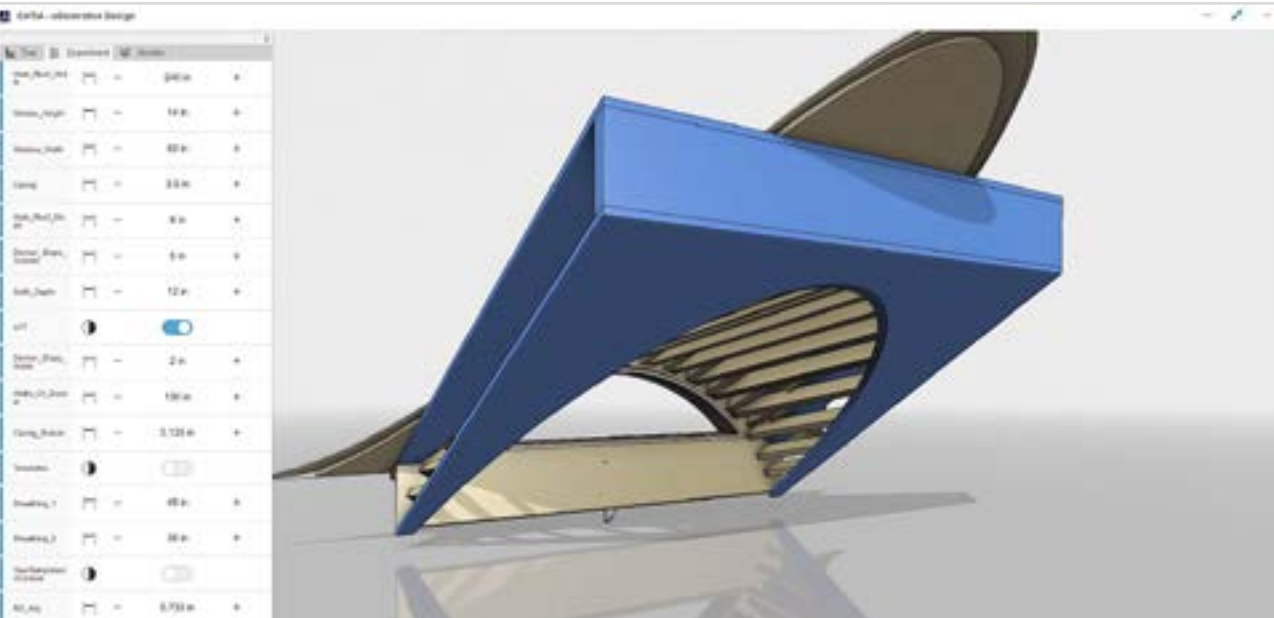
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Design anything ... together

Construction projects bring together large teams of collaborators. This necessary specialization leads to DfMA advances leveraging modules composed of many components that are preassembled off the main assembly line.

The DfMA approach, supported by the **3DEXPERIENCE** platform, amplifies the advancements and eliminates fragmentation by creating a **single shared reference** for DfMA collaborators. By adopting seamless collaborative processes, all parties involved contribute to quality and scope, improving cost and time to deliver.

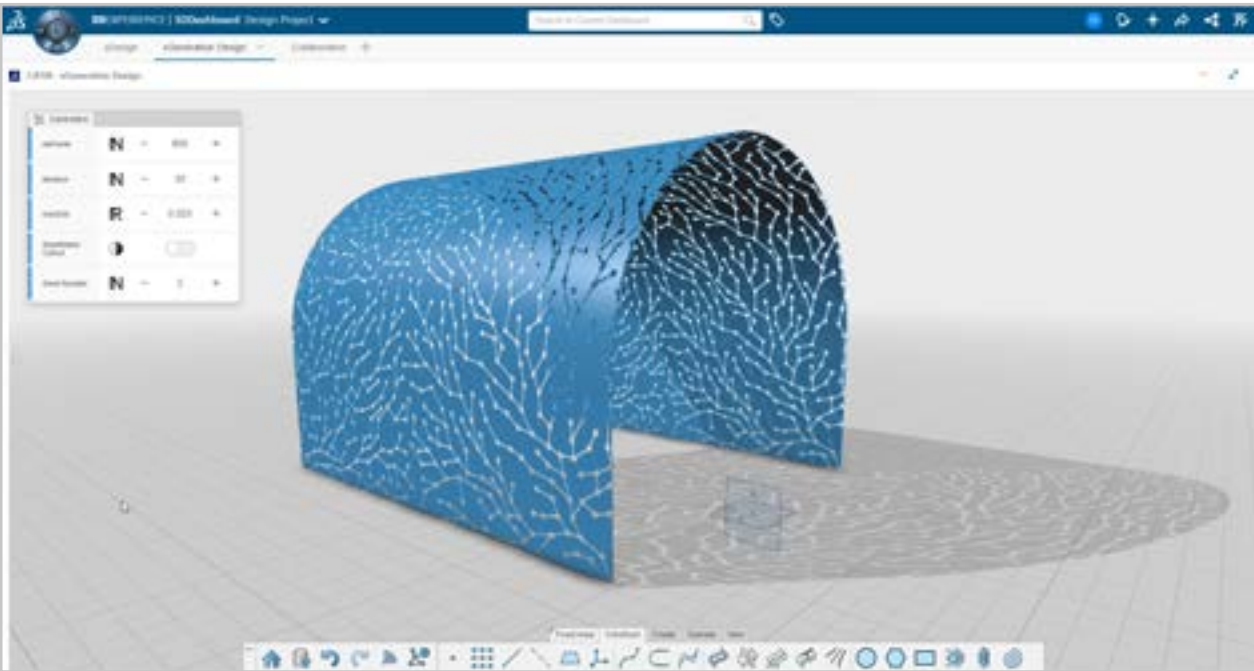


Automate and collectivize your intelligence

It's a challenge for even the best communicators to coordinate teams located in different sites or companies, addressing different aspects of the Design for Manufacture and Assembly process. Project partners in architecture, engineering, construction or manufacturing may be using different systems and processes that build in additional considerations to ensure alignment.

The **3DEXPERIENCE** on the cloud gives you access to the advanced design and automation tools, so you can do highly detailed automation from the earliest stages of process and product design, from the smallest component to the largest assemblies.

The **3DEXPERIENCE** platform and its Virtual Twin Experience use an Enterprise Knowledge Language (EKL) that lets you create rules for your design at any scale: a joinery connection for your mass timber structure, a detail for a panel on the façade of the building, or the rules and algorithms of the project as a whole.



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With **3DEXPERIENCE's** Building Design Engineer, you can create collections of geometries with parameter inputs that can shift depending on the context. Smart templates can be used to create, for instance, a discrete column design that’s set up to adjust parameters based on its start, endpoint, and angle. One element can be repeated and adjusted automatically throughout the design, letting you design structures of any complexity with a fraction of the time and manual work.

The same process can be applied to any other feature of the building, like the piping, so when you need to make changes, you can automate them. Changes are simply applied to the template, and the highly detailed model is reworked through intelligent automation to quickly generate high-precision results. DfMA collaborators can then **share components, modules, assemblies and changes seamlessly** for a wholly accurate Virtual Twin Experience.

Customer highlight | BOXXCRAFT

From a small industrial building in Long Island, New York, carpenter Michael Cunningham makes custom eyebrow window dormers for architects and construction businesses. One of the major challenges Cunningham faced over the years was convincing clients that he could create customized components off site that would fit seamlessly to their precise measurements and requirements.

This all changed when Cunningham met building delivery consultant James Kotronis, who showed him the **3DEXPERIENCE** platform on the cloud. ***“Within about five minutes he did a 3D model of a shape that would have taken me hours to draw out, using swinging tapes as a compass to find my points of tangency and to create an arch,”*** Cunningham recalled.

“I thought it’d be great if we could make this into a tool.” Today, that tool exists. It’s called BOXXCRAFT, and it’s powered by the **3DEXPERIENCE** on the cloud, extending the benefits of DfMA to craftspeople like Michael Cunningham and their partners. By building templates that can be instantly adapted to the client’s measurements, Cunningham estimates he now achieves 40 percent savings in production time alone, ***“with the certainty that it’s going to come out right.”***

[Read the customer story](#)

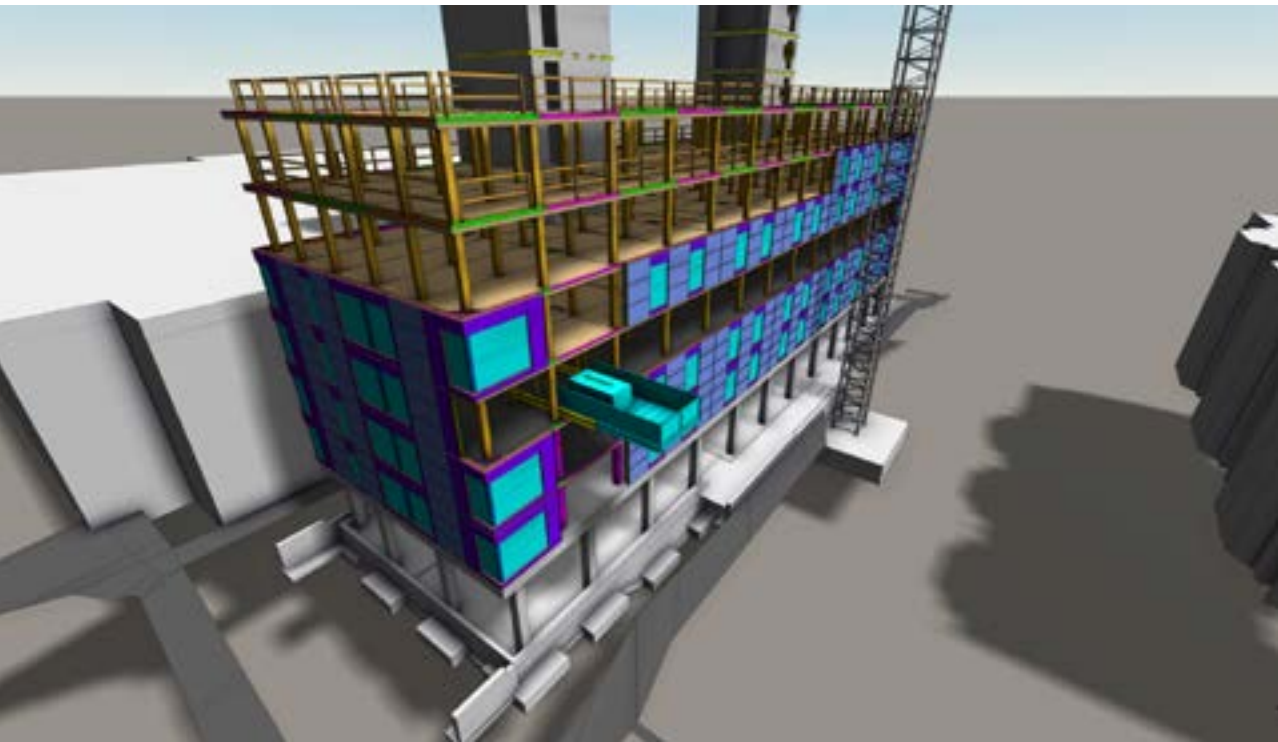
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Always available, always up-to-date

The **3DEXPERIENCE** platform is as an end-to-end solution for architects, engineers, contractors, fabricators and building product manufacturers, enabling coordination across the whole supply chain.

It serves as a single resource for construction projects by seamlessly blending data from the design phase into shop drawings. Through an industrialized construction process, design models become the basis for fabrication. This shared model can significantly reduce the waste and rework found in the traditional design and construction process — and yield big rewards for project owners and stakeholders.



By applying this approach you can:

- Design and simulate any building, structure, component or element, from the conceptual level down to the fasteners.
- Use integrative, parametric, associative, and computational modeling methods to increase productivity and optimize project value through iterative design.
- Deliver high performance, value, and efficiency while reducing waste and embodied energy.
- Leverage insights and expertise across the supply chain to create standout designs.

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*The **3DEXPERIENCE** platform on the cloud gives unprecedented access to powerful 3D tools that aren't just able to provide an image but provide real information so that you can change the geometry actively on a tablet or any device.*

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James Kotronis,
Co-Founder and CEO,
BOXXCRAFT.

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A key advantage of the **3DEXPERIENCE** on the cloud for DfMA comes from its integrated design, simulation, and project management capabilities, all tied to the Virtual Twin Experience (VTE).

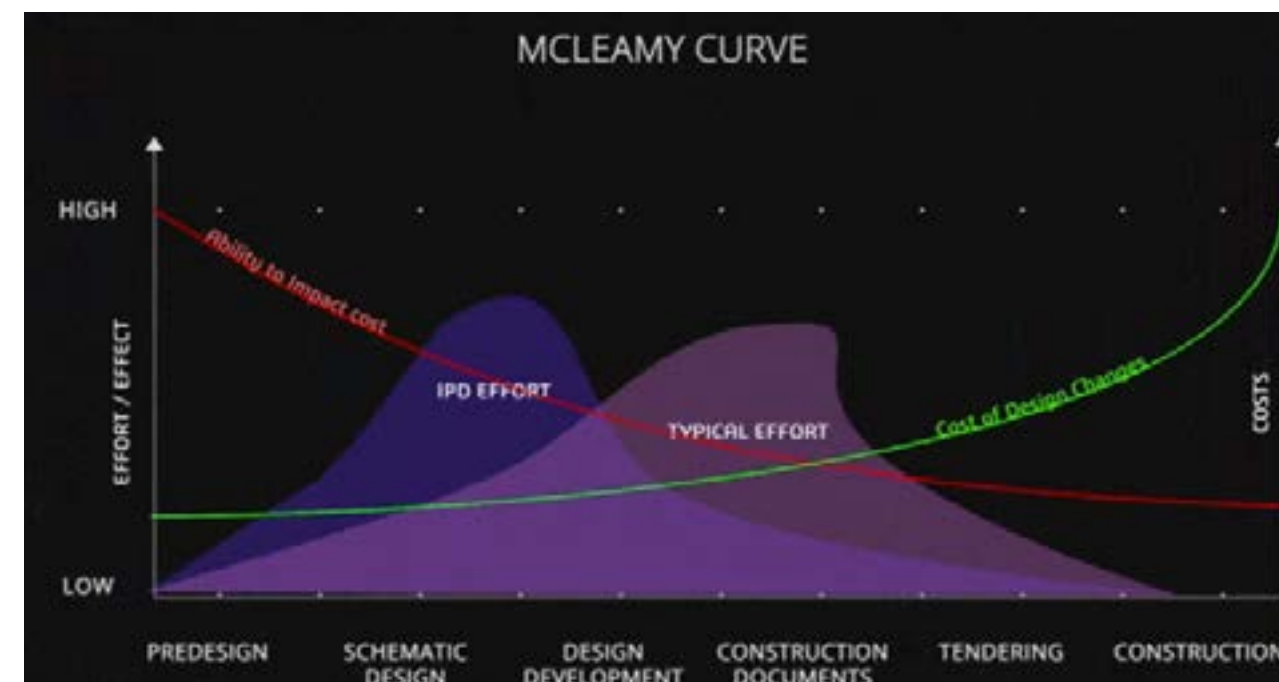
The Virtual Twin Experience is a virtual model of a physical system that lets you connect DfMA models and project information, so that it's possible, for example, to work in parallel across companies, organizations, and disciplines, or simulate how a design and/or assembly will be executed under real-world conditions.

Virtual Twin Experiences allow built environment collaborators to envision, investigate, understand and digitize the collective intelligence of every detail before they produce it.

Process/ product engineers, architects, material scientist, contractors, and consultants can use the Virtual Twin Experience in the **3DEXPERIENCE** cloud platform to simulate how a product would be manufactured and assembled — from component to sub-assembly to module to full product final assembly. DfMA producers and consumers can access the same models while collaborating in parallel on the cloud.

This makes it possible to clearly align design and engineering efforts for the built environment, reducing project risks and increasing productivity while maintaining design quality.

In addition, DfMA Virtual Twin Experiences on the **3DEXPERIENCE** platform provide new ways to capture and reproduce expertise down to a manufacturing level of detail, preserved in a single project resource accessible to all stakeholders.



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With **3DEXPERIENCE** cloud applications, you can open very large assemblies with ease, from anywhere. The virtual twin creates a single 3D reference model that can be used by every team member, for any aspect of the project. Manufacturing, construction, assembly, and design can be accomplished or tested using best-in-class applications, right down to the finest details. The results are net gains across the board, cutting out delays, rework, and up to millions of dollars in unexpected costs. Finally, contractors can validate compliance certification before construction has even been started.



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Customer highlight | Brock Commons Tallwood House

Tallwood House, created by **3DEXPERIENCE** partner CadMakers, demolishes the old paradigm that high-rise buildings must be made of steel and concrete and constructed on-site. At 18 stories high, the residence hall built for the University of British Columbia, amid a forested peninsula, features the first North American use of mass-timber products in a residential high-rise. The pioneering use of DfMA using the **3DEXPERIENCE** helped complete Tallwood House around 70% faster and at a lower cost than a traditional concrete buildings of a comparable size.

Accurate to a tenth of a millimeter, the virtual model that served for the basis of the design helped place and size building penetrations to accommodate pipes, shafts and cabling, while ensuring that clearance and spatial requirements were met.

It also drove data to the digital fabricators manufacturing building components offsite. The mass-timber framing of Tallwood House used cross-laminated timber (CLT) panels and glued laminated timber, or glulam. Because glulam is stronger than steel, builders were able to exceed the traditional six-story limit on wood construction. The whole process of construction was simulated from start to finish to identify any issues ahead of time.

The data went directly to factory computer numerical controlled (CNC) routers that precision-drilled the timber. By the time it reached the building site, the wood was ready for assembly and cut so that all the penetration spaces lined up precisely for tradespeople such as plumbers to do their work.

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"The software allowed us to model in 3D and have a look at everything to confirm all of the specifications and exactly where everything goes [...] From the very top of the building, all our plumbing stacks line up within millimeters of precision of the installation and everything is exactly where it's supposed to be. There's been no additional work on-site as a result. It's a huge savings of effort"

says **Karla Fraser**, senior project manager for Urban One Builders.

[Read the case study](#)



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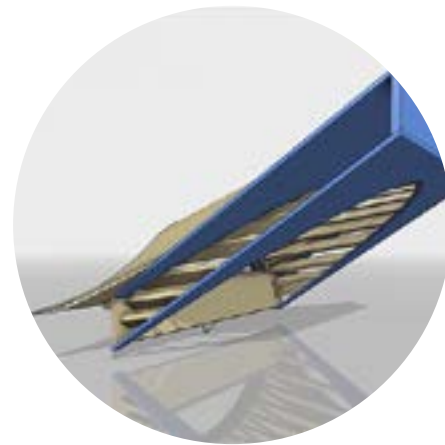
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More predictable installation

Maximizes the use of modules, made up of components, preassembled off the final assembly site.



Higher quality components

Delivers end products with a quality and scope greater than the resources required to produce them.



Improved worksite safety

The site aspects are better illustrated and the workspace is more predictable and safe.

DfMA is about taking a holistic view of a building to determine the best way of making it. The goal: efficient production of a high-quality, cost-effective facility that includes mass production for some processes while providing the variety consumers are looking for.

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Tallwood House is not only a beautiful and functionally advanced living space – it's redefining what's possible in the creation of built environments through its use of sustainable materials. It was one of the demonstration projects in the 2013 Tall Wood Building Demonstration Initiative, a competition to advance the design and production of engineered wood products in Canada and demonstrate that wood is a viable structural option for mid-rise and high-rise buildings.

There's increasing demand for faster, quieter and more sustainable ways to build. New innovative materials are being used to create a healthy urban environment, wood being the most popular. Timber is such an attractive material because it has a lower carbon footprint, uses less energy and water and is 100% renewable when it comes from sustainably managed forests. In construction, it's highly flexible, light and strong.

We're especially referring to structural timber, usually known as "mass timber" (short for massive timber), made by sticking together pieces of soft wood form larger elements.

Mass timber has an enormous advantage for DfMA: modular wood systems can be easily fabricated in a factory setting for on-site assembly, and can more easily be assembled or disassembled, modified or relocated, for greater flexibility. Building with them is quieter than building with concrete or steel, meaning a less disruptive construction process. And finally, they are energy efficient, with low thermal conductivity – advantages across the board.

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A few decades ago, when the first architecture software came out, it was a huge leap in how we think about building designs. Today, technological advances are making it possible to imagine new ways to build our environment. We're seeing DfMA construction projects going up faster than we thought possible, with a precision and quality far beyond what was possible just a few years ago.

The **3DEXPERIENCE** is an end-to-end solution for architects, engineers, contractors, fabricators and building product manufacturers. At any or every step of the process, the **3DEXPERIENCE** allows project partners to collaborate quickly and securely, with a single project model shared across

disciplines, and all the benefits of design automation. You can do the work of an army of draftspeople with just a few highly skilled specialists. The companies leading the charge will be the first to see the benefits of a DfMA approach with the advanced, elegant capabilities of the **3DEXPERIENCE**.

Build faster and better with the power of virtual worlds on the cloud. Learn more about how you can deliver unforgettable experiences:

[Ready to learn more? Request your demo today!](#)

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Our **3DEXPERIENCE®** platform powers our brand applications, serving 11 industries, and provides a rich portfolio of industry solution experiences.

Dassault Systèmes, the **3DEXPERIENCE** Company, is a catalyst for human progress. We provide business and people with collaborative virtual environments to imagine sustainable innovations. By creating ‘virtual experience twins’ of the real world with our **3DEXPERIENCE** platform and applications, our customers push the boundaries of innovation, learning and production.

Dassault Systèmes’ 20,000 employees are bringing value to more than 270,000 customers of all sizes, in all industries, in more than 140 countries. For more information, visit www.3ds.com.

