CS469282

DfMA for Industrialized Construction Myths and Truths

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Learning Objectives

- Discover DfMA.
- Discover how DfMA applies to industrialized construction.
- Learn how to create basic DfMA standards.
- Explore DfMA practices in your current designs.

Description

In recent years, Industrialized Construction (IC) has become a hot topic. The term “design for manufacture and assembly (DfMA)” is used in many conversations when discussing industrialized construction. We will discuss how DfMA pertains to industrialized construction, what DfMA is, and what DfMA is not.

Speaker(s)

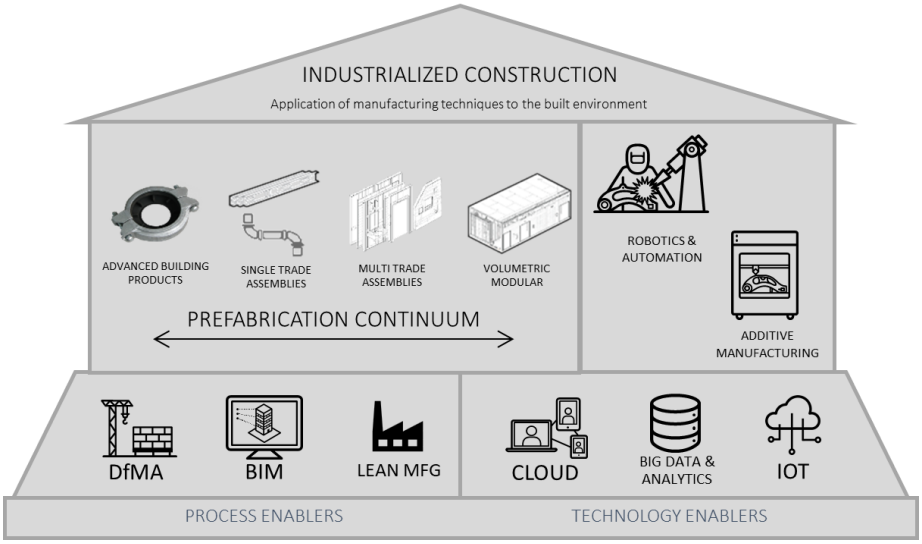


A customer driven consultant proven to solve customer needs with proven technologies and new creative processes.

Tom Closs has worked with multiple manufacturing technologies since 1994. Prior to joining Autodesk, Tom worked as an Automated Machine, Design Engineer, before moving into consulting full time. Tom joined the Autodesk Vault team in 2007, and Autodesk Consulting in 2012. Throughout Tom’s career, he has completed many large-scale projects from Vault implementations and system integrations to custom tool development and teaching. Tom has worked with a wide variety of technologies, including AutoCAD, Inventor, AutoCAD Mechanical, Revit, Navisworks, Fusion 360, Vault, Fusion Lifecycle, 3DS Max, BIM360, Power Mill, NetFabb and others.

DfMA and Industrialized Construction

Many people associate Design for Manufacturing and Assembly (DfMA) with Industrialized Construction (IC). IC is the application of manufacturing techniques in the built environment. IC has many elements, and DfMA is just one of these.



DfMA is not Industrialized Construction

DfMA does not encompass all of IC. DfMA is only an element of the broader IC ecosystem. DfMA is an important enabler for IC. More importantly, DfMA leads into the prefabrication. Do not think of prefabrication as just volumetric design and construction. Instead, think of prefabrication as building elements in a controlled space (factory), transported to a construction site, and then efficiently installed.

In this session, we will discuss what DfMA is and how it applies to this IC ecosystem and can help enable prefabrication.

What is DfMA

Design for Manufacture and Assembly (DfMA) is a process of improving designs and design methods to support the manufacturing and assembly process better. DfMA can be broken into two parts, Design for Manufacturing (DfM) and Design for Assembly (DfA).

Over the last two decades, manufacturing companies have been leveraging DfMA and 3D model-driven design approaches to drive efficiencies in:

- Interactive Collaborative Design
- Modular Design
- Bill of Material Accuracy
- Assembly Methodologies
- Production Optimization

Ask a Manufacturing Engineer what DfMA is, and they will probably answer, “It’s just best design practices.”

Leveraging DfMA

DfMA allows for several advantages when it comes to production:

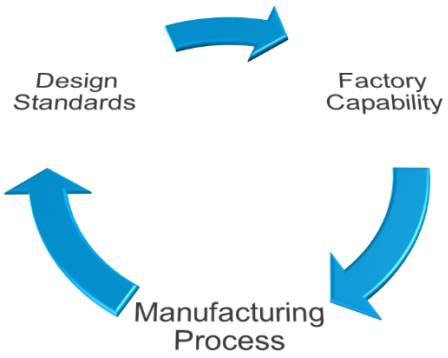
- All-weather fabrication
- Clean, safe working environment
- Modularization of design and materials
- Optimized quality control
- Predictability
- Just in Time (JIT) processes and control

Design for Manufacturing (DfM)

When considering DfM, the following questions can be asked:

- Is special tooling needed?
- What is the best process?
- Can the process be automated?
- What is the best material for the part?
- What is the state of the necessary supply chain?
- What are the capabilities of the factory?

When implementing a DfM process, it is best practice to keep in mind the current and potential manufacturing capabilities. As new capabilities are introduced, it can drive new DfM standards, just as a new design standard may drive a need to enhance or modernize an existing manufacturing capability or process.



Design for Assembly (DfA)

When thinking of DfA, there are many considerations. These Considerations fall into a few groupings:

- Complexity
- Functionality
- Error Proofing

The complexity of parts and interfaces is a significant factor in DfA. The balance of optimization vs. what is realistic and affordable for the project should also be considered. The following questions should be asked:

- Can the assembly be designed, so it is impossible to have assembly errors?
- Can the assembly be designed to reduce the need for manual and supported handling operations?
- Can the assembly be designed to aid in the insertion of individual parts to each other?
- Can secondary operations be reduced?

Reduce Complexity

Reducing the complexity of a design essentially makes the design easier to produce, and this is true for any design, whether it is a ship, machine, or a building. Simplification does not mean designing something plain or boring. It just means that steps should be taken to ensure the design intent is described in the simplest form necessary

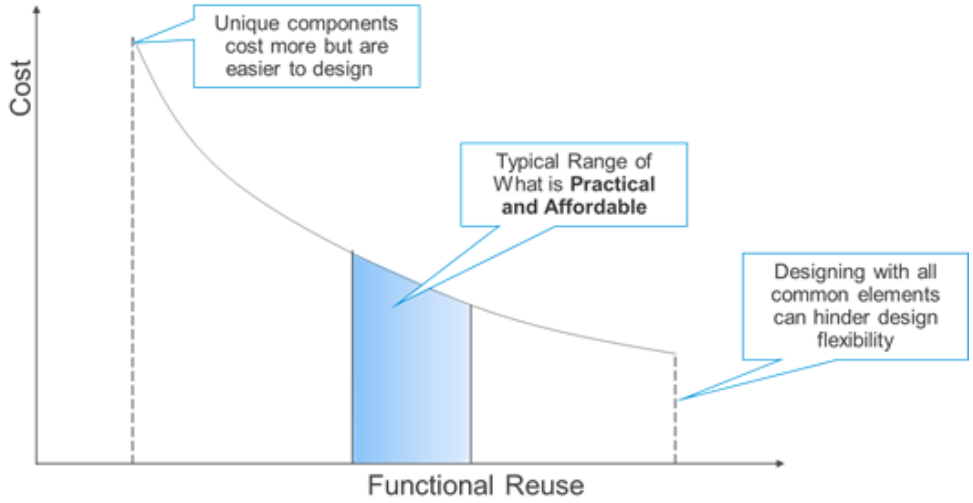
The first step in reducing complexity is to minimize the number of parts or elements. When thinking of a building, it is best to think of parts as elements. This will help when deciding what areas can be manufactured and potentially purchased. Elements can be as simple as a nail or as complex as a prebuilt volumetric module. If a complex element can be purchased already built and tested, it becomes a less complicated element during the assembly process.

With new technologies and new engineering processes, some multi-element assemblies can be combined into a single element. Things like generative design and additive manufacturing can analyze a multi-element assembly and turn it into a single element.

The next step is to minimize the number of connections between those elements. The higher the number of connections, the more time it will take to assemble the different elements and add to the opportunity for errors to be made during the build.

Functionality vs. Cost

Each element needs to be accessed against the cost and its functional need. Some elements will need to be unique, while others can be used in multiple areas in the design. The goal is to find a balance between these aspects.



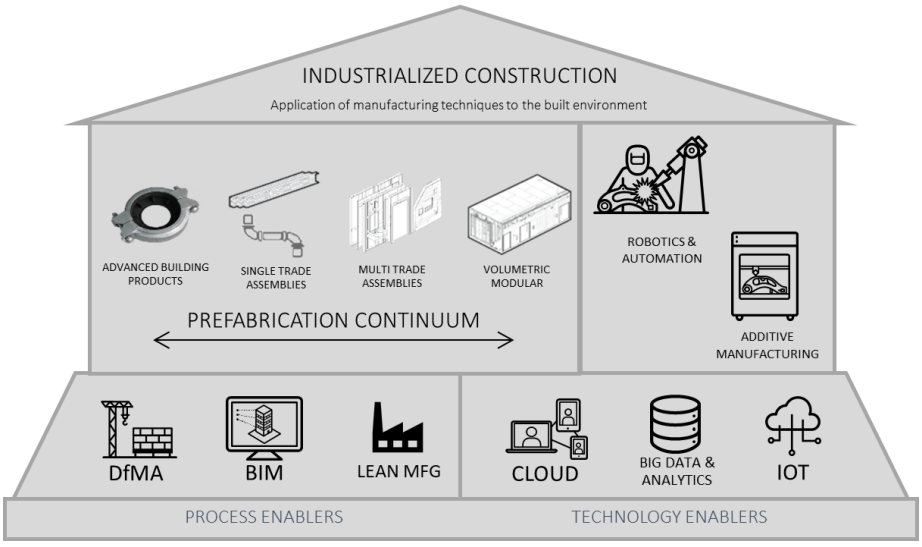
Error Proofing

When planning the assembly of a product, the design should be done to prevent people from making errors. Some of the ways this can be done are:

- Remove the possibility of omitting a part.
- Remove the possibility of using the wrong part.
- Remove the possibility of assembling the part incorrectly.

Applying DfMA

Industrialized Construction (the process of using manufacturing methods in the construction of buildings) may be further explained by consideration as a kind of house.



Every house needs a solid foundation, and DfMA is one of the necessary foundational enablers for IC, along with BIM and LEAN manufacturing. There are also some new technology enablers, including cloud platforms, big data analytics, and IoT.

Product Structure

Design teams now must start thinking with a manufacturing / fabrication mindset. This means looking at a structure not just based on design elements such as walls, doors, and windows for bills of quantity (BOQ) for cost estimation and procurement. The product structure will need to expand to consider the operation steps to manufacture and assemble specific elements.

The optimal way a part is to be manufactured is an inherent part of the design process. This means closer alignment between design and fabrication and manufacturing teams. This process requires collaboration between all parties involved. No team can implement an IC process by themselves

Prefabrication Continuum

Prefabrication is a broad term that encompasses the creation of building elements in a controlled environment that are transported to their final destination, preferably installed on-site using accelerated assembly methods. When you look at prefabrication, you can view it as a continuum containing:

- Advance Building Products
- Single Trade Assemblies
- Multi-Trade Assemblies
- Volumetric Modules